population monitoring in radiation emergencies:

a guide for state and local public health planners

Developed by the Radiation Studies Branch

Division of Environmental Hazards and Health Effects

National Center for Environmental Health

Centers for Disease Control and Prevention

U.S. Department of Health and Human Services

August 2007

PREDECISIONAL DRAFT

CDC

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This planning guide is provided as a predecisional draft. Please send your comments and suggestions to the Radiation Studies Branch at CDC via e-mail (rsb@cdc.gov) or mail them to:

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Electronic copies of this document can be downloaded from
http://emergency.cdc.gov/radiation/pdf/population-monitoring-guide.pdf

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introduction

This planners' guide presents an introduction to population monitoring in radiation emergencies for public health officials and emergency preparedness planners at the state and local levels. Developed by the Centers for Disease Control and Prevention (CDC) with extensive input from its partners, it focuses on planning a public health response to radiological or nuclear terrorism incidents involving ***mass casualties.***

Population monitoring[1] is an essential element that is often overlooked in emergency response planning for radiological or nuclear terrorism incidents. Many critical components of population monitoring should be put in place in the first few hours after the incident, before the arrival of federal assets that might be used to assist in the monitoring efforts. State and local emergency response and public health authorities can use this guide to

- *Evaluate their own emergency response plan to determine if it adequately addresses population monitoring.*
- *Identify staffing needs, training requirements, and necessary material assets.*
- *Prioritize training needs for their staff.*
- *Further develop mutual assistance programs with other states by identifying available resources to meet population monitoring needs.*
- *Be better prepared to prioritize allocation of personnel and material resources in the actual response to a radiation emergency.*

This planners' guide focuses on the significant effort required to identify, screen, measure, and monitor populations (people and possibly even their pets) for exposure to or contamination from radioactive materials. The guide also presents the concept of a community "reception" center (monitoring and decontamination facility) in the event of a large-scale radiation incident. The community reception centers would be established to assess people for exposure, contamination -- and the need for decontamination -- and to register people for follow-up monitoring or medical assessment. As discussed later, the alternate care centers or points of

[1] *The term "public monitoring" used in the context of radiation emergency response has the same meaning as population monitoring.*

dispensing, already considered in many public health emergency response plans, may be used as community reception centers with some additional staffing and resources.

As you work through the planning process, you should consider the size of your community and the characteristics of its population (age distribution, mobility, diversity, density, etc.). Explore and consider all potential resources that could be available to you locally. Consider resources that could be available through agreements with adjoining jurisdictions, as well as the assistance you might require from federal responders, to conduct population monitoring.

Population Monitoring in Radiation Emergencies was developed with input from multi-agency working groups that included physicians, health physicists, emergency services personnel, mental health practitioners, environmental scientists, and international specialists in radiation-related treatment, monitoring, and risk assessment. CDC has made every effort to ensure that the information included is accurate and consistent with sound radiation protection and assessment methods, policies, and practices.

scope

This planners' guide is specifically intended for public health and emergency preparedness personnel involved in planning for response to a radiation emergency. The following two assumptions are made:

- *The incident does not involve biological or chemical agents. In such a case, radiation issues may be overshadowed by more immediate health concerns related to those chemical or biological agents.*
- *The local response infrastructure is relatively intact.*

This document does not address environmental monitoring, assessment, or remediation.

States with Operating Nuclear Power Plants

In the United States, 31 states have operating nuclear power plants. If you are a public health planner in one of these states, you already have local plans for responding to an incident at the nuclear power plant in your own state or at one in a neighboring state. These plans include requirements related to population monitoring[2]. You should also have well-established working relationships with your planning partners in the state radiation control program and your federal partners in the Federal Emergency Management Agency (FEMA), Department of Homeland Security (DHS), and the Nuclear Regulatory Commission (NRC). In addition, you may be working with your area hospitals, which already have plans for receiving and treating patients as a result of a radiation incident.

However, effective response to a radiological or nuclear ***terrorism*** incident requires a broader scope of planning and most likely a different mode of response than those described in your current plans. Plans need to account for the suddenness of an incident (as opposed to a nuclear power plant failure, which would likely unfold over a 24- to 72-hour period); the likelihood that the incident would be larger in scale, involving a much larger urban population; and the unknown aspect of the radionuclide(s) involved. However, the plans and expertise already developed in your state are assets in preparing for a radiological or nuclear terrorism incident with mass casualties.

guiding principles

Several key principles specific to radiation are important in planning for response to a radiation incident, including planning for population monitoring:

1. ***The first priority is to save lives: respond to and treat the injured first.***
   Treatment of life- or limb-threatening medical conditions should take precedence over decontamination. Standard precautions are generally adequate to provide protection for first responders, emergency medical personnel, and clinicians.

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[2] *See NUREG-0654, Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants, FEMA-REP-1, Rev. 1, 1980 and Addenda dated 2002.*

2. ***Contamination with radioactive materials is not immediately life-threatening.***
   Decontamination procedures are straightforward; removing clothing and washing the body thoroughly with soap and water will eliminate most external contamination.

3. ***Initial population monitoring activities should focus on preventing acute radiation health effects.***
   Cross-contamination[3] issues are a secondary concern, especially when the contaminated area or the affected population is large.

4. ***Scalability and flexibility are an important part of the planning process.***
   The screening criteria used for initial monitoring and the radiation survey methods may have to be adjusted to accommodate for the magnitude of the incident and availability of resources.

5. ***Fear of radiation is high, perhaps higher than with other agents of terrorism.***
   Because people are unfamiliar with radiation, including some medical and public health professionals, they often fear radiation more than they fear most chemical and biological agents. Information and clear communication prior to and during an incident will help to lessen public fear and allow people to make appropriate response decisions.

6. ***A key resource for implementing this population monitoring guide is a state's lead agency for radiation control.***
   Community radiation specialists can provide additional expertise and resources to plan for and respond to a radiation incident. Local emergency response plans should identify experts such as health physicists or radiation safety officers in area health departments, environmental agencies, hospitals, and universities. Relationships with these experts should be established in the planning stages.

7. ***First responders and local officials may not be aware initially that a radiation incident has occurred.***
   Public health and emergency personnel's initial response to an incident may be an all-hazards approach. However, once these personnel have determined that radiation or radioactive material is involved, they must begin addressing the issues related to this type of incident.

8. ***Radiological decontamination recommendations differ from those for chemical agents.***
   Decontamination for chemical or biological agents must be performed immediately. In a radiation emergency, individuals may be advised to self-decontaminate at home or at a community reception center. Decontamination should be done as soon as possible, but it usually does not require the same immediacy as chemical or biological contamination.

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[3] *Cross-contamination refers to spreading of radioactive materials from one person, object or place to another.*

9. ***Law enforcement agencies will be involved in response to a radiological terrorism incident.***
If a radiation incident is the result of a terrorist attack, the site will be considered a crime scene. Close coordination with local, state, tribal, or federal law enforcement agencies will be required to manage this aspect of the public health response, and this coordination must be preplanned.

what is population monitoring?

Population monitoring is a process that begins soon after a radiation incident is reported and continues until all potentially affected people have been monitored and evaluated for

- *Needed medical treatment.*
- *The presence of radioactive contamination on the body or clothing.*
- *The intake of radioactive materials into the body.*
- *The removal of external or internal contamination (decontamination).*
- *The radiation dose received and the resulting health risk from the exposure.*
- *Long-term health effects.*

Assessment of the first five elements listed above should be accomplished as soon as possible following an incident. Long-term health effects are usually determined through a population registry and an epidemiologic investigation that will likely span several decades.

The population is primarily the affected individuals in the community (and secondarily may include pets—some people consider them part of their families and will make decisions on that basis). The term population monitoring, as used in this manual, ***does not*** refer to the monitoring of facilities, farm animals, vegetation, or the food supply. The U.S. Environmental Protection Agency, the U.S. Department of Agriculture, and the U.S. Food and Drug Administration have plans and procedures for monitoring the environment, facilities, and the food supply.

In the conduct of population monitoring, specific instruments are used to survey for radioactive contamination on the body (external contamination monitoring); other instruments and laboratory tests may be needed to determine if radioactive material has been taken into the body (internal contamination monitoring). If large amounts of radiation or radioactive materials are involved, additional assessments may be needed to determine whether a lethal or near-lethal radiation dose has been or is likely to be received.

what radiation incidents should be addressed in your emergency response plan?

The U.S. has no experience with a large-scale nuclear or radiological terrorism incident where population monitoring was used to assess and mitigate adverse health effects. However, government authorities and other experts believe a real probability exists that a radiological or nuclear device could be used in a terrorism attack in the future. Therefore, public health authorities should plan for the potential use of radiological or nuclear devices where crisis management personnel are likely to be overwhelmed quickly with mass casualties. These devices can be grouped into the following categories:

- ***RDD (Radiological Dispersal Device)***
  An improvised device (or process) that disperses radioactive material, thereby exposing people and the environment to radiation. An RDD may be noticeable—such as an explosion, commonly known as a "dirty bomb"—or it may be silent. An example of a silent dispersal device is contamination of the food or water supply. Responders and local officials will know that an RDD has been used when radiation is detected by proper instrumentation or through notification by an intelligence or law enforcement agency. Even though the health risks may be low or, in case of a dirty bomb, the scope of the physical damage may be limited, a significantly large number of people may need to be monitored for possible contamination.[4]

- ***RED (Radiation Emission/Exposure Device)***
  A weapon of terror whereby a high-intensity radiation source is placed in a public area to expose those individuals in close proximity—for example, an industrial radiography source placed under the seat of a bus. Radioactive contamination is not spread, and people do not become radioactive. Rather, prolonged exposure to a high-intensity source may lead to acute radiation syndrome (ARS) or to cutaneous radiation syndrome (CRS, or radiation burns).

[4] *The polonium-210 poisoning incident in London (November 2006) had the characteristics of an RDD. Even though the incident apparently targeted only one person, hundreds of people in several countries, including the United States, were monitored for potential contamination as a result of casual contact with contaminated objects and locations.*

- ***IND (Improvised Nuclear Device)***
  A makeshift form of a nuclear weapon. Fissile or fissionable material, such as uranium 233, uranium 235, or plutonium 239, is engineered in such a way that when detonated, it releases significant amounts of energy, creating a shockwave, intense heat, and a cloud of radioactive material (or fallout). INDs are improvised in the sense that the nuclear material is stolen and then assembled in a makeshift fashion. The damage and deaths associated with an IND will vary according to technical skills of the perpetrators, its detonation location, shielding in an urban environment, and building construction materials. Most damage and deaths are likely to be centered nearest the detonation point, and injuries (burns and lacerations) will occur among people farther away. The smallest INDs are on the order of 1–10 kilotons equivalent TNT.

- *State-sponsored, designed, engineered, and tested* ***tactical nuclear weapons*** *exist in many shapes and sizes. These may become terrorism threats if acquired by adversaries.*

what are the roles and responsibilities of federal, state, and local public health agencies?

If a radiation incident occurs in your community, your chief executive officer (the mayor or city or county manager) is responsible for coordinating the overall local response and resources. State and local public health agencies will have many responsibilities, including

- *Protecting the public's health and safety.*
- *Monitoring workers' health and safety.*
- *Ensuring provision of health and medical services.*
- *Ensuring safe shelters for the population.*
- *Ensuring the safety of food and water supplies.*
- *Coordinating sampling and laboratory analysis of biological and environmental samples.*
- *Conducting field investigations.*
- *Monitoring people who may have been contaminated with radioactive materials or exposed to radiation (population monitoring).*
- *Conducting or assisting in decontamination.*
- *Developing criteria for entry and operations within the incident site.*
- *Recommending disease prevention and control measures.*
- *Recommending management protocols for affected populations or individuals.*
- *Communicating necessary information to medical providers.*
- *Communicating situation assessments and required safety measures to the public.*
- *Assisting law enforcement agencies with the criminal investigation.*

Local health agencies may call on state health officials, who in turn may request assistance from the federal government.

The Nuclear/Radiological Incident Annex of the National Response Plan explains how federal agencies will coordinate a response to nuclear or radiological incidents. Under this annex, HHS and CDC are responsible for coordinating public health aspects of the federal response to any Incident of National Significance involving nuclear or radiological material, including

- *Coordinating public health and medical information.*
- *Convening subject matter experts.*
- *Assessing medical and public health status and needs.*
- *Assisting in the establishment of a registry for potentially exposed individuals.*
- *Performing dose reconstructions and long-term monitoring of populations.*
- *Evaluating requests for deployment of the Strategic National Stockpile.*
- *Sending representatives to serve as members of the federal Advisory Team for Environment, Food, and Health*.

These services will be provided to support the affected state or states. ***As a general rule, during the initial stages of the incident local and state officials should be prepared to handle the crisis without federal assistance.***

what are the key considerations in planning for population monitoring?

Planning for a radiation emergency, particularly a large-scale terrorism incident, involves complicated issues and processes. Following are the key considerations in planning for population monitoring in the wake of a radiological terrorism incident.

The Objectives of Population Monitoring

With these key objectives in mind, you may use this guide to work through your planning process for population monitoring.

- *Identify individuals whose health is in immediate danger and who need immediate care, medical attention (whether radiation-related or not), or decontamination.*
- *Identify people who may need medical treatment for contamination or exposure, further evaluation, or short-term health monitoring.*
- *Recommend (and to the extent possible, facilitate) practical steps to minimize risk of future health consequences (e.g., cancer).*
- *Register potentially affected populations for long-term health monitoring.*

Identifying and Prioritizing Affected Population

In the event of a terrorist attack, many people in the affected area would likely request an assessment and treatment from public health authorities and hospitals, clinics, and private physicians. Other people who were not exposed or contaminated may request evaluation to confirm their condition or seek reassurance. Every effort should be made to keep those who do not need immediate medical attention from overburdening local and area hospitals. This would ideally be accomplished by identifying the time-periods and locations where members of the public would have to have been for there to be a credible exposure of concern. This information should then be communicated to members of the public to help alleviate their concerns.

