Preparing for Public Health Emergencies:
A Planning Aid for Public Health and Healthcare Professionals

The Center for Public Health Readiness and Communication

Drexel University School of Public Health

February 2013

pennsylvania
DEPARTMENT OF HEALTH

DREXEL UNIVERSITY
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Acknowledgements

This project was funded by a grant from the Pennsylvania Department of Health, with funding from Cooperative Agreement Number 2U90TP316967–11 from the Centers for Disease Control and Prevention (CDC). Its contents are solely the responsibility of the authors and do not necessarily represent the official views of CDC.

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Introduction

This planning aid for the public health consequences of emergencies and disasters was developed at the request of preparedness planners at the Pennsylvania Department of Health. The work was part of a larger project to determine risks to public health and guide planning and mitigation strategies throughout the Commonwealth of Pennsylvania and the multi-state metropolitan area surrounding the city of Philadelphia. We were asked to develop a guide with brief, succinct descriptions of the consequences of disasters that would be useful for government agency officials in public health or emergency management, as well as individuals working in healthcare or related settings. The objective was to provide essential information that would be needed to understand the potential scope of outcomes and plan to respond accordingly.

What emerged was a condensed description of the health and human consequences of disasters, with a focus on hazards that occur in the Northeastern and Mid-Atlantic regions in the United States, including extreme weather events, coastal storms, flooding, and utility interruptions, as well as man-made events such as accidental hazardous material spills and terrorism. For source materials, we drew upon published accounts of recent or historical incidents to understand and describe their impact. We also referred to several excellent, comprehensive books devoted to public health and disaster preparedness, including Public Health Disasters, by Linda Landesman; Disaster Medicine, by Gregory Ciottone, et al.; and Emergency Public Health by G. Bobby Kapur, et al. The websites of the Centers for Disease Control and Prevention, the Federal Emergency Management Agency, and the Department of Health and Human Services Assistant Secretary of Preparedness and Response were also invaluable resources and contain additional information that will be useful for readers.

This public health planning aid contains three major sections. The first describes the major consequences of likely or possible hazards, with respect to their impact on human health, healthcare services and infrastructure, community functions that relate to health, and public health services and activities. A second section assembles the major impacts of disasters – such as communications and transportation failures – and lists the likely causes of these impacts, their public health consequences, essential response measures, and preparedness or mitigation strategies. Three appendices provide supplemental information that extends specific topics covered in the main sections. The content and length of each section is generally no more than 4 or 5 pages, sufficient to convey the important issues necessary to prepare for, respond to, and recover from major incidents that are likely to disrupt communities and threaten the health of the public. Each section is intended to provide essential information in an easy to read format, as would be needed by public health or emergency management officials when an incident occurs. To those who do the invaluable and often unrecognized work of responding to emergencies that impact the public's health - we hope this planning aid is a useful guide.

Hazards

Natural Disasters

FLOODING (SEE ALSO HURRICANE)

Example: Flooding, Iowa and Wisconsin, 2008

Flooding is caused by an increase in falling or melting precipitation, ground saturation, and damage to containment structures, and results in the destruction of property, washed out transportation routes, and utility disruptions.

HUMAN IMPACT

Flooding brings significant risks to human health, including risk of injury, disease, and death:

- Drowning – the leading cause of death from flood events, including persons driving through flooded roadways
  - Example: 18 flood-related deaths due to the 2008 Iowa flooding
- Injuries – related to debris and clean-up efforts
  - Puncture wounds, lacerations, orthopedic injuries, electrocution, animal bites
  - Antibiotics and vaccine boosters for treatment and prophylactic measures
- Carbon monoxide poisoning – related to use of portable generators
  - Signs and symptoms: headache, dizziness, nausea, vomiting, confusion
    - Seizures and coma result from continued exposure
- Hypothermia – related to prolonged exposure to low temperatures due to lack of power
  - For more information, see **WINTER STORM**
- Chronic disease complications - related to exacerbation of cardiac and respiratory conditions due to overexposure to cold temperatures
  - Disruption in access to medications and other supplies or equipment due to need for evacuation or interruptions in supply chain to pharmacies and other healthcare facilities
- Foodborne illness – related to contaminated food and a lack of refrigeration due to utility disruption or disruption of drinking water supplies (especially well water)
  - For more information, see **INFECTIOUS DISEASE OUTBREAK, FOODBORNE**
- Waterborne illness – related to contamination of potable water as well as poor sanitation and/or hygiene
  - See **INFECTIOUS DISEASE OUTBREAK, WATERBORNE** as well as http://www.cdc.gov/healthywater/wash_diseases.html for more information
- Communicable illness – related to crowded shelter conditions with poor sanitation and/or hygiene
  - Gastrointestinal infections due to pathogens such as norovirus or *Shigella*
  - Respiratory viruses due to influenza, RSV, coronaviruses, parainfluenza viruses, and adenoviruses
- Respiratory illness – related to exposure to post-storm mold, mildew, and other allergens, as well as communicable disease in crowded shelter conditions
- Vector-borne illness – related to the potential for increased mosquito activity in post-storm standing water
  - See **INFECTIOUS DISEASE OUTBREAK, VECTOR-BORNE** for more information
- Skin disease – resulting from abrasions or more severe injuries to skin and soft tissue
  - Bacterial contamination of wounds can result in skin and soft tissue infections by pathogens such as *Streptococci*, *Staphylococci*, and waterborne organisms such as *Aeromonas* and *Vibrio* species
- Chemical exposure – related to flooding damage to facilities storing hazardous materials, resulting in the release of chemicals and other harmful substances into the environment
- Mental health impact – related to depression, anxiety, dissociation, and post-traumatic stress disorder following the incident
  - Crisis response teams and human service agencies can provide psychological first aid to victims immediately following an incident

HEALTHCARE SERVICE IMPACT

Flood events can result in an increased demand for healthcare services as well as potential service shortages due to accessibility issues.

- Emergency department demand – related to an increase in patients presenting for injuries and illnesses post-incident
  - Patient surge has implications for staffing and bed availability, as well as laboratory testing and analysis
- Hospital bed demand – related to an increase of patients admitted to different inpatient wards from the emergency department to receive further medical treatment from illnesses and injuries sustained during an incident as well as those seeking non-disaster related medical care
- Hospitals should be prepared to receive patients evacuated from other healthcare facilities
- Potential disruption of services, including interruption of outpatient, inpatient, and home health services – related to facility infrastructure damage, evacuation, utility disruptions, and/or transportation closures
- Potential disruption of access to healthcare facilities for both patients and staff – related to flooding of major roadways and transportation routes
- Staff shortages due to closure of transportation routes and/or interruption of mass transit services
- Supply shortages, including pharmaceuticals and other critical supplies due to transportation and/or utility disruptions
- Possible need to set up alternate care facilities or shelters for individuals with special medical needs
- Need for fuel for back-up generators for partial restoration of power to critical areas of healthcare facilities

COMMUNITY IMPACT

Communities are affected by flooding in a variety of ways:

- Transportation disruption – related to closures of mass transit routes, highways, and roadways, causing the following disruptions:
  - Access to necessary medical services – dialysis, chemotherapy, transfusions
  - Home health services
  - Potential shortages of medications and other critical supplies
  - Ability of essential personnel to travel to/from work, including healthcare staff
- Utility outages potentially extending over multiple days, causing the following impacts:
  - Unsafe drinking water, potentially resulting in a boil water advisory for extended time periods
  - Disruption of sewage and wastewater treatment facility operations
  - Loss of refrigeration capabilities, resulting in spoiled food and medication
  - Loss of power to critical manufacturing facilities, refineries and other key industries, resulting in shortages of fuel and other necessary supplies and goods
  - Loss of power to critical, life-sustaining equipment (e.g., ventilators), as well as other durable medical equipment in both residential and facility use
    - Example: 30,000 customers lost power following the 2008 Iowa flooding
- Shelter operations for those who have utility outages and/or damage to homes, creating the need for the following:
  - Shelter staff, including security and public health personnel
  - Food, water, and personal hygiene items
  - Animal sheltering, care, and supplies
  - Example: During the 2008 Iowa flooding, 38,000 people were displaced from their homes
- Business continuity – related to the loss of business operations due to structural and/or environmental damage from flooding
- Environmental contamination during and following a flood event
  - Indoor environment – residential and commercial buildings may be flooded, requiring water removal and mold remediation
  - Outdoor environment - related to the release of chemicals and other hazardous materials from flooded industrial buildings, farmland, or residences
    - Outdoor or basement residential fuel tanks have potential to release into water supply

- Vector activity – see **INFECTIOUS DISEASE OUTBREAK, VECTOR-BORNE** for more information

PUBLIC HEALTH SERVICE IMPACT

Increased demand for public health service activities coupled with potential staffing shortages during a flood event can have the following impacts:

- Staffing shortages – related to inability of personnel to travel to/from work due to impassible roadways and mass transit interruptions
- Supply shortages – related to disruptions in transportation routes and increased demand
- Demand for shelter staffing and supplies – related to public health nurses and other essential personnel to address health concerns in general population and special medical needs shelters
  - Possible need to set up alternate care facilities or shelters for individuals with special medical needs
- Disruption of services – related to the following:
  - Power disruption, resulting in loss of computer use for medical records and electronic surveillance efforts
  - Facility damage, resulting in loss of resources, service capacity, and displacement of patients and staff
- Need for surveillance in healthcare settings and shelters – related to reports of infectious, foodborne, and waterborne diseases and outbreaks
- Health communication – related to a need for increased public messaging focused on:
  - Flood-related health hazards, disease risks, and prevention measures
    - Boil water advisories in the event of sewage and water treatment plant disruptions
  - Facility closures
  - Clean-up safety
- Environmental health services – assistance with environmental health assessment following flood damage, including:
  - Mold remediation for indoor environments
  - Assessment of water quality and safety as a result of fuel spilled from disrupted tanks
- Mosquito surveillance and control activities

PREPAREDNESS STRATEGIES FOR PUBLIC HEALTH PROFESSIONALS

- Targeted, pre-incident public health messaging around the following issues:
  - Flooding risks (e.g., driving through flood waters, flash flooding, etc.)
  - Emergency medical kits containing extra medication, supplies, and prescriptions or paperwork
  - Food and medication safety in the event of power outages
  - Realistic health concerns following a flood in an effort to debunk disease myths and to provide guidance and recommendations for vaccines and boosters (e.g., tetanus)
  - Sanitation and personal hygiene
  - Safe handling of debris and clean-up safety efforts in both residential and commercial facilities, including the use of gloves, masks, and rubber boots
  - Injuries and health problems related to clean-up efforts, targeted to individuals with chronic disease who may be at greater risk
  - Recommendations regarding mold prevention and remediation
  - Carbon monoxide poisoning and generator safety
- Targeted post-incident messaging regarding safe clean-up approaches
  - Avoidance of dangerous structures and clean-up activities
- Targeted public health messaging regarding at-risk populations, including early warning of possible utility failures and need for evacuation, if necessary
  - Persons with disabilities, the homebound, and the elderly
  - Individuals living in high-risk areas (e.g., flood plains or high-rise buildings subject to power loss)
- Ensure memoranda of understanding (MOU) and mutual aid agreements (MAA) are in place with surrounding counties in

order to supplement human and material resources, including security services for public health community and field operations
- Facility plans for staffing shortages and staff sheltering due to transportation disruptions
- Facility and agency plans to prevent disruption of services, including:
    - Back-up generator capacity
    - Emergency short-term water supply
    - Redundant communication systems
    - Pharmaceutical and supply caches
    - Chronic illness therapy and maintenance (e.g., pre-event dialysis)
- Protocol development for facility evacuation and patient disposition, including the following:
    - Discharging ambulatory and stable patients prior to the weather event
    - Developing an evacuation triage protocol for inpatients
    - Risk-benefit analysis of evacuating critical care patients versus sheltering in place
    - Plans for hospitals to serve as evacuation destinations for other healthcare, personal care, or rehabilitation facilities
    - Resources necessary for transporting patients, staff, and equipment to an alternate location
    - Maintenance of medical records and patient tracking techniques in order to reunite patients with family members after the weather event
    - Security procedures to prevent pharmaceutical supply theft
    - Alternate identification procedures in the event facility staff lose identification credentials

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HURRICANE (SEE ALSO FLOODING)

Examples: Hurricane Sandy, Northeastern U.S., 2012
Hurricane Irene, Northeastern U.S., 2011
Hurricane Ike, Southern U.S., 2008

Hurricanes are capable of causing tremendous destruction from flooding and high winds, resulting in structural damage, utility outages, and transportation disruptions. The hazards posed by hurricanes have significant consequences for health and safety, as well as healthcare and public health infrastructure.

HUMAN IMPACT

Hurricanes and their associated hazards present significant threats to human health:

- Drowning - the leading cause of death, particularly from flooding and storm surge
  - Other causes of death: landslides, electrocutions, fires, carbon monoxide poisoning, and trauma from falling trees and other debris
- Injuries – related to debris and clean-up efforts
  - Puncture wounds, lacerations, orthopedic injuries, electrocution, animal bites
  - Antibiotics and vaccine boosters for treatment and prophylactic measures
- Carbon monoxide poisoning – related to use of portable generators
  - Signs and symptoms: headache, dizziness, nausea, vomiting, confusion
  - Seizures and coma result from continued exposure
  - Examples:
    - Hurricane Sandy - 263 cases of carbon monoxide poisoning in eight states, resulting in 4 deaths
    - Hurricane Katrina - 51 cases of carbon monoxide poisoning in 3 states, resulting in 5 deaths
    - Hurricane Ike - 77 cases of carbon monoxide poisoning in Texas, resulting in 7 deaths
- Hypothermia - related to prolonged exposure to low temperatures due to lack of power
  - For more information, see **WINTER STORM**
- Chronic disease complications - related to exacerbation of cardiac and respiratory conditions due to overexposure to cold temperatures
  - Disruption in access to medications and other supplies or equipment due to need for evacuation or interruptions in supply chain to pharmacies and other healthcare facilities
- Foodborne illness – related to contaminated food and a lack of refrigeration due to utility disruption or disruption of drinking water supplies (especially well water)
  - For more information, see **INFECTIOUS DISEASE OUTBREAK, FOODBORNE**
- Waterborne illness – related to contamination of potable water as well as poor sanitation and/or hygiene
  - See **INFECTIOUS DISEASE OUTBREAK, WATERBORNE** as well as http://www.cdc.gov/healthywater/wash_diseases.html for more information
- Communicable illness – related to crowded shelter conditions with poor sanitation and/or hygiene
  - Gastrointestinal infections due to pathogens such as norovirus or *Shigella*
  - Respiratory viruses due to influenza, RSV, coronaviruses, parainfluenza viruses, and adenoviruses
- Respiratory illness – related to exposure to post-storm mold, mildew, and other allergens, as well as communicable disease in crowded shelter conditions
- Vector-borne illness – related to the potential for increased mosquito activity in post-storm standing water
  - See **INFECTIOUS DISEASE OUTBREAK, VECTOR-BORNE** for more information
- Skin disease – resulting from abrasions or more severe injuries to skin and soft tissue
  - Bacterial contamination of wounds can result in skin and soft tissue infections by pathogens such as *Streptococci*, *Staphylococci*, and waterborne organisms such as *Aeromonas* and *Vibrio* species
- Chemical exposure – related to flooding damage to facilities storing hazardous materials, resulting in the release of chemicals and other harmful substances into the environment

- Mental health impact – related to depression, anxiety, dissociation, and post-traumatic stress disorder following the incident
    - Crisis response teams and human service agencies can provide psychological first aid to victims immediately following an incident

HEALTHCARE SERVICE IMPACT

The impact of hurricanes on healthcare services focuses on the disruption of utilities and transportation, as well as an increased demand for healthcare services due to illnesses and injuries.

- Emergency department demand – related to an increase in patients presenting for injuries and illnesses post-incident
    - Patient surge has implications for staffing and bed availability, as well as laboratory testing and analysis
    - Example: Hurricane Katrina - one emergency department in Mississippi experienced an 83.6% increase in patients the week following the storm
- Hospital bed demand – related to an increase of patients admitted to different inpatient wards from the emergency department to receive further medical treatment from illnesses and injuries sustained during an incident as well as those seeking non-disaster related medical care
- Hospitals should be prepared to receive patients evacuated from other healthcare facilities
- Potential disruption of services, including interruption of outpatient, inpatient, and home health services – related to facility infrastructure damage, evacuation, utility disruptions, and/or transportation closures
- Potential disruption of access to healthcare facilities for both patients and staff – related to flooding of major roadways and transportation routes
- Staff shortages due to closure of transportation routes and/or interruption of mass transit services
- Supply shortages, including pharmaceuticals and other critical supplies due to transportation and/or utility disruptions
- Possible need to set up alternate care facilities or shelters for individuals with special medical needs
- Need for fuel for back-up generators for partial restoration of power to critical areas of healthcare facilities

COMMUNITY IMPACT

Hurricanes can have several impacts on communities:

- Transportation disruption – related to closures of mass transit routes, highways, and roadways, causing the following disruptions:
    - Access to necessary medical services – dialysis, chemotherapy, transfusions
    - Home health services
    - Potential shortages of medications and other critical supplies
    - Ability of essential personnel to travel to/from work, including healthcare staff
- Utility outages potentially extending over multiple days, causing the following impacts:
    - Unsafe drinking water, potentially resulting in a boil water advisory for extended time periods
    - Disruption of sewage and wastewater treatment facility operations
    - Loss of refrigeration capabilities, resulting in spoiled food and medication
    - Loss of power to critical manufacturing facilities, refineries and other key industries, resulting in shortages of fuel and other necessary supplies and goods
    - Loss of power to critical, life-sustaining equipment (e.g., ventilators), as well as other durable medical equipment in both residential and facility use
- Shelter operations for those who have utility outages and/or damage to homes, creating the need for the following:
    - Shelter staff, including security and public health personnel
    - Food, water, and personal hygiene items
    - Animal sheltering, care, and supplies
- Business continuity – related to the inoperability of businesses due to structural and/or environmental damage from flooding and wind damage
- Environmental contamination during and following a hurricane

- Indoor environment –residential and commercial buildings may be flooded, requiring water removal and mold remediation
- Outdoor environment - related to the release of chemicals and other hazardous materials from flooded industrial buildings and/or farmland

- Vector activity – see **INFECTIOUS DISEASE OUTBREAK, VECTOR-BORNE** for more information

PUBLIC HEALTH SERVICE IMPACT

Increased demand for public health service activities coupled with potential staffing shortages during a hurricane can have the following impacts:

- Staffing shortages – related to inability of personnel to travel to/from work due to impassible roadways, mass transit interruptions, and evacuation orders
- Supply shortages – related to disruptions in transportation routes and increased demand
- Demand for shelter staffing and supplies – related to public health nurses and other essential personnel to address health concerns in general population and special medical needs shelters
  - Possible need to set up alternate care facilities or shelters for individuals with special medical needs
- Disruption of services – related to the following:
  - Power disruption, resulting in loss of computer use for medical records and electronic surveillance efforts
  - Facility damage, resulting in loss of resources, service capacity, and displacement of patients and staff
- Need for surveillance in healthcare settings and shelters – related to reports of infectious, foodborne, and waterborne diseases and outbreaks
- Health communication – related to a need for increased public messaging focused on:
  - Flood-related health hazards, disease risks, and prevention measures
  - Facility closures
  - Clean-up safety
- Environmental health services – assistance with environmental health assessment following flooding damage, including mold remediation for indoor environments
- Mosquito surveillance and control activities

PREPAREDNESS STRATEGIES FOR PUBLIC HEALTH AGENCIES

- Targeted, pre-incident public health messaging around the following issues:
  - Flooding risks (e.g., driving through flood waters, flash flooding, etc.)
  - Emergency medical kits containing extra medication, supplies, and prescriptions or paperwork
  - Food and medication safety in the event of power outages
  - Realistic health concerns following a flood in an effort to debunk disease myths and to provide guidance and recommendations for vaccines and boosters (e.g., tetanus)
  - Sanitation and personal hygiene
  - Safe handling of debris and clean-up safety efforts in both residential and commercial facilities, including the use of gloves, masks, and rubber boots
  - Injuries and health problems related to clean-up efforts, targeted to individuals with chronic disease who may be at greater risk
  - Recommendations regarding mold prevention and remediation
  - Carbon monoxide poisoning and generator safety
- Targeted post-incident messaging regarding safe clean-up approaches
  - Avoidance of dangerous structures and clean-up activities
- Targeted public health messaging regarding at-risk populations, including early warning of possible utility failures and need for evacuation, if necessary
  - Persons with disabilities, the homebound, and the elderly
  - Individuals living in high-risk areas (e.g., flood plains or high-rise buildings subject to power loss)

- Ensure memoranda of understanding (MOU) and mutual aid agreements (MAA) are in place with surrounding counties in order to supplement human and material resources, including security services for public health community and field operations
- Facility plans for staffing shortages and staff sheltering due to transportation disruptions
- Facility and agency plans to prevent disruption of services, including:
    - Back-up generator capacity
    - Emergency short-term water supply
    - Redundant communication systems
    - Pharmaceutical and supply caches
    - Chronic illness therapy and maintenance (e.g., pre-event dialysis)
- Protocol development for facility evacuation and patient disposition, including the following:
    - Discharging ambulatory and stable patients prior to the weather event
    - Developing an evacuation triage protocol for inpatients
    - Risk-benefit analysis of evacuating critical care patients versus sheltering in place
    - Plans for hospitals to serve as evacuation destinations for other healthcare, personal care, or rehabilitation facilities
    - Resources necessary for transporting patients, staff, and equipment to an alternate location
    - Maintenance of medical records and patient tracking techniques in order to reunite patients with family members after the weather event
    - Security procedures to prevent pharmaceutical supply theft
    - Alternate identification procedures in the event facility staff lose identification credentials
- Emergency planning inclusive of mental health crisis response – related to effectively contacting and utilizing community mental health resources for the purposes of psychological first aid response, including:
    - Mutual aid agreements/memoranda of understanding for inter-county services
    - 24/7 crisis hotline
    - Coordination of post-disaster mental health services across all outlets: community-based organizations, hospital providers, youth organizations, etc.
    - Culturally competent psychological services to address non-English speaking communities
    - Caches of mental health providers specializing in different populations (e.g., children, trauma) and emergency contact information for each provider

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INFECTIOUS DISEASE OUTBREAK, LARGE PERSON-TO-PERSON

Examples:
Influenza A H1N1 "Spanish Flu" Pandemic, 1918 (case fatality ratio > 2.0%)
Influenza A H3N2 "Hong Kong Flu" Pandemic, 1968 (case fatality ratio between 0.1-0.5%)
Influenza A H1N1 "Swine Flu" Pandemic, 2009 (case fatality ratio 0.1%)
SARS-Coronavirus, 2003, transmitted via respiratory route

Highly contagious infectious diseases that are transmitted from person-to-person have the potential to cause major epidemics. An epidemic, defined as an increase in incidence of a disease above a baseline or expected level, has the potential to become a pandemic – worldwide in scope – when the infectious agent is both novel (with little population immunity) and easily transmissible. Pandemic influenza is the prototype for this situation, capable of causing widespread disease because of its communicability and short incubation period. The Centers for Disease Control and Prevention (CDC) categorizes pandemic influenza into 5 categories by severity according to the case fatality ratio (proportion of fatalities among ill persons). The most severe pandemic, which has a case fatality ratio > 2.0% (similar to that of 1918), is considered to be a Category 5. For supplemental information regarding proposed "non-pharmaceutical" control measures for large outbreaks due to easily transmissible respiratory pathogens, in the absence of vaccine, **see APPENDIX A**.

HUMAN IMPACT

Human health consequences from a severe, Category 5 pandemic have the potential to devastate populations, assuming that no effective vaccine is available to the public.

