

# **Individual Preparedness and Response to Chemical, Radiological, Nuclear, and Biological Terrorist Attacks**

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This report presents an individual's strategy for preparing for, and responding to, terrorist attacks involving chemical, radiological, nuclear, and biological weapons. The objective is to provide simple and clear guidance for individuals to help them protect themselves in the event of an actual terrorist attack, which may involve extremely hazardous and unfamiliar conditions. Steps individuals are now taking or might take to avoid such attacks are not considered in this report.

In fall 2002, the Alfred P. Sloan Foundation asked RAND to conduct this study in an effort to develop guidance for individuals that would complement terrorism preparedness efforts at the local and national government levels. The result is an empirically based strategy that individuals can adopt and implement on their own.

Beyond individuals, government agencies and nongovernmental organizations charged with emergency preparedness, response, and management are encouraged to integrate this material into their plans, training, education, and public awareness campaigns. In addition, the report outlines the important roles that government and businesses play in enabling some of the individual's actions.

The reference card included at the back of the report encapsulates the key recommendations in the individual's preparedness and response strategy and can be removed for display in a prominent place. This strategy is also available in the form of a quick guide. See *Individual Preparedness and Response to Chemical, Radiological, Nuclear, and Biological Terrorist Attacks: A Quick Guide*, Santa Monica Calif.: RAND, MR-1731/1, 2003.

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## **OVERVIEW**

This report defines a strategy that individuals could adopt to prepare for, and respond to, terrorist attacks involving chemical, radiological, nuclear, and biological weapons. Although the characteristics of such attacks may vary widely, they can all inflict severe damage and, as a result, create circumstances in which individuals would need to be concerned with protecting their safety and health and perhaps even their own lives.

The likelihood of such terrorist attacks is highly uncertain. Focusing on terrorist attacks involving chemical, radiological, nuclear, and biological weapons does not imply anything about their probability. Indeed, numerous recent terrorist attacks in the United States, including those in Oklahoma City and at the World Trade Center and the Pentagon, involved conventional weapons with catastrophic effects. Nonetheless, providing individual guidance for such attacks is important for several reasons. First, such attacks create conditions that can be extremely dangerous, so it is essential for individuals to know what protective actions to take to avoid injury or death. Second, the effects of such weapons are unfamiliar to most people and so individuals may find themselves in situations in which their instincts and conventional wisdom may be wrong. Finally, the recent heightened concern over terrorism has spurred demands for individual guidance for attacks involving chemical, radiological, nuclear, and biological weapons.

The Department of Homeland Security has taken an important step in launching the Ready campaign. A description of the various activities in this campaign can be found on its web page: [www.ready.gov](http://www.ready.gov) (U.S. Department of Homeland Security, 2003a). We view our recommendations as further developing these and other recent terrorism preparedness guidelines.

## **SCENARIO APPROACH TO DEVELOPING AN INDIVIDUAL'S STRATEGY**

To develop an individual's strategy, we designed an approach that began with scenarios and involved five steps:

- Develop scenarios that span the range of terrorist attacks involving chemical, radiological, nuclear, and biological weapons.
- Define the needs of individuals in each scenario, with a focus on those primary to their survival, safety, and health.
- Identify potential actions to meet those needs, drawing heavily on the actions recommended today in emergency preparedness guidelines.
- Evaluate the potential actions to determine their ability to prevent, protect against, or minimize injury from the attack.
- Assemble effective actions into a strategy that an individual could adopt to prepare for, and respond to, terrorist attacks involving chemical, radiological, nuclear, and biological weapons.

The strategy that emerged from this approach involves actions that individuals can take that can save lives, even in catastrophic situations. These actions differ in important ways from how individuals should prepare for natural and other types of disasters. They are appropriate regardless of the likelihood of an attack, the scale of an attack, or whatever the government alert level. They are designed to be sensitive to potential variations in how such attacks might unfold but are also presented in ways to prepare individuals for surprises. Although comprehensive in character, the strategy is defined in terms of simple goals and rules that should be easy for an individual to adopt both to prepare for and respond to terrorist attacks.