The highest priority is people who have life-threatening injuries or are in need of immediate medical care, which may or may not be related to the radiation incident (e.g., heart attack or a pre-existing critical condition). As will be discussed later, effective public communication is a key component of the emergency response. In a mass casualty incident, uninjured people can be encouraged to go home, self-decontaminate, and then return for monitoring at designated locations according to a priority schedule.

Every effort should be made to keep those who do not need immediate medical attention from overburdening local and area hospitals.

The triage process should identify and prioritize people for external contamination monitoring and identify and prioritize a subset of those individuals for internal contamination monitoring and medical follow-up, if needed.

The highest priority is people who have life-threatening injuries or are in need of immediate medical care.

Local and state officials should ensure that the following capabilities are available within the first 24 to 48 hours:

- *Making radiation dose projections (external irradiation and plume predictions).*
- *Assessing the risk of exposure by time and location.*
- *Identifying victims within range, location, and proximity to the incident.*
- *Identifying potential acute symptoms (nausea, vomiting, etc.).*
- *Providing radiation survey equipment to detect the evidence of external beta, gamma, or alpha contamination as applicable, and following up with decontamination.*
- *Performing periodic blood tests (CBC with differential white cell count) for direct exposure assessment if large, whole-body doses are suspected.*

The prioritization scheme to identify individuals for monitoring can be based on

- *Radiation dose projections, if available (external irradiation and plume predictions).*
- *Specific times and locations where people may have had a higher probability of being exposed or contaminated.*
- *Presentation of clinical symptoms consistent with acute radiation syndrome, especially if this is correlated with relevant times and locations specified above.*

Special Populations

As public health authorities and emergency planners, you should identify and prioritize special populations in the community that have special needs after a radiation incident. These include

- *Children (Note: Families should remain together; be cognizant of minor children without custodial adults present, e.g., school children.)*
- *Elderly people.*
- *Pregnant women.*
- *Immuno-compromised individuals.*
- *Disabled persons requiring the use of wheelchairs.*

- *Workers.*
  - *Emergency responders.*
  - *Transient or migrant workers.*
  - *Commuters.*
- *Homeless people.*
- *Institutionalized individuals whom you may or may not be able to evacuate or relocate.*
  - *Hospital patients.*
  - *Residents of nursing homes or other institutions.*
  - *Prison inmates, guards, and workers required to maintain, operate, or secure critical and essential infrastructure.*

You should also

- *Determine any cultural or religious factors in your community that would affect the population monitoring process. For example, changing clothing in a public setting may present a complication for some people.*
- *Identify and develop relationships with organizations that are currently assisting special populations in or near your community. They may be able to provide assistance if needed.*
- *Ensure that communications and educational materials are provided in appropriate languages for your community. People who do not speak English as a first language could have great difficulty in understanding instructions when under the stress of a terrorist incident. Consider visuals, universal signage, or videos to communicate vital information.*
- *Consider how pets and farm animals will be handled and how this will affect population monitoring.*

Population Monitoring (The Initial Hours)

In large metropolitan areas, population density is high during the business hours, and tens or hundreds of thousands of people may be in the immediate vicinity of the incident. First responders at the scene may be naturally inclined to cordon off the area and contain the population they believe to be contaminated until they can decide how to handle the situation. For a variety of reasons, this response tends to be ineffective. The longer members of the public are kept waiting, the higher their level of anxiety, their potential radiation dose from external sources, and the likelihood of ingesting or inhaling radioactive material will be.

The rest of this discussion assumes that the highest priority is to care for people who are critically injured. Others can be divided into two groups:

- *People who self-evacuate, using any means of transportation−These people generally go home or to a place where they feel safe. Guidance should be given to this population through the media (television and radio) on what to do and how to perform their own decontamination. Explain that, like dirt, most contamination washes off with soap and water. They should act as if they were going home in clothes covered with mud and did not want to track it into their homes. Undressing at the doorway or in their garage would be desired. Provide instructions for them to*
    - *Avoid unnecessary hand-to-face contact to minimize potential spread of contamination (avoid smoking, chewing gum, etc., until after decontamination).*
    - *Remove clothing and place it in a sealed plastic bag.*
    - *Gently blow nose and clean out eyes and ears.*
    - *Shower thoroughly with warm (not scalding hot) water and soap, allowing the water to run away from the face.*
    - *Change into uncontaminated clothing.*
    - *Wash out tub or shower.*
    - *Wash car if they drove home from the area of contamination.*
    - *Tune in to television or radio for further instructions from public health and emergency response officials.*

Guidance should be given to people on how to decontaminate themselves, their children and their pets.

- *People who stay on the scene to be monitored or who cannot leave the scene because they have no transportation or have no place to go (in need of shelter)−These people need immediate instructions on what to do while waiting to be helped. These instructions could include*
    - *Avoid touching suspected contaminated surfaces.*
    - *Keep hands away from face (especially mouth) and do not smoke, eat, or drink until your hands and face are washed.*
    - *Carefully remove outer clothing and place in plastic bags (provided).*
    - *Wash hands and face if water is available, or wipe hands and face with moist towels (provided).*

More timely decontamination may occur by sending people home to shower

A quick assessment must be done in deciding how best to assist this second group in the initial hours. If the incident happens on a winter afternoon, you may have only a few hours (or less) to respond and help the affected population get to their homes or shelters. Traditional planning for radiation incidents at this stage focuses on thorough radiation survey monitoring followed by on-scene decontamination, using portable decontamination showers. Radiation contamination monitoring and decontamination should be offered, if feasible, in these early hours. However, this is highly dependent on the number of people waiting and the extent of available resources. If more timely decontamination may occur by sending people home to shower, this action is preferred to having them wait for on-scene decontamination that could take significantly longer. If there is a large crowd that exceeds the local capacity for processing in these early hours, people can be encouraged to go home and self-decontaminate, then return for monitoring on a priority schedule.

A geographic zoning approach may be used (e.g., those within a certain radius, those in a certain city block) to prioritize the population who will receive immediate initial monitoring and assistance with decontamination. If possible, a rapid radiation screening method could be used to isolate those with highest levels of contamination (see Contamination Screening Criteria below).

Although decontamination with soap and water or showering is the best method of external decontamination, individuals can take several practical steps by themselves without any washing to markedly minimize the levels of external contamination and the likelihood of internal contamination. For example, plastic garbage bags can be provided to people, along with instructions to carefully remove their coats or outer garments and bag them (especially if they have visible dust). Moist towels or disposable wipes can be provided so that people can wash their faces and hands while they wait or as they leave to go home. If possible, clean outer garments can be given to them for warmth. This method may be preferred to outdoor showering at this stage, especially when temperatures are cold or the number of people is large.

Contamination Screening Criteria

> ***CDC does not recommend setting, in advance, a fixed screening criteria to be applied to all people for all incidents under all circumstances.***

CDC does not recommend setting, in advance, a fixed screening criteria to be applied to all people for all incidents under all circumstances. CDC recommends that you, as a state planner or decision-maker, along with your state radiation control authority, consider a range of possible circumstances, keeping the following in mind:

- *The population monitoring objectives as described in this planners' guide.*
- *The specific radiation survey instrumentation your responders will be using (dose rate meters, beta/gamma portal monitors, specific type of surface contamination monitors).*
- *The staffing resources and the size of population you may be expected to process.*
- *The facilities and resources you have for offering on-the-scene monitoring and decontamination.*
- *The availability of other resources that can increase your available options.*

The planning should be done in advance, with some room for flexibility. The emergency responders, however, must have very clear instructions to follow on the basis of your evaluation of the specific local circumstances. CDC is available to assist you in the planning process. A discussion of key considerations in selecting a screening criterion and a number of benchmark screening criteria are described in Appendix C. In addition, if requested after an incident, the Federal Advisory Team for Environment, Food, and Health[5] can assist you in establishing practicable screening criteria based on specific local circumstances.

In some circumstances, it may be practical to use geographic zoning criteria to prioritize the population in most urgent need of assistance with decontamination.

Radiation Survey Methodology

> ***Any unnecessary delay can potentially increase the radiation dose to people waiting.***

In routine occupational settings, a head-to-toe radiation survey technique is standard radiation protection work practice, followed by full documentation of survey findings. This is not a recommended survey methodology for the first few hours after a mass casualty incident, for any unnecessary delay can potentially increase the radiation dose to people waiting. If a large population must be surveyed, performing a

[5] *The Federal Advisory Team for Environment, Food, and Health develops coordinated advice and recommendations to the coordinating agencies and state and local governments and includes representatives from CDC, the Food and Drug Administration (FDA), the Environmental Protection Agency (EPA), the Department of Agriculture (USDA), the Department of Homeland Security (DHS), and other federal agencies as needed.*

screening survey of only the head, face, shoulders, and hands is acceptable, rather than performing a more detailed survey, because these are the most likely locations of contamination.

Hand-held survey meters such as GM pancake probes are suitable for either detailed or spot surveys because they are portable, versatile, rugged, easy-to-use, and rather ubiquitous in the radiation protection community. They can also detect alpha contamination, although not with the same efficiency. Portal beta/gamma radiation monitors can also be used at this stage, although they are usually limited in number and require more skilled operators. Walk-through portal monitors may be best employed during later stages of monitoring, such as in community reception centers or in entrances to critical structures (such as hospitals, public buildings, airports, train and bus terminals).

Clothing Services

This planners' guide recommends planning for distribution of large caches of clothing. Such clothing is needed for people who are asked to remove and bag their contaminated outer garments as they are going to homes or shelters. This will also help significantly reduce the extent of cross-contamination as these individuals leave the incident scene. People going home are the easiest to clothe, as durability of that clothing is secondary. In such circumstances, hospital scrubs, paper clothing, sweat suits, and t-shirts, with perhaps blankets for warmth, can be provided.   Make arrangements in advance with large retailers in the community to provide children's clothing, shoes (or flip-flops or sandals), or other clothing needs. People going to shelters need more durable robust clothing. Communities should include participating retailers in their local emergency response plans and, if possible, emergency purchase agreements should be negotiated in advance.

Transportation Services

It is prudent to plan for providing transportation services in the first few hours after an incident for individuals who have a place to go (e.g., their own homes) but have no means of transportation. Cross-contamination of the buses or other vehicles used for this transportation is a secondary issue. Vehicles do not have to be decontaminated between loads of passengers. They will be decontaminated later, prior to their return to normal service.

Washing Facilities

As will be described later, it is important to establish facilities for thorough washing at or near community shelters and reception centers. Many communities have plans for deploying portable decontamination facilities in the first few hours after a radiation incident. However, in mass casualty incidents, it may not be possible to process a large number of people quickly enough by using portable decontamination facilities. As stated earlier, a number of services can be provided in the first few hours to assist people in reducing their dose and decreasing the likelihood of internal contamination. These services include the provision of proper instructions and basic supplies, such as plastic bags for containing their outer garments and moist towels and wet wipes for cleaning their faces and hands.

In the first few hours, it may be necessary to help the most heavily contaminated individuals get to washing facilities. The goals at this stage are to get a person out of contaminated clothing immediately and to get the radioactive material off the body as soon as possible. Replacement clothing must be nearby. People who are able to shower themselves should use plain soap and warm water. Cold water or water from hydrants should not be used unless there are no other options available and definitive provision is made to dry and warm individuals directly after a short wash. After showering, people should be re-monitored and, if necessary, they should take a second shower. If this simple decontamination fails, the individuals should be designated for further assessment for possible internal contamination.

Sports arenas and high school gymnasiums may provide suitable showering facilities. If such facilities are difficult to locate in the affected area, consider transporting people or using a nearby hotel, especially if outdoor weather conditions are not favorable. Staff members can escort people to rooms where showers can be quickly used with minimal impact on the hotel. People may be instructed to wait in hotel rooms until suitable clothing arrives. Allowing them to use the telephone and television in the room will assist in keeping them calm.

Note that providing showering facilities and associated staff services in these first few hours can be done for only a relatively limited number of people. If the radiation screening criteria or the geographic zoning criteria is set too conservatively, a large and unmanageable number of people will be designated for processing at showering facilities, defeating the purpose of expeditious decontamination.

At no time should an individual's identification, jewelry, money, or credit cards be collected. People can try to wash these things as they wash themselves, or the items can be bagged. All contaminated clothing collected before the washing process should be bagged and tagged for further study.

Registry

A critical function that should start as early as possible is the registry of the affected and possibly affected populations. This topic is addressed later in more detail. Initially, the most basic and critical information to collect from each person is his or her name, address, telephone number, and contact information. If time permits, other information can be recorded, including the person's location at time of the incident and radiation readings, but this is not essential and should not become a bottleneck in the registration process. Additional information can be collected later as individuals are processed to send home or when they report to community reception centers. This registry information will be used to contact individuals for follow-up monitoring if needed.

> ***The registration process should start as early as possible, but it should not become a bottleneck.***

Collection of Biological Samples

Typically, it is not practical for local or state responders to engage in the collection of bioassay samples in the first few hours after an incident. Bioassay samples, however, do provide a powerful diagnostic tool for assessment of internal contamination (urine) and for detection of acute radiation syndrome (blood) in cases where relatively high radiation doses are expected. Federal resources will be able to assist in the collection and analysis of urine bioassays, but these resources will not be available in the first few hours. Local hospitals or public health laboratories should be prepared to analyze blood samples (CBC with differential white cell count).