- Morbidity rate – approximately 30% of the population
  - Highest illness rates among school-aged children (40%)
  - Illness rates decline with age (20% of working adults)
  - Approximately 50% of ill individuals will seek medical attention
  - Secondary spread in households, childcare, and school settings
- Mortality rate – approximately 0.6% of the population
  - > 2% of persons who develop illness
- Incubation period – approximately 2 - 4 days, up to one week
- Duration of community outbreak – 6 to 8 weeks
  - Pandemic seasonality uncertain:
    - Example: Largest waves of 20th century pandemics occurred in fall and winter
    - Example: 1957 pandemic waves occurred in summer and fall
  - At least two pandemic disease waves are likely, separated by a period of months

Symptoms may include:

- Respiratory: Cough, shortness of breath, runny nose
- Systemic: Fever (at least 100°F), malaise (general discomfort), fatigue, chills
- Pain: Headache, myalgia (muscle pain), sore throat
- Gastrointestinal: Nausea, vomiting, and/or diarrhea (most common in children)

Potentially life-threatening complications may include:

- Respiratory: Bronchitis, sinusitis, otitis media (ear infection), viral pneumonia, post-influenza bacterial pneumonia (commonly due to *Staphylococcal* and *Streptococcal* bacteria, including methicillin-resistant *S. aureus* (MRSA) and *Streptococcus pneumoniae*), pneumothorax (collapsed lung)
  - Respiratory failure is most common cause of death
- Systemic disease: myocarditis (heart involvement), , acute renal failure, dehydration, encephalitis (brain swelling), exacerbation of pre-existing chronic medical conditions (e.g., heart failure, diabetes, asthma)

Mental health sequellae may include:

- Increased demand for mental health support and human services provided by community-based organizations, social service, and faith-based organizations

- Anxiety, post-traumatic stress disorder, grief, and depression
- May be seen among ill persons, family members, friends, and healthcare workforce

HEALTHCARE SERVICE IMPACT

The impact of pandemics on the healthcare system generally results from an increase in patients seeking treatment as well as a depletion of the healthcare workforce. Healthcare service facilities may experience:

- Emergency department demand – related to an increase in patients presenting with signs and symptoms of influenza illness
  - Patient surge has implications for staffing and bed availability, as well as laboratory testing and analysis
  - Creation of alternative care locations or spaces for triage and medical evaluation in hospital locations to offset burden on emergency department
- Hospital bed demand – related to an increase of patients admitted to different inpatient wards from the emergency department to receive further medical treatment
  - Increased demand for intensive care unit services and equipment, including ventilators
- Demand for outpatient healthcare services – related to an increase in patients seeking care from private physicians and community clinics for influenza illness
- Increased demand for pre-hospital transport services and emergency medical services combined with potential staff shortages due to illness
- Staff shortages in both healthcare and non-healthcare settings due to the following:
  - Personal illness and/or caring for ill relatives
  - Social distancing strategies requiring parents to remain home with children
  - Fear of contracting illness from patient contact
  - An estimated 25-40% of the healthcare workforce will be absent during a severe pandemic event
  - Family members may be needed to provide inpatient support services to patients
- Healthcare supply shortages, including pharmaceuticals and infection control necessities due to patient surge and high usage, as well as potential failures of business continuity in pharmaceutical and manufacturing sectors
  - Depletion of pharmaceutical products for asthma and other chronic medical illnesses as well as specific antiviral compounds for influenza
- Shortage of non-medical supplies (e.g., linens, food, etc.) due to high usage and failures of business continuity in manufacturing and other sectors
- Increased need for just-in-time education for healthcare professionals
  - Outpatient, inpatient , and pre-hospital settings
  - Disease recognition and management, infection control measures
- Implementation of healthcare facility visitor and workforce restrictions, to prevent healthcare-associated transmission of disease
- Increased demand for hospital occupational health services to assess employee illness, monitor and exclude exposed healthcare workers, and administer vaccinations and medication prophylaxis
- Coordinated planning, policy determinations, and public messaging regarding resource limitations and depletion and possible impact on standards of care

COMMUNITY IMPACT

Community impact of an influenza pandemic may entail:

- Widespread influenza-like illness in the community (> 30% attack rate) resulting in increased demand for healthcare services, workforce outages, absenteeism from school
- Depletion of products and supplies used in the care of influenza, including over-the-counter decongestants and pain medications, face masks, tissues, hand sanitizer
- Supply chain disruption – related to an interruption in the delivery of food, fuel, and medical supplies due to operator illness and failures of business continuity in the manufacturing and pharmaceutical sectors
  - Grocery stores, pharmacies, and gas stations may be unable to stock supplies for consumers
- Implementation of community-wide non-pharmaceutical interventions to control disease transmission

- Promotion of respiratory hygiene and social distancing strategies, possibly requiring closure of public venues, schools and other mass congregation facilities
- Transportation disruption – related to reduced mass transit routes in order to limit the spread of infection, causing the following disruptions:
  - Access to necessary medical services – dialysis, chemotherapy, transfusions
  - Home health services
  - Ability of essential personnel to travel to/from work, including healthcare staff
- Business continuity – related to disruption in commercial, non-profit, manufacturing, and government sectors due to workforce depletion and reduced access to necessary supplies and equipment
- Public anxiety and unrest related to fear of disease and transmission
- Civil service disruption – related to police, fire, transportation, and utility personnel shortages due to illness

PUBLIC HEALTH SERVICE IMPACT

An influenza pandemic would require a significant increase in public health services. This, coupled with workforce depletion due to illness, would significantly strain public health resources. Public health services that will be required to address this type of incident are:

- Surveillance – for disease morbidity, mortality, complications, hospitalization rates, outcomes
- Capacity for epidemiological investigations to understand risk factors for disease acquisition, severity
- Laboratory testing services – related to the collection, transport, and analysis of biological specimens to diagnose cases
- Health Communications – related to the creation and distribution of information about the pandemic to both healthcare professionals and the general public
  - Emergency public information and warning, including risk communication regarding disease transmission
  - Frequent updates regarding the status of the incident and control measures
  - Health alerts and other disease-related communications to healthcare professionals and emergency responders
  - Targeted outreach to community sectors serving at-risk populations: hospitals, outpatient clinics, medical providers, and human service agencies
- Coordinated planning, policy determinations, and public messaging with government officials and representatives of key agencies regarding the following:
  - Resource limitations and depletion
  - Possible impacts of pandemic on standards of care
  - Implementation of non-pharmaceutical interventions to control disease transmission
- Implementation of plans to distribute and dispense vaccine and medication to points of care and points of dispensing
- Volunteer management for points of dispensing, telephone call centers, public health surveillance activity, and other response activities
- Support of surge in medical and healthcare facilities as well as coordination of public health and healthcare system activities
- Distribution of needed supplies and equipment, including requesting and distribution of assets from the Strategic National Stockpile, if needed
- Fatality management – related to mortuary services to respond to an increase in the number of deceased persons, including identification processes
  - Utilization of alternate locations and services in the event of exceeded morgue capacity

PREPAREDNESS AND RESPONSE STRATEGIES FOR PUBLIC HEALTH AGENCIES

- Enhanced surveillance for influenza-like illness, emerging infectious diseases or events of public health importance that may signal the beginning of transmission of a novel pathogen
- Surge planning to respond to increased demand for epidemiological services, laboratory services, and other core public health functions and capacities
    - Establish a mechanism for rapidly obtaining reliable laboratory testing results, including characterization of the virus and identifying its susceptibility to antivirals
- Promotion of influenza and pneumococcal vaccination
- Mass prophylaxis planning for the general population, as well as targeted priority and high-risk groups such as healthcare workers, traditional first-responders, and at-risk communities
    - Elderly
    - Young children
    - Pregnant women
    - Persons with pre-existing chronic health conditions
- Develop plans for implementation of non-pharmaceutical control measures
    - Sheltering in place, cancellation of large events with mass congregation, school closure
    - Anticipate possible 4-12 week duration of implementation
    - Coordinate planning with partner agencies, including school personnel
- Create communications networks and infrastructure for information sharing with the healthcare, government, education, and social service sectors
    - Just-in-time communications
    - Bi-directional information exchange
    - Joint planning
- Ensure functionality of plans to request, receive, store, and distribute assets from the Strategic National Stockpile
- Develop agency plans for continuity of operations, including:
    - Determination of critical services
    - Staff communication
    - Information technology
    - Coordination with external partners
    - Staffing shortages due to illness and caregiving absenteeism
    - Activating back-up staff for critical services
    - Volunteer support
- Promote information sharing between agricultural sectors and human health authorities
- Ensuring adequacy of agency and jurisdictional plans for coordinated operations, including activation of emergency operations centers (EOCs) and joint information centers (JICs)
- Public health messaging with templates related to influenza prevention and measures to reduce transmission risk
    - Social distancing strategies (e.g., school closures, telecommuting, staggered shift work)
    - Targeted messages for at-risk populations as well as outreach to culturally and ethnically diverse populations

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INFECTIOUS DISEASE OUTBREAK, FOODBORNE

Examples: Foodborne *listeriosis* outbreak, multiple states, 2002
E. coli 0157:H7 outbreak, multiple states, 2000

Foodborne infectious disease outbreaks occur when food becomes contaminated with microorganisms (e.g., viruses, bacteria, parasites or toxins) and is subsequently ingested, causing human illness. Microbial contamination may occur at any point in the supply or food preparation chain. Outbreaks may be small, limited to individuals exposed to a single point source from a food establishment or food service provider, multi-state, or even global, resulting from widespread distribution of a food item contaminated early in the food supply chain.

The US Department of Agriculture (USDA) Food Safety and Inspection Service (FSIS) is the federal agency that regulates commercially sold meat, poultry and eggs. The US Food and Drug Administration (FDA) regulates the production and safety of all non-meat food products, including produce. The Centers for Disease Control and Prevention (CDC) conduct nation-wide surveillance of foodborne outbreaks and monitors disease related to foodborne pathogens like *Salmonellae* and *E. coli* 0157. CDC also tracks the genetic fingerprints, obtained through pulse field gel electrophoresis or PFGE, of common foodborne pathogens isolated from clinical and environmental specimens nationwide. State and local health departments are responsible for disease surveillance and outbreak investigations in their jurisdictions, as well as the implementation of community control measures. CDC is called upon to assist these efforts, especially in major or multi-state outbreaks. Agencies from all levels of government often work together to collect information and specimens for laboratory testing, perform trace back investigations of implicated food products, and implement appropriate prevention practices.

HUMAN IMPACT

Foodborne diseases pose serious threats to human health by causing acute and chronic illness in those affected.

Common foodborne pathogens are:
Bacteria: *Salmonella, Shigella, Campylobacter, Yersinia, E. coli, Listeria*
Toxin-mediated: *S. aureus, Bacillis cereus*, *Clostridium botulinum* and *C. perfringens*
Parasites: *Cyclosporiasis, Cryptosporidium parvum, Giardiasis, Entamoeba histolytica;* helminths including tape worms, *Toxoplasma gondii, Trichinella*
Viruses: *Norovirus*, enteric adenoviruses

Foodborne disease generally produces the following syndromes:

- Gastrointestinal disease – diarrhea, abdominal pain, cramping, nausea, vomiting, and bloody stools may all occur
  - Symptoms, incubation period, and duration often depend upon the specific causative agent
- Many foodborne or enteric pathogens may cause complications or disease outside of the gastrointestinal tract:
  - Hemolytic uremic syndrome – a complication associated with kidney failure that may occur following infections with organisms that produce shiga or vero toxins, including enterohemorragic strains of *E. coli* (including 0157 and 0104), and *Shigella dysentariae*
    - Young children are most susceptible to this complication, which may be fatal
  - Guillian Barre syndrome – a syndrome of ascending paralysis seen as a complication of infection with *Campylobacter*
    - May result in respiratory failure requiring ventilator support
  - Febrile illness – "enteric fever" syndrome, with fever, muscle aches, fatigue, rash, and some gastrointestinal symptoms
    - May occur with *Salmonella typhi* and *S. parathyphi*
  - Bloodstream invasion by gastrointestinal pathogens may result in infections in sites distant from the gastrointestinal tract, including bones, joints, heart valves, and vascular grafts
  - Meningitis and pregnancy complications including fetal infection and demise seen with *Listeria monocytogenes*
    - Persons with chronic disease or immunosuppression are at greater risk
  - Neurologic complications including life-threatening paralysis may follow ingestion of *C. botulinum* toxin

- Dehydration from diarrhea and vomiting, resulting in significant volume and electrolyte depletion
- Secondary spread – related to the transmission of illness from person-to-person
  - Often occurs after foodborne infection and can result in prolongation of the outbreak
  - May occur from contamination of new food or water sources or direct contact with pathogens (or contaminated surfaces) in closed settings like households or childcare programs
- Approximately 48 million people in the United States are sickened with a foodborne pathogen each year, resulting in 128,000 hospitalizations and 3,000 deaths
- Mental health impact – related to increased anxiety and decreased confidence in safety of food supply

HEALTHCARE SERVICE IMPACT

The impact of foodborne illness on the healthcare system generally results from an increase in patients who seek treatment from emergency departments and primary care settings:

- Emergency department demand – related to visits for gastrointestinal illness
  - May require hospitalization for hydration and care of complications
- Demand for outpatient healthcare services – related to dialysis for patients who suffer from hemolytic uremic syndrome
- Hospital bed demand – related to an increase of patients admitted to different inpatient wards from the emergency department to receive further medical treatment from illnesses
  - Patients with Guillian Barre Syndrome require intensive care
- Laboratory and diagnostic testing demand – related to the need for laboratory testing of both clinical and environmental specimens (food and other sources)
  - May include testing for shiga toxin and isolation of shiga-toxin producing *E. coli* as well as PFGE of clinical and environmental specimens

COMMUNITY IMPACT

Community impact of foodborne disease may entail:

- Recall of implicated food products from commercial markets
- Anxiety and loss of confidence in implicated foods as well as related products, resulting in loss of sales and significant economic impact on that industry
- Environmental contamination may be the cause of foodborne disease – related to soil, crop, and/or water contamination from human or animal feces
  - Identification and remediation require personnel from health department agencies as well as environmental protection organizations to collect samples and conduct laboratory testing
    - U.S. Food and Drug Administration (FDA), and US Department of Agriculture's Food Safety Inspection Services (FSIS)
  - Significant private sector remediation measures may be required to address the source of contamination and render affected food safe for consumption
- Business continuity disruption and economic losses related to the closure of foodservice and food production establishments that may be implicated in outbreak source
  - Farms, restaurants, and catering facilities may be affected

PUBLIC HEALTH SERVICE IMPACT

Foodborne outbreaks often require a significant increase in public health services:

- Enhanced epidemiological capacity for disease surveillance and investigation of cases
  - Conduct of case control studies to identify disease source and associated risks for infection
- Environmental inspections and investigations of food service, food production, and manufacturing establishments
- Collection of clinical and environmental food specimens, with submission of isolates for serotyping, PFGE and other more specific testing at public health reference laboratories

- Restriction of food handlers from workplace and/or closure of food service establishments
- Coordination of investigative efforts and control measures with those of other agencies including other local and state health departments, CDC, USDA and US FDA
- Health communication – related to the development and dissemination of incident information to both the general public and the medical community, including advisories, alerts, and outbreak information

PREPAREDNESS AND RESPONSE STRATEGIES FOR PUBLIC HEALTH AGENCIES

- Proactive public information and messaging regarding food safety practices, especially in summer, when foodborne diseases occur more frequently
- Targeted food safety information for individuals at high risk for foodborne disease:
    - Persons with immune suppression
    - Persons with chronic diseases such as diabetes
    - Pregnant women
    - Infants and small children
- Maintain communicable disease surveillance for foodborne pathogens and ensure that isolates are forwarded for PFGE and serotyping to facilitate early recognition of potential outbreaks
- Regular inspection of food service establishments and enforcement of local and state regulations, especially during special events where temporary food vendors sell food from establishments that may lack running water or adequate food storage or cooking facilities
- Restriction of ill food handlers from work until they are no longer ill or shedding microorganisms
- Compliance with FDA and USDA regulations at food manufacturing and processing plants
- Response and control measures for foodborne disease outbreaks include:
    - Early recognition of outbreaks from communicable disease surveillance systems, including laboratory testing to identify related organisms that might be outbreak related
    - Initiation of epidemiological investigation and control measures, as appropriate, when outbreak source is identified
    - Notification of local and state partners through communication platforms such as CDC's Epi-X network
    - Early notification of medical practitioners to enhance case recognition and assist with implementation of outbreak investigation and control measures
    - Reminders to exclude ill individuals, especially children, from high-risk transmission settings such as pre-school and childcare programs
    - Early notification of general public to convey appropriate information about risk and risk reduction measures including recommendations to minimize secondary spread, especially in households

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INFECTIOUS DISEASE OUTBREAK, VECTOR-BORNE

Example: West Nile Virus Outbreaks, United States, 1999, 2000, 2012

Infectious disease outbreaks due to insect vectors (e.g., mosquitoes, ticks, fleas) represent a major public health threat globally, particularly in tropical regions in the developing world. In the United States, the most significant vector-borne diseases are Lyme Disease (infection caused by *Borrelia Burgdorferi*, transmitted by the deer tick), and, since 1999, West Nile virus, transmitted by mosquitos (*Culex pipiens* and related species). West Nile virus epidemics generally occur in the summer months and may result in significant morbidity and mortality.

HUMAN IMPACT

Vector-borne illnesses present unique consequences to human health and can vary in terms of severity and disease sequellae. Mosquito-borne illnesses include:

- Arthropod-borne virus (arboviral) infections - the major infectious disease transmitted by mosquitoes in the United States
    - West Nile Virus, St. Louis Encephalitis, La Crosse Encephalitis, and Eastern Equine Encephalitis
    - Zoonotic viruses; humans are incidentally infected and not important in maintaining the transmission cycle
    - The majority of arthropod illnesses occur in the summer months.
    - Many infections are asymptomatic; however, symptomatic infections present with headache and fever
    - Serious cases can involve neurologic complications, such as meningitis, encephalitis, or convulsions:
        - West Nile Virus infections may result in asymptomatic illness, undifferentiated illness with fever (West Nile Fever), meningitis, meningoencephalitis, and complex neurologic syndromes resulting in weakness, paralysis, and death
            - The elderly and individuals with immune suppression and chronic illnesses are at greatest risk
            - Cases have been described in 49 of the 50 United States, although seasonal epidemics may impact different regions of the country unpredictably with varying degrees of severity
        - Other important arbovirus infections in the United States are:
            - St. Louis Encephalitis – can occur in most of the United States
            - LaCrosse Encephalitis – occurrences seen in Minnesota, Texas, New York, and Georgia
            - Eastern Equine Encephalitis – eastern, Gulf, and north-central United States regions; has the highest case fatality rate and likelihood of long-term neurologic sequellae
            - Western Equine Encephalitis – western and central United States
- Dengue fever - most commonly occurs outside the United States in hot, tropical climates; however, Florida experienced an outbreak in 2009-2010 in which 28 people were infected
    - Unlike West Nile Virus, humans are the principal source of viral amplification and vector infection
    - Many infections are asymptomatic or present as non-specific febrile illnesses; however, symptomatic infections present with fever, headache, myalgia (muscle pain), arthralgia (joint pain), eye pain, gastrointestinal symptoms, and rash
- Malaria - (*Plasmodium falciparum*, *P. vivax, P. ovale, P. malariae, P. knowelsi*) is not endemic in the United States; most reported cases occur in travelers returning from endemic areas
    - Rare cases of P. vivax infections originating in the United States have been described

Tickborne illnesses that occur in the United States include:

- Lyme Disease (*Borrelia Burgdorferi*)
- Tularemia
- Rickettsial diseases (e.g., Rocky Mountain Spotted Fever)
- Diseases caused by bacteria in the family *Anaplasmataceae* (e.g., *Ehrlichia* species)
- Babesiosis (primarily in Northeastern and Mid-Atlantic states)
- Colorado Tick Fever
- Tick-borne encephalitis

Other vector-borne illnesses occurring in the United States include:

- Illness transmitted via fleas
  - Occurs rarely in United State
  - *Yersinia pestis* (plague) and murine endemic typhus (*Rickettsia typhi)* are most important infections with the potential to occur in this country
- Illness transmitted via rodents
  - Hantavirus pulmonary syndrome – results from inhalation of hantaviruses shed in rodent excreta (e.g., Sin Nombre virus and other variants)
  - Major reservoir is the deer mouse, *Peromyscus maniculatus*

HEALTHCARE SERVICE IMPACT

Persons with symptomatic vector-borne illnesses may seek care from healthcare facilities:

- Emergency Department demand – related to visits for symptomatic illnesses; may require hospitalization for care of complications
- Increase in visits to outpatient healthcare practitioners for medical evaluation of symptoms consistent with infection
- Hospital bed demand – related to an increase of patients admitted to different inpatient wards from the emergency department to receive further medical treatment from illnesses
  - Care for individuals with major neurologic illness, including ventilator support and long-term rehabilitation may be required
- Laboratory and diagnostic testing demand – related to an increase in laboratory testing of both clinical and environmental specimens
  - Diagnostic testing for West Nile virus infection is available at many hospital and commercial clinical laboratories, although confirmatory testing is performed in the public health laboratory system
  - An increased demand for neurologic testing, including imaging of the brain (MRI and CT scan), cerebral spinal fluid analysis, and EEGs may occur during periods of high disease activity

COMMUNITY IMPACT

Community impacts from vector-borne illnesses include:

- Community education to prevent personal exposure to mosquitoes and ticks Community efforts to reduce mosquito breeding grounds
  - Eliminating sources of standing water in residential settings and swimming pools that are not maintained
- Environmental efforts to control mosquito activity
  - Truck-based and aerial insecticide spraying by environmental protection agencies
- Public anxiety – regarding disease transmission and concerns over pesticide safety from mosquito control measures

PUBLIC HEALTH SERVICE IMPACT

Public health personnel will be needed to investigate and mitigate outbreaks of vector-borne illness:

- Enhanced epidemiological capacity for disease surveillance and investigation of human, avian and equine cases
  - Collaboration with Departments of Agriculture and Environmental Protection
  - Conduct of case control studies to identify disease source and associated risks for infection
- Monitor mosquito activity in communities, collection of mosquito pools for species identification and virus testing
- Surveillance in sentinel animals which can potentially predict disease risk in humans (e.g., chickens, horses)
- Collection of clinical and environmental specimens, with submission of specimens for disease confirmation to reference public health and agriculture laboratories
- Coordination of investigative efforts and vector control measures
  - Local and state health departments, environmental agencies, and federal agencies such as CDC

- Mosquito control activities, including truck and aerial spraying, based on results of mosquito, animal, and human surveillance
    - Larviciding to eliminate mosquito breeding
    - Adulticiding to control adult mosquitoes
- Health communication and public health information related to personal and community disease control measures:
    - Application of DEET - containing sprays
    - Wearing long sleeve pants and shirts to reduce exposed skin
        - Useful for ticks and mosquitoes
    - Avoiding outdoor activities during periods of high mosquito activity
    - Elimination of standing water
    - Targeted messaging for prevention measures in high-risk populations
        - Elderly and immunosuppressed for West Nile Virus
        - Park employees, gardeners, and other outdoor workers for Lyme Disease

PREPAREDNESS STRATEGIES FOR PUBLIC HEALTH AGENCIES

- Comprehensive disease surveillance and control plan for WNV and other mosquito borne pathogens that addresses the following:
    - Communication and coordination with other key agencies including Environmental Protection and Agriculture
    - Surveillance and testing of mosquitoes
    - Animal surveillance
    - Human surveillance
    - Public health laboratory testing and access for clinical specimens
    - Plans for case investigation, outreach, and epidemiological analysis of surveillance data
    - Plans for public dissemination of findings of surveillance activities in mosquitoes, birds and animals, and targeted communication to healthcare professionals to stimulate human surveillance
    - Plans for public information regarding the following:
        - Disease prevention, outbreak status, mosquito control measures, and personal protection measures
        - Insecticide use, health risks, and safety profile of agents
        - Targeted communication to high risk communities
    - Plans for vector control activities, including access to subject matter experts re: insecticide use and safety
- Public information and communication to healthcare professionals:
    - Develop educational programs and plans to disseminate information on prevention strategies for vector-borne disease outbreaks:
        - Using window screens and/or mosquito bed nets
        - Remaining indoors during evening hours
        - Wearing long-sleeved shirts and pants
        - Using insect repellent
        - Avoiding standing water areas
    - Targeted safety information to individuals at high risk for vector-borne diseases:
        - Elderly
        - Infants and small children
        - Persons working in outdoor environments

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INFECTIOUS DISEASE OUTBREAK, WATERBORNE

Examples: *Cryptosporidium* infections, Wisconsin, 1993
Cryptosporidium infections, Utah 2008
Legionella outbreak, Quebec City, Canada 2012

In the developed world, waterborne diseases occur rarely from fecal contamination of potable water sources, particularly wells and other untreated water sources. Currently, the majority of waterborne disease outbreaks in the United States occur following exposures to contaminated recreational water, and from inhalation or aspiration of aerosols contaminated with *Legionella* bacteria, the agent of Legionnaire's Disease. The likelihood of exposures to waterborne pathogens may also increase in the aftermath of disaster that compromises water and sewage treatment infrastructure.

HUMAN IMPACT

Waterborne pathogens have the potential to cause serious illness and death in humans, depending on the agent causing the illness.

Common waterborne pathogens include:

- Fecal/oral transmission
  - *Amebiasis*, *Campylobacter, Cryptosporidium parvum, E. coli, Giardiasis, Listeria monocytogenes, Norovirus*, *Salmonellae* (including *Salmonella typhi*), *Shigella, Vibrio* (including *Vibrio cholerae*)
  - Hepatitis E is an important pathogen in parts of Asia and Africa; most cases in the United States result from travel to endemic areas
- Other modes of transmission
  - Aspiration: *Legionella*
  - Ingestion: *Leptospirosis*
    - Usually acquired during swimming in untreated fresh water that has been contaminated by animal urine
- Waterborne pathogens produce the following syndromes:
  - Gastrointestinal disease – diarrhea (bloody and non-bloody), abdominal pain, cramping, nausea, and vomiting may all occur
    - Symptoms, incubation period, and duration often depend upon the specific causative agent
  - Complications outside of the gastrointestinal tract:
    - Hemolytic uremic syndrome – a complication associated with kidney failure that may occur following infections with organisms that produce shiga- or verotoxins, including enterohemorragic strains of *E. coli* (including 0157 and 0104), and *Shigella dysentariae*
      - Young children are most susceptible; some infections result in death
    - Guillian Barre syndrome – a syndrome of ascending paralysis seen as a complication of infection with *Campylobacter*
      - May result in respiratory failure requiring ventilator support
    - Severe dehydration – a condition caused by a loss of fluids and an imbalance in electrolytes due to diarrhea and vomiting
      - Oral or intravenous rehydration solutions may be given to correct this
    - Leptospirosis - a systemic disease characterized by fever, headache, jaundice, and anemia
      - Kidney and respiratory failure occur rarely
  - Respiratory disease - Infection with *Legionella* bacteria generally results in pneumonia (Legionnaire's disease)
    - Most infections occur sporadically in the community
      - Hot tub use can be a cause of community-acquired legionellosis
    - Healthcare-associated cases and outbreaks related to a common source
    - *Legionella* infection may also produce a non-specific febrile illness that is known as Pontiac Fever
  - Skin, ear, and eye illnesses - may be caused by a variety of less common waterborne pathogens such as pseudomonas, mycobacteria, and schistosomes
    - Skin and soft tissue infections may result from exposure to *Vibrio* species (e.g., *Vibrio parahemolyticus* or *Vibrio vulnificans*) *or Aeromonas*

- Neurologic illness - rarely results from exposures to parasites in fresh water
  - Naegleria fowleri

HEALTHCARE SERVICE IMPACT

The impact of waterborne illness on the healthcare system generally results from an increase in patients who seek treatment from emergency departments and primary care settings.