At the same time, we appreciate that any preparedness strategy will need to be refined and updated continually, both as opportunities arise for further analysis and to account for the evolving nature of the terrorist threat.

## **OUR RECOMMENDED INDIVIDUAL'S STRATEGY**

The individual's strategy that we recommend begins with specific actions that individuals would take in response to four types of terrorist attacks: chemical, radiological, nuclear, and biological. For each of the four types of terrorist attacks, the strategy provides the context in which individuals will be acting, what their overarching goals should be, and why these responses are appropriate and others are not. The strategy goes on to list the priorities individuals should have in responding, because one's initial instincts may not always be the

right ones. The strategy concludes by defining those preparatory steps that individuals should take to be able to respond in these recommended ways. While not a part of our individual's strategy, enabling government and business actions will be important to its success, and so these are included as well.

## Response Strategy: Chemical Attack

Box S.1 (below) summarizes the response strategy for a chemical attack.

Chemical attacks entail the dispersal of chemical vapors, aerosols, liquids, or solids and affect individuals through inhalation or exposure to eyes and skin. Numerous chemical agents could be used in a terrorist attack, including both industrial chemicals and chemical warfare agents. Chemical weapons act very quickly, often within a few seconds. As a result, government officials are unlikely to be able to give warning or guidance. Individuals must act almost instantly and on their own to minimize exposure. Critical to an individual's response will be knowing where the chemical attack has occurred (outdoors or indoors) and then taking actions in light of where one is in relation to that release. An individual's overarching goal would be to find clean air very quickly.

If the chemical attack is outdoors, sheltering inside and taking steps to close off the air flows provides protection by keeping out the chemical agent that is so dangerous when inhaled. However, because shelters cannot be entirely sealed

### Box S.1

#### Overarching Goal

*Find clean air very quickly.*

#### Specific Actions

1. *If attack is outdoors and you are outdoors, take shelter quickly in the closest building, close all windows/doors, and shut off the flow of air. If inside, stay inside. Then, to the extent possible, move upstairs, find an interior room, and seal the room. Remain inside until told it is safe to leave, and then ventilate and vacate the shelter immediately.*
2. *If attack is indoors, follow chemical attack response plans specific to your building. If these are not available, open windows and breathe fresh air. If open windows are not accessible, evacuate (using escape hood if available) by stairs to street or roof.*
3. *Once protected from chemical agent exposure, decontaminate by removing clothes and showering.*
4. *When conditions are safe to move about freely, seek medical treatment.*

from chemical agents, an individual needs to vacate the shelter as soon as it is safe. Knowing when it is safe will likely require guidance from emergency officials. Evacuation in such attacks is not recommended because individuals could not discover soon enough where it would be safe to evacuate to. Neither is using respiratory protective equipment recommended in an outdoor chemical attack because it would provide protection only if it could be done within a minute or less, and this is probably not feasible.

Finding clean air is particularly challenging in an indoor chemical attack, given the variations in ventilation systems. Consequently, response plans designed specifically for particular buildings should be followed. If no specific plan is available, the following strategy should be used. The most direct way to get fresh air is to open a window or door to the outside. If that option is not available, individuals should evacuate the building by the stairs to the street or, if closer and known to be accessible, to the roof. Because a risk exists that evacuation will involve moving through areas with dangerous concentrations of chemical agents, evacuation can be made safer by using an emergency escape hood.<sup>1</sup> However, because escape hoods are costly and require advance training, using one may not be an option for many individuals. Individuals should evacuate the premises whether they have a hood or not because the alternative of sheltering in an interior space creates potentially more serious dangers.

Once an individual has obtained a reliable source of clean air, decontamination (remove and bag clothing, wash with soap and water) should be undertaken, because of the residual dangers of the chemical agents.<sup>2</sup> Given the range of potential medical effects of chemical agents, anyone potentially exposed should also seek medical care.