Worker Protection

Responders who are engaged in the initial screening of people at the scene should wear personal protective equipment including respiratory protection as designated by the Site Safety Officer. Subsequent population monitoring activities should take place at locations that are not contaminated or are minimally impacted by contamination and where no known airborne or respiratory hazards exist (for example, community reception centers described in the following section). At these locations, it is highly recommended that local responders conducting population monitoring activities be provided and wear, on a voluntary basis, filtering face-piece respirators certified by NIOSH, preferably N-95 respirators. The use of these respirators will prevent the inhalation of radioactive particles or other hazardous particles or fibers that may become airborne in the process of removing contaminated clothing from affected individuals or performing similar actions. Filters with exhalation valves are recommended to improve communication. However, the lack of immediate availability of these respirators should NOT prevent or hinder population monitoring activities. OSHA permits the voluntary use of respiratory protection[6]. It allows responders conducting population monitoring to add a measure of personal safety according to their own assessment of the situation. Implementing voluntary use of filtering face-piece respirators may also prove to be an effective legal and economic incentive for employers, because the use of these respirators does not require a respiratory protection program.

Frequent changes of vinyl examination gloves are also recommended for responders who physically assist people in removing potentially contaminated clothing.

Population Monitoring (Day 2 and Beyond)

On the day after the incident, there still may be only a limited number of federal responders at the site. As federal teams arrive to assist, many of the services described in this section can be augmented, but the initial set-up and conduct of these operations will have to rely on local or state resources.

Setting Up Community Reception Centers

A radiation incident that results in mass casualties will require planners to establish one or more population monitoring and decontamination sites (or “reception centers”) to assess people for exposure, contamination, and the need for decontamination or medical follow-up. Some community reception centers should be established at or near shelters operated by the American Red Cross.

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[6] *OSHA Voluntary Use Program 29 CFR 1910.134: http://www.osha.gov/SLTC/etools/respiratory/oshafiles/employeevoluntary1.html.*

These reception centers should be able to

- *Support contamination detection through beta/gamma portal monitors, if appropriate.*
- *Support general contamination monitoring via hand-held instruments.*
- *Field questions and address all concerns.*
- *Provide information and give instructions, as applicable.*

You need to assess facilities or sites in your community for use as reception centers on the basis of the following characteristics:

- *Size.*
- *Location.*
- *Adequate restroom facilities.*
- *Shower (decontamination) rooms or facilities.*
- *Accommodations for people with disabilities.*
- *Environmental control (against excessive heat or cold).*
- *Adequate access and regress control (in case of emergency evacuation).*

An all-weather facility designed for crowds, such as a covered sports arena or convention center, would be ideal, but depending on the circumstances and weather, a nearby park or large parking lot would also suffice. You should establish agreements in advance with facility or site owners and operators.

It is important to note that planning for these community reception centers does not involve much more than what is most likely already included in your community public health emergency response plans. Many communities' emergency response plans incorporate a concept similar to the Modular Emergency Medical System (MEMS),[7] which includes surge capacity provisions for Alternate Care Centers (ACC) to help those who may need some assistance or medical care, but do not need hospitalization (likely the majority of the affected population). In some communities, these centers are referred to as Neighborhood Emergency Help Centers (NEHC).[8] These are usually well-known locations within the community, such as the area high schools. Many communities also have plans to use these facilities as Points of Dispensing (PODs) for medical supplies from the Strategic National Stockpile in case of pandemic flu, for example, or other biological threats.

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[7] *See Appendix B in Altered Standards of Care in Mass Casualty Events, Agency for Healthcare Research and Quality (AHRQ), U.S. Department of Health and Human Services, April 2005. Also see Expanding Local Healthcare Structure in a Mass Casualty Terrorism Incident, Department of Defense, June, 2002*

[8] *A Mass Casualty Care Strategy for Biological Terrorism Incidents, Department of Defense, May 2001.*

Because they have very similar functions and staffing requirements, these same facilities (ACC, NEHC, or PODs) can be used as community reception centers with the addition of health physics instrumentation and health physics support personnel to conduct radiation monitoring and decontamination. A suggested listing of supplies, resources, and staffing needs for reception centers is provided in Appendix E. Many of these may already be part of your plan for setting up either PODs or ACCs.

The community reception center should have sufficient staff, both technical and non-technical, to manage the center for up to several days or weeks. A technical staff that is competent in the use of radiological survey equipment must be available for monitoring, but having additional staff members to process affected individuals and help with decontamination is also critical. Additionally, centers will likely need one or more clinicians to assess and refer individuals who need medical follow-up or to administer pharmaceutical countermeasures. As federal personnel and assets arrive, they should be able to supplement staffing at these centers. This would include 24-hour operations as needed.

Local plans already in place to set up PODs can be adapted and augmented to establish community reception centers.

As with PODs or ACCs, you must plan to set up a registry area within the reception center to

- *Manage the registration process and provide support to volunteers and data collectors.*
- *Register and log in those who arrive.*
- *Issue wrist bands or other identification tags.*
- *Control crowds.*
- *Collect vital exposure and health information related to the incident and enter it into a computer database.*
- *Distribute information sheets.*

As members of the public are released from reception centers, each should be given a discharge instruction sheet written in clear, easy-to-understand language. It should tell people that the health department may need to contact them to conduct further monitoring or an additional medical evaluation. The instruction sheets should also provide the following: 1) basic information about radiation and its effects on human health; 2) recommended actions to be taken by the public to safeguard their health; and 3) points of contact for news and information. Since these contacts may change, we recommend reviewing this information periodically to ensure its accuracy.

Those discharged should be tracked in a database common to all service centers and it is recommended that it be computerized. Such a database will help preclude duplication of tracking efforts for anyone who may visit more than one reception center. It should also be used to notify local physicians about their patients who may have been irradiated or contaminated. At the same time, local healthcare providers should receive appropriate training about managing victims of radiation exposure and contamination.

Be prepared to address psychosocial needs at community reception centers.

In addition, public health and emergency preparedness personnel should plan to augment pre-existing psychosocial services. The need for such services will be in demand both by people acutely affected by the radiation incident as well as by members of the public with chronic, long-term mental health needs. The need for such services will be exacerbated following a radiation mass casualty incident.

Practical Considerations for Reception Center Operations

The primary purpose of the reception center is to identify people who may need immediate assistance—decontamination and the use of washing facilities, medical attention, psychosocial needs, or other special assistance. These services must be provided expeditiously for large numbers of people. You should expect that many people who come to the reception centers will not need any of these services, but are nevertheless concerned. Effective communication through the news media and easily understood schedules that stagger the times people report to reception centers can decrease the impact of this population on your timely provision of services to those who really need them. It is better for people who may not need services to come to community reception centers, however, than to go to nearby hospital emergency rooms, which could be already overwhelmed.

If the local communications media are operational, use them to educate the public on how to control contamination and self-decontaminate at home before they go to the community reception centers. Removal of clothing can eliminate most of external contamination on a person and washing can remove most of the rest.

Communicating with people about the process and goals of the monitoring will be important in managing the monitoring process. This critical function can be performed by a series of “greeters” or line staff who will answer quick questions, direct people to monitoring areas, and try to identify those needing special attention. Having an adequate number of greeters is important for crowd control because it helps people understand what is happening and how their needs will be addressed quickly. Having greeters who speak additional languages that are common in the local area is extremely helpful.

The stations should be set up to give people standing in line the perception that they are moving, not stagnant. Even if it takes a long time for everyone to get through the monitoring and decontamination stations, crowd control will be significantly improved if people perceive that the line is moving.

As monitoring lines form, one or more monitoring assistants with a radiation survey instrument should walk the line looking for individuals who might slow things down. These staff members are looking for individuals who

- *Are highly contaminated.*
- *Have small children.*
- *Might have medical problems.*
- *Might be pregnant.*
- *Do not speak or understand simple English.*
- *Have cultural or religious issues that might slow down monitoring.*

Families should never be separated.

This initial screening by walking the line begins a triage system enabling the monitoring center to process people quickly. Having two staff members per line would be ideal for this initial screening, one concentrating on radiation readings (using headphones with external speaker off) and the other observing and interacting with people in line. It is important to remember that families should never be separated.

Those needing medical assistance should be taken to the medical station immediately. It may be prudent to divide the others into two groups: a) those who have performed self-decontamination at home and have already showered and changed clothes, and b) those who have not yet changed clothes or showered. The first group can be processed through a portal monitor. The second group may be surveyed with hand-held probes and directed to decontamination or “wash” stations if needed.

<u>Pets</u>

People arriving with pets, especially service animals, need to have the same services provided to their pets. Although it may be difficult to wash a pet in a monitoring location, the concern with contamination is significant, and the owner should be apprised of options. Cross-contamination of the owner is of greater concern than the dose to the pet. Pet owners should be encouraged to wash their own pets, when able to do so.

Scaling for Size of Incident

The size of incident is a major consideration in planning for population monitoring. Population monitoring plans should be scalable, up or down, based on the number of people expected to be affected. If only 100 people need to be surveyed and decontaminated, responders can probably provide very thorough services at the scene. However, if thousands or even more people are affected, plans will have to be modified so that everyone can be processed quickly and safely.

Monitoring for External Contamination and Conducting Decontamination

As mentioned previously, decontamination may be performed at various stages in the monitoring process. Immediate decontamination may be necessary to reduce an individual's exposure to radiation from radioactive contamination and to help control cross-contamination at the scene.

> ***If adequate decontamination resources allow, you may consider more restrictive radiological screening criteria than those used in the early hours after the incident.***

The first step in external monitoring is to check people for radioactive contamination on their bodies and clothing. Note that at this stage, if adequate decontamination resources allow, you may consider more restrictive radiological screening criteria than those used in the early hours after the incident. For external monitoring, you will need to verify that appropriate instruments (portal monitors or hand-held meters) are available[9] and that the instruments are working properly. Be sure to check for both gamma- and beta-emitting radioactive material and (if suspected) alpha-emitters, and document the results. Refer uncontaminated people to discharge stations and contaminated people to washing (decontamination) stations.

You must ensure that materials needed for external decontamination are available. Establish an efficient flow system so that people in need of decontamination do not co-mingle with people who have already washed. You should also be prepared to provide for the security of personal valuables.

In your planning, assume that most people will be able to self-decontaminate, but be prepared to provide assistance to those who cannot, such as people using wheelchairs or people with

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[9] *These instruments are for personal monitoring. You should also consider area-monitoring devices at the community reception centers to assess and monitor background radiation levels. Consult with your state radiation control program.*

other disabilities. Determine if parents can assist their children with washing. Direct people with wounds to the designated medical station for special handling, and institute a referral plan for transfer to hospitals and other health care settings. For people who do not have wounds, direct them to

- *Wash with warm water.*
- *Use the mechanical action of flushing or friction of cloth, sponge, or soft brush.*
- *Begin with the least aggressive techniques and mildest agents.*
- *When showering, begin with the head and proceed to the feet.*
- *Keep materials out of eyes, nose, mouth, and wounds. Use waterproof draping to limit the spread of contamination.*
- *Avoid causing mechanical, chemical, or thermal damage to skin.*

After decontamination, survey individuals again, and repeat washing once if needed. Refer individuals who still have contamination to the internal contamination monitoring station. Be sure to collect basic epidemiologic information, health and exposure history. Follow policy and procedures established in your emergency plan for dealing with people who leave without being decontaminated.

Be prepared to provide assistance with decontamination for people with special needs.

Monitoring for Internal Contamination and Conducting Decontamination

Internal contamination is when radioactive material enters the body through, for example, ingestion or inhalation. Having accurate information about the levels of internal contamination is important in deciding whether medical intervention is warranted. The methods and equipment needed for assessing internal contamination are more advanced than the equipment required to conduct external monitoring. Collectively, internal contamination monitoring procedures are referred to as “bioassays,” and in general these bioassays require off-site analysis (by a clinically certified commercial laboratory or hospital). People should be advised that it may be some time before results are available.

For gamma-emitting radionuclides, external monitoring can provide some indication of the extent of internal contamination. Furthermore, the physical location of the individuals during the incident or the extent of external contamination on their bodies prior to washing can be additional indicators of the likelihood and magnitude of internal contamination. However, laboratory results can provide definitive information, especially in the case of alpha-emitting radionuclides.

You should identify in advance personnel and resources necessary for these evaluations. These include whole-body counters and lung counters (for in-vivo analysis), and the ability to perform radiochemical analysis of excreta (e.g., urine) or other samples. Other needed resources are sample collection kits, appropriate administrative forms, and chain-of-custody documentation. Federal resources would be available, but not immediately. CDC can assist you by identifying resources and answering your questions in the planning process. See the section, *Who Can I Contact For Further Information About This Guide.*

When a person is internally contaminated, depending on the type of radioactive material the person is contaminated with, certain medications can be administered to speed up the rate at which the radioactive material is eliminated from the body. ***Internal decontamination is a medical procedure and should only be performed at the order of, and under the guidance of, a licensed physician.***

The Strategic National Stockpile (SNS) can provide pharmaceuticals to states for this purpose, if needed (see Appendix F). State health officers can contact CDC to discuss procedures and receive more information about the SNS. In addition, the following resources can provide information about treatments for internal contamination:

- ***The Food and Drug Administration (FDA)***
  http://www.fda.gov/cder/drugprepare/default.htm#Radiation
- ***Radiation Emergency Assistance Center/Training Site (REAC/TS)***
  http://orise.orau.gov/reacts/med-countermeasures.htm
- ***Radiation Event Medical Management (REMM) – Guidance on Diagnosis and Treatment for Healthcare Providers***
  http://www.remm.nlm.gov/
- ***Centers for Disease Control and Prevention (CDC)***
  http://www.bt.cdc.gov/radiation
- ***National Council on Radiation Protection and Measurement (NCRP) Report 65, "Management of Persons Accidentally Contaminated with Radionuclides".***
  http://www.ncrponline.org/Publications/65press.html [currently under revision]

Laboratory Capabilities and Biodosimetry

For medical management of patients, it is helpful to know what amount of radioactive material has entered the body and what radiation dose was received from external sources. Monitoring for internal contamination or significant exposure to external radiation will require specific laboratory capabilities.