- Emergency department demand - related to visits for gastrointestinal illness; may require hospitalization for hydration and care of complications
- Demand for outpatient healthcare services from primary care physicians
- Hospital bed demand – related to an increase of patients admitted to different inpatient wards from the emergency department to receive further medical treatment from illnesses
  - Patients with Guillian Barre Syndrome require intensive care
  - Patients with hemolytic uremic syndrome following infection with shiga-toxin producing *E. coli* require inpatient care
- Laboratory and diagnostic testing demand – related to the need for laboratory testing of both clinical specimens including testing for shiga toxin and isolation of shiga-toxin producing *E. coli*
- Healthcare facilities who have patients who develop *Legionella* infection during their hospitalization should increase surveillance for additional cases and conduct appropriate epidemiological and environmental investigation to identify and eliminate sources of this bacterium

COMMUNITY IMPACT

Community impact of waterborne disease may entail:

- Water supply disruption – related to the contamination of residential, commercial, and/or recreational water systems
  - May result in boil water notices as well as disruption in water supply in order to identify and remediate the source of the outbreak
- Sanitation/sewage disruption – related to a failure of infrastructure, causing contamination to the potable water supply
  - Could be caused by system damage due to natural disasters such as hurricanes and flooding as well as accidental damage
- Environmental contamination – related to drinking and recreational water contamination from human or animal feces
  - Remediation requires personnel from health department agencies as well as environmental protection organizations to collect samples, conduct laboratory testing, and clean the contamination in order to render water safe
- Business continuity – related to the closure of food service, private, municipal, or recreation facilities that may be implicated as an outbreak source
- Anxiety and concern – outbreaks of Legionnaire's Disease and of waterborne disease that are linked to a common source such as a facility's water distribution system often generate significant anxiety among potentially exposed persons

PUBLIC HEALTH SERVICE IMPACT

Waterborne outbreaks often require a significant increase in public health services:

- Enhanced epidemiological capacity for disease surveillance and investigation of cases
  - Conduct of case control studies to identify disease source and associated risks for infection
- Environmental inspections and investigations of institutional, recreational, and food service establishments, as well as public and private water systems
- Collection of clinical and environmental specimens, with submission of isolates for serotyping, PFGE and other more specific testing at public health reference laboratories
- Restriction of food handlers, healthcare workers, and daycare workers from workplace, and/or closure of establishments

- Environmental remediation of the following:
  - Water storage, cooling, or distribution systems (e.g., in the case of *Legionella* contamination)
  - Recreational water facilities
  - Closure of public or private water systems that cannot be remediated
- Coordination of investigative efforts and control measures with those of other agencies, including other local and state health departments in the setting of outbreaks, as well as federal agencies such as the Centers for Disease Control and Prevention, (CDC), U.S. Department of Agriculture (USDA), and U.S. Food and Drug Administration (FDA)
- Health and risk communication – related to the development and dissemination of incident information to both the general public and the medical community, including advisories, alerts, and outbreak information

PREPAREDNESS STRATEGIES FOR PUBLIC HEALTH AGENCIES

- Proactive public information re: recreational water activities and proper hygiene precautions
- Targeted health information to individuals at high risk for waterborne disease
  - Persons with immune suppression
  - Elderly
  - Infants and small children
- Maintain communicable disease surveillance for waterborne pathogens and ensure that isolates are forwarded for PFGE and serotyping to facilitate early recognition of potential outbreaks
- Regular inspection of recreational water facilities and enforcement of local and state regulations
  - Monitoring of all bathing areas including oceans, lakes, rivers, and swimming pools
- Restriction of bathers with gastrointestinal illness from recreational water facilities
  - Especially important for young children who wear diapers
- Ensure capacity to monitor public and private potable water systems following disasters that have the potential to disrupt normal operations and maintenance procedures
- Response and control measures for waterborne disease outbreaks include:
  - Early recognition of outbreaks from communicable disease surveillance systems including laboratory testing to identify related organisms that might be outbreak related
  - Initiation of epidemiological investigation and control measures, as appropriate, when outbreak source is identified
  - Notification of local and state partners through communication platforms such as CDC's Epi-X network
  - Remediation of contaminated recreational water, including hyperchlorination and filtration
  - Disinfection of facility-based water distribution systems if sampling identifies contamination that is associated with human illness (e.g., *Legionella* infection in healthcare or other facility)
  - Early notification of medical practitioners to enhance case recognition and assist with implementation of outbreak investigation and control measures
  - Targeted risk communication to communities that may have disproportionate risk for disease or complications
  - Early notification of general public to convey appropriate information about risk and risk reduction measures, including recommendations to minimize secondary spread, especially in households
  - Development of working relationships and joint procedures with agencies and contractors who conduct environmental inspections and remediation to public and private water treatment and distribution systems

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TEMPERATURE EXTREMES

Examples: Heat wave, Midwestern U.S., 1995
Heat wave, Russia, 2010

Extreme temperature conditions, particularly related to heat, have the capacity to cause severe physical harm, resulting in an increase in illnesses and deaths related both directly and indirectly to hot weather. While no one is immune to the effects of a heat wave, certain populations prove to be more susceptible to its effects, leading to an increase in morbidity and mortality.

HUMAN IMPACT

Heat extremes present significant health consequences:

- Dehydration – related to excessive sweating, alcohol consumption, and inadequate water intake
- Heat stroke – related to a rapid increase in body temperature (hyperthermia)
    - Can lead to extensive neurologic damage and is often fatal
    - Individuals with predisposition to hyperthermia include:
        - Elderly, due to their decreased thirst and heat regulation capabilities
        - Persons with chronic diseases, such as cardiovascular or respiratory diseases, diabetes, and obesity
        - Persons with chronic medical illness on medications that interfere with either cognition or thermal regulatory mechanisms (e.g., barbiturates, benzodiazepines, chlorpromazine, tricyclic antidepressants)
    - Persons suffering from heat stroke exhibit the following signs and symptoms:
        - Increased core body temperature (>105°F or >40.6°C)
        - Altered mental status, including lethargy(drowsiness), disorientation, delirium, and coma
        - Anhidrosis (inability to sweat)
- Heat exhaustion – related to extended exposure to high temperatures and dehydration
    - Heat exhaustion leads to the following signs and symptoms:
        - Dizziness, weakness, or fatigue
        - Nausea, vomiting, and headaches
- Heat syncope (fainting) – related to loss of consciousness due to physical exertion and peripheral vasodilation, particularly in the elderly population
    - Persons who are not acclimatized to extreme temperatures are more likely to suffer heat syncope
- Heat cramps – related to electrolyte imbalances from profuse sweating
    - Heat cramps cause painful, involuntary large muscle group cramps, usually in the legs or shoulders
- Accidental drowning – related to an increase in water-related deaths
    - Example: During a 2010 heat wave in Russia, over 1,200 people drowned, 233 of whom drowned within the span of one week

HEALTHCARE SERVICE IMPACT

The impact of extreme heat on healthcare services is generally due to an increase in patients requiring emergency medical treatment for heat-related illnesses.

- Demand for emergency medical services and transport – related to a high volume of persons suffering heat-related illnesses requiring emergency care at hospitals.
    - Example: During the 1995 heat wave, 3,192 people were transported to Chicago-area hospitals
        - The number of persons requiring EMS transport to hospitals exceeded the number of ambulances available for transport and required the use of fire trucks as an alternate source of patient transportation
- Emergency department demand – related to an increase in patients presenting for heat-related illness
    - Patient surge has implications for staffing and bed availability, as well as laboratory testing and analysis
- Events that are held outdoors on extremely hot days should be prepared to provide on-site medical assessment and treatment of heat-related illness, as well as transport to acute healthcare facilities as needed

- Hospital bed demand – related to an increase of patients admitted to different inpatient wards from the emergency department to receive further medical treatment from heat-related illnesses
    - Example: During the 1995 Chicago heat wave, increased demand for inpatient beds resulted in the following:
        - 11% increase in hospital admissions, including a 35% increase in persons over 65, for dehydration, heat exhaustion, and heat stroke
        - 18 area hospitals were put on bypass because they had no available inpatient beds

COMMUNITY IMPACT

There are various community impacts related to extreme temperatures:

- Utility outage – related to increased energy consumption resulting from air conditioning and other power usage
    - Example: During the 1995 heat wave, there were both unintentional and deliberate power outages due to the increased energy consumption
    - Loss of power can have the following impacts:
        - Loss of air conditioning for in-home and facility cooling capabilities
        - Loss of refrigeration capabilities, resulting in spoiled food and medication
        - Loss of power to critical, life-sustaining equipment (e.g., ventilators), as well as other durable medical equipment for both residential and facility use
- Food supply impacts – related to the deaths of cattle and poultry
- Transportation disruption – related to roadways and rail lines buckling
- Water supply contamination – related to insufficient pumping capabilities due to low water pressure from illegally opening fire hydrants
    - Boil water advisories may be issued in the event of system-wide low water pressure in order to ensure bacteria are killed and water is safe to consume

PUBLIC HEALTH SERVICE IMPACT

Public health services can be impacted by extreme temperatures in terms of power disruptions, staffing demands, and an increased need for public health messaging.

- Disruption of power – related to loss of computer use for medical records and electronic surveillance efforts
- Staffing demands – related to the need for personnel to conduct neighborhood/building wellness checks for persons at high risk for heat-related complications
    - Elderly, small children, homebound, and chronically ill
- Health communication – related to a need for increased public messaging at least 48 hours prior to an extreme heat event in order to allow for message saturation across all media outlets
- Fatality management – related to an increase in the number of deceased persons, thus exceeding morgue capacity
    - Alternate locations and resources will need to be established in order to carry out morgue operations if capacity is exceeded, including requesting assistance from other jurisdictions
    - Example: During July of 1995, there were 514 heat-related deaths and 696 excess deaths, which constituted a 31% increase over baseline

PREPAREDNESS STRATEGIES FOR PUBLIC HEALTH AGENCIES

- Targeted, pre-incident public health messaging around the following issues:
    - In-home cooling strategies, including air conditioner use, proper fan and window ventilation, and frequent bathing in cool water
    - Outdoor weather safety, including limiting physical activity, avoiding direct sun exposure, and wearing light, loose-fitting clothing
    - Adequate hydration and alcohol avoidance
    - Food and medication safety in the event of power outages

- Targeted public health messaging regarding at-risk populations to healthcare providers, social service agencies, and to general public:
  - Elderly
  - Persons with chronic medical conditions
  - Persons with mobility issues, including the homebound
  - Persons living alone
  - Infants and small children
- Opening and promoting local cooling centers; distribution of fans and air conditioners
- Agency plans to work with communities and human service agencies to implement a door-to-door system of checking on at-risk populations in an effort to prevent heat-related illnesses and deaths
- Facility and agency plans to prevent disruption of services due to deliberate or unintentional power outages
  - Back-up generator capacity
  - Redundant communication systems
  - Pharmaceutical and supply caches

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TORNADO

Example: F5 tornado, Joplin, MO, 2011

Tornadoes have the capacity to cause major infrastructure damage and loss of life from high-velocity winds and projectile debris. Although most common in the Midwestern and Southeastern United States, tornadoes can strike anywhere following a strong thunderstorm, wreaking havoc on communities and the healthcare system.

HUMAN IMPACT

Tornadoes present considerable consequences for human health:

- Head injuries are the most common fatal injury
- Traumatic injuries – related to persons being thrown by the tornado, flying debris, and persons located in buildings with structural damage
- Soft-tissue injuries are the most common form of post-tornado injury reported
    - Approximately 50% of injured persons who present to hospital emergency departments have a soft-tissue injury
    - Injuries are often contaminated with dirt or other debris and lead to infections from bacteria or fungal growth
        - Due to the risk of a developing infection, primary closure of a soft-tissue injury is often delayed
    - *E. coli, Klebsiella, Serratia, Proteus*, and *Pseudomonas* are common waterborne gram-negative bacteria found in post-tornado injuries
    - Cutaneous mucormycosis is a rare infection caused by a fungus that belongs to the order Mucorales normally found in soil, decaying wood and organic matter
        - Example: Following the 2011 Joplin, Missouri tornado this caused wound necrosis (tissue death) and death in 13 individuals with soft-tissue injuries
- Fractures are the second most common injury in a tornado and are the leading cause of hospitalization
- Hazardous conditions for emergency response agencies, including unstable buildings, gas leaks, and downed power lines
- Mental health impact – related to depression, anxiety, dissociation, and post-traumatic stress disorder following the incident
    - Mental health crisis response teams and human service agencies can provide psychological first aid to victims immediately following an incident
    - Example: Following the 2011 Joplin tornado, there were 1,752 calls to the crisis hotline and an estimated 700-800 children were in need of mental health evaluation and therapy

HEALTHCARE SERVICE IMPACT

Following a tornado, the healthcare system can be overwhelmed with an influx of patients seeking treatment for injuries sustained during and after the event.

- Demand for emergency medical services and transport – related to a high volume of persons suffering injuries from winds, flying debris, or structural collapse
    - Major activities include search and rescue efforts, collection and triage of patients, and hospital transport
    - Example: EMS units were needed to transport 183 patients evacuated from a hospital following the 2011 Joplin tornado
- Emergency department demand – related to an increase in patients presenting for injuries post-incident
    - Self-transported, less critically wounded patients will arrive at hospitals before those with life-threatening injuries
    - Minor injuries can overwhelm hospital staff and resources
        - Should be triaged effectively in order to ensure care is given to critical patients
    - Patient surge has implications for staffing and bed availability, as well as laboratory testing and analysis
    - Example: Following the 2011 Joplin tornado, 130 people self-transported to a 40-bed area emergency department for treatment

- Hospital bed demand – related to an increase of patients admitted to different inpatient wards from the emergency department to receive further medical treatment from illnesses and injuries sustained during the incident
- Potential disruption of services due to wind and structural damage, including interruption of outpatient, inpatient, and home health services
    - Facility damage, evacuation, utility outages and/or transportation closures
    - Example: During the 2011 tornado 183 patients were evacuated from St. John's Regional Medical Center due to building destruction
- Staff shortages due to closure of transportation routes and/or interruption of mass transit services
- Supply shortages, including pharmaceuticals and other critical supplies due to transportation and/or utility disruption

COMMUNITY IMPACT

Communities can expect to face significant challenges in the aftermath of a tornado.

- Transportation disruption – related to closures of mass transit routes, highways, and roadways
    - Loss of transit capabilities can cause the following disruptions:
        - Access to necessary medical services – dialysis, chemotherapy, transfusions
        - Home health services
        - Potential shortages of medications and other critical supplies
        - Ability of essential personnel to travel to/from work, including healthcare staff
- Utility outages have the potential to extend over multiple days, as hazards could prevent restoration efforts
    - Disruptions to normal utilities can have the following impacts:
        - Unsafe drinking water, potentially resulting in a boil water advisory for extended time periods
        - Loss of refrigeration capabilities, resulting in spoiled food and medication
        - Loss of power to critical, life-sustaining equipment (e.g., ventilators), as well as other durable medical equipment for both residential and facility use
- Shelter operations for those who have utility outages and/or damage to homes
    - Sheltering operations have the potential to extend for multiple days or weeks, thus creating a need for the following:
        - Shelter staff, including security and public health personnel
        - Food, water, and personal hygiene items
        - Animal sheltering, care, and supplies
- Business continuity – related to the closure of businesses, including healthcare offices and facilities, due to inoperability from storm damage
    - Long-term unemployment if business operations sustain significant disruption
- Environmental contamination – related to the release of hazardous materials from above-ground storage sites and retail establishments damaged by the storm
- Long-term recovery challenges to affected communities, including re-building of critical infrastructure, re-location of schools, healthcare institutions, businesses

PUBLIC HEALTH SERVICE IMPACT

The impacts on public health from a tornado include:

- Staffing shortages – related to the inability of personnel to travel to/from work due to impassible roadways and mass transit interruptions
- Supply shortages – related to disruptions in transportation routes and/or utility outages
- Demand for shelter staffing and supplies – related to public health nurses and other essential personnel to address health concerns in general population and special medical needs shelters
- Disruption of power – related to loss of computer use for medical records and electronic surveillance efforts
- Need for clinical surveillance in hospitals and shelters – related to reports of infectious disease, foodborne, and waterborne disease outbreaks as well as injuries and unusual illnesses related to incident

- Health communication – related to the dissemination of event-related information to the following:
  - General public – regarding health-related consequences of storm clean-up efforts
  - Healthcare providers – regarding outbreak information and medical management guidelines for storm related illnesses and injuries
- Fatality management – related to an increase in the number of deceased persons as well as post-mortem identification processes
  - Alternate locations and resources will need to be established in order to carry out morgue operations, including requesting assistance from other jurisdictions if capacity is exceeded
  - Example: During the 2011 tornado, the U.S. Department of Health & Human Services deployed National Disaster Medical System (NDMS) Disaster Mortuary Operational Response Team personnel to assist with morgue operations and victim identification

PREPAREDNESS STRATEGIES FOR PUBLIC HEALTH AGENCIES

- Targeted, pre-incident public health messaging around the following issues:
  - Appropriate sheltering options and tornado safety
  - Encouraging practice tornado drills for homes, schools, healthcare facilities, and work environments
  - Creation of emergency medical kits containing extra medication, supplies, and prescriptions or paperwork for individuals and families
  - Food and medication safety in the event of power outages
  - Sanitation and personal hygiene
  - Clean-up safety strategies, including the use of gloves, masks, and rubber boots, safe handling of debris, avoidance of dangerous activities (e.g., climbing on roofs, unsafe structures)
  - Carbon monoxide poisoning and generator safety
- Targeted public health messaging regarding at-risk populations:
  - Ambulatory or cognitive disabilities
  - Hearing or visual disabilities
  - Limited English proficiency
  - Elderly
  - Young children
  - Mobile home community residents
- Early warning systems – related to redundant media alerts and active warning systems (e.g., sirens); coordinated messaging and public information with tornado warnings issued by emergency management agencies
- Ensure memoranda of understanding (MOU) and mutual aid agreements (MAA) are in place with surrounding counties in order to supplement human and material resources, including security services for public health community and field operations
- Continuity of operations plans for public health agency facilities, including identification of critical services and staff, communications plans, facility relocation if necessary, and shelter operations
- Support healthcare facility preparedness:
  - Facility plans to activate on-call or back-up physicians, nurses, paramedics, and other essential healthcare and response staff in the event of staff shortage and/or patient surge
  - Facility protocols to handle surge events:
    - Postpone elective surgeries and treatment procedures
    - Discharge non-urgent patients from the emergency room and stable inpatients
    - Transferring ICU patients to regular hospital wards
    - Designating separate areas of emergency departments for less critical patients
    - Mobilize equipment and resources
    - Facility and agency plans to prevent disruption of services
    - Back-up generator capacity
    - Emergency short-term water supply

- Redundant communication systems
- Pharmaceutical and supply caches
- Chronic illness therapy and maintenance

- Facility security protocols for mass casualty incidents, including traffic control and securing entry and exit points for hospitals
- Protocol development for facility evacuation and patient disposition, including the following:
  - Developing an evacuation triage protocol for inpatients
  - Risk-benefit analysis of evacuating critical care patients versus sheltering in place
  - Plans for hospitals to serve as evacuation destinations for other healthcare, personal care, or rehabilitation facilities
  - Resources necessary for transporting patients, staff, and equipment to an alternate location
  - Maintenance of medical records and patient tracking techniques in order to reunite patients with family members after the weather event
  - Security procedures to prevent pharmaceutical supply theft
  - Alternate identification procedures in the event facility staff lose identification credentials

- Emergency planning inclusive of mental health crisis response – related to effectively contacting and utilizing community mental health resources for the purposes of psychological first aid response for both disaster victims and public health and clinical staff involved in the disaster
  - Plans should include provisions for the following:
    - Mutual aid agreements/memoranda of understanding for inter-county services
    - 24/7 crisis hotline
    - Coordination of post-disaster mental health services across all outlets: community-based organizations, hospital providers, youth organizations, etc.
    - Culturally competent psychological services to address non-English speaking communities
    - Caches of mental health providers specializing in different populations (e.g., children, trauma) and emergency contact information for each provider

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WINTER STORM

Examples: Blizzard, Northeastern U.S., 1996
Winter Storm, Northwestern U.S., 1993

Winter storms or blizzards can have significant impact on human health and on the healthcare and public health infrastructure. Extreme temperatures, high winds and heavy precipitation (including snow and ice) have the potential to disrupt utilities and transportation routes, with both short and long-term impact on healthcare and other services.

HUMAN IMPACT

Winter storms present multiple hazards to human health:

- Transportation accidents are the leading cause of death
- Carbon monoxide poisoning – related to use of generators and space heaters
    - Signs and symptoms include headache, dizziness, nausea, vomiting, and confusion, leading to seizures and coma with continued exposure
    - Example: During a January, 1993 winter storm, 44 cases of carbon monoxide poisoning were reported in Washington state
        - Poisoning attributable to alternative heat sources (e.g., generators, portable heaters, charcoal briquettes) and automobile exhaust
    - During the blizzard of January, 1996, 3 cases of carbon monoxide poisoning were reported in Philadelphia and 22 were reported in New York City
        - Poisoning resulted from snow-clogged vehicle exhaust pipes
        - 2 total fatalities, 1 from each city
- Myocardial infarctions (heart attacks) and other cardiovascular morbidity due to overexertion from snow removal activities
- Injuries, both soft tissue and orthopedic, from the following:
    - Snow removal equipment
    - Falling objects (tree limbs, power lines, ice)
    - Motor vehicle accidents
    - Pedestrians slipping and falling on icy roads, sidewalks, and driveways
- Frostbite – related to prolonged exposure to freezing temperatures
    - Frostbite is caused by local tissue injuries resulting from skin exposure to temperatures below 2°C
    - Individuals with predisposition to frostbite include:
        - People who remain outdoors during extremely low temperatures (e.g., workers in outdoor environments)
        - Those with impaired judgment or inability to seek shelter (e.g., alcohol and substance abusers)
        - Persons with altered mental status, cognitive or psychiatric disorders
        - Individuals with peripheral vascular disease
        - Malnourished persons
- Hypothermia – related to prolonged exposure to low temperatures
    - Individuals with predisposition to hypothermia are similar to frostbite, and also include:
        - Persons with hypothyroidism
        - Persons with chronic medical illness on medications that interfere with either cognition or thermal regulatory mechanisms (e.g., barbiturates, benzodiazepines, chlorpromazine, tricyclic antidepressants)
    - There are 3 major categories:
        - Mild hypothermia
            - Core temperature 32-35°C
            - Tachypnea (rapid breathing), tachycardia (rapid heart rate), shivering, altered mental status
            - Treatment: removal of wet clothing, passive external rewarming
        - Moderate hypothermia
            - Core temperature 28-32°C

- Decreased heart rate, CNS depression
- Risk of renal failure, atrial fibrillation, bradycardia (slow heart rate)
- Treatment: passive and active external rewarming

▪ Severe hypothermia

- Core temperature below 28°C
- Hypotension (low blood pressure), bradycardia (slow heart rate), ventricular fibrillation, pulmonary edema, coma
- Treatment: active internal rewarming
- Facilities should develop a rewarming protocol

HEALTHCARE SERVICE IMPACT

The impact on healthcare services is generally due to disruption of power and disruption of transportation routes, leading to supply and staff shortages that may be prolonged.

- Staff shortages due to closure of transportation routes and/or interruption of mass transit services
- Supply shortages, including pharmaceuticals, food, linens, disposable personal protective equipment, and other critical supplies due to transportation and/or utility disruption
- Potential disruption of services, including interruption of outpatient, inpatient, and home health services
  - Facility damage, utility outages and/or transportation closures
  - Outpatient dialysis centers may require support to ensure patients with end stage renal disease do not miss dialysis treatments
- Activation of facility emergency plans including prolonged staff shifts to ensure coverage of critical in-patient services
- Closure of outpatient healthcare facilities, pharmacies
- Short and long-term utility interruptions requiring reliance on back-up generators and fuel supplies
- Restriction of patient access to healthcare facilities because of road closures, hazardous driving conditions:
  - Hospitals
  - Dialysis centers
  - Ambulatory care centers
  - Community-based medical practices and clinic

COMMUNITY IMPACT

The impact on the community generally results from long-term disruptions of power and transportation routes.

- Transportation disruption – related to closures of mass transit routes, highways, and roadways
  - Loss of transit capabilities can cause the following disruptions:
    - Access to necessary medical services – dialysis, chemotherapy, transfusions
    - Home health services
    - Potential shortages of medications and other critical supplies
    - Ability of essential personnel to travel to/from work, including healthcare staff
- Utility outages have the potential to extend over multiple days, as weather hazards could prevent restoration efforts
  - Disruptions to normal utilities can have the following impacts:
    - Unsafe drinking water, potentially resulting in a boil water advisory for extended time periods
    - Loss of refrigeration capabilities, resulting in spoiled food and medication
    - Loss of power to critical, life-sustaining equipment (e.g., ventilators), as well as other durable medical equipment for both residential and facility use
- Shelter operations for those who have utility outages and/or damage to homes
  - Sheltering operations have the potential to extend for multiple days or weeks, thus creating a need for the following:
    - Shelter staff, including security and public health personnel
    - Food, water, and personal hygiene items

- Animal sheltering, care, and supplies
- Sheltering in place – related to residents having to remain in their homes to avoid hazardous weather conditions
- Business continuity – related to the inoperability of businesses due to power outages and/or transportation route closures

PUBLIC HEALTH SERVICE IMPACT

The impact on public health infrastructure generally results from disruption of power and transportation routes.

- Disruption of power – related to loss of computer use for medical records and electronic surveillance efforts
- Staffing shortages – related to inability of personnel to travel to/from work due to impassible roadways and mass transit interruptions
- Supply shortages – related to disruptions in transportation routes
- Demand for shelter staffing and supplies – related to public health nurses and other essential personnel to address health concerns in general population and special medical needs shelters
- Need for medical support and surveillance in shelters – to recognize and interrupt infectious disease outbreaks
- Surveillance for clinical illness related to utility disruptions and storm sequellae (e.g., carbon monoxide poisoning, foodborne illness)
- Health communication – related to the need to provide timely, accurate information to hospitals, healthcare clinics, medical providers
- Messaging to general public regarding cold weather health hazards, information about signs and symptoms of cold exposure, and generator safety

PREPAREDNESS STRATEGIES FOR PUBLIC HEALTH AGENCIES

- Activation of emergency plans to ensure continuity of critical services:
  - Staff communication
- Coordinated planning and response activities with emergency management agencies and healthcare facilities to ensure provision of critical healthcare services during and after storm:
  - Identification of at-risk individuals
  - Assure staffing and other needs for critical services such as dialysis centers and hospitals
- Public health messaging regarding physical weather hazards:
  - Snow removal injuries
  - Cold weather-related injuries
  - Carbon monoxide poisoning and heater/generator safety
  - Road safety in icy conditions
- Post-incident messaging re: safe clean-up practices
- Targeted public health messaging regarding at-risk populations:
  - Elderly
  - Ambulatory and cognitive disabilities
  - Infants
  - Individuals with chronic disease: chronic illness therapy and maintenance (e.g., pre-storm dialysis, ensuring access to critical medications)

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Accidental/Technological Hazards

FIRE: URBAN AND WILDFIRE

Examples:
Urban Fires: Hotel high rise building fire, Las Vegas, NV, 1980 Commercial high rise building fire, Philadelphia, PA, 1991
Wildfires: Texas Wildfires, 2006
California wildfires, 2003, 2009, 2010
Colorado wildfires, 2012

High rise building fires in urban areas present a unique set of challenges for emergency response operations, healthcare services, and community activities. Large numbers of casualties among first responders and laypersons lead to surge in demand for EMS transports, emergency department utilization, and hospitalization for burns and smoke inhalation. Wildfires that occur near population centers may result in mass evacuations and property losses.