### **Response Strategy: Radiological Attack**

Box S.2 (next page) summarizes the response strategy for a radiological attack.

A dirty bomb is likely to use conventional explosives to disperse radioactive material quickly across a wide area. The primary short-term exposure hazard is inhalation of radioactive material suspended with the dust and smoke from the explosion. A second, long-term hazard exists for many years for individuals

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<sup>1</sup>An emergency escape hood is a soft-sided pullover hood with an elastic neck seal. These hoods provide chemical and biological air filtration for 15–60 minutes to enable the wearer to exit dangerous environments. Because there is no face seal, hoods require no fit-testing and are compatible with eye glasses and facial hair. As with any respiratory protection, users should be trained on proper employment of the hood. Escape hoods should only be used when issued as part of a workplace or other organizational safety program.

<sup>2</sup>Contaminated clothing should be treated or disposed of in accordance with official guidance.

**Box S.2****Overarching Goal**

*Avoid inhaling dust that could be radioactive.*

**Specific Actions**

- 1. If an explosion occurs outdoors or you are informed of an outside release of radiation and you are outside, cover nose and mouth and seek indoor shelter. If you are inside an undamaged building, stay there. Close windows and doors and shut down ventilation systems. Exit shelter when told it is safe.*
- 2. If an explosion occurs inside your building or you are informed of a release of radiation, cover nose and mouth and go outside immediately.*
- 3. Decontaminate by removing clothing and showering.*
- 4. Relocate outside the contaminated zone, only if instructed to do so by public officials*

who remain in the contaminated areas. The levels of radiation will be quite low, and, except for individuals injured by the explosion, the health effects will manifest themselves only after many years in the form of an elevated risk of cancer. As authorities are unlikely to detect the radiation immediately, individuals will need to respond on their own, without knowing whether radiation is present.

Critical to an individual's response will be identifying where the radiological attack has occurred (outdoors or indoors) and then taking actions appropriate for where one is in relation to release of the radiation. The individual's overarching goal would be to avoid inhaling dust that could be radioactive.

Individuals can protect themselves against radiological dust by quickly moving inside or outside—as appropriate, depending on where the explosion occurs—and covering their nose and mouth, using cloth or a particulate filter-equipped (dust) mask. A complication is that it is unlikely to be apparent for some time that radioactive material has been released. However, these actions are generally advisable in any explosion because many types of nonradioactive dust present health hazards and should be avoided as well. Evacuating the area immediately is not recommended because it cannot be accomplished in time to avoid the danger of inhaling radiation. Individuals on their own will also have little way of knowing the direction or extent of the radioactive contamination and, thus, where or how to find safety.

Anyone who has been exposed to radioactive material should undergo decontamination (remove and bag clothing, wash with soap and water) once safely sheltered from the source of radioactive material. Although contamination

levels from a radiological weapon are likely to be quite low, the possibility of long-term exposure may be high enough in some areas that authorities will ask individuals to leave their homes or businesses for an extended period. Individuals should seek medical attention after officials tell them that it is safe to do so.

### Response Strategy: Nuclear Attack

Box S.3 (below) summarizes the response strategy for a nuclear attack.

A nuclear explosion has immediate blast effects that knock over buildings. It also produces high-energy radiation and extreme heat. After 10–15 minutes, highly lethal radioactive material begins to fall out of a cloud that can extend for tens of miles. A nuclear detonation will be unmistakable the moment it occurs, but individuals are unlikely to receive any warning, guidance, or support from officials for up to several days. Critical to an individual's response will be locating the area of this radioactive cloud. The individual's overarching goal would be to avoid fallout by either evacuating the fallout zone quickly or seeking the best available shelter.