Analysis of radioactivity in excreta can establish amounts of radioactive material in the body. Although the analysis can be performed fairly rapidly, it will take some time for this information to be available for everyone in the affected and potentially affected populations. Therefore, some prioritization scheme for analysis of bioassay samples will be necessary.

A prioritization scheme for analysis of bioassay samples will be necessary.

Analysis of chromosomal aberrations (cytogenetic biodosimetry) can estimate the external radiation dose to the individual; however, these results will not be immediately available. Performing a complete blood count with differential (standard and routine analysis in local clinics and hospitals) and noting the time delay to onset of nausea can provide estimates of the range of acute radiation doses. This information can be used to assist in medical management of patients.[10]

Issues that should be addressed in planning for laboratory analysis include a prioritization scheme for triaging samples, analytical capability, sample volume, turnaround time, throughput, and other limitations. In the planning process, public health laboratory directors should assess their roles and capabilities following a radiation emergency. They can contact the following resources for additional information to assist them in their planning:

- *For information about analysis of radioactive contamination in urine, contact CDC's Environmental Health Laboratory*
  http://www.cdc.gov/nceh/dls
- *For information on cytogenetic analysis of blood samples, contact REAC/TS' Cytogenetics Biodosimetry Laboratory*
  http://orise.orau.gov/reacts/cytogenetics-lab.htm

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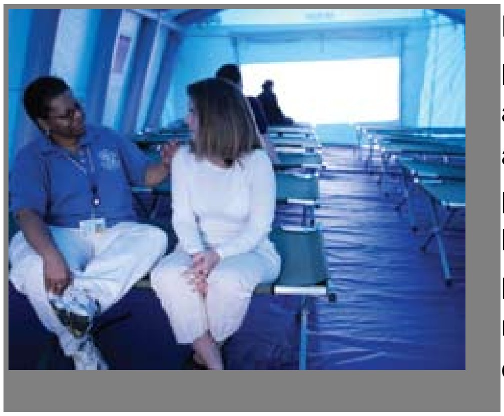
[10] *Visit http://www.bt.cdc.gov/radiation/toolkit.asp for more information*

Psychosocial Issues



Psychosocial issues will present significant challenges to public health and medical practitioners both during and after a radiological emergency incident. Public health and medical systems could be totally overwhelmed by people seeking assessment and care. Little planning has occurred in this area, but preparing to deal with psychosocial issues is critically important for efficiently managing and monitoring the affected population and engaging in other response efforts.

Your plan should include strategies for assisting both affected individuals and their families and public health workers. Adequate rotation of staff members to reduce physical and emotional fatigue will be essential. In the aftermath of a radiation emergency, state and local agencies should be prepared to distribute materials on the effects of radiation incidents and how to cope with them. These materials should also address

- *Post-traumatic stress.*
- *Concern about exposure to radiation.*
- *Anxiety about potential exposure.*
- *Depression and despair.*

You should ensure that your health department has a psychological assistance coordinator on staff for each of the community reception centers. During the planning process, you should establish a contact list of credentialed individuals who could provide mental health assistance.

Registry

State and local agencies should establish a registry as early as possible after a radiation incident. This registry will be used to contact people in the affected population who require short-term medical follow-up or long-term health monitoring. The long-term monitoring process involves observing and recording any health effects that could be related to radiation exposure, including effects on subsequent generations. Extensive resources will be required, and federal agencies, specifically CDC and the Agency for Toxic Substances and Disease Registry (ATSDR), will provide assistance in establishing and maintaining this registry.

The registry should include information from

- *All members of the public who were potentially contaminated or irradiated.*
- *All first responders, public health workers, and hospital staff who were potentially contaminated or irradiated or who responded to a radiation incident within your jurisdiction.*

As you consider the following in planning for the registry, please note that collecting all of this information early in the process may not be practical.

It is recommended that you assign unique identifiers to each individual as people present themselves to the community reception center and are registered. Initially, you should gather basic information such as name, address, telephone number, other contact information, date of birth, and sex. If possible, copying a driver's license with current information can expedite the registry process. It may be helpful to include the individual's status as

- *A paid responder.*
- *A volunteer responder at the scene.*
- *A person affected at the scene of the incident.*
- *A person who heard a public announcement and believes he or she fits the category for monitoring.*

If possible, you should include spatial and temporal information related to the incident. You should ask questions such as, "Where were you when the incident occurred? How close were you to the incident location? How long were you there?"

If possible, categorize (triage) individuals radiologically:

- *Unexposed/uncontaminated*
- *External contamination*
- *Internal contamination*
- *External exposure only*

Your plans should address confidentiality and potential liability issues associated with registering and collecting data on all persons who come to a processing center, even if they were not affected by the incident. The public should be informed that inclusion in the registry does not imply any form of future compensation.

You should determine, in advance, who will have access to the registry database and how it will be archived.

Radiation Dose Reconstruction

Radiation dose reconstruction is a scientific study that estimates radiation doses to people from external exposure or intakes of radioactive materials. Dose reconstruction differs from dose estimations and projections that are done in the emergency phase of the incident, which deal with management of immediate public health issues and acute radiation health effects among the affected population. Radiation dose reconstruction studies typically focus on determining who (if anyone) may be at a greater risk for cancer. In this context, dose reconstruction is part of the population monitoring process, but it should not preoccupy public health responders in the initial emergency phase of the response.

Radiation dose reconstruction studies determine what the external dose rates were in time and space, how much material was released, how people came in contact with radiation, and the amount of radioactive material that was taken into their bodies. HHS/CDC will provide technical support and assistance to state and local authorities to conduct dose reconstruction studies, using sophisticated computer models. Local public health agencies will provide public information and collect data to be used in the dose reconstruction.

Training

Training is essential in building a population monitoring capability in your community. Training should focus on increasing the understanding of and “demystifying” radiation and its effects in the public health and emergency response communities and among the public at large. In addition, you should prepare public health workers to focus on their roles and responsibilities, resource identification, and proper use of equipment and laboratory methods and procedures.

Training should be provided to promote awareness of population monitoring among first responders (e.g., hazmat teams, fire departments, volunteer fire groups, law enforcement agencies, and the National Guard); elected officials and key community stakeholders; public information and communication specialists in public health and medical organizations; clinicians, mental health practitioners, and all hospital staff; journalists and radio and television personalities; and supporting workers and volunteers (such as American Red Cross volunteers and others).

Training should be interactive and affordable. Use drills and exercises to test health preparedness plans; ensure that all entities that will be involved in the response (from both the emergency response and the health care/hospital worker communities) are involved. Existing training resources, such as satellite broadcasts, Web casts, videos, and print materials, are available on many federal and state Websites; these materials can be adapted for your community. You can also partner with other agencies and organizations to reduce the cost of training.

Training for public health personnel should cover these activities:

- *Determining the location of community reception centers based on the amount of space needed, the anticipated magnitude of the radiation incident, and the population and special needs of the community.*
- *Establishing crowd management operations, including the development of process flow/ triage procedures and the distribution of patient information sheets during population monitoring.*
- *Using on-site equipment to monitor external contamination.*
- *Identifying and handling special population needs.*
- *Managing individuals experiencing psychological trauma.*
- *Identifying the process and procedures for requesting federal support.*
- *Establishing and maintaining contacts with federal agencies for equipment, personnel, and expertise.*
- *Working effectively with partner agencies (DHS/FEMA, HHS/CDC, HHS/FDA, DOE, EPA, NRC, USDA, and the American Red Cross).*

Educational materials and instruction should address the following:

- *Contamination control.*
- *Minimizing individual exposure.*
- *Principles of dose reconstruction.*
- *Principles of registry management.*

Medical personnel should be trained on

- *Assessment and diagnosis of radiation exposures.*
- *Emergency and first aid procedures for radiation victims.*
- *Diagnosis of external and internal radiation exposure.*
- *Prompt triage and management of the contaminated patient.*
- *Psychological features and dynamics of radiation incidents.*

Communications

The task of communicating about radiation and related emergency issues is extremely challenging, and it requires considerable skill. The information provided to stakeholders may range from informative to authoritative. Effectively communicated health messages can influence individual citizens, health care providers and other professionals, and policy makers at all levels as they make health protection decisions; therefore, these messages can have a direct and highly significant effect on the health and safety of large segments of the population.

When people are asked or demand to be monitored for radioactive contamination, they will primarily want to know the following:

- *Was I exposed to radiation?*
- *Am I radioactive?*
- *Am I still carrying around radioactive contamination on my body? Skin? Clothes? How do I get it off? Is my condition contagious? Is it curable?*
- *Did I ingest or inhale radioactive material or otherwise become contaminated internally? If so, how long will the material stay in my body? Should I be medically treated?*
- *Were my children exposed? What about my unborn child?*
- *Were my pets exposed? My farm animals?*

For any levels or amounts of exposure, even miniscule, people will want to know what health effects they may have in the future. You should pre-plan the communication strategy to lessen people's understandable fears and anxiety. You will need an effective and credible communication strategy to explain that *the overwhelming majority of radiation exposures will not result in any measurable health effects.*

As part of your emergency preparedness planning, you should ensure that your communication and public information staff establishes a network of qualified public health media contacts, specifically those with radiation expertise; develops and disseminates information kits that include materials specific to a radiation incident, including population monitoring and protective actions (such as decontamination); identifies and trains key public health spokespersons for media announcements or interviews; and prepares to communicate with special populations.

You should also ensure that your public health department is aware of procedures for contacting community and civic organizations, local government and corporate officials, and federal organizations listed in the National Response Plan. Local government and corporate officials need to be aware of their roles in the overall response plan, ideally through participation in training, drills, and exercises.

who can I contact for further information about this guide?

For more information about population monitoring, this planners' guide, or the public health role in radiation emergency preparedness, please contact the Radiation Studies Branch at CDC via e-mail at rsb@cdc.gov or by telephone at 404-498-1800.

You will also find many other sources of information about radiation emergency preparedness in Appendix H.

In a public health emergency, you can reach the CDC Director's Emergency Operation Center, 24 hours a day, at 770-488-7100.

appendix a

Acronyms

ACC......................Alternate Care Centers
AHRQ..................Agency for Healthcare Research and Quality
ALI........................Annual Limit of Intake
ARC......................American Red Cross
ARS......................Acute Radiation Syndrome
ATSDR.................Agency for Toxic Substances and Disease Registry
CBC......................Complete Blood Count
CDC......................Centers for Disease Control and Prevention
CDER..................Center for Drug Evaluation and Research
CRCPD................Conference of Radiation Control Program Directors, Inc
CRS......................Cutaneous Radiation Syndrome
CSF......................Colony Stimulating Factor
DHS......................U.S. Department of Homeland Security
EPA......................U.S. Environmental Protection Agency
FAQ......................Frequently Asked Questions
FDA......................Food and Drug Administration
FEMA..................Federal Emergency Management Agency
DOE......................U.S. Department of Energy
DOE/NNSA..........National Nuclear Security Administration
DTPA....................Diethylenetriamene pentaacetate
HHS......................U.S. Department of Health and Human Services
IAEA.....................International Atomic Energy Agency
ICRP.....................International Commission on Radiological Protection
IND.......................Improvised Nuclear Device
IRB.......................Institutional Review Board
MEMS..................Modular Emergency Medical System
NEHC..................Neighborhood Emergency Help Centers
NIOSH.................National Institute for Occupational Safety and Health
NCRP..................National Council on Radiation Protection and Measurement
NPP......................Nuclear Power Plant

NRC......................U.S. Nuclear Regulatory Commission

NRP......................National Response Plan

ORAU...................Oak Ridge Associated Universities

ORISE..................Oak Ridge Institute for Science and Education

OSHA...................Occupational Safety & Health Administration

POD......................Point of Dispensing

PSA......................Public Service Announcements

RDD......................Radiological Dispersal Device

REAC/TS..............Radiation Emergency Assistance Center/Training Site

RED......................Radiation Emission Device

REP......................Radiological Emergency Preparedness

RSO......................Radiation Safety Officer

SNS......................Strategic National Stockpile

TNT......................Trinitrotoluene

USDA...................U.S. Department of Agriculture

appendix b

Glossary

Absorbed dose

The amount of energy deposited by ionizing radiation in a unit mass of tissue is called radiation absorbed dose. It is expressed in units of joule per kilogram (J/kg), which is given the special name 'gray' (Gy). The conventional (or non-SI unit) unit of absorbed dose is the rad. [100 rad equals 1 Gy; or 1 Gy equals 0.01 rad]. For more information, see CDC Primer on Radiation Measurement:
http://www.bt.cdc.gov/radiation/glossary.asp#primer

Activity (radioactivity)

The rate of decay of radioactive material expressed as the number of atoms breaking down per second measured in units called becquerels or curies.

Acute Radiation Syndrome (ARS)

A serious illness caused by receiving a large dose of radiation energy that penetrates the body within a short time period (usually minutes). The first symptoms include nausea, vomiting, and diarrhea starting within minutes to days after the exposure and lasting for minutes to several days; these symptoms may come and go. Then the person usually looks and feels healthy for a short time, after which he or she will become sick again with loss of appetite, fatigue, fever, nausea, vomiting, diarrhea, and possibly even seizures and coma. This seriously ill stage may last from a few hours to several months.