HUMAN IMPACT

Fires pose significant risks to human health, including traumatic injuries and significant mental health impacts.

- Traumatic injuries from fires include the following:
  - Smoke and chemical inhalation: most common and most deadly fire-related injury
    - Injury is caused by breathing in combustion byproducts
    - Carbon monoxide, cyanide, phosgene, hydrogen chloride, nitrogen oxides
    - Results in respiratory distress, airway injury, and death
    - High rise building fires exacerbate the effects of inhalational injuries due to HVAC systems and sealed windows
    - Example: Out of 85 total deaths, 75 resulted from inhalation of smoke and carbon monoxide in the 1980 Las Vegas MGM Grand hotel fire
  - Burns: classified into four major categories
    - First degree: superficial burn causing redness and pain to the outer layer of skin
    - Second degree: partial thickness burn causing tissue damage to multiple layers of skin
      - Can be superficial (causing blisters) or deep (requiring skin grafting)
    - Third degree: full thickness burn causing tissue damage to all layers of skin as well as underlying fatty tissue
    - Fourth degree: deeper full thickness burn affecting muscles, tendons, ligaments, and bone
  - Orthopedic: resulting from trapped persons jumping from burning structures as well as persons injured during evacuation efforts
- Hazardous conditions for emergency response agencies, including smoke inhalation, fire, and structural collapse
  - Example: 35 firefighters sought medical treatment during the 1980 Las Vegas hotel fire and an estimated 300 experienced signs and symptoms of illness following the fire.
  - Example: 3 firefighters were killed during the 1991 Philadelphia commercial building fire
- Mental health impact – related to depression, anxiety, dissociation, and post-traumatic stress disorder following the incident
  - Mental health crisis response teams and human service agencies can provide psychological first aid to victims immediately following an incident

HEALTHCARE SERVICE IMPACT

Healthcare facilities can expect to be overwhelmed during and following a fire. Effective on-scene and inter-hospital triage efforts are crucial to ensure patients with significant burn injuries are treated at the appropriate facilities.

- Demand for emergency medical services and transport – related to a high volume of persons suffering inhalational, burn, and traumatic injuries
    - Example: Approximately 600 injured persons were transported to local hospitals following the 1980 Las Vegas hotel fire
- Emergency department demand – related to an increase in patients presenting for injuries post-incident
    - Patient surge has implications for staffing and bed availability, as well as laboratory testing and analysis.
    - Example: During the 1980 Las Vegas hotel fire, 600 injured persons were evaluated and treated in local emergency departments
- Hospital bed demand – related to an increase of patients admitted to different inpatient wards from the emergency department to receive further medical treatment from injuries sustained from a fire
    - Example: During the 1980 Las Vegas hotel fire, 318 injured persons were admitted to inpatient hospital wards following emergency department evaluation
- Demand for treatment supplies, including pharmaceuticals, blood products, and wound care items
- Disruption of routine surgical procedures including elective surgeries
- Demand for staffing – related to an increase in the number of emergency department, ICU, inpatient, and specialty burn unit beds as well as operating rooms needing to be staffed
    - Staff members might be unable to reach the hospital if there are disruptions to transportation or if they have been evacuated from an affected area
- Laboratory and diagnostic testing demand – related to patients in the emergency department, intensive care unit, or other hospital inpatient wards requiring laboratory services and diagnostic imaging for diagnosis and treatment of inhalational injuries

COMMUNITY IMPACT

Fires have the ability to cripple community functioning, including utility disruptions, environmental contamination, and large numbers of displaced persons requiring shelter.

- Transportation disruption – related to closures of mass transit routes, highways, and roadways
    - Loss of transit capabilities can cause the following disruptions:
        - Access to necessary medical services – dialysis, chemotherapy, transfusions
        - Home health services
        - Potential shortages of medications and other critical supplies
        - Ability of essential personnel to travel to/from work, including healthcare staff
- Utility outages have the potential to extend over multiple days, as hazards could prevent restoration efforts
    - Disruptions to normal utilities can have the following impacts:
        - Unsafe drinking water, potentially resulting in a boil water advisory for extended time periods
        - Loss of refrigeration capabilities, resulting in spoiled food and medication
        - Loss of power to critical, life-sustaining equipment (e.g., ventilators), as well as other durable medical equipment for both residential and facility use
- Environmental contamination – related to any waste or hazardous materials which get released into air, soil, or water as a result of the fire and/or as a result of the emergency responder mitigation activities (e.g., firefighting)
- Shelter operations for those who have utility outages and/or damage to homes
    - Sheltering operations have the potential to extend for multiple days or weeks, thus creating a need for the following:
        - Shelter staff, including security and public health personnel
        - Food, water, and personal hygiene items
        - Animal sheltering, care, and supplies
- Significant loss of farm land, loss of cattle and horses, destruction of property including residential dwellings, commercial and industrial facilities
    - Example: In 2006, wildfires in Texas destroyed 15 homes, killed 10,000 cattle and horses, and burned 191,000 acres in a 24 hour period

- Large-scale evacuations – related to persons suffering significant property damage as well as those in imminent danger from proximal fire locations
    - Example: Wildfires in southern California in 2007 forced the evacuation of over 500,000 people, burned nearly 500,000 acres, destroyed 1,300 homes, and required the efforts of over 1,000 firefighters
    - Example: Wildfires in Alaska in 2004 burned nearly 4 million acres of land

PUBLIC HEALTH SERVICE IMPACT

Public health personnel play a significant role in the aftermath of fires, monitoring illness and casualties, providing public information regarding health risks and control measures, assisting with shelter operations, and supporting fatality management.

- Need for monitoring of clinical illness related to smoke exposure, including respiratory illness in firefighters as well as those downwind from smoke plume (through syndromic surveillance, emergency department encounters, reports of smoke inhalation)
- Need for tracking casualties and fatalities directly related to fire exposure
- Support of medical care and disease surveillance in mass shelters:
    - Demand for shelter staffing and supplies – related to public health nurses and other essential personnel to address health concerns in general population and special medical needs shelters
- Health communication – related to the need to provide timely, accurate information to hospitals, healthcare clinics, medical providers, and the general public regarding the health implications of traumatic injuries and illnesses
    - Need to formulate messages regarding protection from inhalation of particulates and other harmful substances related to fire
- Fatality management – related to an increase in the number of deceased persons as well as post-mortem identification processes
    - In the event of exceeded morgue capacity and/or loss of power to morgue, alternate locations and resources will need to be established in order to carry out morgue operations
- Public health agencies may experience the following impacts on their own capacity to provide services:
    - Disruption of power – related to loss of computer use for medical records and electronic surveillance efforts
    - Supply shortages – related to disruptions in transportation routes
    - Staffing shortages – related to inability of personnel to travel to/from work due to impassible roadways and mass transit interruptions

PREPAREDNESS STRATEGIES FOR PUBLIC HEALTH AGENCIES

- Ensure memoranda of understanding (MOU) and mutual aid agreements (MAA) are in place with surrounding counties in order to supplement human and material resources, including security services for public health community and field operations
- Work with emergency management agencies to ensure accurate, real-time communication between incident scene and area hospitals as well as inter-facility communication to triage, treat, and transport patients to the proper receiving facilities
- Prepare public information materials and message maps specific to evacuation and respiratory protection steps in the event of fire, especially for regions vulnerable to wildfire
- Ensure adequacy of disease surveillance systems, including syndromic surveillance that can detect increases in respiratory conditions in specific geographic areas, as well as ad-hoc systems that can be used in the event of mass sheltering
- Public health agencies should ensure that they have access to meteorological data to anticipate wind and other weather events that will impact exposure to particulates downwind of fire
- Healthcare facilities should ensure adequacy of:
    - Facility evacuation plans
    - Facility plans to activate on-call or back-up physicians, nurses, paramedics, and other essential healthcare and response staff in the event of staff shortage and/or patient surge

- Facility protocols to handle surge events:
  - Postpone elective surgeries and treatment procedures
  - Discharge non-urgent patients from the emergency room and stable inpatients
  - Transferring ICU patients to regular hospital wards
  - Designating separate areas of emergency departments for less critical patients
  - Mobilize equipment and resources
- Facility security protocols for mass casualty incidents, including traffic control and securing entry and exit points for hospitals

- Emergency planning inclusive of mental health crisis response – related to effectively contacting and utilizing community mental health resources for the purposes of psychological first aid response for both disaster victims and public health and clinical staff involved in the disaster
  - Plans should include provisions for the following:
    - Mutual aid agreements/memoranda of understanding for inter-county services
    - 24/7 crisis hotline
    - Coordination of post-disaster mental health services across all outlets: community-based organizations, hospital providers, youth organizations, etc.
    - Culturally competent psychological services to address non-English speaking communities
    - Caches of mental health providers specializing in different populations (e.g., children, trauma) and emergency contact information for each provider

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HAZARDOUS MATERIALS RELEASE

Example: Chlorine release, South Carolina, 2005

A release of hazardous materials can have major impacts on the health and safety of affected communities through human exposure and environmental contamination. Because a release can cause illness and injury to those exposed to the material, healthcare systems and public health infrastructure are also impacted, as there will be an increase in demand for clinical services and surveillance. Hazardous materials can be gasses, liquids or solids. A release or spill of solid or liquid hazardous material may require environmental assessment and remediation.

HUMAN IMPACT

Hazardous materials (hazmat) releases pose significant consequences to human health:

- Traumatic injuries are the leading cause of death for hazmat releases
  - Injuries are caused by fires, explosions, transportation accidents, and chemical burns causing or resulting from a hazmat release
- Acute illnesses – related to exposure to the released substance and/or environmental contamination
  - Toxic exposures to hazmat substances may include the following symptoms:
    - Nausea and vomiting
    - Respiratory symptoms – cough, shortness of breath, airway compromise due to chemical irritation of lungs and airways
    - Altered mental status
    - Skin irritation or burns
    - Eye irritation
    - Headache
- Chronic illnesses – related to long-term effects of exposure to the substance released (e.g., cancer, usually related to multiple, prolonged exposures to offending agents)
- Non-traumatic injuries and deaths – related to exposures to chlorine, ammonia, nitrogen, fertilizer, hydrochloric acid, petroleum products, pesticides, corrosives, metals, and volatile organic compounds
- Hazardous conditions for emergency response agencies, including agent exposure, fire, and explosions
- Mental health impact – related to depression, anxiety, dissociation, and post-traumatic stress disorder following the incident
  - Mental health crisis response teams and human service agencies can provide psychological first aid to victims immediately following an incident

HEALTHCARE SERVICE IMPACT

Healthcare services will likely be overwhelmed in the aftermath of a hazardous materials release due to patient surge and decontamination efforts.

- Decontamination – to ensure that incoming emergency department patients do not have hazardous materials remaining on clothing, hair, or skin
  - Patients arriving to emergency departments who have particulate matter remaining on them risk contaminating other patients, visitors, and staff
    - Patients should be decontaminated before entering the ED
  - Persons arriving at the hospital via EMS will likely have undergone decontamination at the incident scene
  - Over 90% of hazardous materials are generally removed when clothing is removed
- Demand for emergency medical services and transport – related to a high volume of persons suffering injuries from agent exposure, fire, explosions, and debris, as well as panic injuries
- Emergency department demand – related to an increase in patients presenting for injuries post-incident

- Patient surge has implications for staffing and bed availability, supplies needed for clinical care (such as personal protective equipment) as well as laboratory testing and analysis
- Example: 511 people sought evaluation and treatment at area emergency departments following the 2005 chlorine spill

- Hospital bed demand – related to an increase in patients admitted to different inpatient wards from the emergency department to receive further medical treatment from illnesses and injuries sustained during a hazmat incident
  - Example: After the 2005 chlorine release, 69 persons were admitted to seven area hospitals
- Laboratory and diagnostic testing demand – related to an increase in diagnostic and laboratory testing as well as pharmaceutical interventions
- Influx of worried well to emergency departments and other clinical facilities, concerned about possible exposure
- Need for psychological support and reassurance to affected populations

COMMUNITY IMPACT

Community impacts surrounding hazmat events involve population displacement, environmental contamination, and disruption of services.

- Transportation disruption – related to closures of mass transit routes, highways, and roadways
  - Loss of transit capabilities can cause the following disruptions:
    - Access to necessary medical services – dialysis, chemotherapy, transfusions
    - Home health services
    - Potential shortages of medications and other critical supplies
    - Ability of essential personnel to travel to/from work, including healthcare staff
- Utility disruption – related to an emergency shut-off of power and/or gas to affected areas in order to prevent further damage
  - Disruptions to normal utilities can have the following impacts:
    - Unsafe drinking water, potentially resulting in a boil water advisory for extended time periods
    - Loss of refrigeration capabilities, resulting in spoiled food and medication
    - Loss of power to critical, life-sustaining equipment (e.g., ventilators), as well as other durable medical equipment for both residential and facility use
- Shelter operations for those who have been ordered to evacuate their homes due to environmental contamination from the hazmat release
  - Example: Following the 2005 chlorine release in South Carolina, 5,453 residents located within a one mile radius of the spill site were evacuated to shelters
  - Sheltering operations have the potential to extend for multiple days or weeks, thus creating a need for the following:
    - Shelter staff, including security and public health personnel
    - Food, water, and personal hygiene items
    - Animal sheltering, care, and supplies
- Environmental contamination – related to soil, water, air, and structural contamination with particles from the released substance
  - Remediation requires personnel from health department agencies as well as state and federal environmental protection organizations to collect samples, conduct laboratory testing, and clean the contamination in order to render sites safe for reoccupation
- Business continuity – related to the inoperability of businesses due to environmental contamination and/or structural damage resulting from a hazmat release

PUBLIC HEALTH SERVICE IMPACT

Depending upon the nature of the hazmat release, public health personnel may face an increased demand for services relating to surveillance, mass care, communications, and fatality management.

- Staffing shortages – related to inability of personnel to travel to/from work due to impassible roadways and mass transit interruptions as well as evacuation orders
- Supply shortages – related to disruptions in transportation routes
- Demand for shelter staffing and supplies – related to public health nurses and other essential personnel to address health concerns in general population and special medical needs shelters
- Need for surveillance in shelters – related to reports of infectious disease, foodborne, and waterborne disease outbreaks
- Need for community and healthcare surveillance – related to monitoring populations for symptom identification as well as long-term health consequences related to the release
- Health and risk communication – related to the need to provide timely, accurate information to hospitals, healthcare clinics, medical providers, and the general public regarding the health implications of the release
    - Messaging can include information about the following:
        - Appropriate precautionary measures
        - Signs and symptoms of exposure and when to seek medical care
        - Appropriate treatment courses
        - Information about the risk of illness based on degree of exposure and how to recognize and manage symptoms
        - Targeted messaging may be necessary for at-risk populations including children, pregnant women, individuals with chronic illnesses
- Fatality management – related to an increase in the number of deceased persons as well as post-mortem decontamination and identification processes
    - Alternate locations and services will need to be established in order to carry out morgue operations if capacity is exceeded

PREPAREDNESS STRATEGIES FOR PUBLIC HEALTH AGENCIES

- Ensure memoranda of understanding (MOU) and mutual aid agreements (MAA) are in place with surrounding counties in order to supplement human and material resources, including security services for public health community and field operations
- Develop public information and message templates addressing hazardous materials that are likely to be released or result in exposures, based on local knowledge of manufacturing or chemical facilities, as well as transportation routes for hazardous materials through communities (information available through regional office of Environmental Protection Agency or EPA)
    - Ensure that information is available for general public
    - Ensure that community-based primary care physicians in affected area receive guidance regarding management of exposures
        - Effectively respond to questions from their patients
        - Offset burden on hospital emergency departments
- Emergency planning inclusive of mental health crisis response – related to effectively contacting and utilizing community mental health resources to provide psychological first aid for disaster victims, public health, and clinical staff involved in the disaster
    - Plans should include provisions for the following:
        - Mutual aid agreements/memoranda of understanding for inter-county services
        - 24/7 crisis hotline
        - Coordination of post-disaster mental health services across all outlets: community-based organizations, hospital providers, youth organizations, etc.
        - Culturally competent psychological services to address non-English speaking communities
        - Caches of mental health providers specializing in different populations (e.g., children, trauma) and emergency contact information for each provider
- Ensure that area healthcare facilities have plans in place to manage casualties and to maintain operations:
    - Facility plans for staffing shortages and staff sheltering due to transportation disruptions or shelter in place orders

- Activating on-call or back-up physicians, nurses, paramedics, and other essential healthcare and response staff in the event of staff shortage and/or surge
- Facility protocols to handle surge events:
  - Postpone elective surgeries and treatment procedures
  - Discharge non-urgent patients from the emergency room and stable inpatients
  - Transferring ICU patients to regular hospital wards
  - Designating separate areas of emergency departments for less critical patients
  - Mobilize equipment and resources
  - Facility and agency plans to prevent disruption of services
- Facility security protocols for mass casualty incidents, including traffic control and securing entry and exit points for hospitals
- Facility decontamination and personal protective equipment (PPE) protocols to ensure patient, visitor, and staff protection
- Protocol development for facility evacuation and patient disposition, including the following:
  - Developing an evacuation triage protocol for inpatients
  - Risk-benefit analysis of evacuating critical care patients versus sheltering in place
  - Plans for hospitals to serve as evacuation destinations for other healthcare, personal care, or rehabilitation facilities
  - Resources necessary for transporting patients, staff, and equipment to an alternate location
  - Maintenance of medical records and patient tracking techniques in order to reunite patients with family members after the weather event
  - Security procedures to prevent pharmaceutical supply theft
  - Alternate identification procedures in the event facility staff lose identification credentials

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NUCLEAR FACILITY ACCIDENT

Examples: Fukushima Daiichi Disaster, Japan, 2011
Chernobyl Disaster, Ukraine, 1986
Three Mile Island Accident, Pennsylvania, 1979

Nuclear facility accidents of concern to public health are accidents that allow for the release of radioactive products of fission into the environment, with exposure of workers and/or the general public to radiation. Unlike the nuclear reactor at Chernobyl, nuclear reactors in the United States today are built with containment structures that house the reactor core. These are intended to prevent the release of significant amounts of radioactivity in the event of a meltdown. The containment structure at Three Mile Island prevented the release of significant amounts of radiation. General information regarding radiation and the health consequences of exposure is provided in **APPENDIX B**.

HUMAN IMPACT

Initial injuries following an explosion in a nuclear reactor include blast injuries and burns, and are most likely to impact reactor workers or first responders.

- Human radiation exposure as a result of reactor accidents can occur in 3 ways:
  - Total or partial body exposure as a result of close proximity to a radiation source
    - Nuclear plant workers and emergency personnel involved in response to reactor are at highest risk
    - Exposure occurs when external source irradiates body, either superficially (skin burns) or deeply into internal organs (depends on type and energy of radiation – beta and gamma radiation pose greatest risk)
    - Persons with exposure but no contamination are not radioactive and do not expose others to radiation
  - External contamination by radioactive isotopes that are released and dispersed widely into the plume, settling on skin and clothing
    - Sheltering indoors may minimize external contamination in the vicinity of a reactor
  - Internal contamination through ingestion, inhalation or incorporation into open wounds
    - Primary mechanism through which large populations are exposed to radiation following a reactor accident
    - Contamination of fruits, vegetables, milk (through cows consuming contaminated grass), and groundwater is important concern
- Specific isotopes pose specific health threats, depending on their half-life, quantities released, tendency to settle on ground, nature of release (e.g., isotopes released into water may be integrated into food chain if ingested by marine life), the organs where they are likely to accumulate, and whether they are gaseous or non-gaseous
  - Iodine-131 may be released in significant quantities during a reactor accident and may be ingested by individuals in proximity to the reactor
    - It is taken up by the thyroid gland (unless blocked by potassium iodide administered prior to exposure) where it is a source of beta radiation, ultimately leading to a high risk of thyroid cancer
- The most significant short-term health effect of radiation exposure is acute radiation sickness (ARS)
  - ARS can occur following exposure to a single dose of more than 1 Gy of radiation
    - Symptoms are more severe with higher doses of radiation and treatment is generally guided by estimating the total dose of radiation to which an individual was exposed:
      - Armed Forces Radiobiology Research Institute (AFRRI) tool is available to estimate total dose, based on initial clinical symptoms, lymphocyte depletion kinetics (the number of lymphocytes in a blood specimen, over time), and cytogenetic analyses, when available

- There are three major manifestations of ARS which result from the effects of radiation on radiosensitive cells with high replication rates:
  - Hematologic complications - depression of white blood cells and other bone marrow components, with susceptibility to infections
  - Gastrointestinal complications – nausea, vomiting
  - Skin effects - radiation dermatitis or cutaneous radiation syndrome (CRS) resulting from beta and low-energy gamma radiation absorbed in the skin

- Most significant long-term health effect of radiation is an increase in cancer risk, notably in cells that are most sensitive to radiation
  - Bone marrow stem cells - leukemia and lymphoma
  - Thyroid gland
- Mental health impact - individuals involved in nuclear reactor accidents have significant psychological impact, including anxiety and post-traumatic stress responses
  - Nuclear power plant workers are at high risk for psychological distress, related to radiation exposure as well as discrimination and perceived societal rejection and lack of support

HEALTHCARE SERVICE IMPACT

Medical management of persons involved in a nuclear facility accident, as well as those who might have been exposed to radioactive elements released, presents the biggest challenge to the healthcare system in terms of decontamination efforts, emergency department services, and long-term treatment of health effects.

- Demand for emergency medical services and transport – related to a high volume of persons suffering injuries from the incident
- Emergency department demand – related to an increase in patients presenting for injuries post-incident
  - Trauma, burns, and other blast injuries
  - Influx of worried well to emergency departments and other clinical facilities, concerned about possible exposure
  - Patient surge has implications for staffing and bed availability, supplies needed for clinical care (such as personal protective equipment) as well as laboratory testing and analysis
- Decontamination – to ensure that incoming emergency department patients do not have contaminated particles remaining on clothing, hair, or skin
  - Patients arriving to emergency departments who have particulate matter remaining on them risk contaminating other patients, visitors, and staff
  - Need to assess individuals presenting for care for internal and external contamination with radiation, ideally before entry into the hospital or healthcare facility
  - Persons arriving at the hospital via EMS will likely have undergone decontamination at the incident scene
  - Need for decontamination capacity for individuals with external contamination, including removal of clothing and provision of temporary re-dress garments, in addition to washing with soap and water
    - Urgent decontamination (e.g., for biological or chemical agent contamination) not required
- Management of internal contamination with isotope-specific medical countermeasures designed to reduce levels of internal contamination and uptake into organs
  - Use of reference laboratories for clinical specimens collected from contaminated individuals (e.g., urine, nasal swab, rectal swab, stool specimens)
    - Facilitated by departments of public health, environmental protection, and federal agencies
  - Collaboration with public health agencies to access chelating agents and other medical countermeasures available through the federal Strategic National Stockpile and other sources

- Hospital bed demand – related to an increase in patients admitted to different inpatient wards from the emergency department to receive further medical treatment from illnesses and injuries sustained during a nuclear facility accident
- Laboratory and diagnostic testing demand – related to an increase in diagnostic and laboratory testing as well as pharmaceutical interventions
- Assessment and management of individuals with symptoms of ARS and its complications
    - Healthcare facilities and providers will need to understand how to estimate radiation exposures and subsequent management protocols
        - Provide access to "just-in-time" training and education for clinical providers, including tools such as Armed Forces Radiobiology Research Institute biodosimetry tool, available at http://www.usuhs.mil/afrri/outreach/biodostools.htm
    - Use of supportive therapy for suppressed white blood cell counts (e.g., use of blood cell stimulating factors such as Neupogen®) and infection prevention with antibiotics and antiviral medications
    - Anticipate increased demand on clinical laboratory for complete blood cell count (white blood cell and lymphocyte) determinations, as well as other relevant tests
- Need to ensure the protection of healthcare workers, providing personal protective equipment and dosimeters to assess total dose of radiation exposure that may result from patient care of contaminated individuals
- Need to provide information to workers, patients and the general public regarding the health risks of radiation, specifically related to the accident and to potential exposures in the facility and community
- Need to provide psychological support to both exposed individuals who present for medical care as well as healthcare workers

COMMUNITY IMPACT

The impacts of a nuclear facility accident on surrounding communities include:

- Environmental impact – related to the following:
    - Release of fissionable products into the environment through an airborne plume
    - Diversion of water used to cool the reactor core
- Emergency planning zones (EPZ), defined by the Nuclear Regulatory Commission (NRC), surround every nuclear power plant:
    - Plume Exposure Pathway EPZ
        - Has a radius of approximately 10 miles from the reactor site
        - Represents the area around the reactor with the highest potential for exposure of the public to, and inhalation of, airborne radioactive contamination
        - Predetermined action plans designed to protect the public within the 10-mile zone around a nuclear power plant include:
            - Sheltering in place with windows closed and intake ventilation turned off to avoid the radioactive plume (initially or if only short-term release of radioactive materials)
            - Possible evacuation
        - Prophylactic use of potassium iodide (KI) may be recommended within the 10 mile EPZ as a supplement to sheltering or evacuation
    - Ingestion Pathway EPZ
        - Has a radius of approximately 50 miles from the reactor site
        - Defines the area where food, produce, and consumable liquids are likely to be contaminated by radioactive materials (e.g., ground water, produce, milk from cows that graze within the zone)

- Predetermined action plans such as banning the ingestion of potentially contaminated food or water in this zone are designed to avoid or reduce ingestion of radioactive materials

- Evacuation from the entire 10-mile zone around the plant may not always be necessary because released materials will move with the wind
  - Evacuation recommendations will likely reflect the path of the release
  - Based on environmental testing and on wind and weather modeling that will attempt to anticipate this path
  - Generally, the Nuclear Regulatory Commission recommends evacuation for individuals within a two-mile radius of the reactor, along with people living in the 5-mile zone downwind of the projected path of the release, in a "keyhole" pattern
  - Evacuation beyond 5 miles may be recommended based on the evolution of the accident and containment measures, as well as the results of environmental testing
- Protective community response actions following a reactor accident can be broken down into incident phases:
  - Early phase - hours to days after the reactor accident
  - Intermediate phase - begins when immediate emergency situation is under control, generally days to weeks after the accident
    - Can overlap early and late phase
  - Late phase - recovery phase
- Possible need for community-based decontamination or recommendations for individuals to self-decontaminate:
  - Removal of clothing
  - Wash with soap and water
- Anticipate large-scale population displacements, need for short-term and long-term sheltering

Exposure Pathways and Protective Actions

These are examples of exposure routes and various protective actions. The phases are not set timeframes and protective actions may overlap more than one phase.