Evacuating out of the path of the radioactive cloud within 10 minutes provides highly effective protection against the fallout danger and is possible for individuals able to walk, even in the time available, given the relatively short distances. Finding the right way out of the path of the radioactive cloud requires effort but

#### Box S.3

##### Overarching Goal

*Avoid radioactive fallout: evacuate the fallout zone quickly or, if not possible, seek best available shelter.*

##### Specific Actions

1. *Move out of the path of the radioactive fallout cloud as quickly as possible (less than 10 minutes when in immediate blast zone) and then find medical care immediately.*
2. *If it is not possible to move out of the path of the radioactive fallout cloud, take shelter as far underground as possible, or if underground shelter is not available, seek shelter in the upper floors of a multistory building.*
3. *Find ways to cover skin, nose, and mouth, if it does not impede either evacuating the fallout zone or taking shelter.*
4. *Decontaminate as soon as possible, once protected from the fallout.*
5. *If outside the radioactive fallout area, still take shelter to avoid any residual radiation.*

is not as difficult as it may first seem. The cloud is likely to cover a portion of the blast zone, so anyone there should move directly away from the blast center (away from the location of initial bright flash and from the greatest damage) until clear. The approximate location of the rest of the radioactive cloud can be determined by the direction in which the wind seems to be blowing the cloud. Individuals should move cross-wind until out from underneath the cloud. Once safe, individuals should find medical care immediately.

If evacuating is not possible, then sheltering is essential. Sheltering from nuclear fallout requires getting as much solid material (dirt, concrete, or masonry) and space as possible between the individual and the radioactive fallout. Such sheltering would be required for at least 24 to 48 hours. If the individual cannot get to an underground shelter within the timelines of the arrival of the radioactive fallout, the next-best shelter would be on the upper floors of a multistory building (greater than 10 stories), but at least three stories below the roof to avoid the fallout deposited there.

Individuals moving out of the path of the radioactive cloud can gain some additional protection by covering their skin, nose, and mouth, but this should be done only if it causes no more than a few moments delay in evacuating the fallout zone or finding shelter. Once protected from the fallout, people should decontaminate themselves. Those anywhere outside this fallout area should also take shelter, in their house or building basements, given the uncertainties about exactly where the radioactive cloud will travel.

### **Response Strategy: Biological Attack**

Box S.4 (next page) summarizes the response strategy for a biological attack.

Biological attacks can involve two basic types of biological agents: contagious and noncontagious. Some agents (possibly anthrax) can survive in the environment for extended periods and cause further risk of exposure if the agent is resuspended into the air.

Each disease has its own timeline that depends on the properties of the biological agent. Most biological agents possess the unique feature that the attack may not be recognized until days later, after the incubation period of the disease. What this means is the government will play a central role in identifying the attack and guiding individuals about what to do. At the same time, the government will face many challenges in providing appropriate medical care, especially when many essential services will be disrupted. So individuals will need to be ready to act on their own, even in covert attacks, to achieve the overarching goal: to get medical aid and minimize further exposure to agents.

**Box S.4****Overarching Goal**

*Get medical aid and minimize further exposure to agents.*

**Specific Actions**

1. *If symptomatic, immediately go to medical provider specified by public health officials for medical treatment.*
2. *If informed by public health officials of being potentially exposed, follow their guidance.*
  - *For contagious diseases, expect to receive medical evaluation, surveillance, or quarantine.*
    - *If “in contact” with persons symptomatic with smallpox, obtain vaccination immediately.*
  - *For noncontagious diseases, expect to receive medical evaluation.*
    - *For anthrax, obtain appropriate antibiotics quickly.*
3. *For all others, monitor for symptoms and, for contagious diseases, minimize contact with others.*
4. *Leave anthrax-affected area once on antibiotics if advised to do so by public health officials.*

Critical to an individual's response will be knowing whether the biological agent is contagious or not and then whether he or she has been exposed. This strategy defines actions in general for contagious and noncontagious agents and then describes the guidance that individuals today would expect to receive for smallpox and anthrax, contagious and noncontagious agents, respectively, for those cases when the attacks are identified through clinical diagnosis.<sup>3</sup>

Individuals would be instructed to get medical treatment immediately if they are symptomatic. Anthrax can be countered with aggressive antibiotic treatment. Although no cure for smallpox exists, chances of survival improve with medical care.