Clinically, ARS is very difficult to diagnose in the absence of any other radiological information from the incident scene because symptoms within the first few hours after exposure are no different from common diarrhea, vomiting, and nausea. Proper diagnosis of exposure to ionizing radiation (no contamination) and an estimate of the total dose can only be achieved by analysis of the complete blood count (CBC), chromosome aberration cytogenetic bioassay, and consultation with radiation experts. For more information, see CDC fact sheets:

Acute Radiation Syndrome
http://www.bt.cdc.gov/radiation/ars.asp

Acute Radiation Syndrome: A Fact Sheet for Physicians
http://www.bt.cdc.gov/radiation/arsphysicianfactsheet.asp

Alpha particle

One of the primary ionizing radiations, the others being beta particles, gamma-rays, x-rays, and neutrons. Alpha particles can be stopped by a thin layer of light material, such as a sheet of paper, and cannot penetrate the outer, dead layer of skin. Therefore, they do not pose a hazard as long as they are outside the body. Protection from this radiation is directed to preventing, or at least minimizing, inhalation or ingestion of the radioactive material.

Alpha particles are difficult to detect in an accidental situation because they penetrate only a few inches in air, and most "general purpose" detection instruments are poorly suited to this particular detection scheme. If radiation is detected at an incident scene, instruments should be brought in as quickly as possible to determine whether alpha-emitting radioisotopes are present.

Annual Limit on Intake (ALI)

The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the 'reference man' that would result in a committed effective dose equivalent of 5 rem (0.05 sievert) or a committed dose equivalent of 50 rem (0.5 sievert) to any individual organ or tissue. The unit of ALI is the becquerel (Bq) or the conventional unit, curie (Ci).

Background radiation

This is the radiation that the population is naturally and continually exposed to from natural sources. It consists of radiation from natural sources of radionuclides such as those found in soil, rocks, the air, our bodies, and our food, as well cosmic radiation originating in outer space.

Becquerel (Bq)

The SI unit describing the amount of radioactivity. One Bq is the amount of a radioactive material that will undergo one decay (disintegration) per second, a very small rate. Industrial sources of radioactivity are normally described in terms of giga-bequerels (GBq), or one billion Bq. The conventional unit for radioactivity is the curie (Ci). [1 Ci is equal to 3.7×10^{10} Bq]

Beta particles

One of the primary ionizing radiations, the others being alpha particles, gamma-rays, x-rays, and neutrons. They travel only a few feet in air and can be stopped by a thin sheet of aluminum. However, beta particles can penetrate the dead skin layer and, if present in large amounts or long period of time, cause skin burns. Protection from this radiation is directed toward washing the skin with mild soap and water and preventing, or at least minimizing, inhalation or ingestion of the radioactive material.

Beta particles are easier to detect than alpha particles. While most "general purpose" detection instruments can detect beta particles, the instrument must be within a few yards of a sizeable source. Fortunately, the vast majority of beta-emitting radioisotopes release high-energy gamma rays that can be detected at distances of tens of yards.

When radiation is detected at an incident scene, proper instruments should be brought in as quickly as possible to determine whether pure beta-emitting radioisotopes are present or not, followed in turn by alpha monitoring equipment.

Bioassay (radiobioassay)

An assessment of radioactive materials that may be present inside a person's body through direct analysis of the radioactivity in a person's blood, urine, feces, or sweat, or by detection methods to monitor the radiation emitted from the body.

Biological half-life

Once an amount of radioactive material has been taken into the body, this is the time it takes for one half of that amount to be expelled from the body by natural metabolic processes, not counting radioactive decay.

Contamination (radioactive)

The deposit of unwanted radioactive material on the surfaces of structures, areas, objects, or people (where it may be external or internal). External contamination occurs when radioactive material is outside of the body, such as on a person's skin. Internal contamination occurs when radioactive material is taken into the body through breathing, eating, or drinking. For more information, see CDC fact sheet:

Radioactive Contamination and Radiation Exposure
http://www.bt.cdc.gov/radiation/contamination.asp

Curie (Ci)

The conventional unit describing the amount of radioactivity. See Becquerel (Bq).

Cutaneous Radiation Syndrome (CRS)

The complex syndrome resulting from significant skin exposure to radiation. The immediate effects can be reddening and swelling of the exposed area (like a severe burn), blisters, ulcers on the skin, hair loss, and severe pain. Very large doses can result in permanent hair loss, scarring, altered skin color, deterioration of the affected body part, and death of the affected tissue (requiring surgery). For more information, see CDC fact sheets:

Acute Radiation Syndrome
http://www.bt.cdc.gov/radiation/ars.asp

Cutaneous Radiation Injury: Fact Sheet for Physicians
http://www.bt.cdc.gov/radiation/criphysicianfactsheet.asp

Decontamination

Removal of radioactive materials from people, materials, surfaces, food, or water. For people, external decontamination is done by removal of clothing and washing the hair and skin. Internal decontamination is a medical procedure.

Decay, radioactive

Disintegration of the nucleus of an unstable atom by the release of radiation.

Deterministic effects (non-stochastic effects)

Health effects that can be related directly to the radiation dose received (e.g., skin burn). The severity increases as the dose increases. A deterministic effect typically has a threshold below which the effect will not occur. See also stochastic effects.

Dirty bomb

A device designed to spread radioactive material by conventional explosives when the bomb explodes. A dirty bomb kills or injures people through the initial blast of the conventional explosive and spreads radioactive contamination over a possibly large area—hence the term "dirty." Such bombs could be miniature devices or large truck bombs. A dirty bomb is much simpler to make than a true nuclear weapon. See discussion on radiological dispersal device (RDD) in the text.

Dose rate meters

Instruments that measure the radiation dose delivered per unit of time.

Dose Reconstruction

A scientific study that estimates doses to people from releases of radioactivity or other pollutants. The reconstruction is done by determining how much material was released, how people came in contact with it, and the amount absorbed by their bodies.

Dosimetry

Assessment (by measurement or calculation) of radiation dose.

Effective half-life

The time required for the amount of a radionuclide deposited in a living organism to be diminished by 50% as a result of the combined action of radioactive decay and biologic elimination. See also biological half-life, radioactive half-life.

Exposure (irradiation)

This occurs when radiation energy penetrates the body. Exposure to very large doses of radiation may cause death within a few days or months. Exposure to lower doses of radiation may lead to an increased risk of developing cancer or other adverse health effects later in life. Compare with contamination. For more information, see CDC fact sheet:

Radioactive Contamination and Radiation Exposure
http://www.bt.cdc.gov/radiation/contamination.asp

Fallout, nuclear

The slow descent of minute particles of radioactive debris in the atmosphere following a nuclear explosion. For more information, see Chapter 2 of CDC's Fallout Report at: http://www.cdc.gov/nceh/radiation/fallout/falloutreport.pdf

Gamma rays

One of the primary ionizing radiations, the others being alpha particles, beta particles, x-rays, and neutrons. Different from alpha and beta particles, gamma-rays are very similar to x-rays and pose an external radiation hazard. Gamma-rays are highly penetrating (up to tens of yards in air). Gamma rays also penetrate tissue farther than do beta or alpha particles. Gamma-rays are relatively easy to detect with commonly available radiation detection instruments.

Geiger counter

Geiger-Mueller or GM counters are the most widely recognized and commonly used portable radiation detection instruments. The modern pancake GM detector can detect gamma, beta, and to a limited extent, alpha contamination. The sensitivity of various GM probes varies markedly. For example, an old civil defense instrument and a modern instrument will record very different readings when used side by side. Knowledgeable and experienced radiation protection specialists should interpret the measurement results.

Genetic effects

Hereditary effects (mutations) that can be passed on through reproduction because of changes in sperm or ova. See also teratogenic effects, somatic effects.

Gray (Gy)

A unit of measurement for absorbed dose. It measures the amount of energy absorbed in a material. The unit Gy can be used for any type of radiation, but it does not describe the biological effects of the different radiations. For more information, see CDC Primer on Radiation Measurement: http://www.bt.cdc.gov/radiation/glossary.asp#primer

Half-life (radioactive)

The time it takes for any amount of radioactive material to decay (and reduce) to half of its original amount. See also biological half-life, effective half-life, radioactive half-life.

Health physics

A scientific field that focuses on protection of humans and the environment from radiation. Health physics uses physics, biology, chemistry, statistics, and electronic instrumentation to help protect people from any potential hazards of radiation. For more information, see the Health Physics Society Website: http://www.hps.org/.

Health Physicist

A specialist in radiation safety. See health physics.

Intake

Amount of radioactive material taken into the body by ingestion, inhalation, or absorption through the skin,via wounds or injection.

Ionizing radiation

Any radiation capable of displacing electrons from atoms, thereby producing ions. High doses of ionizing radiation may produce severe skin or tissue damage

Irradiation

Exposure to radiation. See exposure and compare with contamination.

Latent period

The time between exposure to a toxic material and the appearance of a resultant health effect.

Neutron

One of the primary ionizing radiations, the others being alpha particles, beta particles, gamma-rays, and x-rays. Neutrons are highly penetrating and are a radiation hazard at the instance of a nuclear detonation. In almost all other scenarios, it is unlikely for public health officials to encounter neutron radiation or contamination. Detection of neutrons requires specialized equipment.

Non-stochastic effects

See deterministic effects.

Penetrating radiation

Radiation that can penetrate the skin and reach internal organs and tissues. Photons (gamma rays and x-rays), neutrons, and protons are penetrating radiations. However, alpha particles and all but extremely high-energy beta particles are not considered penetrating radiation.

Portal Monitor

A portable doorway-like radiation detection system for monitoring people for radioactive contamination. The monitors look similar to metal detectors used in airport security screening stations. Certain types of portal monitors are used routinely to monitor vehicles or waste containers leaving hospitals. When used to monitor people, they can be used in walk-through mode or by having each person stand in the monitor for a brief time period. The portal monitors do NOT produce radiation. They can only measure radiation coming from contaminated individuals.

Plume

A cloud, gas, or vapor that carries radioactive material released into the atmosphere away from the incident site in the direction of the wind. Making plume concentration predictions with time after the incident is necessary to determine whether affected populations should shelter in place or evacuate. Plume predictions use mathematical models and, although very helpful, are prone to inherent uncertainties.

Prenatal radiation exposure

Radiation exposure to an embryo or fetus while it is still in its mother's womb. At certain stages of the pregnancy, the fetus is particularly sensitive to radiation, and the health consequences could be severe above certain radiation dose levels. For more information see CDC fact sheets:

Possible Health Effects of Radiation Exposure on Unborn Babies
http://www.bt.cdc.gov/radiation/prenatal.asp

Prenatal Radiation Exposure: A Fact Sheet for Physicians
http://www.bt.cdc.gov/radiation/prenatalphysician.asp

Rad (radiation absorbed dose)

See absorbed dose. For more information, see CDC Primer on Radiation Measurement: http://www.bt.cdc.gov/radiation/glossary.asp#primer

Radiation

Energy moving in the form of particles or waves. Familiar radiations are heat, light, radio waves, and microwaves. Ionizing radiation is a very high-energy form of electromagnetic radiation.

Radiation sickness

See acute radiation syndrome (ARS).

Radioactive contamination

See contamination.

Radioactive decay

The spontaneous disintegration of the nucleus of an atom.

Radioactive half-life

See half-life.

Radioactive material

Material that contains unstable (radioactive) atoms that give off radiation as they decay.

Radioactivity

The process of spontaneous transformation of the nucleus, generally with the emission of alpha or beta particles that are often accompanied by gamma rays. This process is referred to as decay or disintegration of an atom. See activity.

Radiobioassay

See bioassay.

Radiogenic

Health effects caused by exposure to ionizing radiation.

Radiological or radiologic

Related to radioactive materials or radiation. The radiological sciences focus on the measurement and effects of radiation.

Radionuclide

An unstable and therefore radioactive form of a nuclide.

Rem (roentgen equivalent, man)

A conventional unit for a derived quantity called radiation dose equivalent. One rem equals 0.01 Sieverts (Sv). See Sievert.

Resuspension

The physical process of making airborne radioactive contamination that otherwise would have remained deposited on the surface of objects. For example, wind blowing across a sidewalk will resuspend previously deposited contaminants, making them airborne in the breathing zone.

Roentgen (R)

A unit of exposure to x-rays or gamma rays.

Shielding

The material between a radiation source and a potentially exposed person that reduces his or her exposure.

Sievert (Sv)

The SI unit for a derived quantity called radiation dose equivalent. This relates the absorbed dose in human tissue to the effective biological damage of the radiation. Not all radiation has the same biological effect, even for the same amount of absorbed dose. Dose equivalent is often expressed as millionths of a sievert, or micro-sieverts (μSv). One sievert is equivalent to 100 rem. For more information, see CDC Primer on Radiation Measurement: http://www.bt.cdc.gov/radiation/glossary.asp#primer

S.I. units

The Systeme Internationale (or International System) of units and measurements. This system of units officially came into being in October 1960 and has been adopted by nearly all countries, although the amount of actual usage varies considerably. For more information, see CDC Primer on Radiation Measurement: http://www.bt.cdc.gov/radiation/glossary.asp#primer

Somatic effects

Effects of radiation that are limited to the exposed person, as distinguished from genetic effects, which may also affect subsequent generations. See also teratogenic effects.

Stochastic effects

Health effects that occur on a random basis independent of the size of dose (e.g., cancer). The effect typically has no threshold and is based on probabilities, with the chances of seeing the effect increasing with dose. If it occurs, the severity of a stochastic effect is independent of the dose received. See also deterministic effect.

Teratogenic effect

Birth defects that are not passed on to future generations, caused by exposure to a toxin as a fetus. See also genetic effects, somatic effects.

appendix c

Radiological Screening Criteria—
External Contamination

Radiological screening for external contamination is performed to assess the amount of radioactive materials on the skin and clothing. These materials can irradiate the body when beta and gamma-emitting radionuclides are present. If the radioactive material remains on skin or clothing, it could be released to the air and inhaled, or be incidentally ingested, resulting in internal contamination. Internal contamination is particularly significant in the case of alpha-emitting radionuclides.

External contamination on individuals can also be spread, resulting in cross-contamination—that is, spreading radioactive materials to other places where they should not be. Cross-contamination is a public health concern, although it is secondary to immediate concerns for people's health and safety.

