

Washington State Disaster Risk and Preparedness: A Primer for Health Care Providers

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Conflicts of interest: none

Keywords: disaster risk; planning; Washington
State

Abbreviations:

DOH: Department of Health
ESF: Emergency Support Function
FEMA: Federal Emergency Management Agency
HCC: Health Care Coalitions
HHS: US Department of Health and Human
Services
HVA: Hazard Vulnerability Assessment

Received: November 15, 2019

Revised: January 12, 2020

Accepted: January 23, 2020

doi:[10.1017/S1049023X20000412](https://doi.org/10.1017/S1049023X20000412)

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Abstract

Disaster in Washington State (USA) is inevitable. It is incumbent on health care providers to understand the practice environment as it will be affected by disasters. This means understanding the basic concepts of emergency management, local to national emergency response structure, and the risks and vulnerabilities of the region where one works. This understanding will help health care providers anticipate and prepare for disaster response and recovery. Washington State has many unique features with regard to climate and geography, population, public health, and general infrastructure that create significant vulnerabilities to disaster and strengths with regard to potential response and recovery. This report attempts to define and contextualize emergency management and to condense the extensive research and planning that has been conducted in Washington State surrounding disaster assessment, planning, mitigation, and response from a health care provider's perspective. The aim is to increase awareness of and preparation for disaster-related topics among health care providers by creating informed responders.

Morris SC. Washington State disaster risk and preparedness: a primer for health care providers. *Prehosp Disaster Med.* 2020;35(3):341–345.

Introduction

Understanding Emergency Management, The Basics

The Federal Emergency Management Agency (FEMA; Washington, DC USA), the main federal government organization charged with protecting the population from and responding to disasters, defines emergency management as the following:

Emergency management is the managerial function charged with creating the framework within which communities reduce vulnerability to hazards and cope with disasters. Emergency management seeks to promote safer, less vulnerable communities with the capacity to cope with hazards and disasters.

Emergency management is a very rich field that encompasses all areas of society as well as elements of science, social science, and management. As such, it is beyond the scope of this report to provide a comprehensive background on the subject. However, several organizations offer online and written briefs that maybe helpful; for example, FEMA and Washington State.^{1,2} The US Department of Health and Human Services (HHS; Washington, DC USA) also maintains a comprehensive list of emergency management definitions and acronyms which may be helpful in reviewing the emergency management literature.³ From a health care practitioner or health care manager perspective, there are several key principles of emergency management that are critical to understanding disaster preparation and response as it may relate to health care delivery.

Understanding Risk-Hazard Identification and Vulnerability Assessment

Four principles and one tool represent the foundation of pre-disaster emergency management: Hazard, Risk, Mitigation, and Vulnerability, with the tool Hazard Vulnerability Assessment (HVA). Each will be defined with health care related examples from Washington State.

Hazard—A potentially damaging physical event, phenomenon, or human activity that may cause the loss of life or injury, property damage, social and economic disruption, or environmental degradation.⁴

Washington State Example: The Cascadia Fault off the coast of Washington State represents a significant hazard; slippage of the fault would result in significant environmental, structural, and personal consequences.

Risk—The probability and outcome of the occurrence of a hazard on a particular population or area.

Washington State Example: The confluence of a warm water upwelling of the Pacific and the high elevation of the coastal cascades results in periodic risk of heavy snow fall.

Mitigation—The actions that are taken to reduce the impact of both hazard and risk.

Washington State Example: In 2009, the Army Corps of Engineers identified the following structural deficiencies on a flood control dam on the Green River: two depressions on the right abutment had been weakened by heavy rains. Mitigation included provisional, transitioning to permanent repairs, and temporary placement of sandbags on levees through Kent, Renton, Auburn, and Tukwila.⁵

Vulnerability—A set of conditions and processes resulting from physical, social, economic, and environmental factors which increase the susceptibility of a community to the impact of hazards.⁶

Washington State Example: Soil conditions, heavy rain, and earthquakes make many hillsides in King County vulnerable to mudslide.

Hazard Vulnerability Assessment—The main tool by which organizations assess their risk and plan for mitigation is HVA: “A study that identifies possible hazards and the susceptibility of an organization to the hazard impact. The HVA provides guidance for mitigation and preparedness plans in an emergency management program.”

Washington State Example: All acute care hospitals in Washington State are required to conduct annual HVA demonstrating understood hazards, risks, and vulnerability to nature and human disasters.

Management during a disaster is characterized by a structured series of management principles known as “all-hazards planning” and the incident command system. “All hazards” refers to the concept that a state of preparedness, planning, organization, and implementation of response to an incident can achieve positive results regardless of the specific nature of the hazard. The incident command system and hospital command system are structures that allow for holistic but rigid lines of communication and establishment of responsibilities during a disaster. Using clear communication of leadership, roles, and responsibilities, incident command creates guidance, completeness, and transparency during a chaotic event.