Those individuals *potentially* exposed in a biological attack are those not showing symptoms but who were either present in the area of the attack or, in the case of a contagious agent, exposed to those who were. The primary concern for these individuals is the heightened probability that they may have been

<sup>3</sup>We include biological toxin agents, such as botulinum toxin or ricin, under biological attacks because, while their effects in the body are chemical in nature and they do not contain organisms or viruses, the consequences of the attack might not be realized for hours or even a few days and so the steps an individual would take would be similar to those for an attack involving noncontagious biological agents.

infected but are not yet showing symptoms. These individuals will be identified by public health officials.

For contagious diseases, individuals should expect and closely follow guidance from public health officials about the possible need for medical evaluations, medical surveillance, or quarantine. This helps ensure that if they become symptomatic they are treated quickly for their own safety and that they also do not infect others.

In the case of smallpox, individuals potentially exposed fall into two groups: those “in contact” with persons infected with smallpox and those present in the release area at the time of the attack or over the next two days. Because smallpox is thought to be contagious from the time a patient develops a rash until scabs have formed, it is critical that individuals “in contact” with those persons receive a smallpox vaccination as quickly as possible.<sup>4</sup> Smallpox is the only known potential biological weapon for which postexposure vaccination has proven value, if given within three to seven days after exposure. In the case where a smallpox attack is identified more than seven days after the exposure, vaccination is unlikely for those individuals in the area at the time of attack because their exposure will have occurred too long ago for vaccination to be effective.

For noncontagious diseases, individuals should expect and closely follow guidance from public health officials about the possible need for medical evaluations and, in the case of anthrax, receive antibiotic therapy, which is useful for prevention in those who have been infected with anthrax spores. Individuals potentially exposed to anthrax include those present in the release area at any time since the attack.

Considerable uncertainty exists about the extent to which anthrax spores released in the air can become resuspended again after they have settled on the ground, thereby presenting a continuing health hazard. To avoid long-term dangers, officials may call for individuals in the affected area to relocate themselves to housing in other areas.

Because biological attacks will most likely be undetected for many days, the threat of being infected by the release is long past by the time individuals become aware of an attack. Thus, there is no practical benefit at this point to protect oneself by taking shelter or pursuing forms of respiratory protection

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<sup>4</sup>The contagious period is approximately 12 days, beginning 12–16 days after infection (Henderson et al., 1999). A “contact” is an individual who has come into close contact with an infected person while that person is contagious, as well as household members of those contacts (CDC, 2003a). Close contact is defined as living in the same home as someone who has smallpox or spending at least three hours in the same room with someone who has smallpox (CDC, 2003a).

(e.g., wearing particulate masks). If an attack were, however, identified at the time, such respiratory protection and sheltering would provide effective protection.

For sheltering and respiratory protection to be useful in a covert attack, they would need to be in place at the time. Possibilities for passive, “always-on” sheltering or respiratory protection exist, and these are discussed below as a useful preparatory action.

### **Response Strategy: Priorities**

Box S.5 (below) summarizes the priorities to take as part of the individual’s strategy.

In responding in these ways to these potential terrorist attacks, it will be important for an individual to act with a set of clear priorities because an individual’s initial instincts may be wrong. Stopping to help others or acting to contact family and friends is a natural reaction. However, such actions could put an individual’s own survival at risk, where taking the recommended actions needs to happen quickly. Given the dangers to an individual’s body of radiological dust, radioactive fallout, and chemical agents, an individual’s next priority needs to be to take decontamination steps. In the case of helping others, most individuals will not be qualified medically to provide treatment in these types of terrorist attacks. Only after individuals have ensured their own safety should they attempt to contact family members or friends.