In this Appendix, a number of benchmark screening criteria and their technical bases are briefly described. This is followed by recommendations on how to select particular screening criteria to best serve public health in a variety of circumstances.

The information in this appendix is meant for public health planners, not first responders. It should be considered and discussed with health physics experts in your state radiation control and public health programs during the planning process, prior to any incidents.

Benchmark Screening Criteria

This Appendix will describe the following documents:

- *Contamination Monitoring Standard for a Portal Monitor Used for Radiological Emergency Response, Federal Emergency Management Agency, FEMA-REP-21, March 1995.*
- *Contamination Monitoring Guidance for Portable Instruments Used for Radiological Emergency Response to Nuclear Power Plant Accidents, Federal Emergency Management Agency, FEMA-REP-22, October 2002.*
- *Key Elements of Preparing Emergency Responders for Nuclear and Radiological Terrorism, National Council on Radiation Protection and Measurements (NCRP) Commentary No. 19, December 2005.*

- *Handbook for Responding to a Radiological Dispersal Device. First Responder's Guide— the First 12 Hours, Conference of Radiation Control Program Directors, Inc. (CRCPD), September 2006.*
- *Manual for First Responders to a Radiological Emergency, International Atomic Energy Agency (IAEA), October 2006*
- *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents, U.S. Environmental Protection Agency (EPA), EPA-400-R-92-001, May 1992.*

The first two documents, FEMA REP-21 and REP-22, have associated technical background documents that discuss the technical bases and assumptions of the guidance. These two guidance documents are currently being combined in a revised guidance document. They address radiation emergencies involving nuclear power plant facilities. They do not address terrorism incidents. The remaining documents do address terrorism, with CRCPD specifically focusing on Radiological Dispersal Device (RDD) incidents. The EPA document is currently being updated, but the recommended contamination screening levels are not expected to change and will be described here.

Radiation Control Zones

Although this topic does not directly deal with "population" monitoring, it does affect the manner in which people at the scene are directed. FEMA REP documents do not address this topic, but the NCRP, CRCPD, and IAEA documents are consistent in the manner in which they delineate radiation control zones at the scene. All three documents identify two major zones:

- *Inner perimeters with radiation levels exceeding 100 mSy/h (10 R/h) and where only lifesaving or other mission-critical activities should be performed with very short (few minutes) stay times.*
- *Outer perimeter with radiation levels exceeding 0.1 mSv/h (10 mR/h) from which people are evacuated, the area is isolated, and controlled entry is implemented to allow in only first responders with appropriate personal protection equipment.*

CRCPD recommends that the outer perimeter should be set at lower than 10 mR/h if it is practical (i.e., the area does not become too large or too distant from the epicenter of the blast). CRCPD also states that responders may define additional boundaries, if needed, at 100 mR/h and 1000 mR/h.

People (Skin and Clothing) Screening Criteria

Both the FEMA REP documents and the NCRP recognize two health-based concerns:

- *Deterministic effects—acute exudative radiodermatitis has the limiting radiation dose threshold.*
- *Long-term stochastic effects—skin cancer.*

FEMA also defines two types of contamination, “loose” and “fixed.” Loose contamination can be removed by washing or changing clothes. FEMA assumes that, on average, people will be able to bathe and remove loose contamination within 36 hours of the incident. Fixed skin contamination will remain even after bathing and will be removed by natural processes within 2 weeks.

Concerning acute effects, FEMA sets a limit of 0.1 μCi (3.7 kBq) for fixed contamination on a spot of skin.[1] If it is assumed that contamination is mixed (loose-plus-fixed contamination), FEMA sets a higher limit of 1.0 μCi (37 kBq) for spot contamination.

Concerning the stochastic effects, FEMA sets a limit of 74 μCi (2.7 MBq) for fixed contamination over the body, regardless of distribution. If uniformly distributed over the surface of an adult body, this corresponds to 0.004 $\mu Ci/cm^2$, which is equal to 150 Bq/cm^2 or 9000 dpm/cm^2. If it is assumed that contamination is mixed, a higher limit of 740 μCi (27 MBq) is set for distributed contamination. For an adult, this is equal to 0.04 $\mu Ci/cm^2$, which is equal to 1.5 kBq/cm^2 or 90,000 dpm/cm^2.

NCRP states that individuals with spot contamination on the skin exceeding 2.2×10^6 dpm have priority for decontamination. This equals FEMA’s 1 μCi (37 kBq) limit for mixed contamination described above.

NCRP further states that “decontamination procedures should strive to reduce” surface contamination to below the following limits:

- *2.2×10^5 dpm (3.7 kBq) on any one spot.*
- *10,000 dpm/cm^2 (167 Bq/cm^2) surface body contamination.*

Note that NCRP contamination guides numerically equal FEMA’s limits for fixed contamination. The language is slightly different in the two documents. Whereas FEMA sets these values as upper limits, NCRP recommends these as guides that the decontamination procedures should strive to meet or exceed.

[1] *Spot size is defined by both FEMA and NCRP as an area of 0.2 cm^2 or a circle 0.5 cm in diameter.*

Contamination survey equipment does not measure in units of surface activity such as μCi or kBq/cm^2. The instruments typically read in units of counts per minute (cpm). For first responders, the screening criteria should be given in operational units. The conversion to operational units is made considering the sensitive area of the probe and the probe counting efficiency for the particular type of radionuclide. Operational units may vary by orders of magnitude between the various available probes.

FEMA evaluated several instruments and decided to recommend a single value, equivalent to the response for the least sensitive instrument (CD V-700 with a standard detector). This value is 300 cpm above background. FEMA states that using this criterion with more sensitive instrument combinations will provide an additional level of protection. In the Background Information document for REP-22 Guidance, FEMA states the following:

- *For CD V-700s that have been retrofitted with a pancake detector, criteria could be set at 1,000 cpm and 10,000 cpm for fixed and loose-plus-fixed contamination, respectively.*
- *For more modern (non CD V-700) instruments with pancake detectors, criteria of 10,000 cpm and 100,000 cpm could be used for fixed and loose-plus-fixed contamination, respectively.*

Generally, the fixed contamination criterion is applied to individuals who have showered and changed clothes. The criterion for loose-plus-fixed contamination is applied to those who have not yet washed or changed clothes.

NCRP Commentary 19 values correspond to FEMA's values for fixed contamination. NCRP, however, does not provide operational units. Users would have to make such calculations for their own types of instruments.

Both NCRP and FEMA documents assume a mixture of radionuclides from a nuclear reactor mix.

FEMA REP-21 is the only one of the documents that addresses portal monitors and suggests one microcurie (1 μCi) as the Standard of Detectability for beta gamma activity.

The CRCPD Handbook focuses on RDD incidents. The screening criteria given in the CRCPD Handbook are in operational units and assume using a modern Geiger-Mueller (GM) pancake probe. CRCPD states the following:

- *With contamination levels up to 1,000 cpm, people can be instructed to go home and shower. This level is equal[2] to 440 dpm/cm^2, compared to the NCRP value of 10,000 dpm/cm^2.*

[2] *Assuming a probe area of 15 cm^2 and 15% counting efficiency.*

- *In case of a large incident or if adequate decontamination resources are not available, the" release level" can be increased to 10,000 cpm (0.05 mR/h using a gamma detector). This is equal to 4,400 dpm/cm^2, compared to the NCRP value of 10,000 dpm/cm^2.*

The CRCPD Handbook also recommends that to minimize spread of contamination at hospitals, you should attempt to decontaminate to levels below 1,000 cpm by using a pancake GM, but only if such decontamination efforts do not interfere with patient medical treatment.

The CRCPD further states that establishing higher decontamination limits (i.e., higher than 10,000 cpm) may be necessary, depending on the number of patients and the decontamination resources available.

The IAEA Manual recommends a somewhat different approach. A single dose rate criterion of 1 μSv/h (0.1 mrem/h) measured at 10 cm from the body is provided. This particular criterion can only be used to assess skin or clothing contamination from strong gamma emitters.

The IAEA also provides the following surface activity criteria, and IAEA's is the only document that provides specific population screening criteria for alpha contamination:

- *>10,000 Bq/cm^2 beta/gamma contamination.*
- *> 1,000 Bq/cm^2 for alpha contamination.*

Note that the IAEA value of 10,000 Bq/cm^2 for beta/gamma contamination equals 600,000 dpm/cm^2, compared to the NCRP decontamination value of 220,000 dpm/cm^2 on any one spot and 10,000 dpm/cm^2 body surface contamination.

The IAEA Manual states that the following were considered in developing these criteria:

- *All important isotopes.*
- *All members of the public, including children and pregnant women.*
- *Inadvertent ingestion of contamination from the skin.*
- *External dose from skin contamination.*
- *Skin contamination as an indicator of inhalation dose.*

The EPA Protective Action Guides (also referred to as EPA-400) was published in 1992 before any of the other documents discussed in this Appendix. It recommends that monitoring and decontamination facilities be established in low background areas. These are areas with gamma exposure rates less than 0.1 mR/h. It also acknowledges that in major radiation incidents, emergency contamination screening stations may need to be set up in areas not qualifying as low background area. EPA-400 recommends that gamma exposure rates in these areas should be less than 5 mR/h.

In either case, EPA's recommended surface screening levels for persons is set at twice existing background. Corresponding levels, expressed in units related to particular survey instruments, may be used for convenience. The EPA screening levels are derived primarily on the basis of what are considered easily measurable radiation levels using portable instruments. EPA-400 further recommends that levels higher than twice existing background (not to exceed 0.1 mR/h) may be used to speed the monitoring process in "very low background areas".

This EPA document is currently being revised, but the recommended surface contamination levels are not expected to change.

Selecting a Screening Criterion

As evident from the preceding discussion, there are a large number of factors to consider in deciding on a screening criterion. The guidance documents consider health-based criteria for establishing limits. CRCPD screening values are somewhat lower than those recommended by FEMA and NCRP. This is due to consideration given to cross-contamination issues, which do not necessarily present a health concern. However, public perception can cause anxiety, lack of confidence, and disruption of other services that could then affect the public health in a different way.

The initial screening criteria must focus on preventing acute health effects and must take into account the magnitude of the incident and availability of resources. The specific operational criteria provided to first responders must match the types of instruments they will be using.

The plan should also be flexible. It may be prudent to use higher screening criteria for people with their own personal transportation or those using transportation provided by emergency response authorities. On the other hand, using more restrictive criteria for people who plan to use uncontrolled public transportation may be warranted.

If the initial screening criterion is isolating an unmanageable number of people for decontamination, the criteria may have to be adjusted upwards. Conversely, if resources allow, a more restrictive criterion may be adopted.

In some circumstances, it may be practical to use physical location based on proximity to the incident site as a criterion for prioritizing the population in most urgent need of assistance with decontamination. Under those circumstances, assist those in the specified zone (without any initial screening) to decontaminate at the scene, and instruct people outside the zone to go home to self-decontaminate.

As a result of these considerations, CDC does not recommend setting, a priori, a fixed screening criterion to be applied to all people for all incidents, under all circumstances. CDC recommends that you and your state radiation control authority, as state planners and decision makers, consider a range of possible circumstances, keeping the following in mind:

- *Population monitoring objectives as described in this planners' guide.*
- *Specific radiation survey instruments your responders will be using (dose rate meters, portal monitors, specific types of surface contamination monitors).*
- *Staffing resources and size of the population you may be expected to process.*
- *Facilities and resources you have for offering on-the-scene monitoring and decontamination.*
- *Availability of other resources that can increase or decrease your available options.*

The planning should be done in advance, allowing some room for flexibility. The emergency responders, however, must have very clear instructions to follow on the basis of your evaluation of the specific local circumstances. CDC is available to assist you in the planning process. In the aftermath of a radiological or nuclear incident, the Federal Advisory Team for Environment, Food, and Health can assist you in establishing practicable screening criteria based on specific local circumstances. [3]

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[3] *The Federal Advisory Team for Environment, Food, and Health develops coordinated advice and recommendations to the coordinating agencies and state and local governments and includes representatives from CDC, the Food and Drug Administration (FDA), the Environmental Protection Agency (EPA), the Department of Agriculture (USDA), the Department of Homeland Security (DHS), and other Federal agencies as needed.*

appendix d

Radiological Screening Criteria— Internal Contamination

Internal contamination occurs when people swallow or breathe in radioactive materials, or when radioactive materials enter the body through an open wound or are absorbed through the skin. Some types of radioactive materials stay in the body and are deposited in different body organs. Over time, the radioactive materials are eliminated from the body in blood, sweat, urine, and feces. This could take days, months, or years, depending on the type of radionuclides and their physical and biological half-lives.

Having internal contamination does not necessarily mean the person is going to experience health problems. Every day, thousands of people in the United States receive diagnostic tests that involve administering traces of short-lived internal radioactive materials on an outpatient basis, and they are released to go home after their procedures.

If the amount of radioactive material is medically significant (this will be discussed later), the person may have an increased risk of developing cancer. In case of extremely high doses, internal contamination with radioactive material could be lethal. However, this is extremely rare.[1] RDD incidents are likely to result in small (most likely inconsequential) amounts of internal contamination.

When a person is internally contaminated, depending on the type of radioactive material he/she is contaminated with, certain medications can be administered to speed up the rate at which the radioactive material is eliminated from the body.[2] Note that internal decontamination is a medical procedure that should only be performed at the order and under the guidance of a licensed physician.

Information about the levels of internal contamination is important in deciding whether any or both of the following are warranted:

- *Medical intervention*
- *Long-term health monitoring*

Decisions about medical intervention are time-sensitive, but decisions about long-term health monitoring can be made in a more deliberative fashion involving all stakeholders.