POTENTIAL EXPOSURE PATHWAYS	INCIDENT PHASES	PROTECTIVE ACTIONS
1. External radiation from facility	EARLY	1. Sheltering, evacuation, control of access
2. External radiation from plume		2. Sheltering, evacuation, control of access
3. Inhalation of activity in plume		3. Sheltering, administration of stable iodine, evacuation, control of access
4. Contamination of skin and clothes	INTERMEDIATE	4. Sheltering, evacuation, decontamination of persons
5. External radiation from ground deposition of activity	LATE	5. Evacuation, relocation, decontamination of land and property
6. Ingestion of contaminated food, water		6. Food and water controls
7. Inhalation of re-suspended activity		7. Relocation, decontamination of land and property

Table accessed from http://www.epa.gov/radiation/rert/pags.html, December 3, 2012

PUBLIC HEALTH SERVICE IMPACT

Public health agencies play a significant role in the response to, and remediation from, a nuclear facility accident.

- Public health agencies will need to work with the following agencies to formulate and implement exposure control measures assessing radiation exposure and contamination as well as formulating response plans:
    - Emergency management agencies
    - Public safety agencies (e.g., fire-hazmat and law enforcement)
    - State agencies that oversee radiation protection services (e.g., Department of Environmental Protection)
    - Federal agencies involved in nuclear or radiation oversight and regulation
- Agencies will engage in ongoing re-evaluation of response plans based on environmental assessment of radiation contamination, status of reactor
- Large-scale monitoring of population for radiation contamination based on assessment of risk from dispersion of radioactivity, as well as public anxiety and concern
- Public health agencies may need to activate plans for community reception centers and population monitoring to accomplish the following:
    - 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
- Rapid distribution of KI to households and individuals at risk for radioactive iodine ingestion who do not have pre-positioned KI
- Dissemination of guidance re: medical and public health management of potentially exposed individuals to healthcare providers
    - Specific recommendations for pregnant women, children
    - Recommendations for use of KI (potassium iodide)
    - Recommendations for use of medical countermeasures for contamination
- Facilitation of access to medical countermeasures for radioactive isotopes, through coordination with CDC's Strategic National Stockpile and other federal agencies
- Evacuation and shelter operations for those who are located within the EPZ surrounding the reactor
    - Sheltering operations have the potential to extend for multiple days or weeks, thus creating a need for the following:
        - Shelter staff, including security and public health personnel
        - Food, water, and personal hygiene items
        - Animal sheltering, care, and supplies
- Dissemination of health information, including risks following exposure and contamination to general public
    - Specific recommendations and targeted information needed for pregnant women and children
    - Clear recommendations for protective actions (e.g., shelter in place, evacuation, etc.):
        - 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 water and soap, allowing the water to run away from the face

- Change into uncontaminated clothing
- Wash out tub or shower after use
- Wash car if driving home from the area of contamination
- Tune in to television or radio for further instructions from public health and emergency management officials

PREPAREDNESS STRATEGIES FOR PUBLIC HEALTH AGENCIES

- Pre-event distribution of potassium iodide (KI), and development of educational materials that can be distributed urgently upon recommendations to take KI following a release
- Coordinate plans with emergency management officials so that evacuation zones are understood, along with plans to issue shelter in place orders
- Anticipate need for population monitoring:
  - Develop plans for establishing community reception and population monitoring centers
  - Identify personnel and resources necessary for mass population monitoring, including:
    - Whole-body counters
    - Lung counters (in-vivo analysis)
    - Ability to perform radiochemical analysis of urine, blood and other clinical specimens
    - Location of sample collection kits
    - Administrative forms, such as chain of custody documentation
  - Establish crowd management operations including process flow/triage procedures
  - Anticipate need to distribute patient information
  - Train staff to use on-site equipment to monitor external contamination
  - Identify and handle needs of special populations
  - Manage individuals with psychological trauma
  - Identify procedures for requesting federal support
  - Develop educational materials that address the following:
    - Contamination control
    - Minimizing individual exposure
    - Principles of dose reconstruction
  - Registry management for long-term follow-up based on exposure history and likely risk
- Coordinate planning with healthcare facilities for mass casualty response to radiation emergencies:
  - Ensure planning for decontamination and assessment of radiation dose
  - Make guidance for medical management of radiation exposure available to clinicians on urgent basis and anticipate need for "just-in-time" trainings and education
  - Surge planning for medical countermeasures needed for radiation exposure management including access to Strategic National Stockpile
  - Surge planning for laboratory resources, including identification of appropriate laboratories to detect radioactive isotopes in clinical specimens from individuals with suspected internal contamination
  - Mental health services for exposed individuals, healthcare and public health professionals

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UTILITY INTERRUPTION

Example: Blackout, Northeastern U.S., 2003

Utility interruptions may occur following major weather incidents such as hurricanes, blizzards, or ice storms; system failure related to human errors, excessive demand, or malfunction; or cyber terrorism. Commerce, critical infrastructure operations, communication platforms, as well as most aspects of healthcare, public health, and community services rely on electronic systems to function. The loss of power from a massive utility disruption would have major implications for daily activities controlled by electrical and/or computer signals, including environmental and disease surveillance, healthcare delivery, and transportation.

HUMAN IMPACT

During a utility disruption, there are significant risks to human health due to malfunctioning equipment, weather exposures, food and medication spoilage, and evacuation injuries.

- Temperature exposure risk – related to a lack of heating or air conditioning in homes and healthcare facilities
  - See **WINTER STORM** and **TEMPERATURE EXTREMES** sections for further information on exposure-related illnesses and injuries
- Carbon monoxide poisoning – related to use of generators, gas-burning stoves and similar means to generate heat
  - Signs and symptoms include headache, dizziness, nausea, vomiting, and confusion, leading to seizures and coma with continued exposure
- Burn injuries and increased fire risk resulting from use of candles for light
- Foodborne illness – related to contaminated food and a lack of refrigeration due to loss of electricity
- Waterborne illness – related to contamination of the potable water due to water and sewage pump failures, causing an increase in diarrheal diseases
- Industrial exposure risk – related to injuries from machinery and hazardous substances due to compromised machinery and safety equipment
- Individuals with chronic illnesses who live in the community and rely on durable medical equipment requiring electricity (e.g., ventilators) are extremely vulnerable
- Critical care patient mortality – related to deaths of patients relying on life support equipment in hospitals and long-term care facilities
  - Long-term utility disruptions that extend beyond the fuel and generator capacity of healthcare facilities
- Transportation injuries – related to disruption of power to elevators, mass transit lines, and other electrically-run equipment
  - Persons trapped in elevators between floors and rail cars between stations risk injury from both self- and professional evacuation efforts
  - Example: During the 2003 blackout, more than 600 subway and commuter train cars were stopped between stations
- Evacuation injuries – related to individuals with chronic illnesses and/or access and mobility needs

HEALTHCARE SERVICE IMPACT

Healthcare services during a utility outage can be severely compromised, depending on facilities' access to uninterruptible back-up power systems, generators, and back-up fuel capacity. Most acute healthcare facilities maintain back-up power for intensive care units and critical services; however, most inpatient and outpatient services are severely disrupted.

- Demand for emergency medical services and transport – related to persons requiring electrically powered medical devices
  - Example: New York City experienced a 9% increase in 9-1-1 calls during the 2003 blackout
- Interruption in emergency medical dispatch services – related to a loss of main and back-up power sources
  - Example: New York City 9-1-1 emergency dispatch service had three (3) service interruptions due to back-up battery failures during the 2003 blackout

- Emergency department demand in unaffected hospitals – related to an increase in patients presenting for illnesses and injuries due to weather exposure, evacuation efforts, and electricity supply for home medical equipment
    - Example: During the 2003 blackout, a New York City emergency department saw an increase in patients due to minor injuries from self-evacuation and heat exhaustion
- Loss of medical equipment functioning – related to disruption of electrical power and computer capabilities for home- and facility-based healthcare machinery:
    - Critical care – ventilator and other life support equipment
    - Diagnostic – radiographic examination and laboratory specimen equipment
    - Medication – IV pumps and refrigerator equipment for certain medications and vaccines
        - Refrigeration lapses may jeopardize safety of biological and other pharmaceutical products that require cold storage (including blood products)
    - Safety – sterilization equipment
    - Healthcare information systems – electronic medical records, electronic ordering systems for diagnostic tests and medication
- Staff shortages due to closure of transportation routes and/or interruption of mass transit services, as well as staff addressing outage consequences at home
- Supply shortages, including pharmaceuticals and other critical supplies due to transportation disruption as well as spoilage of perishable vaccines and medications from loss of electricity
- Loss of hospital service capacity, including:
    - Operating rooms
    - Pharmacy equipment and services
    - Food storage and preparation
- Loss of emergency department capacity – related to EDs having to turn away incoming patients and potentially moving current patients to an alternate care site due to loss of electrical and/or computer power
    - Example: During the 2003 blackout, four New York City hospitals lost power, the longest outage lasting almost three hours
- Potential for facility evacuation – related to the safety concerns due to nonfunctioning equipment and disruption of services
- Interruption of community-based outpatient medical facilities, including surgical centers, dialysis centers, and clinical practices
- Interruption in operations of community-based pharmacies, resulting in reduced access to medications

COMMUNITY IMPACT

Loss of power can adversely affect communities by causing environmental contamination, transportation closures, and service disruptions.

- Loss of potable water supply – related to disruption of power to pumping and treatment systems
    - Example: 1.5 million people in the Cleveland area were without water during the 2003 blackout due to pumping station failures
- Environmental contamination – related to failures of sewage treatment plants as well as improper food waste disposal
    - Remediation requires personnel from health department agencies and environmental protection organizations to do the following:
        - Collect samples
        - Conduct laboratory testing
        - Clean any contamination that occurs as a result of the incident
    - Example: Failure of back-up generators at sewage treatment plants resulted in 500 million gallons of human waste dumping into New York City waterways during the 2003 blackout
        - 50 sets of water samples taken from New York City beaches to monitor levels of contamination
- Shelter operations – related to the need to provide heat and electricity for those affected by the power outage

- Sheltering operations have the potential to extend for multiple days or weeks, thus creating a need for the following:
  - Shelter staff, including security and public health personnel
  - Food, water, and personal hygiene items
  - Animal sheltering, care, and supplies
  - Back-up power system for shelter operations

- Business continuity disruption – related to the inability of businesses to operate in the absence of power
  - Grocery stores may be closed, resulting in reduced availability of food supplies to the general public
  - For restaurants, closures due to power outages lead to spoiled food and require inspection to re-open to the public
- Long term utility disruptions may lead to shut-downs of manufacturing facilities, including gas/oil refineries
  - May result in shortages of necessary fuel and other goods
- Transportation disruption – related to nonfunctional electric and computer signaling systems
  - Mass transit vehicles can be disrupted in mid-route, causing passengers to be evacuated, often in underground tunnels
  - Air traffic operations will be disrupted due to failed communication systems, nonfunctional runway lights, and navigation equipment
  - Roadway traffic is dangerous due to the outage of traffic signals, requiring manual traffic control from first responders
  - Transportation disruptions can cause the following disruptions:
    - Access to necessary medical services – dialysis, chemotherapy, transfusions
    - Home health services
    - Potential shortages of medications and other critical supplies
    - Ability of essential personnel to travel to/from work, including healthcare staff

PUBLIC HEALTH SERVICE IMPACT

The demand for public health services during a major utility disruption encompasses a broad range of activities, including surveillance, inspections, and messaging.

- Surge requirement for public health surveillance – related to a need for public health personnel to track illness and injury patterns for patients in hospital, emergency department, and outpatient settings, including the following:
  - Food- and waterborne illnesses
  - Reportable illnesses, including respiratory and vector-borne
- Disruption of public health information systems and electronic reporting
- Increased demand for environmental sanitation staff – related to restaurant inspections necessitated due to spoiled food
  - Example: New York City public health personnel worked with outside county personnel to conduct approximately 500 restaurant inspections following the 2003 blackout and set approximately 400 rodent extermination sites
- Staff shortages – related to staff failing to come to work in order to address outage consequences at home
- Sheltering operations – related to anticipating the need to provide temporary shelter for persons with special medical needs who cannot remain at home without power
  - Ensuring back-up power in shelters for persons with special medical needs
- Health communication – related to the development and distribution of public messaging regarding the following issues:
  - Food and medication safety
  - Environmental contamination
  - Weather exposure risks
  - Operational and non-operational healthcare facilities
  - Evacuation safety
- Need for public health laboratory continuity planning and security – related to the potential failure of security systems for specimen storage as well as disruption of laboratory operations
- Possible compromise of vaccines and other biological products distributed by public health agencies if duration of utility interruption exceeds back-up refrigeration capacity

PREPAREDNESS STRATEGIES FOR PUBLIC HEALTH AGENCIES

- Ensure public health agency has continuity of operations plans, including plans for identification of critical services and ensuring their operations
    - Ensure staff communication plan is redundant and operable during long-term outages and overwhelmed telephone systems
- Ensure public health and healthcare agencies have back-up, uninterruptible power sources to prevent disruption of services
    - Back-up generator capacity
    - Redundant communication systems
- Develop and maintain a database for resources during emergencies:
    - Essential employees with contact information
    - Emergency supplies, medications, vaccines, water, generator fuel
- Encourage all businesses to establish and exercise evacuation plans, in accordance with building codes
- Establish memoranda of understanding (MOU) with surrounding county governments to provide mutual aid in the event of a power disruption
- Healthcare facilities should maintain a protocol for facility evacuation and patient disposition, including the following:
    - Developing an evacuation triage protocol for inpatients
    - Risk-benefit analysis of evacuating critical care patients versus sheltering in place
    - Plans for hospitals to serve as evacuation destinations for other healthcare, personal care, or rehabilitation facilities
    - Resources necessary for transporting patients, staff, and equipment to an alternate location
    - Maintenance of medical records and patient tracking techniques in order to reunite patients with family members after the event
    - Security procedures to prevent pharmaceutical supply theft
    - Staffing plans for non-facility based alternate care sites
- Targeted public health messaging around the following issues:
    - Food and medication safety in the event of power outages
    - Sanitation and personal hygiene
- Carbon monoxide poisoning and generator safety
- Targeted messaging to high-risk individuals in community (e.g., those with functional needs, chronic diseases) who may suffer disproportionately during long-term utility outages:
    - Ensure pre-incident preparedness plans
    - Ensure they have communications plans during incidents to request services
    - Ensure that healthcare providers and human service agencies that serve high-risk individuals promote preparedness planning and have their own plans for continuity of operations

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Adversarial/Intentional Hazards

ACTIVE SHOOTER

Example: School shooting, Virginia Technological Institute, 2007

An active shooter is an individual actively engaged in killing or attempting to kill people in confined and/or populated areas. In most cases, active shooters use firearms and there is no pattern or method to their selection of victims. Active shooter situations are unpredictable and evolve quickly. Recent examples include school shootings such as the 2007 attack at Virginia Tech, or the Washington, D.C. sniper shootings in 2002. The impact of an active shooter relates to the immediate surge of casualties and the short-term and long-term mental health effects on affected populations. In the last decade, schools and workplaces have experienced the majority of these incidents although other public venues are also vulnerable.

HUMAN IMPACT

Active shooter scenarios pose multiple hazards to human health:

- Incidents may result in more fatalities than injuries
    - Example: The Virginia Tech shooting resulted in 33 deaths at the scene compared to 26 injuries
        - Of the 26 who were evaluated at hospitals, 19 had penetrating injuries from gunshot wounds, 4 had blunt trauma from falls, 1 had burns, and 1 had asthma
    - Gunshot wound mortality usually occurs within 24 hours after the event
- Soft tissue injuries from bullets are the most common injuries in active shooter scenarios
    - Bullet wounds cause soft tissue injury in two ways:
        - Tissue crush - Primary method of injury from gunshot wounds
            - As a bullet travels through tissue, it crushes the tissue directly in its path, forming a permanent tissue cavity
            - The most important determinant of injury is the tissue the bullet crushes
        - Tissue stretch - Passage of the bullet at a high rate of speed displaces tissue surrounding the direct pathway, forming a temporary tissue cavity
- Mental health impact – related to depression, anxiety, dissociation, grief, and post-traumatic stress disorder following the incident
    - Mental health crisis response teams and human service agencies can provide psychological first aid to victims immediately following an incident
    - Long-term mental health care will be needed for survivors, families, and response personnel
    - Example: Subsequent screening of 4,639 Virginia Tech students found that 15.4% experienced high levels of post-traumatic stress symptoms
    - Example: Following the 2002 sniper attacks in the Washington, D.C. area, hospital staff were found to have lower levels of perceived safety and higher levels of alcohol use, depression, and acute stress disorder

HEALTHCARE SERVICE IMPACT

An active shooter incident will likely tax resources in the healthcare sector, including emergency medical services and emergency department availability, if there are large numbers of casualties.

- Demand for emergency medical services and transport – related to a high volume of persons suffering traumatic injuries
    - EMS personnel will need to implement effective triage measures to ensure patients receive care and transport in order of priority
        - Example: Following the Virginia Tech shooting, 25 patients were triaged by EMS for transport to hospitals

- 11 patients were considered to be "over-triaged" and received a higher level of priority than necessary
- 1 patient was considered to be "under-triaged" meaning a lower level of priority was assigned than was necessary

▪ Example: Following the Virginia Tech shooting, 60-mph wind gusts prevented patients from being evacuated via air transport

- 17 patients were transported to hospitals by EMS ground transport

o First responders will need adequate resuscitation equipment for critically injured patients

- Emergency department demand – related to an increase in patients presenting for injuries post-incident
  - o Patient surge has implications for staffing and bed availability
  - o Example: Following the Virginia Tech incident, 26 participants are known to have been treated by local emergency departments
    - ▪ 10 of the shooting victims required surgical intervention within the first 24 hours post-incident
- Hospital bed demand – related to an increase of patients admitted to different inpatient wards from the emergency department to receive further medical treatment from injuries sustained due to gunshot wounds
- Demand for treatment supplies, including pharmaceuticals, blood products, and wound care items
- Disruption of routine surgical procedures, including elective surgeries
- Increased demand for immediate mental health services, including psychological first aid and grief counseling, to affected populations
  - o Need to provide long-term mental health services that address skills for psychological recovery and post-traumatic stress disorder

COMMUNITY IMPACT

Aside from the physical and mental health impacts of an active shooter incident, community health impacts can include temporary population displacement, transportation disruption, and interruption of businesses or services.

- Population shelter-in-place and/or displacement – related to the need for short-term lock down or temporary evacuation of residences and/or businesses in order to ensure population safety and to facilitate investigative efforts
  - o Example: After the Virginia Tech shooting, more than 100 buildings on the campus were evacuated in response to bomb threats and reports of a second shooter
- Transportation disruption – related to the temporary closure or re-routing of transportation routes in order to secure the incident scene and to facilitate investigative efforts
- Business continuity – related to the closure or interruption of facilities affected by an active shooter incident
  - o Decisions to close businesses affected by an incident are affected by the following:
    - ▪ Loss of employers or employees
    - ▪ Psychological trauma suffered by witnesses to the incident
    - ▪ On-going investigations being conducted at or around facilities

PUBLIC HEALTH SERVICE IMPACT

The impact of an active shooter incident on public health services includes an increased demand for the release of public information related to the incident, and the management of those fatally wounded in the attack.

- Health communication – related to the need to provide timely, accurate information to hospitals, healthcare clinics, medical providers, and the general public regarding the following:
  - o Status of casualties

- Health implications of traumatic injuries and illnesses
- Collaboration with mental health agencies and professionals – related to the following:
  - Provision of on-scene providers for psychological first-aid and additional support for affected community and the general public
  - General guidance for discussing violence with young children, especially when victims are also young
  - Long-term mental health services for first responders as well as victims and their families
- Fatality Management – related to an increase in the number of deceased persons as well as post-mortem identification processes
  - In the event of exceeded morgue capacity, alternate locations and resources will need to be established in order to carry out morgue operations, including requesting assistance from other jurisdictions
  - Example: Following the Virginia Tech shooting, the Office of the Chief Medical Examiner requested regional resources to manage the high volume of autopsies

PREPAREDNESS STRATEGIES FOR PUBLIC HEALTH AGENCIES

- Ensure memoranda of understanding (MOU) and mutual aid agreements (MAA) are in place with surrounding counties in order to supplement human and material resources, including security services for public health community and field operations
- Healthcare facilities should ensure that they have protocols for dealing with a surge of acute trauma needs, including facilities that normally have limited trauma resources to receive patients with serious injuries:
  - Facility plans to activate on-call or back-up physicians, nurses, paramedics, and other essential healthcare and response staff in the event of staff shortage and/or surge
  - Facility protocols to handle surge events:
    - Postpone elective surgeries and treatment procedures
    - Discharge non-urgent patients from the emergency room and stable inpatients
    - Transferring ICU patients to regular hospital wards
    - Designating separate areas of emergency departments for less critical patients
    - Mobilize equipment and resources
  - Facility security protocols for mass casualty incidents, including traffic control and securing entry and exit points for hospitals
- Support law enforcement, emergency medical services, and hospitals, to include pre-event planning to identify critical needs in the community related to these incidents
- Collaborate with EMS and hospitals to develop a unified patient tracking system
- Collaborate with universities/schools to improve communications with public health and healthcare systems
- Emergency planning inclusive of mental health crisis response – related to effectively contacting and utilizing community mental health resources for the purposes of psychological first aid response for both disaster victims and public health and clinical staff involved in the disaster Plans should include provisions for the following:
  - Mutual aid agreements/memoranda of understanding for inter-county services
  - 24/7 crisis hotline
  - Coordination of post-disaster mental health services across all outlets:
    - Universities/schools
    - Community-based and youth organizations
    - Hospital providers
  - Culturally competent psychological services to address non-English speaking communities
  - Caches of mental health providers specializing in different populations (e.g., children, trauma) and emergency contact for each provider

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BIOLOGICAL TERRORISM

Examples:
Anthrax outbreak, eastern United States, 2001
United States National Planning Scenario 2: Aerosolized Anthrax

Biological weapons are considered to be weapons of mass destruction (WMDs) because of their ability to produce large numbers of casualties in populations in which they are released. The Centers for Disease Control and Prevention (CDC) classifies biological warfare agents into categories based on criteria including availability, dissemination characteristics, agent stability, and virulence. The major concern related to the use of biological weapons is their ability to cause large numbers of serious casualties in exposed individuals in a short period of time, overwhelming healthcare resources and leading to significant morbidity and mortality.

HUMAN IMPACT

A biological weapon release is likely to be result in an infectious disease epidemic, similar to an epidemic of a naturally-occurring infectious disease, although due to an intentional act. Depending on the agent released, person-to-person contagion may or may not be important.

The Centers for Disease Control and Prevention places potential biological weapons into three major categories:
Agent classifications

- Category A agents – Highest priority agents due to national security risks
  - Examples: Anthrax, Botulism, Plague, Smallpox, Tularemia, Viral Hemorrhagic Fevers (e.g., Ebola, Marburg, Lassa, and Rift Valley)
  - Classification reflects the following:
    - High morbidity and mortality rates
    - Ease of dissemination and/or person-to-person transmission
    - Large public health impact
    - Potential for social disruption
    - Requirements for special public health preparedness efforts
- Category B agents – Second highest priority agents
  - Examples: Brucellosis, foodborne illnesses, Glanders, Melioidoisis, Psittacosis, Q Fever, Ricin toxin, Staphylococcal toxins, Typhus, Viral encephalitis, waterborne illnesses
  - Classification reflects the following:
    - Moderate morbidity and low mortality
    - Moderate ease of dissemination and/or person-to-person transmission
    - Enhanced disease surveillance
- Category C agents – Third highest priority agents, including emerging agents with potential to be weaponized
  - Examples: Viral hemorrhagic fevers (e.g., Yellow fever), multidrug resistant Tuberculosis
  - Classification reflects the following:
    - Agent availability, ease of production, and dissemination
    - Potentially high morbidity and mortality
    - Potentially large public health impact

Agent health effects

- Agents can be disseminated via aerosol (inhalation), contamination of food or water (ingestion), or rarely, through skin exposure or vector transmission
- Clinical syndromes resulting from the dispersal of bioweapons are specific to the agent, and may result in the following:
  - Febrile illness manifestations that may include respiratory compromise
  - Skin manifestations
  - Gastrointestinal disease
  - Central nervous system disease
  - Death may result from many of these organisms, particularly in the absence of medical intervention

- Post-exposure prophylaxis may interrupt transmission and prevent disease following exposure to anthrax, plague, brucellosis, and smallpox, as well as a number of the category B and C bacterial agents
    - Prophylaxis given either via antibiotics or vaccines
- Mental health impact – related to depression, anxiety, dissociation, and post-traumatic stress disorder following the incident
    - Mental health crisis response teams and human service agencies can provide psychological first aid to victims immediately following an incident

HEALTHCARE SERVICE IMPACT

The impacts of biological terror agents on the healthcare services sector include patient surge in outpatient medical offices, emergency departments, and inpatient hospital units; increased demand for pharmaceuticals and laboratory testing; and potential supply and service disruptions. Patients presenting for medical care may be misdiagnosed due to the non-specific symptoms that occur following an agent release.