### **Preparatory Actions**

To accomplish the actions necessary to respond to the different types of attacks discussed above, an individual will need to take preparatory actions, the most critical one being to gain an understanding of what will be required and why. (See Table S.1.) Beyond this, advance plans can facilitate family communications, provide for long-term shelter, ensure proper medical treatment, and prepare for safe building evacuations and sheltering. A few items are important to have in an individual’s emergency kit for terrorist attacks. One is a dust mask

#### **Box S.5**

- 1. Act first to ensure your own survival.*
- 2. Take steps to decontaminate yourself.*
- 3. Help others if it is safe to do so.*
- 4. Make contact with family/friends.*

**Table S.1**  
**Preparatory Actions**

Preparatory Action	Chemical	Radio-logical	Nuclear	Biological
Gain understanding of what will be required to accomplish response actions in each type of terrorist attack				
Learn to recognize characteristics, dangers, and effects	X	X	X	X
Understand individual response strategy	X	X	X	X
Prepare to act without official guidance	X	X	X	
Facilitate response actions by making plans and gathering information in advance				
Develop family plans for communicating and gathering	X	X	X	X
Plan for long-term shelter		X	X	X
Learn about appropriate kinds of medical treatment from medical professionals				X
Discover what plans exist for evacuation in building you occupy frequently	X	X		
Find potential shelters near home, school, or workplace	X	X	X	
Ensure general emergency kit accounts for terrorist attacks				
Dust mask		X	X	X
Battery-powered radio	X	X	X	
Duct tape and plastic sheeting	X			
Enhance protection through passive steps				
Weatherize home				X
Install good-quality particulate filters				X

with an 95-rated particulate filter, which protects against radiological dust and fallout as well as from biological agents. They are inexpensive and can be stored easily at home, at work, and in the car. Another is a battery-operated radio that could be a critical tool in providing information regarding when it is safe to vacate shelters and for receiving other instructions from government officials after chemical, radiological, and nuclear attacks. In the event of a chemical release, duct tape and plastic sheeting would be useful in sealing openings in a shelter that could admit chemical agents. Finally, protection against a biological attack can be improved by creating barriers to biological agents (weatherizing homes) and by installing high-quality particulate filtering systems that can remove contaminants from indoor air. To be effective during biological attacks, they would need to be in place in advance.

### **Enabling Government and Business Actions**

Box S.6 (next page) summarizes enabling government and business actions.

**Box S.6**

1. *Informing individuals about official terrorism response plans.*
2. *Designing education and training programs to explain and practice response actions.*
3. *Implementing terrorist attack detection and warning systems.*
4. *Regulating and providing usage guidelines for retail equipment marketed for terrorism response.*

While not a part of an individual's strategy, enabling government and business actions will be important to an individual's ability to carry out the recommended response actions. The more that individuals know about government plans for emergency and other kinds of medical treatment (vaccinations and antibiotics), decontamination steps, possible relocation plans, and how such information will be conveyed, the better they are prepared to respond appropriately and the more likely they are to comply with official guidance. Education and training programs, spearheaded by government and private industry, could serve these same goals. An individual's ability to survive in different types of terrorist attacks could also be improved, perhaps significantly, through the introduction of detection and warning systems. A final area of government and business enabling activity would be to help ensure that products marketed for terrorism preparedness and response are safe and effective by setting standards for the design and performance of equipment, guidelines for their use, and warning labels.

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## ACRONYMS

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ACH	Air changes per hour
CDC	Centers for Disease Control and Prevention (U.S. Department of Health and Human Services)
EMS	Emergency Medical Services
FDA	Food and Drug Administration
FEMA	Federal Emergency Management Agency
HVAC	Heating, ventilation, and air conditioning
NIOSH	National Institute of Occupational Health and Safety
NPS	National Pharmaceutical Stockpile
OSHA	Occupational Safety and Health Administration
RDD	Radiological dispersal device
SES	Socioeconomic status