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[1] *The Polonium-210 targeted poisoning in London (November 2006) is an example*

[2] *National Council on Radiation Protection and Measurement (NCRP) Report No. 65, Management of Persons Accidentally Contaminated with Radionuclides, 1980. [currently under revision]*

Regarding medical management of internally contaminated individuals, presently there is no national guidance or consensus on what internal contamination level would constitute a medically significant amount that warrants intervention.

The amount of internal radioactive contamination is only one of many parameters a physician would evaluate in assessing the need for treatment. A person's age and general health and organ function (kidney, liver, lung, etc.) are among the information physicians would need to make their best medical judgment.

The Medical Preparedness and Response Sub-Group of the U.S. Department of Homeland Security Working Group on Radiological Dispersal Device (RDD) Preparedness provides the following recommendations for treatment of internal contamination[3]:

- *For intakes less than one annual limit on intake (ALI)[4], treatment should not be considered.*
- *For intakes greater than 1 ALI, but less than 10 ALI, "clinical judgment" may dictate treatment.*
- *For intakes greater than 10 ALI, treatment is highly recommended.*

The International Commission on Radiological Protection (ICRP) Publication 96 states that, with the exception of potassium iodide,[5]

"Therapies for internal contamination are not recommended for general population use unless intakes are high. Generally, if the intake is <1 annual limit of intake (ALI), treatment is not usually needed, and if the intake is >10 ALI, treatment is usually indicated."

The ICRP 96 further states in the same paragraph,

"These treatments should be under the direction of a physician experienced in these matters, and should take individual patient factors into account."

In a mass casualty incident, however, it is unlikely that detailed medical evaluations can be made for each person.

The amount of internal contamination also may not be known immediately.

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[3] *The report is dated May 2003 and is available from http://www1.va.gov/emshg/docs/Radiologic_Medical_Counter measures_051403.pdf accessed March 1, 2007*

[4] *For a definition on ALI, consult with experts in your radiation control program, see 10 CFR 20.1003 or visit http://www.nrc.gov/reading-rm/basic-ref/glossary/annual-limit-on-intake-ali.html .*

[5] *ICRP Publication 96: Protecting People Against Radiation Exposure in the Event of a Radiological Attack, 2005. See paragraph 171 on page 80.*

For gamma-emitting radionuclides, field-deployable instruments may be used to perform whole body counting capable of detecting medically significant amounts of internal contamination.[6] Analysis of radioactivity in excreta (e.g., urine) by a clinically certified commercial laboratory or hospital can establish amounts of radioactive material in the body. Although the urine analysis can be performed fairly rapidly (within 24 hours), it takes some time for this information to be available for all the affected and potentially affected population. Therefore, some prioritization scheme for analysis of samples will be necessary. This prioritization can be based in part on radiation measurements using field-deployable instruments or on people's physical location at the time of the incident.

External radiation monitoring can provide some indication of the extent of internal contamination. CRCPD recommends that people with external contamination greater than 100,000 cpm (measured with a Geiger-Mueller pancake probe) should be identified as a priority for follow-up for internal contamination.[7] In case of alpha-emitting radionuclides, only laboratory analysis can provide a definitive assessment.

Furthermore, the physical location of people during the incident can be an additional indicator of the likelihood and magnitude of internal contamination. It may be necessary to recommend treatment for internal contamination for a subset of the affected population only on the basis of their location at the time of the incident.

As part of the planning process, public health authorities should consult with other experts and evaluate the need, relative effectiveness, logistical requirements or limitations, priority for administration of decorporation agents, potential prioritization schemes, and, most importantly, the decision-making process needed to make these clinical judgments in a mass casualty incident.

CDC is available to assist you in the planning process. In the aftermath of a radiological or nuclear incident, assistance can be requested from the Federal Advisory Team for Environment, Food, and Health[8] through the Coordinating Agency.

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[6] *Kramer, Gary H, Capello, Kevin, Hauck, Barry M, The HML's New Field Deployable, High-Resolution Whole Body Counter, Health Phys. 89(5 Suppl):S60-8, November 2005.*

[7] *Handbook for Responding to a Radiological Dispersal Device. First Responder's Guide – the First 12 Hours, Conference of Radiation Control Program Directors, Inc. (CRCPD), September 2006.*

[8] *The Federal Advisory Team for Environment, Food, and Health develops coordinated advice and recommendations to the coordinating agencies and state and local governments and includes representatives from the CDC, the Food and Drug Administration (FDA), the Environmental Protection Agency (EPA), the Department of Agriculture (USDA), the Department of Homeland Security (DHS), and other Federal agencies as needed.*

appendix e

Community Reception Center Specifications

A radiation incident involving mass casualties will require planners to establish one or more population monitoring and decontamination facilities (or “reception centers”) to assess people for exposure, contamination, and the need for decontamination or other medical follow-up. Some community reception centers should be established at or near shelters operated by the American Red Cross.

These reception centers must include staff members and equipment capable of

- *Detecting contamination through beta/gamma portal monitors.*
- *Monitoring for general contamination using hand-held instruments.*
- *Fielding questions and addressing all concerns.*
- *Distributing event and follow-up information.*

It is likely that your community has previously developed plans for responding to other public health emergencies. These plans may already include provisions for establishing alternate care centers to help the majority of the people who may need some assistance or medical care but do not need hospitalization. In some communities, these may be referred to as Neighborhood Emergency Help Centers (NEHC). Plans usually call for these to be set up in well-known locations within the community, such as the area high schools. Many communities also have plans to use these facilities as Points of Dispensing (PODs) for distribution of medical supplies from the Strategic National Stockpile in case of pandemic flu, for example, or other biological threats. These same facilities can also be used as community reception centers because they have very similar functions and similar staffing requirements—the only new requirement would be to add health physics instrumentation and health physics support personnel for radiation monitoring and decontamination.

This appendix describes some of the features and requirement for community reception centers. You can compare the description with what is already included in your public health emergency plan for setting up PODs.[1]

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[1] *For example, see Point of Dispensing (POD) Operations Manual, Philadelphia Department of Public Health, Division of Disease Control, Emergency Preparedness and Bioterrorism Program, 2006. Available from www.phila.gov/ready/bioterrorism.htm*
Also see archived CDC Webcasts, Mass Antibiotic Dispensing: Streamlining POD Design and Operations, available from www2.cdc.gov/phtn/antibiotic3/ , and Mass Antibiotic Dispensing: Taking the Guesswork out of POD Design, available from www2a.cdc.gov/phtn/poddesign/default.asp .

Facility Description

You need to evaluate facilities or sites in your community that potentially could serve as reception centers. You should consider

- *Size.*
- *Location.*
- *Adequate restroom facilities.*
- *Shower (decontamination) rooms or facilities.*
- *Accommodations for people with disabilities.*
- *Environmental control (against excessive heat or cold).*
- *Adequate access and regress control (in case of emergency evacuation).*

To process about 1,000 people per hour, the facility should have about 5,000 square feet of covered space and 8,000 square feet of uncovered space. The chosen locations must have definable entries and exits that can be controlled. Choosing an all-weather facility, like a nearby covered sports arena or convention center, is ideal. However, depending on the circumstances and weather, a nearby park or large parking lot will also suffice. You should establish agreements in advance with facility or site owners and operators.

Staffing

The community reception centers must have sufficient staff, both technical and non-technical, to manage the center for up to several days or weeks. Technical staff members who are competent in the use of radiological survey equipment must be available for monitoring, but having additional staffers for processing and decontamination may also be critical. As federal personnel and others arrive, they should be able to supplement staffing at these centers. One or more clinicians will likely be needed at each center to assess and refer individuals who need medical follow-up or to administer pharmaceutical countermeasures.

Many community public health departments have established Medical Reserve Corps (MRC) with medical and non-medical volunteers to assist in times of public health emergency.[2] MRC volunteers are usually trained to staff PODs, and they can also assist with staffing community reception centers. It is prudent for MRCs to also recruit health physicists or other radiation safety professionals as volunteers.

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[2] *For general information about the Medical Reserve Corps program, see www.medicalreservecorps.gov/*
To locate an MRC in your area, see www.medicalreservecorps.gov/FindMRC.asp

Consider the following staffing needs for each shift. For certain positions (e.g., greeters), consider shorter (4–6 hour) shifts to minimize physical and mental fatigue. The following staffing requirements are recommended for processing 1,000 individuals per hour:

- *Facility Director/Assistant (2 persons per shift).*
- *Greeters (2 greeters per 1,000 people per hour). It is recommended that greeters represent the cultural diversity of the community and be able to converse in languages commonly spoken there.*
- *Uniformed security officers (police/National Guard).*
- *On-site media relations staff.*
- *Crisis (grief) counselors (5).*
- *Hand-held monitoring stations (10).*
    - *Line staff (2 each station, 20 total).*
    - *Radiation monitoring staff (1 each station, 20 total).*
    - *Escort staff (1 each station, 10 total).*
- *Beta/gamma portal monitoring stations (10).*
    - *Line staff (1 each station, 10 total).*
    - *Radiation monitoring staff (2 each station, 20 total).*
    - *Escort staff (1 each station, 10 total).*
- *Registry staff (25).*
- *Nursing/Medical referral stations (10). Clinicians will likely be needed to assess and refer individuals who need medical follow-up. Use same as already planned for POD, NEHC, or alternate care centers in your community. What medical support is needed will depend on the nature and scope of the incident.*

At least one ambulance with emergency medical technicians and paramedics should be available to transfer individuals who are referred by the medical team to hospitals.

In addition, it is prudent to plan for a number of buses (and bus drivers) who can provide transportation on a priority schedule to and from the community reception centers for those who need such transportation.

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[6] *Kramer, Gary H, Capello, Kevin, Hauck, Barry M, The HML's New Field Deployable, High-Resolution Whole Body Counter, Health Phys. 89(5 Suppl):S60-8, November 2005.*

[7] *Handbook for Responding to a Radiological Dispersal Device. First Responder's Guide – the First 12 Hours, Conference of Radiation Control Program Directors, Inc. (CRCPD), September 2006.*

[8] *The Federal Advisory Team for Environment, Food, and Health develops coordinated advice and recommendations to the coordinating agencies and state and local governments and includes representatives from the CDC, the Food and Drug Administration (FDA), the Environmental Protection Agency (EPA), the Department of Agriculture (USDA), the Department of Homeland Security (DHS), and other Federal agencies as needed.*

Supplies

The following list contains some suggested items that would be needed at a community reception center. This is not intended to be a complete listing of all needed supplies.

- ***Contamination control supplies.***
  - *Materials for constructing signs or instruction posters.*
  - *Barriers.*
  - *Step-off pads (tacky mats).*
  - *Plastic bags (variety of sizes).*
  - *Butcher paper (or absorbent floor covering such as disposable painting drop cloths).*
  - *Plastic sheeting.*

- ***Personal protective equipment (PPE).***
  - *Scrubs.*
  - *Coveralls (e.g., Tyvek®) or waterproof surgical gowns.*
  - *Vinyl examination gloves.*
  - *Plastic shoe covers.*
  - *Surgical masks.*
  - *N-95 masks.*
  - *Face shields.*
  - *Duct tape.*
  - *Masking tape.*

- ***Personal decontamination equipment.***
  - *Moist towels or disposable wipes.*
  - *Paper towels.*
  - *Large plastic bags (a variety of sizes to hold clothing).*
  - *Zipper-type bags for small personal items.*
  - *Adhesive labels.*
  - *Soap (mild).*
  - *Shampoo (no conditioner).*
  - *Baby shampoo.*
  - *Plastic sponges.*
  - *Soft nail brushes.*
  - *Towels.*
  - *Clothing items (coveralls or scrubs for people to wear as they exit showers). Various sizes are needed including very large as well as children's sizes.*
  - *Shoes, sandals, or shoe coverings.*
  - *Blankets or heaters for warmth.*
    (Note: Heaters should not blow air across a potentially contaminated area.)

- ***Forms and telecommunications equipment.***
  - *Informational fact sheets to distribute to people at the center.*
  - *Record forms.*
  - *Notebooks.*
  - *Telephone and facsimile machine.*
  - *Computers (laptops) and Internet connectivity (if possible).*
  - *Photocopiers. (Copying driver's license with current information may expedite the registry process.)*

- ***Sample collection.***
  - *Appropriate administrative forms (e.g., consent forms).*
  - *Urine sample collection kit.*
  - *Blood sample collection kit.*
  - *Chain-of-custody documentation.*

- ***Radiation detection and measurement equipment.***
  - *Geiger-Mueller (GM) pancake probes with rate meters (10).*
  - *Hand-held alpha contamination monitors (only if alpha contamination is suspected) (10).*
  - *Beta/gamma portal monitors (10).*

  Note that these instruments require periodic calibration and maintenance. For specific information on these instruments and their maintenance requirements, consult with health physics experts in your state radiation control program.

- ***Miscellaneous supplies.***
  - *Large garbage bags.*
  - *55-gallon waste drums.*
  - *Folding chairs. (At various places in the monitoring and decontamination facility, folding chairs should be available in temporary waiting areas. Some people, particularly the elderly, may find it difficult to stand for an hour or more until they get cleared through the monitoring process.)*
  - *Drinking water.*
  - *First-aid kits.*
  - *Defibrillator.*
  - *Portable toilet facility (outside area only).*
  - *Portable sinks or tubs (outside area only).*

appendix f

Pharmaceutical Radiation Countermeasures in the Strategic National Stockpile

The Strategic National Stockpile (SNS) maintains several drugs that can be used to treat patients who are internally contaminated with certain radionuclides or who are externally exposed to radiation. The decision to administer such drugs is a medical one that must be made by appropriate medical authorities. However, public health planners can benefit from a basic understanding of what these drugs can do and what their limitations are.

As part of the planning process, public health authorities should consult with other experts and evaluate the need, relative effectiveness, logistical requirements or limitations, priority for administration of decorporation agents, potential prioritization schemes, and, most importantly, the decision-making process needed to make these clinical judgments in a mass casualty incident.