- Emergency department demand – related to an increase in patients presenting for illness post-release or exposure
    - Patient surge has implications for staffing and bed availability, as well as laboratory testing and analysis
    - Surge in demand for evaluation of clinical symptoms may overwhelm emergency departments, interfering with care for other emergencies (e.g., labor and delivery, trauma)
    - Worried well individuals who may not warrant emergency department care may also seek services in hospital emergency departments, competing with resources for more significantly ill persons
- Hospital bed demand – related to an increase of patients admitted to different inpatient wards, including intensive care, to receive medical treatment for biological agent illness complications
- Demand for outpatient medical services – related to an increase in visits to primary care practitioners
    - Signs and symptoms of biological WMD agents can appear days after the release event and can manifest as common ailments to providers, thus leaving potential for misdiagnosis
    - Demand by patients for information from primary care physicians will increase, including telephone calls and requests for urgent visits
- Potential disruption of services, including interruption of outpatient, inpatient, and home health services
    - Related to evacuation orders, utility outages, and/or transportation closures
- Staff shortages due to illness, fear of agent exposure, and/or closure of transportation routes and/or interruption of mass transit services
- Supply shortages, including pharmaceuticals and other critical supplies due to potential transportation disruption
- Increased demand for laboratory testing and diagnostic imaging – related to surge in both outpatients and inpatients in all clinical settings
- Pharmaceutical demand – related to the need for medications for treatment and for post-exposure prophylaxis
    - Likely release of medications from CDC's Strategic National Stockpile (SNS), including antibiotics, vaccines and antitoxin therapies

COMMUNITY IMPACT

A biological agent release can have several impacts on communities, ranging from environmental contamination to disruptions in transportation and utilities, to fear and distrust of the population.

- Environmental contamination – related to soil, water, air, and structural contamination with particles from the released substance
    - Remediation requires personnel from health department agencies as well as environmental protection agencies to collect samples, conduct laboratory testing, and remediate in order to render buildings and external environment safe for re-occupation
    - Duration and extent of environmental contamination as well as potential for ongoing dissemination of the bioweapon is pathogen-specific

- Business continuity – related to the inoperability of businesses due to the following:
  - Environmental contamination
  - Staff depletion due to illnesses resulting from a bioterrorism agent release
  - Control measures requiring quarantine or social distancing
- Community-wide grief, anxiety, and distress related to the following:
  - Fear and panic over the source of the release
  - Concerns for personal and family health and safety
  - Demand for scarce medication or post-exposure prophylactic measures
  - Social stigmatization for those in areas affected by release
- Transportation disruption – related to potential closures of mass transit routes, highways, and roadways
  - Loss of transit capabilities can cause the following disruptions:
    - Access to necessary medical services – dialysis, chemotherapy, transfusions
    - Home health services
    - Potential shortages of medications and other critical supplies
- Possible implementation of community-wide mass prophylaxis distribution plans
- Shelter operations for those who have been ordered to evacuate their homes due to environmental contamination from the biological agent
  - Sheltering operations have the potential to extend for multiple days or weeks, thus creating a need for the following:
    - Shelter staff, including security and public health personnel
      - Sheltering for this incident may require additional medical support personnel to monitor for the development of symptoms and ensure rapid initiation of treatment and/or transfer to appropriate healthcare facilities
    - Food, water, and personal hygiene items
    - Animal sheltering, care, and supplies

PUBLIC HEALTH SERVICE IMPACT

Public health demand following the release of a bioterrorism agent will be high, due to the extensive need for health information releases, staffing requirements, and surveillance efforts to monitor morbidity and mortality of patients.

- Joint forensic and epidemiological investigations of disease etiology with public health and law enforcement partners at local, state, and federal levels, including Federal Bureau of Investigation
- Implementation of mass prophylaxis plans, including activation of the following:
  - Points of dispensing (PODs)
  - Door-to-door countermeasure distribution (“push” strategy)
  - Priority medication or vaccine dispensing to priority populations (e.g., healthcare workers, first responders)
- Expanded public health surveillance for illness due to bioweapon release as well as adverse events following counter-measure distribution
  - Long-term monitoring will be necessary (e.g., months to years post incident)
- Increased demand for clinical and public health laboratory services with special attention to chain of custody procedures for forensic investigation around individual cases of illness
- Implementation of non-pharmaceutical interventions, including the following:
  - Social distancing strategies
  - Closure of public facilities
  - Cancellation of mass gatherings
  - Shelter-in-place advisories
  - Some strategies may require long-term durations (e.g., days to weeks)
- Staffing shortages – related to illness, inability of personnel to travel to/from work due to impassible roadways and mass transit interruptions, as well as evacuation orders
- Supply shortages – related to disruptions in transportation routes

- Environmental surveillance – related to monitoring of soil, air, water, and other environmental specimens to determine extent of environmental contamination, assess remediation steps, and determine safety for re-use or re-entry
- Increased demand for pharmaceuticals needed for care of casualties resulting from bioterrorism agent release, as well as routine medical illnesses
- Pharmaceutical management – related to acquiring and distributing SNS supplies and medications for treatment and prophylaxis, including antibiotics and antitoxin agents
- Health and crisis risk communication – to provide timely, accurate information to hospitals, healthcare clinics, medical providers, and the general public regarding the health implications of the agent released and appropriate use of post-exposure countermeasures
    - Messaging can include information about appropriate precautionary measures, signs and symptoms of exposure, and appropriate treatment courses
- Fatality management – related to an increase in the number of deceased persons in need of mortuary services
    - In the event of exceeded morgue capacity, alternate locations and resources will need to be established in order to carry out morgue operations
- Demand for shelter staffing and supplies – related to public health nurses and other essential personnel to address health concerns in general population and special medical needs shelters
    - Medical surveillance in shelters needed for reports of infectious disease, foodborne, and waterborne disease outbreaks, as well as early detection and treatment of bioterrorism agent related illness

PREPAREDNESS STRATEGIES FOR PUBLIC HEALTH AGENCIES

- Plan, train, and exercise strategies for mass prophylaxis, using either vaccines or medications
- Plan, train, and exercise for implementation of non-pharmaceutical disease control measures
- Ensure memoranda of understanding (MOU) and mutual aid agreements (MAA) are in place with surrounding counties in order to supplement human and material resources, including security services for public health community and field operations
- Joint planning with law enforcement partners for coordinated epidemiological and criminal investigation procedures, including chain of custody issues for clinical and environmental specimens
    - Review HIPAA regulations and ensure understanding of privacy-related regulations regarding personal and public health information and procedures for sharing with law enforcement agencies
- Healthcare facility protocols to handle surge events:
    - Postpone elective surgeries and treatment procedures
    - Discharge non-urgent patients from the emergency room and stable inpatients
    - Transferring ICU patients to regular hospital wards
    - Designating separate areas of emergency departments for less critical patients
    - Mobilize equipment and resources
    - Facility and agency plans to prevent disruption of services
    - Facility security protocols for mass casualty incidents, including traffic control and securing entry and exit points for hospitals
    - Personal protective equipment (PPE) protocols to ensure patient, visitor, and staff protection
    - Facility plans to activate on-call or back-up physicians, nurses, paramedics, and other essential healthcare and response staff in the event of staff shortage and/or patient surge
- Emergency planning and procedures for requesting, receiving, staging, and distributing Strategic National Stockpile (SNS) resources
- Trainings of healthcare providers to recognize signs and symptoms of biological WMD agents
- Develop bi-directional communication systems between public health officials, hospital and healthcare facilities, and community physicians in order to ensure consistent information exchange, convey treatment guidelines, and inform public health plans with knowledge of community-level information

- Develop public information templates for crisis and risk communication related to likely bioterrorism agents:
  - Ensure that designated staff are trained in crisis and risk communication and anticipate significant need for both media briefings and direct communications with the public, particularly communities that may be at highest risk for disease
  - Ensure that agency implements multiple public information strategies, including use of media, outreach through healthcare professionals and community groups, and rapid emergency information systems
  - Capacity must include ability to communicate to culturally and ethnically diverse communities with limited English proficiency
- Develop cadre of volunteer healthcare professionals through initiatives such as Medical Reserve Corps and ESAR-VHP (Emergency System for Advance Registration of Volunteer Healthcare Professionals), to support surge of surveillance, healthcare delivery, mass prophylaxis, and other control measure strategies
  - Ensure inclusion of lay persons in volunteer workforce, including community health workers and others who can provide administrative services, translation, etc.
- Mass fatality planning, to include plans for dealing with remains of individuals with contagious or infectious diseases
  - Culturally appropriate plans needed for religious groups in affected communities
- Emergency planning inclusive of mental health crisis response – related to effectively contacting and utilizing community mental health resources for the purposes of psychological first aid response for both disaster victims and public health and clinical staff involved in the disaster
  - Plans should include provisions for the following:
    - Mutual aid agreements/memoranda of understanding for inter-county services
    - 24/7 crisis hotline
    - Coordination of post-disaster mental health services across all outlets: community-based organizations, hospital providers, youth organizations, etc.
    - Culturally competent psychological services to address non-English speaking communities
    - Caches of mental health providers specializing in different populations (e.g., children, trauma) and emergency contact information for each provider

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CHEMICAL WEAPONS OF MASS DESTRUCTION

Example: Sarin gas release, Tokyo, 1995

Chemical weapons of mass destruction (WMD) are classified by four (4) main agent types: blister, blood, nerve, and respiratory agents. These are the most rapid and virulent terrorist weapons, with each class of agent causing tremendous physical health consequences, resulting in acute illness and/or death.

HUMAN IMPACT

Chemical WMDs have significant adverse consequences for human health. All chemical weapons have the potential to cause acute illness; however, certain agents are more virulent, resulting in almost immediate death upon exposure.

- Blister agents (vesicants)
  - Examples: sulfur mustards, lewisite
  - Symptoms caused by direct skin contact or inhalation of agent
  - Symptom onset: 2-12 hours post-exposure for sulfur mustard; seconds to minutes for lewisite
    - Visual: eye tearing, irritation, pain, light sensitivity, corneal damage, blindness
    - Respiratory: runny nose, hoarseness, cough, shortness of breath, pulmonary edema
    - Skin: redness, burning, itching, development of blisters
    - Other: nausea, vomiting, convulsions, tremors, lack of muscle coordination, immune system compromise
  - Mortality: generally caused by respiratory effects of exposure (respiratory failure) and/or infections resulting from original injuries
- Blood agents
  - Examples: hydrogen cyanide, cyanogen chloride
  - Symptoms caused by ingestion, direct contact, or inhalation of agent
  - Symptom onset: immediate
    - Respiratory: gasping, shortness of breath
    - Central nervous system: seizures, dilated pupils, coma
    - Other: headache, chest pain, dizziness, nausea, sweating, flushing, weakness, vertigo (dizziness)
  - Mortality: caused by cellular death due to hypoxia (lack of oxygen), usually within minutes of high exposure
- Nerve agents
  - Examples: sarin, soman, tabun, and VX
  - Symptoms caused by direct contact or inhalation of agent
  - Symptom onset: seconds to minutes for inhalational exposure
    - Muscarinic: DUMBBELS – diarrhea, urination, miosis (small pupils), bradycardia (slow heart rate), bronchoconstriction (airway tightness), emesis (vomiting), lacrimation (eye tearing), salivation
    - Nicotinic: muscle twitching, weakness, paralysis
    - Cardiac: tachycardia (rapid heart rate), hypertension (high blood pressure)
    - Central Nervous System: altered mental status, convulsions, coma
  - Mortality: caused by respiratory failure
- Respiratory agents
  - Examples: chlorine and phosgene gas
  - Symptoms caused by inhalation of agent
  - Symptom onset: minutes to hours
    - Respiratory: coughing, sneezing, wheezing, shortness of breath
  - Mortality: caused by respiratory failure, usually within 48 hours of high exposure
- Hazardous conditions for emergency response agencies, including agent exposure, fire, and explosions
  - Many first responders carry personal protective equipment (PPE) and have access to blood and nerve agent antidote supplies for personal use
  - Example: During the 1995 Tokyo sarin gas attack, approximately 10% of emergency medical technicians who weren't using PPE received secondary agent exposure

- Mental health impact – related to depression, anxiety, dissociation, and post-traumatic stress disorder following the incident
    - Mental health crisis response teams and human service agencies can provide psychological first aid to victims immediately following an incident
    - Example: Following the 1995 Tokyo sarin gas attack, approximately 60% of survivors suffered post-traumatic stress disorder for longer than 6 months

HEALTHCARE SERVICE IMPACT

Chemical WMD events will lead to a surge in patients seeking treatment for possible exposure to the offending agent. Because of an increase in the demand for healthcare services, emergency responders and hospitals need to be prepared to manage the increase in patient volume.

- Demand for emergency medical services and transport – related to a high volume of persons suffering injuries from agent exposure, fire, explosions, debris, psychological distress, and panic injuries
    - Example: 1,364 emergency medical technicians (EMTs) and 131 ambulances responded to the 1995 Tokyo subway attack, subsequently transporting 668 persons to hospitals
- Decontamination – related to ensuring that incoming emergency department patients do not have chemical WMD particles remaining on clothing, hair, or skin
    - Patients arriving to the emergency department who have particulate matter remaining on them risk contaminating other patients, visitors, and staff
        - Example: 23% of hospital staff experienced secondary exposure symptoms during the 1995 Tokyo sarin subway attacks
    - Persons arriving at the hospital via EMS will likely have undergone decontamination at the incident scene, whereas those who self-transport to a hospital are unlikely to have been decontaminated
    - Hospital security staff will need to monitor entry/exit routes to ensure all persons entering the hospital are decontaminated
- Emergency department demand – related to an increase in patients presenting for injuries post-incident
    - Patient surge has implications for staffing and bed availability, as well as laboratory testing and analysis
    - Anxiety and panic among asymptomatic “worried well” who may seek care and overwhelm healthcare resources
    - Example: Over 5,000 people sought treatment at emergency rooms following the 1995 Tokyo sarin release
        - Significant percentage of these individuals were “worried well”, without sarin-related injuries
- Hospital bed demand – related to an increase of patients admitted to different inpatient wards from the emergency department to receive further medical treatment from illnesses and injuries sustained during a chemical WMD release
- Laboratory and diagnostic testing demand – related to patients in the emergency department, intensive care unit, or other hospital inpatient wards requiring laboratory services and diagnostic imaging for diagnosis and treatment
- Pharmaceutical demand – related to the administration of antidote drugs for blood and nerve agent attacks
    - Antidotes are available through the Strategic National Stockpile’s CHEMPACK program
        - Many hospitals and first responders have access to antidote kits for nerve and blood agents
    - Hospitals have supplies of certain drugs used for antidote purposes, including valium and atropine

COMMUNITY IMPACT

The community impacts of a chemical WMD release center around issues related to environmental contamination, evacuation and sheltering, as well as disruptions to normal business and transportation operations.

- Transportation disruption – related to closures of mass transit routes, highways, and roadways
    - Loss of transit capabilities can cause the following disruptions:
        - Access to necessary medical services – dialysis, chemotherapy, transfusions
        - Home health services
        - Potential shortages of medications and other critical supplies
        - Ability of essential personnel to travel to/from work, including healthcare staff

- Environmental contamination – related to soil, water, air, and structural contamination with particles from the released substance
    - Remediation requires personnel from health department agencies as well as environmental protection organizations to:
        - Collect samples
        - Conduct laboratory testing
        - Remediate contaminated areas in order to render sites safe for reoccupation
- Business continuity – related to the inoperability of businesses due to environmental contamination, remediation efforts, and/or investigative efforts
- Shelter operations for those who have been ordered to evacuate their homes due to environmental contamination if chemical weapon release occurs in residential area
    - Sheltering operations have the potential to extend for multiple days or weeks, thus creating a need for the following:
        - Shelter staff, including security and public health personnel
        - Food, water, and personal hygiene items
        - Animal sheltering, care, and supplies

PUBLIC HEALTH SERVICE IMPACT

Public health demand following the release of a chemical agent will be high, due to the extensive need for health information releases, staffing requirements, and surveillance efforts to monitor morbidity and mortality of patients.

- Need for community and healthcare surveillance – related to monitoring populations for symptom identification as well as long-term health consequences related to the release
- Laboratory services – related to receiving and processing samples to identify the offending agent
    - Public health Laboratory Response Network (LRN) laboratories have capacity to identify major chemical weapons of concern
- Health communication and public information – related to providing timely, accurate information to hospitals, healthcare clinics, medical providers, and the general public regarding the health implications of the agent released
    - Messaging can include information about appropriate precautionary measures, signs and symptoms of exposure, and appropriate treatment courses
    - Health communication to reassure asymptomatic individuals who are concerned about exposure but who are not at risk
- Support of healthcare facility and medical response
    - Likely use of pre-positioned CHEMPACKS containing blood and nerve agent antidotes
        - Strategic National Stockpile assets located in selected healthcare facilities in major metropolitan areas
        - Possible need to distribute CHEMPACK assets to other facilities
    - Anticipate need to request Strategic National Stockpile assets to obtain additional supplies of chemical antidotes that require repeated administration
- Fatality management – related to an increase in the number of deceased persons as well as post-mortem decontamination and identification processes
    - In the event of exceeded morgue capacity, alternate locations and resources will need to be established in order to carry out morgue operations
- Staffing shortages – related to inability of personnel to travel to/from work due to impassible roadways and mass transit interruptions as well as evacuation orders
- Supply shortages – related to disruptions in transportation routes
- If shelters are established, expect need for shelter staffing and supplies
    - Public health nurses and other essential personnel to address health concerns in general population and special medical needs shelters
    - Need for surveillance in shelters – to identify and control infectious disease outbreaks, including foodborne and waterborne illnesses

PREPAREDNESS STRATEGIES FOR PUBLIC HEALTH AGENCIES

- Ensure memoranda of understanding (MOU) and mutual aid agreements (MAA) are in place with surrounding counties in order to supplement human and material resources, including security services for public health community and field operations
- Healthcare facility preparedness:
  - Develop and exercise plans for decontamination, including decontamination of individuals who may present for care without field decontamination or EMS transport
  - Facility decontamination and personal protective equipment (PPE) protocols to ensure patient, visitor, and staff protection
  - Facility plans to activate on-call or back-up physicians, nurses, paramedics, and other essential healthcare and response staff in the event of staff shortage and/or surge
  - Facility protocols to handle surge events:
    - Postpone elective surgeries and treatment procedures
    - Discharge non-urgent patients from the emergency room and stable inpatients
    - Transferring ICU patients to regular hospital wards
    - Designating separate areas of emergency departments for less critical patients
    - Mobilize equipment and resources
  - Facility and agency plans to prevent disruption of services
  - Facility security protocols for mass casualty incidents, including traffic control and securing entry and exit points for hospitals
- Emergency planning and procedures for accessing and distributing CHEMPACK antidote resources
- Provider trainings to recognize signs and symptoms of chemical WMD agents
- Communication systems between public health officials, hospital and healthcare facilities, community physicians, and poison control hotlines in order to ensure consistent information exchange and treatment guidelines
- Procedure for sample collection, transportation to laboratory, and specimen analysis
- Emergency planning inclusive of mental health crisis response – related to effectively contacting and utilizing community mental health resources for the purposes of psychological first aid response for disaster victims, public health, and clinical staff involved in the disaster
  - Plans should include provisions for the following:
    - Mutual aid agreements/memoranda of understanding for inter-county services
    - 24/7 crisis hotline
    - Coordination of post-disaster mental health services across all outlets: community-based organizations, hospital providers, youth organizations, etc.
    - Culturally competent psychological services to address non-English speaking communities
    - Caches of mental health providers specializing in different populations (e.g., children, trauma) and emergency contact information for each provider

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CIVIL DISTURBANCE

Example: Riots, Los Angeles, CA, 1992

The effects of civil disturbances are far-reaching, including destruction of property, looting, transportation disruption, and physical injury. Injuries and mental health effects from these events may impact healthcare facilities and require public health response activities.

HUMAN IMPACT

Civil disturbances may have the following impacts on human health:

- Physical health consequences of civil disturbances fall into the following main categories:
  - Injuries due to:
    - Assaults – related to attacks by demonstrators or looters, including gunshot wounds, stab wounds, and beatings
    - Automobile accidents – related to drivers, passengers, and pedestrians involved in motor vehicle accidents resulting from disrupted traffic patterns, malfunctioning traffic signals, and erratic driving
    - Chemical agents – related to the use of less-lethal force by law enforcement officers, including tear gas and pepper spray
      - Eye pain and upper respiratory symptoms are the common side effects of these agents
    - Projectile munitions – related to the use of "bean bag" rounds or rubber bullets, leading to soft tissue injuries and the potential for internal injuries
    - Example: 2,325 persons were injured during the 1992 Los Angeles riots
  - Chronic illness complications – related to the inability of patients to obtain treatments, care, or medications in the event of road closures or community-lock down with closure of pharmacies, transportation routes, and mass transit
    - Diabetic or dialysis-dependent patients
- Hazardous conditions for emergency response agencies, including protestor violence, fire, contamination from items thrown at responders (e.g., blood products), and riot control agents (e.g., tear gas)
  - Example: During the 1992 Los Angeles riots, 18 law enforcement officers and 54 firefighters and paramedics were injured
- Mental health impact – related to depression, anxiety, and post-traumatic stress disorder following the incident, particularly in first responders and public health professionals

HEALTHCARE SERVICE IMPACT

Healthcare services can be affected by civil disturbance in the following ways:

- Demand for emergency medical services and transport – related to persons injured as a result of rioting
- Emergency department demand – related to an increase in patients presenting for injuries received as a result of violence, fires, and accidents
  - Patient surge has implications for staffing and bed availability, as well as laboratory testing and analysis
- Hospital bed demand – related to an increase of patients admitted to different inpatient wards from the emergency department to receive further medical treatment from injuries and chronic illness complications
  - Example: 248 persons were admitted to hospitals as a result of the 1992 Los Angeles riots
- Staff shortages due to closure of transportation routes and/or interruption of mass transit services
- Demand for treatment supplies, including pharmaceuticals, blood products, and wound care items
- Disruption of necessary medical services, including outpatient and home health services, due to destruction or damage to clinical facilities, roadways, and transportation systems, as well as provider safety concerns
- Interruption of pharmacy services – related to structural damage and/or looting
  - Example: During the 1992 Los Angeles riots, over 45 pharmacies were damaged

- Disruption of private, outpatient practices – related to the destruction of medical and dental offices, equipment, and patient records
    - Implications for required immunization records, prescriptions, as well as transferring care to other unaffected practitioners
    - Example: 15 medical and 23 dental offices were destroyed, resulting in the loss of an estimated 20,000 patient medical records as a result of the 1992 Los Angeles riots
- Mental health services – related to the demand for behavioral and substance abuse services during and following an incident
    - Example: During the 1992 Los Angeles riots, approximately 20 substance abuse treatment and rehabilitation centers experienced service disruption and structural damage

COMMUNITY IMPACT

Community impacts during and following a civil disturbance center primarily around the disruption of community services, including transportation, utilities, and businesses.

- Transportation disruption – related to closures of mass transit routes, highways, and roadways
    - Loss of transit capabilities can cause the following disruptions:
        - Access to necessary medical services – dialysis, chemotherapy, transfusions
        - Home health service delivery
        - Potential shortages of medications and other critical supplies
        - Ability of essential personnel to travel to/from work, including healthcare staff
- Utility disruption – related to power and telephone outages
    - Phone service outages prohibit 9-1-1 services due to an inability to call for help
    - Power outages pose risks for food and medication items that need to be refrigerated
    - Examples from the 1992 Los Angeles riots:
        - 240,000 persons lost phone service due to system damage 45,500 customers lost electricity due to damaged power lines and transformers
- Environmental contamination – related to concerns for the following:
    - Waste and hazardous materials released into the air, ground, or water systems due to fire activity
    - Animal infestations resulting from damage to food establishments
    - Examples from the 1992 Los Angeles riots:
        - Run-off from fire hoses caused polluted water along public beaches, requiring beach closure
        - Water run-off resulted in pools of stagnant water, raising concerns about vector control and vector-borne illnesses
        - Fires caused chemicals to burn, including paint and cleaning products as well as gasoline
- Business continuity disruption – related to the temporary or permanent closure of business establishments, including medical and dental offices, grocery stores, and pharmacies

PUBLIC HEALTH SERVICE IMPACT

Public health personnel may be required to perform the following activities during and following a civil disturbance:

- Conduct disease and injury surveillance
    - Conduct environmental inspections, including restaurants and other food service establishments
        - Example: Following the Los Angeles riots, environmental health staff were tasked with inspection and monitoring services for up to 4 weeks post-incident
- Provide public information and health communication related to the development and distribution of public messaging regarding the following issues:
    - Food and medication safety
    - Environmental contamination
    - Operational and non-operational healthcare facilities

- Support and supplement healthcare service delivery to communities affected by civil disturbance:
  - Examples from the 1992 Los Angeles riots:
    - Health department staff and facilities were used to assist with community pharmacy operations
    - 10 public health nurses were needed for 2 weeks to assist the American Red Cross with patients whose medical records were lost in the riots
- Fatality management – related to an increase in the number of deceased persons as well as post-mortem identification processes
  - In the event of exceeded morgue capacity and/or loss of power to morgue, alternate locations and resources will need to be established in order to carry out morgue operations
- Public health agencies may experience the following challenges:
  - Staffing shortages – related to inability of personnel to travel to/from work due to impassible roadways and mass transit interruptions
  - Supply shortages – related to disruptions in transportation routes

PREPAREDNESS STRATEGIES FOR PUBLIC HEALTH AGENCIES

- Ensure capacity for urgent communication to healthcare and public health partners to provide updates regarding incident status and community impact
  - Need to assist healthcare partners and/or non-profit agencies in service delivery following disturbance, including staff support and acquisition of necessary medications
- Ensure capacity to provide public information and risk communication regarding health issues arising from incident
- Ensure memoranda of understanding (MOU) and mutual aid agreements (MAA) are in place with surrounding counties in order to supplement human and material resources, including security services for public health community and field operations
- Healthcare facilities should have plans in place to handle surge of individuals with injuries:
  - Facility plans to activate on-call or back-up physicians, nurses, paramedics, and other essential healthcare and response staff in the event of staff shortage and/or patient surge
  - Facility protocols to handle surge events, including designation of separate areas of emergency departments for less critical patients
    - Capacity to care for eye injuries in the event that tear gas is used
  - Facility security protocols for mass casualty incidents, including traffic control and securing entry and exit points for hospitals
- Emergency planning inclusive of mental health crisis response – related to effectively contacting and utilizing community mental health resources for the purposes of psychological first aid response for incident victims, public health, and clinical staff involved in the incident response and remediation
  - Plans should include provisions for the following:
    - Mutual aid agreements/memoranda of understanding for inter-county services
    - 24/7 crisis hotline
    - Coordination of post-disaster mental health services across all outlets: community-based organizations, hospital providers, youth organizations, etc.
    - Culturally competent psychological services to address non-English speaking communities
    - Caches of mental health providers specializing in different populations (e.g., children, trauma) and emergency contact information for each provider
    - Employee Assistance Programs (EAPs) to offer critical incident stress management and counseling to emergency responders and public health staff

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CONVENTIONAL EXPLOSIVE

Examples: Subway bombings, London, 2005
Train bombings, Madrid, Spain 2004
Oklahoma City, Oklahoma, 1995

Conventional explosives result in significant casualties from physical injuries, destroy the physical environment, and lead to major psychological trauma. For the purposes of this planning aid, conventional explosives are regarded as bombs or incendiary devices without the use of chemical, biological, or radiological agents.