This appendix provides an overview of the four (4) pharmaceutical radiation countermeasures that are currently available from the SNS. These are

- *Potassium iodide (KI).*
- *Prussian blue.*
- *DTPA*[1] *(calcium and zinc).*
- *Neupogen®.*

The first three drugs are used to treat internal contamination and are approved by the U.S. Food and Drug Administration (FDA) for this use. The fourth drug, Neupogen®, can be used to treat acute radiation syndrome (ARS). Although this drug is commonly used to treat patients undergoing radiotherapy and chemotherapy procedures, its use to treat ARS patients is not yet approved by FDA.

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[1] *Diethylene triamine pentaacetate.*

For more detailed descriptions of these drugs, dosing requirements, and other clinical information and related fact sheets, you may refer to the following Web sites:

- ***FDA Center for Drug Evaluation and Research (CDER)***
  http://www.fda.gov/cder/drugprepare/default.htm

- ***U.S. Centers for Disease Control and Prevention***
  http://www.bt.cdc.gov/radiation/

Potassium Iodide (KI)

KI is a blocking agent that comes in the form of a tablet. It protects the thyroid gland against absorption of radioactive iodine. It is important to note that KI can only be effective when radioactive iodine is a contaminant of concern. It offers no protection for other radionuclides. It also does not protect against external exposure to radiation.

There is a finite period of time immediately before and after inhaling or ingesting radioactive iodine during which KI can be effective. Often, the best measure of protection is to avoid the radioactive material in the first place. Protective measures that public health authorities may recommend include evacuation or seeking shelter. When it is warranted, they may advise against consumption of milk or other food products as the best method to avoid internal contamination. KI is usually regarded as a potential supplementary measure of protection, not a primary one, even in cases of radioactive iodine contamination.

Public health officials in states with operating nuclear power plants and communities surrounding nuclear power plants are already familiar with KI and its potential use in case of an off-site release of radioactive iodine from the power plants. If you live in a state or a community without nuclear power plants, you may consult your colleagues in other states about how their communities have incorporated KI in their emergency plans. Another resource is the following report by the National Academy of Sciences:

- *Distribution and Administration of Potassium Iodide in the Event of a Nuclear Incident, National Academies Press, 2004. http://books.nap.edu/catalog.php?record_id=10868*

Prussian Blue

Prussian blue is used to treat internal contamination by radioactive cesium and thallium.[2] It binds to radioactive cesium or thallium in the gut and speeds up its excretion from the body through feces. Prussian blue is administered orally and comes in the form of a capsule.

Prussian blue is not effective for radionuclides other than cesium or thallium. It also does not protect against external radiation.

Prussian blue is technically a dye, and some formulations have industrial applications in the form of paint, dye, or stain. Therefore, there may be supplies of Prussian blue used in these applications. For administrating to people, it is advisable to use only the FDA-approved formulations.

DTPA

DTPA is used to treat internal contamination by plutonium, americium, and curium. It acts by chelating (or binding) these radionuclides in the blood stream and speeding up their excretion from the body through urine. DTPA is not currently available as an oral medication. It is typically administered through intravenous injection. Therefore, providing this drug to a large number of contaminated or presumptively-contaminated people may present logistical challenges, especially in a resource-depleted environment.

DTPA comes in two forms: calcium (Ca-DTPA) and zinc (Zn-DTPA). When given within the first day after internal contamination has occurred, Ca-DTPA is about 10 times more effective than Zn-DTPA at chelating plutonium, americium, and curium. After 24 hours have passed, Ca-DTPA and Zn-DTPA are equally effective in chelating these radioactive materials. As is usual with these types of drugs, there are additional considerations for children and pregnant or breast-feeding women.

Chelating agents work best when given shortly after radioactive materials have entered the body. The more quickly the radioactive material is removed from the body, the fewer and less serious the health effects will be. After 24 hours, plutonium, americium, and curium are harder

[3] *Prussian blue has also been used to treat contamination with non-radioactive thallium (once an ingredient of rat poison).*

to chelate. However, DTPA can still work to remove these radioactive materials from the body several days or even weeks after a person has been internally contaminated.

DTPA does not protect against external radiation.

Neupogen®

This drug is different from the previous three drugs in that it is not used to treat internal contamination with any radionuclide. Neupogen® belongs to a class of drugs known as “colony stimulating factors,” or CSF, and it is used to treat one of the more serious adverse effects of acute radiation syndrome—bone marrow suppression. This is a condition in which the body is not producing enough white blood cells and is therefore more susceptible to infections.

Neupogen® can stimulate the bone marrow to produce more white blood cells.
It is administered intravenously.

Public health officials should know that although Neupogen® has been stockpiled for this purpose, it has not been approved by the FDA for the treatment of bone marrow suppression following acute radiation exposure. Neupogen would be administered to victims of acute radiation syndrome either as an Investigative New Drug or under an Emergency Use Authorization from the FDA. CDC currently holds both the Investigative New Drug and Emergency Use Authorization applications with the FDA for the use of Neupogen® in a nuclear or radiological incident.

You should note that use of any of these pharmaceutical countermeasures is not needed for low levels of exposure to radiation or low levels of internal contamination. The estimation of the levels of exposure or contamination is made by the appropriate radiation control authority and health physics specialists. The decision whether to treat people with any of these pharmaceutical countermeasures is made by appropriate medical authorities.

In the aftermath of a nuclear or radiological incident, the emphasis should be on minimizing public exposure to radiation and minimizing the chances of radionuclides’ entering the body by providing timely and appropriate recommendations for protective actions the public can take. ***Where prevention of exposure or contamination is possible, the need for pharmaceutical countermeasures can potentially be avoided.***

appendix g

Additional Considerations after a Nuclear Detonation

One assumption in defining the scope of this planners' guide was that the local response infrastructure remained relatively intact. This assumption is not likely to hold in the case of a nuclear detonation (military weapon or improvised nuclear device). The public health authorities responding to a nuclear detonation are likely to be from surrounding communities that are less affected by the detonation and from even further distant communities that may be receiving dislocated populations from the impacted areas.

This appendix describes how key concepts provided in this planners' guide can be used to prepare for population monitoring after a nuclear detonation. It also provides additional considerations that may be helpful in managing public health resources in such an emergency.

In a nuclear emergency, the guiding principles of population monitoring outlined in this planners' guide still apply. The following are the most pertinent of these:

- *The first priority is to save lives: respond to and treat the injured first.*
- *Initial population monitoring activities should focus on preventing acute radiation health effects.*
- *Scalability and flexibility are an important part of the planning process.*

what are the objectives of population monitoring after a nuclear detonation?

The objectives of population monitoring, as stated in this planners' guide, are also applicable to a nuclear detonation. These objectives, in the order of priority, are to

1. *Identify individuals whose health is in immediate danger and who need immediate care or medical attention (whether radiation-related or not).*
2. *Identify people who may need medical treatment for contamination or exposure, further evaluation, or short-term health monitoring.*
3. *Recommend (and to the extent possible, facilitate) practical steps to minimize risk of future health consequences (e.g., cancer).*
4. *Register potentially affected populations for long-term health monitoring.*

In a radiological incident (such as the detonation of a "dirty bomb"), it is expected that the majority of the population will be cared for under Objective #3. This is because relatively few casualties are expected from the conventional explosion and because it is not expected that people will be contaminated with amounts of radioactive material that will be immediately hazardous to their health.

However, after a nuclear detonation, focus will be on Objective #1. The number of people who would need immediate medical care is almost certain to overwhelm available resources. Models of a small improvised nuclear device detonation predict upwards of 300,000 victims who will have a variety of immediate medical needs.[1] Therefore, the focus should be placed on (1) locating people who need immediate medical care and (2) providing that care. Extensive search and rescue operations will require accompanying health physics support and expertise due to the residual radiation environment. Providing medical care to those immediately in need will likely consume all of the available medical staff's time and resources.

are there any radioactive contamination issues?

The potential contamination issues will be very significant. A terrorism-related nuclear detonation is likely to be a ground-burst that causes significant nuclear fallout. This can result in additional (but avoidable) casualties. Emphasis should be placed on preventing or minimizing exposure to nuclear fallout. By issuing timely recommendations for protective action (what to do or what to avoid doing), public health authorities can help people in the community minimize their exposure to nuclear fallout.

are community reception centers still needed?

Absolutely. A multitude of community reception centers will have to be established in surrounding communities, perhaps stretching as far as hundreds of miles away, to address the needs of people who have been displaced because of the blast or evacuated because of the fallout. The needs in this population− such as monitoring for external and internal contamination

[1] *Weisdorf D, Chao N, Waselenko JK, Dainiak N, Armitage JO, McNiece I, Confer D (2006). Acute Radiation Injury: Contingency Planning for Triage, Supportive Care, and Transplantation. Biology of Blood and Marrow Transplantation 12(6):672-82.*

and providing clothing, shelter, and counseling−are similar to those described in this planners' guide.

Care facilities established near the detonation site will be focused on providing immediate medical care to those who are injured. Monitoring for radioactive contamination, decontamination, and other issues typically addressed at reception centers will be a secondary priority there.

what types of injuries are expected from a nuclear blast?

For more detailed information regarding medical management of radiation injuries, health care providers will find the following Web site a helpful resource:

> ***Radiation Event Medical Management (REMM)—Guidance on Diagnosis and Treatment for Health Care Providers***
> *http://www.remm.nlm.gov/*

The following overview is provided for public health planners.

People who survive the immediate effect of a nuclear detonation are likely to suffer from combined injury. That means in addition to radiation exposure, they have sustained burns and physical trauma.

People who are exposed to radiation fall into one of three general categories:

1. *Individuals who may be expected to make a full recovery from their radiation exposure with little or no medical intervention.*
2. *Individuals who are unlikely to survive regardless of the level of medical care provided.*
3. *Individuals whose survival will depend on the careful administration of supportive care. The ability to deliver supportive care will depend on the number of casualties and available resources.*

Supportive care for acute radiation syndrome (ARS) includes several modalities. While administration of colony stimulating factors (CSFs; cytokines) is critical to recovery, the provision of high-quality intensive nursing care is equally important to ensuring long-term survival of ARS patients. Supportive care interventions requiring skilled physician and nursing care include the following:

- *Antibiotics, antiviral, and antifungal medications.*
- *Antiemetics to control vomiting.*
- *Antidiarrheals.*
- *Fluid and electrolyte resuscitation.*
- *Pain management.*
- *Endotracheal intubation.*
- *Blood products.*
- *Stem cell transplantation.*
- *Cytokines and other medical countermeasures.*
- *Combined injury management (i.e., treatment of burns and other injuries). Individuals requiring surgical intervention should undergo necessary surgery within 36 hours and no later than 48 hours post-injury*

People who have sustained combined injury represent a separate triage category. These individuals, depending on their radiation dose and the nature of their trauma, have a higher risk for a poor prognosis. As the number of victims rises in a nuclear mass casualty incident, and because the management of ARS victims is complex and resource intensive, medical authorities working in resource-depleted conditions may be faced with making difficult decisions to focus on patients with better prognoses for survival.[2]

Clearly, any available resources will be directed toward these life-saving activities in support of the first objective of the population monitoring process.

[2] *Waselenko JK, MacVittie TJ, Blakely WF, Pesik N, Wiley AL, Dickerson WE, Tsu H, Confer DL, Coleman CN, Seed T, Lowry P, Armitage JO, Dainiak N (2004). Medical Management of the Acute Radiation Syndrome: Recommendations of the Strategic National Stockpile Radiation Working Group. Annals of Internal Medicine 140:1037-51.*

appendix h

Additional Resources

This resource list is not intended to be all-inclusive. A number of Web sites are identified that may be helpful to public health planners as they address the issue of population monitoring in their communities:

- ***Conference of Radiation Control Program Directors, Inc. (CRCPD)***
  http://www.crcpd.org/
  If you want to know who the radiation control authority is in your state, contact CRCPD at 502-227-4543 or visit http://www.crcpd.org/Map/map.asp.

- ***Department of Health and Human Services***
  Office of the Assistant Secretary for Preparedness and Response (ASPR)
  http://www.hhs.gov/aspr/

- ***Centers for Disease Control and Prevention (CDC)***
  http://www.bt.cdc.gov/radiation
  404-498-1800 (for questions about this planners' guide)
  770-488-7100 (for emergencies only)

- ***ATSDR Rapid Response Registry***
  https://www.rapidresponseregistry.org

- ***The Food and Drug Administration (FDA)***
  http://www.fda.gov/cder/drugprepare/default.htm#Radiation

- ***Radiation Emergency Assistance Center/Training Site (REAC/TS)***
  http://orise.orau.gov/reacts/med-countermeasures.htm
  865-576-3131
  865-576-1005 (after hours)

- ***Radiation Event Medical Management (REMM) – Guidance on Diagnosis and Treatment for Healthcare Providers***
  http://www.remm.nlm.gov/

- ***Communicating in the First Hours***
  http://www.bt.cdc.gov/firsthours/

Initial communication with the public during a potential terrorism incident.
Resources on this CDC Web site include short and extended messages giving health and safety information for the first few hours, message templates, B-roll, and sound bites.

- ***Terrorism and Other Public Health Emergencies: A Reference Guide for Media***
  http://www.hhs.gov/emergency/mediaguide/PDF/
  Request a free copy by telephone at 240-629-3161.

- ***U.S. Environmental Protection Agency. Communicating Radiation Risks: Crisis Communications for Emergency Responders.***
  EPA-402-F-07-008, Washington, DC. Government Printing Office, 2007 (expected publication date).

- ***Responder Knowledge Base is a Web-based information service for the emergency responder community funded by the Department of Homeland Security (DHS) and hosted by the National Memorial Institute for the Prevention of Terrorism.***
  https://www.rkb.mipt.org/