HUMAN IMPACT

Conventional explosives present considerable consequences for human health, inflicting physical injury on victims as well as psychological trauma on survivors.

- Blast injuries are the most common injuries following conventional explosive events:
  - Primary blast injuries: caused by effects of pressure changes from blast wave
    - Ears, lungs, hollow organs most commonly affected
    - Death is immediate for most victims
    - Must be considered for all victims of an explosive event, regardless of external trauma
  - Secondary blast injuries: caused by projectile debris from explosion
    - Blunt or penetrating trauma anywhere on body
  - Tertiary blast injuries: caused by the force of the blast throwing a body
    - Blunt or penetrating trauma anywhere on body
    - Children are more susceptible due to lower body weight
  - Quaternary blast injuries: caused by smoke inhalation, carbon monoxide poisoning, burns, or structural collapse
- Traumatic injuries resulting from conventional explosives are dependent upon the type of incident:
  - Open-air bombings are likely to result in wound injuries (lacerations, penetrating objects)
  - Structural-collapse bombings are likely to result in orthopedic and inhalational injuries as well as amputations
  - Explosions in confined spaces (e.g., buildings, large vehicles) are associated with the greatest morbidity and mortality, and may be more likely to result in lung injuries (blast lung)
  - Blast lung is most common fatal injury among initial survivors
- Mental health impact – related to depression, anxiety, dissociation, and post-traumatic stress disorder following the incident
  - Mental health crisis response teams and human service agencies can provide psychological first aid to victims immediately following an incident
  - Example: Within two weeks of the 2005 London bombings, 31% of persons surveyed reported experiencing significant stress

HEALTHCARE SERVICE IMPACT

Emergency responders, hospitals, and other healthcare centers can expect an increase in demand for triage, transport, and treatment of critically injured patients wounded in a conventional explosive event, as well as an influx in less critically injured, "worried well" patients.

- Demand for emergency medical services and transport – related to a high volume of persons suffering traumatic injuries from fire, explosions, debris, building collapse, psychological distress, and panic injuries
  - Alternate forms of transportation (e.g., school or transit buses) may be used to transport less critically injured patients to healthcare facilities
  - Example: 101 ambulances and 25 fast response units were deployed in the 2005 London bombings
  - Example: 966 patients were transported to local hospitals following the 2004 Madrid bombings
- Post-blast, half of the initial casualties will seek medical care within the first hour:
  - Those with minor injuries arrive before more severely wounded because they self-transport to nearest hospital

- Rule of thumb: double number of persons presenting for care in first hour to estimate the total number likely to present in the "first wave" of casualties
- Example: Approximately 270 injured persons arrived at the closest hospital in the initial 2 hours following the Madrid bombings

- Emergency department demand – related to an increase in patients presenting for injuries post-incident
  - Patient surge has implications for ED staffing and bed availability, radiology, as well as laboratory testing
  - Example: During the 1995 Oklahoma City bombing, 351 injured persons sought emergency department treatment
  - Example: During the 2005 London Underground bombings, 194 persons were received at one hospital, with a surge rate for seriously injured patients at 18/hour
    - Maximum capacity for critical medical needs was reached in 15 minutes
  - Possible need for alternate care site can to be opened to for less acutely injured patients
- Hospital bed demand – related to an increase in patients admitted to different inpatient wards from the emergency department to receive further medical treatment from injuries sustained from the explosive device or structural collapse
- Demand for treatment supplies, including pharmaceuticals, blood products, and wound care items
  - Example: Following the 2005 London bombings, 264 units of blood were used in the first 15 hours post-incident
- Disruption of routine surgical procedures including elective surgeries
- Demand for staffing – related to an increase in the number of emergency department, ICU, and inpatient beds as well as operating rooms needing to be staffed
  - Staff members might be unable to reach the hospital if there are disruptions to transportation or if they have been evacuated from an affected area
- Laboratory and diagnostic testing demand – related to patients in the emergency department, intensive care unit, or other hospital inpatient wards requiring laboratory services and diagnostic imaging for diagnosis and treatment

COMMUNITY IMPACT

The impacts of a conventional explosive on communities include disruptions in transportation and utility services, unsafe conditions due to structural compromise of buildings, environmental contamination, and the need to open shelters to house displaced persons. Explosions that result from terrorism also have significant mental health impact on affected communities.

- Environmental destruction – related to the following:
  - Debris from collapsed structures
  - Dangerous conditions requiring closure of unsafe buildings
  - Remediation and clean-up of sites
  - Re-building of structures destroyed by the incident and/or those destroyed post-incident for safety reasons
- Environmental contamination – related to any waste or hazardous materials which get released into air, soil, or water as a result of the explosion incident and/or as a result of the emergency responder mitigation activities (e.g., firefighting)
- Transportation disruption – related to short- and long-term closures of mass transit routes, highways, and roadways
  - Loss of transit capabilities can cause the following disruptions:
    - Access to necessary medical services – dialysis, chemotherapy, transfusions
    - Home health services
    - Potential shortages of medications and other critical supplies
    - Ability of essential personnel to travel to/from work, including healthcare staff
- Utility outages – related to water, electric, and gas system failures due to destruction from the explosion, as well as mandatory shut-off for safety
  - Potential to extend over multiple days, as hazards could prevent restoration efforts
  - Disruptions to normal utilities can have the following impacts:
    - Unsafe drinking water, potentially resulting in a boil water advisory for extended time periods
    - Loss of refrigeration capabilities, resulting in spoiled food and medication
    - Loss of power to critical, life-sustaining equipment (e.g., ventilators), as well as other durable medical equipment for both residential and facility use

- Shelter operations may be required for those who have utility outages and/or damage to homes
    - Sheltering operations have the potential to extend for multiple days or weeks, thus creating a need for the following:
        - Shelter staff, including security and public health personnel
        - Food, water, and personal hygiene items
        - Animal sheltering, care, and supplies

PUBLIC HEALTH SERVICE IMPACT

Public health agencies will need to provide the following services following an incident involving conventional explosives:

- Public health surveillance to assess total casualties, types of injuries, overall health impacts of incident
- Staffing shortages – related to inability of personnel to travel to/from work due to impassible roadways and mass transit interruptions
- Supply shortages – related to disruptions in transportation routes
- Disruption of power – related to loss of computer use for medical records and electronic surveillance efforts
- Supporting service and supply needs of all hospitals receiving injured, including the following:
    - Otologic (ear) care and audiology services
    - Hyperbaric oxygen
    - Mental health, including care for post-traumatic stress
    - Access to additional medications, wound care supplies, antibiotics and vaccines
- Environmental assessment of bombing site - inspection of affected facilities, with likely closure of establishments and residences affected by bombing
- Health communication – to provide timely, accurate information to hospitals, healthcare clinics, medical providers, and the general public regarding the following:
    - Health implications of traumatic injuries and illnesses
    - Environmental hazards, possible exposures requiring protection, monitoring, and possible treatment recommendations
- Working with government and non-profit agencies to provide support for public information platforms for individuals seeking information about victims and other potential casualties
    - Establish and/or support victim registries and tracking systems
- Collaboration with law enforcement, EMS, and emergency management to support unified response within Incident Command System structure
- Fatality management – related to an increase in the number of deceased persons as well as post-mortem identification processes
    - In the event of exceeded morgue capacity and/or loss of power to morgue, alternate locations and resources will need to be established in order to carry out morgue operations
- Provide staffing and supplies to support temporary shelters, if explosions affect residential dwellings
    - Public health nurses and other essential personnel needed to address health concerns in general population and special medical needs shelters

PREPAREDNESS STRATEGIES FOR PUBLIC HEALTH AGENCIES

- Pre-event planning with healthcare facilities in community to identify burn and trauma centers, as well as facilities with additional capacity likely to be needed following an explosive incident
    - Coordinated planning with public safety partners including police, fire, EMS, and emergency management

- Pre-event communications plan to address need for urgent communications to healthcare facilities , first responders, and general public
    - Anticipate need for immediate capacity for outreach to public regarding victim status
        - Plans for call center activation
    - Establish plans for victim registry and victim tracking system
- Anticipate possible need to request additional pharmaceuticals, general and critical medical supplies, and blood products
    - Possible need to request Strategic National Stockpile assets to support casualty response
- Ensure hospitals and first responders have adequate information about any potential chemical, biological, or radiological substances released in the explosion and how to properly decontaminate and care for casualties
    - For more information, see **BIOLOGICAL TERRORISM**, **CHEMICAL WEAPONS OF MASS DESTRUCTION**, and **RADIATION DISPERSAL DEVICE** sections
- Ensure memoranda of understanding (MOU) and mutual aid agreements (MAA) are in place with surrounding counties in order to supplement human and material resources, including security services for public health community and field operations
- Healthcare facility plans should include:
    - Facility plans to activate on-call or back-up physicians, nurses, paramedics, and other essential healthcare and response staff in the event of staff shortage and/or patient surge
        - Many community hospitals do not have 24-hour critical care capabilities and require staff to be called in to work during off-hours
    - Implementation of a critical care staffing expansion model:
        - One critical care physician may supervise up to 4 non-critical care physicians who may care for up to 6 patients each
        - One critical care nurse may supervise up to 3 non-critical care nurses who may care for up to 2 patients each
    - Facility plans to manage a backlog of diagnostic imaging studies and laboratory analyses
    - Facility protocols to handle surge events:
        - Postponing elective surgeries and treatment procedures
        - Discharging non-urgent patients from the emergency room and stable inpatients
        - Transferring ICU patients to regular hospital wards and/or using specialty care areas of hospitals for patients in need of critical care resources (e.g., operating rooms and specialty procedure suites)
        - Designating separate areas of emergency departments or using proximal locations to treat less critical patients
        - Mobilizing equipment and resources
        - Arranging for transportation resources to transport discharged patients to alternate locations, including their homes
        - Assessment and reporting availability of hospital beds, operating rooms, and ICU resources
        - Implementing a patient-tracking system both for incoming patients as well as existing hospital patients
    - Facility security protocols for mass casualty incidents, including traffic control, securing entry and exit points for hospitals, and credentialing clinicians and staff from outside facilities
    - Involvement of a facility's legal department to address issues surrounding volunteer provider credentialing, standards of care, and clinical documentation practices
- Emergency planning inclusive of mental health crisis response – related to effectively contacting and utilizing community mental health resources for the purposes of psychological first aid response for disaster victims, public health, and clinical staff involved in the disaster
    - Plans should include provisions for the following:
        - Mutual aid agreements/memoranda of understanding for inter-county services
        - 24/7 crisis hotline
        - Coordination of post-disaster mental health services across all outlets: community-based organizations,

hospital providers, youth organizations, etc.
- Culturally competent psychological services to address non-English speaking communities
- Caches of mental health providers specializing in different populations (e.g., children, trauma) and emergency contact information for each provider

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CYBER THREAT

Example: "Botnet" attack, Seattle Northwest Hospital, 2005

Cyber-attacks involve the use of technology to disable operational systems, including those with information, communication, and security functions. By remotely infiltrating a network, hackers can install viruses or other malware to infect computers, resulting in system malfunction. Additionally, hackers can redirect or change operational functions, including safety procedures. In terms of public health and health care, cyber-attacks have the potential to disrupt public health operations and the delivery of healthcare service through a cascading effect of disabling emergency communication systems, electronic medical records, and computer supply systems.

HUMAN IMPACT

A cyber-attack can affect human health as a result of the following:

- Potential to disrupt communications systems, information technology systems, transportation networks, and utility operations
    - Failures of business continuity in healthcare facilities, pharmacies, and general goods and services may result in loss of access to:
        - Critical medications
        - Outpatient and inpatient healthcare facilities
        - Food and water
        - Home energy needs, including heat and air conditioning, and electricity
- Potential for risk of illness, injury, and death – related to altered medical records and/or malfunctioning equipment due to hacking efforts
    - In healthcare settings, electronic medical records could be altered, resulting in significant disruption of overall operations, and potentially complicating accurate dosing of medication
- Economic disruption – related to loss of business continuity as well as personal economic losses that compromise access to short- and long-term medical care

HEALTHCARE SERVICE IMPACT

Cyber-attacks have the potential to interrupt computer-based medical services, including equipment and medical records.

- Loss of emergency response capabilities – related to the disabling of the 9-1-1 telecommunication system by a denial of service (DoS) attack
    - DoS attack would prevent access to the 9-1-1 system for callers by overloading the system with automated prank calls
        - Prevents the dispatching of EMS and fire services to actual emergencies
- Loss of computer-dependent hospital operations:
    - Critical care – patient monitoring equipment
    - Diagnostic – ordering, performing, and interpreting radiologic studies
    - Pharmaceutical – medication ordering as well as controlled access systems for medications and supplies
    - Safety – door security systems, including controlled access operating room doors
    - Communication – intra-facility paging services
- Failure of critical equipment and technology in home and outpatient settings, potentially impacting the following:
    - Dialysis centers
    - Outpatient medical offices and surgical centers
    - Durable medical equipment used in homes that relies on either computers or continuity of utilities (e.g., electricity)
- Loss of emergency department capacity – related to EDs having to turn away incoming patients and potentially moving current patients to an alternate care site or facility due to loss of computer capabilities

- Loss of medical records – related to the tampering of medication orders and dosages, as well as the altering, release, or deletion of electronic medical records

COMMUNITY IMPACT

Cyber-attacks can have the following impacts on the community:

- Disruption of utilities – related to disruption and/or damage to water pumping systems as well as electrical grids
  - See **UTILITY INTERRUPTION** section for more information
- Disruption of transportation routes – related to signal tampering
  - Could result in an increase in traffic accidents, as well as mass transit disruptions and potential accidents
- Disruption of airport and mass transit operations
- Disruption of public water and sanitation systems
- Disruption of economic functioning and continuity of business operations, leading to shortages of critical supplies necessary for daily living
- Environmental contamination – related to any waste or hazardous materials which get released into air, soil, or water as a result of an attack on computerized control and safety systems

PUBLIC HEALTH SERVICE IMPACT

Cyber-attacks can disrupt information/communication systems, which can disrupt public health agency operations:

- Disruption of internal communication networks (e.g., e-mail)
- Disruption of data management systems and electronic surveillance systems
- Disruption of vaccine storage and maintenance systems, including distribution networks
- Disruption of emergency alert systems and health alert networks
  - Example: A Chevron refinery in California was unable to enact its neighborhood emergency notification system during a plant emergency in 1992 as the system had been disabled by a disgruntled former employee

Public health agencies may also be called upon to address impacts of cyber-events that have the potential to directly or indirectly impact human health:

- Health impacts of utility disruptions
- Health impacts of loss of access to medications
- Health impacts of transportation disruption
- Health impacts of healthcare service and healthcare facility disruption

PREPAREDNESS STRATEGIES FOR PUBLIC HEALTH AGENCIES

- Ensure all public health, healthcare, and laboratory facilities have anti-virus software installed and maintained
- Ensure all public health, healthcare, and laboratory facilities have redundant, manual, and/or paper capabilities for malfunctioning computer-controlled systems whenever possible
- Ensure facilities have back-up communication systems in the event of a hacker interrupting phone and/or e-mail systems
- See **UTILITY INTERRUPTION** for further recommendations

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RADIATION DISPERSAL DEVICE

Example: National Planning Scenario 11: Radiological Attack –Radiation Dispersal Devices

A radiation dispersal device (RDD) is a device that purposefully disseminates radioactive material, without a nuclear detonation. A "dirty bomb" is a conventional explosive device in which explosives are combined with radioactive materials that are aerosolized and propelled into the air upon detonation. The impact of the device will depend on its design, the type and quantity of radioactive material, and the pattern of dispersion following the release. Dirty bombs are sometimes referred to as "weapons of mass disruption." Human casualties are more likely to result from the explosive device itself than radioactivity, but it will produce widespread environmental contamination and anxiety.

A dirty bomb is very different from a nuclear weapon or nuclear bomb, which creates an explosion millions of times more powerful than a dirty bomb. A nuclear bomb can produce a radiation cloud that may extend tens to hundreds of square miles. A dirty bomb's radiation is more likely to be dispersed within a few blocks or miles of the explosion.

HUMAN IMPACT

Individuals closest to the RDD are likely to sustain injuries due to the explosion itself. Immediate health effects from exposure to the low radiation levels expected from an RDD are likely to be minimal.

- Blast injuries related to impact of explosion (see **CONVENTIONAL EXPLOSIVE** section):
  - Ears, lungs, and injuries to other hollow organs
  - Injuries secondary to blunt trauma, including burns
  - Fractures and/or amputations from collapse of buildings and other structures
  - Potential injuries due to radioactive shrapnel or fragments
- Health effects of radiation are directly proportional to the radiation dose, and would be determined by the following:
  - Amount of radiation absorbed by body
  - Type of radiation used in the RDD
  - Distance from radiation to individual
  - Means of exposure to radiation (e.g., external vs. internal – whether absorbed by skin, inhaled, or ingested)
  - Length of time exposed
- Exposed individuals will need to take immediate protective actions to minimize exposure
  - Avoid obvious plume or dust clouds
  - Shelter in place in building with closed doors and windows
  - Cover mouth and nose with tissue, filter, clothing or damp cloth to avoid inhalation or ingestion of radioactive materials
  - Removal of contaminated clothing
    - Place in sealed bag so clothing can be used later to estimate person's exposure
  - Wash skin gently to remove possible contamination
- Victims will require the following:
  - Decontamination at scene
  - External monitoring to assess contamination
  - Testing to assess internal contamination
  - Medical countermeasures to reduce impact of internal contamination
    - Agents to facilitate elimination or reduce isotope uptake by organs
  - Long-term medical follow-up
- Victims will have mental health impacts related to explosion, including concern regarding potential health impact of radiation exposure
  - Depression, anxiety, post-traumatic stress, and disassociation symptoms
  - Victims with radiation exposure may experience stigma

HEALTHCARE SERVICE IMPACT

Healthcare facilities should anticipate influx of patients similar to incidents involving conventional explosives although with potential contamination by radiation:

- Large numbers of individuals who self-transport to emergency departments within hours of event
- Increasing severity of casualties over time, as more severely injured are stabilized and transported
- Large numbers of 'worried well' presenting to healthcare facilities for radiation assessment and concerns about perceived injuries
- Need to for external decontamination of patients, with zones outside and in hospital to prevent contamination of hospital facilities and staff
    - Patients who self-transport to hospitals need to be decontaminated prior to entering facility
    - Patients arriving via emergency medical services likely have undergone initial decontamination
- Need for personal protective equipment for staff involved in decontamination activities, monitoring, and patient care, for casualties and others with radiation exposure who present to the emergency department without undergoing decontamination in the field
- Need for radiation monitoring equipment and plans for incoming casualties potentially contaminated with radiation
- Need to be prepared for mental health sequellae related to exposure to radiation as well as terrorism impact
    - Patients as well as healthcare professionals
- Need to coordinate with public health agencies regarding access to testing for radioactive isotopes in clinical specimens to assess internal contamination
- Need for rapid dissemination of medical management guidelines for front-line clinical staff regarding management of exposure and contamination with specific isotopes
- Staff in healthcare settings may be unwilling or reluctant to work due to fear of radiation exposure from patients

COMMUNITY IMPACT

The extent of local contamination by radiation as a result of an RDD or dirty bomb will depend on the size of the explosive, the amount and type of radioactive material, the means of dispersal, and weather conditions at the time of the explosion. As radioactive material spreads, it becomes less concentrated and less harmful. Potential community impacts include:

- Environmental contamination – related to an agent contaminating the following through direct contact or from decontamination efforts:
    - Low-level contamination of potable water supply
    - Soil, air, and building contamination from the elemental release and resulting plume
    - Radioactive contamination inside and outside of buildings
    - Assessment of extent of contamination generally conducted by agencies responsible for environmental assessment, radiation safety, and public health
- Transportation disruption – related to the closure and/or re-routing of mass transit and roadways due to contamination concerns
    - Altered Bus, rail, and air transport routes
    - Highway checkpoints established to monitor incoming traffic for contamination
    - Subways closed due to contamination via air intakes
- Property damage due to radioactive contamination and/or conventional explosive use
- Prompt detection of the type of radioactive material is important to formulate recommendations for community protective measures
    - Shelter-in-place and/or emergency evacuation orders depending on the type of material used as well as plume patterns
- Decontamination and re-assessment of affected environment to assure public safety
- Need for mass population monitoring following exposure to radiation, either by public safety/hazmat officials, and/or at community reception centers that can provide the following:
    - Radiation monitoring

- Decontamination
- Screening for internal contamination
- Referral and risk-related education and information

PUBLIC HEALTH SERVICE IMPACT

In the event of a radiologic attack, public health personnel will be faced with providing public health services as part of a multi-agency response that includes mass decontamination, sheltering of evacuees, risk communications, environmental assessment, population monitoring, distribution of medical countermeasures from the Strategic National Stockpile, and fatality management.

- Public health services in shelters, including medical services for special medical needs and surveillance for communicable and other diseases
  - Nearby towns and cities may close their doors to evacuees for fear of contamination
- Health communications and emergency public information and warning – related to the need to provide timely, accurate information to hospitals, healthcare clinics, medical providers, and the general public regarding the following:
  - Health implications of radiation exposure
  - Effective decontamination measures
  - Medical countermeasures, if applicable
- Fatality management – related to an increase in the number of deceased persons as well as post-mortem identification processes
  - Decedents contaminated by radioactive material present a safety risk and will need to be decontaminated prior to entering the morgue
  - In the event of exceeded morgue capacity and/or contamination of morgue, alternate locations and resources will need to be established in order to carry out morgue operations
- Coordinate with appropriate state and federal agencies to obtain information regarding environmental characterization of isotope and its dissemination, as well as appropriate exposure control and remediation steps:
  - Use of atmospheric plume modeling to identify evacuation routes
  - Development of protective action guidance, such as recommendations for sheltering in place versus evacuation
  - Collection and use of real-time environmental monitoring data to verify the atmospheric modeling results and guide decision-making
- Mass population monitoring and activation of community reception centers to do the following:
  - Identify exposed individuals
  - Assess for external and internal contamination
  - Provide risk communication and health information
  - Facilitate medical referrals
  - Establish registry for longer-term follow-up
  - Community reception centers will need capacity for:
    - Laboratory analyses and radiological testing of biologic samples
      - Identification of appropriate laboratories for testing of clinical specimens
    - Health Physics
      - External radioactive contamination – assessed with readily available radiation survey meters
      - Internal contamination by strong gamma emitters – detected by whole body counters, radiation meters, or bioassays
      - Internal contamination by most alpha and beta emitters – requires a urine bioassay
- Obtain access, if necessary to medical countermeasures in the Strategic National Stockpile and distribute to medical practitioners to manage internal contamination

PREPAREDNESS STRATEGIES FOR PUBLIC HEALTH AGENCIES

Develop a community preparedness plan for radiation incidents, to include:

- Develop memoranda of understanding (MOU) and mutual aid agreements (MAA) with surrounding counties in order to supplement human and material resources, including security services for public health community and field operations
- Develop plans for mass population radiation monitoring such as community reception centers with capacity for:
  - External monitoring
  - Decontamination
  - Assessment of internal contamination (collection of urine and other clinical specimens)
  - Health education and risk communication
  - Referral to healthcare facilities for further management and medical countermeasure use
  - Creation of registry for short-term and long-term follow-up of individuals exposed to radiation
  - Protection of workers and volunteers
- Advance planning for radiation incidents with local, state, federal, and military partners who have both subject matter expertise and specific response and support roles when incidents occur
  - Understand the roles and responsibilities of different agencies during and following radiation incidents
  - Identify subject matter experts who can inform public heath decision-making
  - Identify laboratories that can process clinical specimens for radiation and understand their capacity
  - Develop plans to transport clinical specimens to specialized reference laboratories
  - Develop protocols for worker safety, including use of personal protective equipment (PPE)
- Plan for public information that conveys risks of radiation exposure in lay-person's terms
- Plan to provide guidance to healthcare professionals regarding management of radiation exposure and risk communication to patients
- Mental health crisis response
  - Coordination of post-disaster mental health services across all outlets: community-based organizations, hospital providers, youth organizations, etc.
- Culturally competent psychological services to address non-English speaking communities
- Healthcare facilities should develop plans that address:
  - Staffing shortages and staff sheltering due to transportation disruptions or shelter–in-place orders
  - Protocols to handle surge events
  - Decontamination and personal protective equipment (PPE) protocols to ensure patient, visitor, and staff protection
  - Establishment of a victim identification registry with the help of the hospital community

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Disaster Impacts with Public Health Consequences

COMMUNICATION FAILURE	
CAUSES OF IMPACT	• Utility interruption • Hurricane • Winter storm • Tornado • Cyber threat • Explosion involving communications infrastructure • Incidents that overwhelm existing networks • Incidents that disrupt electricity to systems that require electrical power o Telephone networks, computer networks, internet access (including wireless access)

PUBLIC HEALTH CONSEQUENCES	• Interference with inter- and intra-facility notification networks
	  o Healthcare facilities, public health agencies, first responder agencies
	  o Disruption of electronic surveillance systems
	  o Disruption of health alert networks and similar systems
	• Disruption of public health agency and healthcare operations
	• Inability of civilians to contact emergency medical services via 9-1-1 system
	• Inability to convey emergency public information and warning
	• Loss of ability to assess community health through reporting and information collection

RESPONSE MEASURES	• Use of back-up generators to power communications equipment • Implementation of redundant, uninterruptible communication methods – radios, text messaging if cellular telephones functioning • Outreach to healthcare partners, communities through direct visits (“boots on the ground”)

PREPAREDNESS STRATEGIES	• Ensure interoperability and redundancy of communication systems
	  o Telecommunications, text alerts, electronic mail, radios, data reporting systems, media broadcast systems
	• Ensure public health agencies and healthcare facilities receive notification alerts from emergency management and first responder agencies
	• Establish policies and procedures for using all forms of communication
	  o Device instructions
	  o Channels/frequencies used during emergencies
	• Establish plans for uninterruptible communications strategies
	  o Back-up computer servers, data recovery procedures
	  o Back-up generators and batteries, charging systems
	  o Satellite communications systems where available
	• Test all communications systems regularly
	• Maintain updated contact lists for all essential personnel
	• Maintain records of telephone line locations for repair operations post-incident
	• Access to systems to re-charge personal communication devices
	• Develop partnerships with healthcare systems for information exchange through person to person interactions and outreach
	• Develop partnerships with community leaders and others who can identify and assess health issues in potentially vulnerable populations and relay them to public health agencies

	o Especially if communications failure occurs as part of natural disaster that has its own public health impact

POPULATION DISPLACEMENT	
CAUSES OF IMPACT	• Flood • Hurricane • Tornado • Winter storm • Hazardous materials release • Nuclear facility accident • Biological terrorism • Chemical terrorism • Conventional explosive • Radiation dispersal device

PUBLIC HEALTH CONSEQUENCES	• Interruption in medical management of acute and chronic conditions
	  o Dialysis patients, oncology patients, individuals taking daily life-sustaining medications
	• Loss of access to medical records, including immunization histories and medication lists
	• Support of healthcare services in shelters, particularly for individuals with special medical needs either living in the community or in group home situations
	• Communicable disease surveillance and disease control in shelters and in community
	• Mental health impact of displacement from home, possible separation of families
	  o Children especially vulnerable

RESPONSE MEASURES	• Assign staff to perform clinical and surveillance duties at reception centers and shelters
	• Implement plans for back-up staff to compensate for staff assigned to shelter operations
	• Obtain medical supplies and durable medical equipment for sheltering populations
	• Transfer of individuals with special medical needs to healthcare facilities if unable to support in public shelter
	• Issue public health information updates to hospitals, outpatient offices, emergency response agencies, and the public
	  o Communicable disease surveillance updates
	  o Medical management guidelines for conditions observed in displaced population
	• Access, transport, and distribute medications necessary for displaced persons
	• Facilitate access to primary and specialty medical care for displaced persons in new locations

PREPAREDNESS STRATEGIES	• Develop jurisdictional plans for receiving persons displaced from other geographic areas, including:
	  o Medical triage and treatment upon arrival at the airport or port of entry (if applicable)
	  o Surge capacity for healthcare facilities to accept additional patients
	  o Providing staff support to established shelters for clinical and surveillance efforts
	  o Management of communicable and chronic diseases among displaced persons, including medications and equipment
	  o Enhanced surveillance of communicable diseases among displaced persons in healthcare facilities and shelters
	  o Accessing existing medical records for the displaced population
	• Develop plans for managing patients with special medical needs in shelters, including having designated shelters for medically fragile patients

	• Ensure access to mental health providers to provide both acute psychological first aid and long-term psychological recovery , including providers with pediatric focus
	• Memoranda of understanding (MOU) with hospitals and skilled nursing facilities for transfer and care of patients whose medical needs exceed shelter capabilities
	• Plan to facilitate enrollment of children in school district
	  o Engage school health professionals in registration process
	• Ensure mutual aid agreements (MAA) and memoranda of understanding (MOU) are in place to request resource support from surrounding jurisdictions
	  o Public health staff
	  o Medical supplies, pharmaceuticals, equipment
	  o Transportation resources

SUPPLY DISRUPTION	
CAUSES OF IMPACT	• Flood • Hurricane • Infectious disease outbreak – large, person-to-person • Tornado • Winter storm • Hazardous materials release • Nuclear facility accident • Utility disruption (including communications failure) • Biological terrorism • Chemical terrorism • Conventional explosive • Radiation dispersal device

PUBLIC HEALTH CONSEQUENCES	• Inability for healthcare providers and facilities to receive and distribute pharmaceuticals, vaccines, and medical equipment
	  o Disease treatment and prophylaxis
	  o Biological, chemical, and radiological terrorism agent antidotes
	• Loss of access to medications for the management of chronic diseases
	• Interruption in healthcare services in acute and long-term care facilities, as well as outpatient clinical facilities
	• Sustained interruption in food supplies and other materials may lead to the following:
	  o Dehydration and acute hunger syndromes
	  o Select nutritional deficiencies
	  o Overall public anxiety and unrest in the community
	• Public shelters (either permanent or activated for a specific hazard) will not receive food, water, medical, and mass care supplies
	• Fuel shortages that limit use of automobiles and generators

RESPONSE MEASURES	• Assess inventory of necessary medical and non-medical supplies in public health and healthcare facilities • Collaborate with emergency management and other government officials to re-distribute necessary supplies across facilities • Access and deliver pharmaceuticals and medical equipment from existing stockpiles to hospitals, outpatient healthcare facilities, and shelters • Work with state and federal public health agencies and pharmaceutical distributors to deliver medications and supplies to areas in need • Work with state and federal government agencies to obtain and distribute other necessary supplies and equipment for the health and safety of the community (e.g., food, water) • Assist with operations of temporary healthcare facilities, including providing resources and staff as needed
PREPAREDNESS STRATEGIES	• Create a pre-event inventory of medications, medical equipment, supplies, staffing, and transportation resources • Ensure mutual aid agreements (MAA) and memoranda of understanding (MOU) are in

	place to request resource support from surrounding jurisdictions • Ensure agreements are in place to procure supplies from private vendors • Develop plans to transport and distribute supplies and medications as needed to hospitals, outpatient healthcare facilities, and shelters o Medications for chronic diseases and vaccines • Develop inventory tracking system for supplies received and distributed • Develop medical surveillance systems to monitor health outcomes of supply disruptions and assess health outcomes • Identify sources of fuel such as natural gas, oil, to replete local supplies

TRANSPORTATION DISRUPTION	
CAUSES OF IMPACT	• Flood • Hurricane • Infectious disease outbreak – large, person-to-person • Tornado • Winter storm • Hazardous materials release • Nuclear facility accident • Utility disruption • Active shooter • Biological terrorism • Chemical terrorism • Civil disturbance • Conventional explosive • Radiation dispersal device
PUBLIC HEALTH CONSEQUENCES	• Inability of public health and healthcare staff to travel to/from work • Inability of home healthcare workers to travel to clients • Inability of patients to receive outpatient disease management procedures o Dialysis, chemotherapy • Interference with or inability of emergency response vehicles to respond to incident scenes • Inability of emergency personnel to transport patients to hospitals and inability of patients to access hospitals and other healthcare facilities • Supply depletion to stores, pharmacies, and healthcare facilities • Human illnesses and injuries due to mass casualty incidents on transportation venues • Fuel shortages if transportation of gas and/or oil are disrupted

RESPONSE MEASURES	• Allow remote or off-site work options where possible, for public health functions
	• Consider plans to expand shift hours for critical staff
	• Collaborate with emergency management to identify transportation for critical employees for public health and healthcare facilities
	• Use of unaffected transportation routes and resources to deliver supplies to hospitals, outpatient healthcare facilities, and shelters as needed
	• Support activation of alternate healthcare facilities and deployment of resources to accommodate individuals unable to reach usual source of care (e.g., dialysis centers)
	• Assess health needs of individuals who rely on home health services
	  o Support visiting nurse and other healthcare professional agencies to maintain or expand operations
	• Anticipate and assess possible supply disruptions due to transportation interruptions
	• If transportation disruption results from major accident with casualties:
	  o Emergency medical services personnel needed to triage, treat, and transport incident victims to hospitals
	  o Road and mass transit route closures in order to secure incident scene
	  o Medical examiner/coroner operations to identify deceased persons
	• Air, water, and soil sampling to determine any incident-related environmental

	contamination

PREPAREDNESS STRATEGIES	• Continuity of operations planning for staff and resource management in public health and healthcare agencies
	• Create a pre-event inventory of medications, medical equipment, supplies, staffing, and transportation resources
	• Ensure mutual aid agreements (MAA) and memoranda of understanding (MOU) are in place to request resource support from surrounding jurisdictions
	• Develop plans to transport and distribute supplies and medications as needed to hospitals, outpatient healthcare facilities, and shelters
	• Work with outpatient facilities to ensure patient care is not disrupted during the transportation disruption
	  o Dialysis centers
	• Work with home health agencies and other community-based service organizations that serve at-risk individuals
	  o Ensure that continuity of operations planning addresses transportation disruptions,
	  o Ensure that patients have alternate or back-up plans if home health professionals or agency staff do not arrive
	• Promote preparedness planning among at-risk communities dependent on visiting professional services or transportation to medical or other facilities

UTILITY DISRUPTION	
CAUSES OF IMPACT	• Hurricane • Winter storm • Flood • Tornado • Cyber threat • Conventional explosive • Nuclear accident • Radiation dispersal device • Infectious disease outbreak – large, person to person

PUBLIC HEALTH CONSEQUENCES	• Disruption of public health agency and healthcare operations
	• Reliance on generators and fuel for short-term operations
	• Risk of carbon monoxide-related injuries due to improper use of generators
	• Workforce depletion due to transit failures and workers who remain home to address family and household issues
	• Failure of communications systems, including inter- and intra-facility notification networks
	  o Healthcare facilities, public health agencies, first responder agencies
	  o Disruption of electronic surveillance systems
	  o Disruption of health alert networks and similar systems
	• Inability of civilians to contact emergency medical services via 9-1-1 system
	• Inability to convey emergency public information and warning
	• Evacuation of individuals in community who rely on power-dependent medical equipment (e.g., ventilators, wheelchairs) to shelters and other locations
	• Evacuation of long-term care and personal homes because of power disruption
	• Support of general and special medical needs shelters
	• Lack of information regarding disaster-related community health problems because of communication system disruption

RESPONSE MEASURES	• Use of back-up generators to power communications equipment, electricity, and other power-dependent operations
	• Implementation of redundant, uninterruptible communication methods
	  o Radios, text messaging if cellular telephones functioning
	• Outreach to healthcare partners and communities through direct visits (“boots on the ground”)
	• Partnership with home health and other critical community agencies to perform health outreach and assessment of at-risk homebound individuals
	  o Visiting nurse services
	• Partnership with skilled care and acute care facilities to provide care to homebound individuals who need power-dependent services and equipment
	• Need to field inquiries from out-of-town relatives and others who are unable to reach individuals because of communications system failures

PREPAREDNESS STRATEGIES	• Ensure interoperability and redundancy of communication systems
	  o Telecommunications, text alerts, electronic mail, radios, data reporting systems, media broadcast systems
	• Ensure public health agencies and healthcare facilities receive notification alerts from emergency management and first responder agencies
	• Establish policies and procedures for using all forms of communication
	  o Device instructions
	  o Channels/frequencies used during emergencies
	• Establish plans for uninterruptible communications strategies
	  o Back-up computer servers and data recovery procedures
	  o Back-up generators and batteries, as well as charging systems
	  o Satellite communications systems where available
	• Maintain updated contact lists for all essential personnel
	• Ensure access to systems to re-charge personal communication devices
	• Develop partnerships with healthcare systems for information exchange through person to person interactions and outreach
	• Develop partnerships with community leaders and others who can identify and assess health issues in potentially vulnerable populations and communicate them to public health
	  o Especially if communications failure occurs as part of natural disaster that has its own public health impact
	• Develop mutual aid agreements (MAA) and memoranda of understanding (MOU) with public-accessible Information and Referral systems such as 2-1-1, to provide public with access point for conveying needs and obtaining non-emergency assistance
	• Partner with healthcare providers and social service agencies who serve vulnerable individuals and communities to develop pre-disaster preparedness plans
	• Develop plans for emergency public information and warning systems that do not rely on power-dependent communications systems

WORKFORCE DEPLETION	
CAUSES OF IMPACT	• Flood • Hurricane • Infectious disease outbreak – large, person-to-person • Tornado • Winter storm • Hazardous materials release • Nuclear facility accident • Utility disruption • Active shooter • Biological terrorism • Chemical terrorism • Civil disturbance • Conventional explosive • Radiation dispersal device

PUBLIC HEALTH CONSEQUENCES	• Inability of public health and healthcare staff to perform job operations
	  o Clinical care, public health surveillance, investigation, disease control, and communication responsibilities
	• Inability of home healthcare workers and other community-based agency staff to visit clients
	• Potential for diminished patient care capacity in hospitals and outpatient healthcare facilities due to decreased staff
	  o High patient to provider ratios
	• Disruption of business continuity in non-healthcare agencies, organizations and companies
	  o Shortages of healthcare and non-healthcare related supplies
	  o Transportation disruptions
	  o Communications failures
	• Disruption of school and childcare programs which may exacerbate workforce shortages in healthcare and public health settings

RESPONSE MEASURES	• Activating back-up clinical, public health, emergency response, and other essential personnel to assist with daily operations • Requesting staffing resources from neighboring jurisdictions per mutual aid agreements (MAA) and memoranda of understanding (MOU) • Extending shifts for essential personnel who are able to perform job operations • Providing housing and meals for critical healthcare and public health staff who provide long-term services • Identifying services that can be accomplished remotely by off-site staff who may be able to work
PREPAREDNESS STRATEGIES	• Continuity of operations planning to ensure essential functions are carried out in the event of absent staff • Planning to ensure back-up of clinical, public health, emergency response, and other essential personnel • Maintaining an up-to-date contact list for staff • Ensure mutual aid agreements (MAA) and memoranda of understanding (MOU) are in place to request resource support from surrounding jurisdictions

	• Plan for housing and food delivery to support staff who remain in facility/agency
	• Pre-identification of services and jobs that can be performed remotely, along with staff who can perform them
	• Ensure communications with other peer facilities to:
	  o Identify common needs and service gaps
	  o Share resources
	  o Clarify crisis standards of care and service delivery that are uniform across communities

Appendices

Appendix A: Control Measures for Pandemic Influenza in the Absence of Vaccine

The table below describes interventions and mitigation strategies proposed by CDC to contain a pandemic of influenza relying mainly on non-pharmaceutical control measures. These measures provide useful guidance for controlling epidemics that might result from other extremely contagious respiratory infections in the absence of vaccine or highly effective therapy. TABLE: Public Health Interventions, by Pandemic Severity

Control Measures by Pandemic Severity Index (Case Fatality Ratio (CFR))*			
Interventions by Setting	1 (CFR 0.1%)	2 and 3 (CFR 0.1-1.0%)	4 and 5 (CFR 1-2% or higher)
HOME			
Voluntary isolation of ill individuals at home; antiviral medications	Recommend	Recommend	Recommend
Voluntary quarantine of household members in homes with ill persons (close contacts); consider antiviral prophylaxis	Generally not recommended	Consider short-term implementation	Recommend, plus antiviral prophylaxis to household contacts where national policy advises
SCHOOL AND CHILDCARE PROGRAMS			
Social distancing of children by school dismissal, closure of childcare facilities Reduce social contacts and community meetings	Generally not recommended	Consider ≤4 weeks	Recommend ≤12 weeks (Actual duration may vary depending on transmission in community)
WORKPLACE/COMMUNITY – ADULT SOCIAL DISTANCING			
Decrease social contacts by: • Modification of workplace schedules and practices, including telework and teleconferences • Reduce density in public transit, workplace • Postpone or cancel public gatherings (e.g., stadium events, theater performances)	Generally not recommended	Consider	Recommend

*CDC has proposed 5 categories of pandemic severity, based on the case fatality ratio, or the proportion of deaths among clinically ill persons. This Table is adapted from CDC, Community Strategy for Pandemic Influenza Mitigation, 2007; and Landesman, Public Health Management of Disasters, 2012)

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Appendix B: General Radiation Information

Types of Radiation Exposure

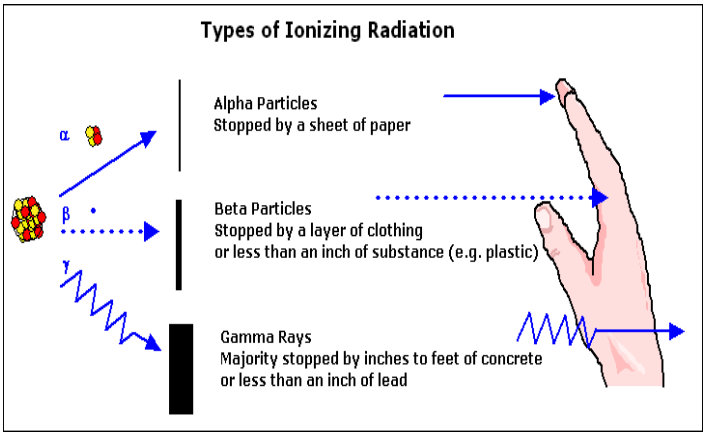
Reactor accidents can release a variety of radioactive isotopes into the environment, each with a different half-life and energy. The health threats from each radioactive isotope depend on a number of factors, including the amount and nature of the release, as well as the potential for the isotope to contaminate the ground and/or bodies of water. Radioisotopes which settle on the ground have the potential to affect the food chain by contaminating produce, ground water, and milk, while those which settle in bodies of water have the potential to contaminate seafood. Nuclear reactors contain radionuclides that are products of activation as well as products of fission (spent fuel). There are three major types of ionizing radiation (radioisotopes) that might be released following a reactor accident:

Alpha particles are high energy particles that deposit energy quickly while passing through tissue. They can be stopped by a thin layer of light material (such as paper) and cannot penetrate the outer layer of skin. Thus, they do not damage living tissue when outside the body but can cause significant damage when inhaled or swallowed (*internal contamination*).

Beta particles can be stopped by more dense materials such as aluminum but do penetrate the outer layer of skin, causing burns. They can pose a serious direct or external radiation threat (*external contamination*), and can also cause significant harm of ingested or inhaled.

Gamma rays are high energy electromagnetic radiation emitted by certain radionuclides. They have a short wavelength and penetrate tissue further than alpha or beta particles; however, they leave a lower concentration of ions in their path to potentially cause cell damage.

This is depicted in the illustration below, from http://www.remm.nlm.gov/ionizingrads.htm:



The dose or amount of radiation to which individuals are exposed is expressed by the international system (SI) unit "Gray," (Gy) which refers to the absorbed energy per unit mass of tissue (e.g., 1 Gy = 1 joule/kilogram = 100 rad). The "Gray" has replaced the older "rad" designation. The Sievert (Sv) is the unit of measurement for the effective dose,

which is the absorbed dose multiplied by factors accounting for the biologic effect of different types of radiation and the radiation sensitivities of different tissues. Sievert is calculated by multiplying the Gray by the factors that account for the biological effects of different types of radiation (the "radiation weighting factor" or "quality factor" associated with a specific type of radiation) and the radiation sensitivities of different tissues. For high energy gamma radiation and whole-body exposures, 1 Gy equals 1 Sv.

Mechanisms of radiation exposure

Exposure occurs when all or part of the body absorbs penetrating ionizing radiation from an external source. Exposure can also occur after internal contamination, when a radioactive isotope is ingested, inhaled, or absorbed into the bloodstream. Exposure stops when a person leaves the area of the radiation source or it is shielded completely. An individual exposed only to an external source of radiation is not radioactive or contaminated and may be approached without risk. If scanned with a radiation survey monitor after external exposure alone, the device will not register radiation above background levels.

Internal contamination results when radioactive materials are taken into the body by ingestion, inhalation, or via open wounds. It is removed when the material decays naturally, is flushed from the gastrointestinal tract or other portals, or is removed by medical countermeasures such as chelating agents.

External contamination results when radioactive material is deposited on skin, hair, eyes, or other external structures. The contamination stops when the material is removed, by shedding clothing and/or washing.

Limiting Radiation Exposure

In general, exposure to ionizing radiation occurs every day in the normal environment, and results from exposure to naturally occurring isotopes and cosmic rays. Radiation exposure is generally quantified by considering the amount of exposure relative to average background radiation. Exposure to radiation is limited through three basic ways:

- Time - limiting or minimizing the exposure time to the radiation source will reduce the dose
- Distance – radiation exposure decreases sharply as distance from radiation source increases
- Shielding – barriers of lead, concrete or water protect individuals from high energy gamma radiation
    - Air or skin is often sufficient to attenuate lower energy alpha or beta irradiation
    - Plastic shields will stop beta particles

Containment is generally achieved through shielding and distance.

Nuclear Power Plants and Emergency Planning Zones

The Nuclear Regulatory Commission (NRC) has defined *emergency planning zones* (EPZ) surrounding every nuclear power plant for which required plans are made in advance to ensure the safety and health of the public in the event of an incident. Two zones are defined:

The *Plume Exposure Pathway* EPZ has a radius of approximately 10 miles from the reactor site, and represents the area around the reactor for which specific protective actions should be taken in the event of an incident that releases a

radioactive plume. These actions include sheltering in place, evacuation, and taking KI (potassium iodide) to protect the thyroid gland from the radioisotope Iodine-131 (I-131).

The *Ingestion Exposure Pathway* EPZ has a radius of approximately 50 miles from the reactor site. It defines the area that is likely to be contaminated by radioactive materials (e.g., ground water, produce, milk from cows that graze within the zone). Predetermined action plans are designed to avoid or reduce the dose from ingestion of radioactive materials (e.g. ban of contaminated food or water).

Isotopes of Public Health Importance

Many different isotopes are released during an accident at a nuclear reactor; over one hundred were released following the Chernobyl accident. The table below summarizes characteristics of several important isotopes that can have public health consequences following a reactor accident. Note that in the event of a radiation dispersal device, a "dirty bomb," or transportation accident, the radiation effect will depend on the specific isotope that is dispersed. Additional information can be found at http://www.remm.nlm.gov/int_contamination.htm#isotopestable.

Isotope	Radiation type	Radioactive half-life[1]	Biological half-life[2]	Major exposure pathways	Focal accumulation	Countermeasures
Americium Am-241	Alpha	458 years	73,000 days	Inhalation Skin	Lungs Liver Bone Bone marrow	DTPA
Cesium Cs-137	Beta Gamma	30 years	70 days	Inhalation Ingestion	Follows potassium; renal excretion	Prussian blue, insoluble
Cobalt Co-60	Beta Gamma	5.26 years	9.5 days	Inhalation	Liver	Succimer DTPA EDTA
Iodine I-131	Beta Gamma	8.1 days	138 days	Inhalation Ingestion Skin	Thyroid	Potassium iodide Propylthiouracil
Iridium Ir-192	Beta Gamma	74 days	50 days	N/A	Spleen	DTPA EDTA
Plutonium Pu-239	Alpha	24,000 years	73,000 days	Inhalation (limited absorption)	Lung Bone Bone marrow Liver Gonads	DTPA DFOA EDTA
Polonium Po-210	Alpha	138.4 days	60 days	Inhalation Ingestion Skin	Spleen Kidneys Lymph nodes Bone marrow Liver Lung mucosa	Gastric lavage Dimercaprol Succimer (DMSA) D-Penicillamine
Radium Ra-226	Alpha Beta Gamma	1,602 years	16,400 days	Ingestion	Bone	Aluminum hydroxide Barium sulfate Sodium alginate Calcium phosphate
Strontium Sr-90	Beta	28 years	18,000 days	Inhalation Ingestion	Bone	Inhalation: Calcium gluconate or barium sulfate Ingestion: Same as for radium
Uranium U-235	Alpha	710 million years	15 days	Ingestion	Kidneys Bone	Sodium bicarbonate (Diuretics or dialysis)

[1] Radioactive half-life: the time required for a quantity of a radioisotope to decay by half.

[2] Biological half-life: the time required for one half of the amount of a substance, such as a radionuclide, to be expelled from the body by natural metabolic processes, not counting radioactive decay, once it has been taken in through inhalation, ingestion, or absorption.

Appendix C: Jurisdictional Planning for At-Risk Populations

Planning for At-Risk Populations – Knowing Your Jurisdiction

Many disasters result in disproportionately severe consequences for certain communities or populations. These so-called "at-risk" populations are more likely to suffer severe health outcomes, or may require specific public health planning for events that require evacuation, medical interventions, and/or special communication approaches. There is no clear consensus about which populations should be considered "at-risk" in preparedness planning. Studies have documented disparate disaster impacts in children, the poor, pregnant women, ethnic minorities, non-English speakers, and people with access and functional needs. More broadly, individuals with access and functional needs are people who have additional needs before, during, and after an incident in functional areas, including but not limited to: maintaining independence, communication, transportation, supervision, and medical care. The U.S. Department of Health and Human Services defines at-risk populations as children, senior citizens, pregnant women, and individuals who have disabilities, live in institutionalized settings, are from diverse cultures, have limited English proficiency or are non-English speaking, are transportation disadvantaged, have chronic medical disorders, or have pharmacological dependency.

It is important for planners to understand something about the at-risk populations in their jurisdiction - what percentage of the population they comprise, where they are located, and what special or unique needs they may have in a disaster. Each community has unique concerns and considerations, and should identify the populations who are at greatest risk in their own jurisdiction. For example, it is useful for planners to anticipate who might need assistance with evacuation, or know the numbers of children and elderly persons who might be priority candidates for a vaccine in a biological event. Estimates of the number of individuals living with chronic diseases can help predict who might be more vulnerable to the effects of infectious disease hazards, and allow public health agencies to plan for the impact of medication shortages for diseases like diabetes or asthma.

Data related to at-risk populations and other demographic groups can be obtained from either the U.S. Census or from the Robert Wood Johnson Foundation's county health rankings. Additional data sources that may be relevant for other populations include: the CDC's Behavioral Risk Factor Surveillance System (BRFSS), the National Health and Nutrition Examination Survey (NHANES), resources from state health departments, or other national databases. A list of data sources with community-specific data is provided below.

Data Sets:

Behavioral Risk Factor Surveillance (BRFSS)

http://www.cdc.gov/brfss/technical_infodata/surveydata.htm

Community Health Status Indicators
http://communityhealth.hhs.gov/HomePage.aspx

Healthy People 2020 Data
http://healthindicators.gov/

National Health and Nutritional Examination Survey (NHANES)
http://www.cdc.gov/nchs/nhanes/nhanes_questionnaires.htm

National Center for Education Statistics
http://nces.ed.gov/

Robert Wood Johnson Foundation County Health Rankings (includes risk factor data by county)
http://www.countyhealthrankings.org/

Social Determinants of Health Maps
http://www.cdc.gov/dhdsp/maps/social_determinants_maps.htm

US Census data
http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml

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