Recovery refers to the post-disaster phase of an event. This encompasses all of the structured and unstructured events that are required to bring society back to its normal level of function. Elements of recovery include, but are not limited to, infrastructure rebuilding, environmental restoration, livelihood restoration, and psychosocial recovery, to name a few.

Understanding Role - Local, State, Federal Agencies

Disaster management largely falls under the domain of government with specific roles and responsibilities maintained by different levels of government, agencies, and departments. A limited understanding of roles these groups play with regard to emergency management is critical to understanding the context within which health care delivery exists.

Practically and legally, disaster management is a function of the state. This having been said, local governments often are the main implementing bodies and federal elements become involved in a supportive and consultative role.

The main government body to focus on disaster in Washington State is the Washington Military Department Emergency Management Division that is under the auspices of the governor. The main structural body of this part of government is the

Comprehensive Emergency Management Plan (CEMP), which divides the scope of the work into 10 Emergency Support Functions (ESF) in line with other local, state, and federal framework. Health care is represented under ESF 8: Public Health, Medical, and Mortuary Services. The Washington State Department of Health (DOH; Tumwater, Washington USA) is the primary agency for ESF 8. This plan is publicly available.⁷

Mission

The Washington Emergency Management Division leads and coordinates mitigation, preparedness, response, and recovery in Washington State to minimize the impact of disasters and emergencies on the people, property, environment, and economy.⁸

Understanding Washington State Demographics, Geography, Economy, Key Infrastructure

According to the 2016 US Census estimates, there are 7,288,000 residents of Washington State.⁹ Despite its large land mass, the population as of the 2010 census was 84% urban. Additionally, these urban populations are clustered largely along the western coastal corridor. The population is also largely educated with 90% of adults having a high school diploma or equivalent and 32% having a bachelor's degree. The population is also largely wealthy with a per capital income of almost US\$32,000 in 2010, making it 12th in the United States.

Covering approximately 70,000 square miles, Washington is the 18th largest state in the nation (comparable to the Dakotas). Several geographical features have important disaster implications: the Cascade and Olympic Mountains; multiple active volcanos; and several large rivers, including the Columbia, the fourth largest river by volume in the United States. The topography is diverse and includes coasts, plains, mountains, forests, agricultural land, and waterways. Sitting on the Pacific coast of the north 49th parallel, Washington State's weather is noteworthy for the predictability for inclemency. Bordering states and regions of Canada have similar geography and climate.

Washington State has a diverse economy that includes service industry, agriculture, technology, manufacturing, and shipping. Each area of the economy has unique risks and vulnerabilities with regard to various disaster event types.

There is extensive overlap between disaster-related concerns and public and private infrastructure. The American Society of Civil Engineers (ASCE; Reston, Virginia USA) publishes an annual report of states' infrastructure in nine categories: Aviation, Bridges, Dams, Drinking Water, Rail, Roads, Schools, Solid and Hazardous Waste, and Transit. The report gives the state an overall rating of “C,” which indicates “needs attention.” The state's roads and schools were of particular concern, while its dams received a rating of “B.”¹⁰ While Washington has few bridges compared with other states, several affecting dense populations on islands and peninsulas may represent choke points in the event of a major disaster.

Hospital infrastructure is considered a unique entity, and as such has a science of its own. Hospital infrastructure is directed and evaluated by other entities, including the state DOH and credentialing and licensing organizations.

Washington State Risk Assessment Overview

Break Down of Specific Events

Natural Disasters—Based on the Washington State Enhanced State Hazard Mitigation Plan, natural hazards are broken into

categories with brief descriptions of frequency and impact on health care, as outlined in the report.

Avalanche—Events occur yearly with associated deaths and injuries related to isolated, usually recreational exposures.

Drought—“Severe or extreme” droughts in Washington State may be expected approximately every five years with significant impacts to agriculture, tourism, the environment, and the economy. Droughts also contribute to the public health risks of floods, landslides, and wildfires. Droughts are significantly more common in the eastern part of the state where there is greater reliance on agriculture.

Earthquake—Unfortunately, the epicenter of potential earthquake activity correlates roughly with the highest population density near Puget Sound. While the state as a whole has over 1,000 earthquakes annually, major earthquakes affecting infrastructure and population are less frequent, with damaging earthquakes to the Puget Sound basin recorded in 1909, 1939, 1946, 1949, 1965, and 2001. While future earthquakes are inevitable, those that will cause significant impact on society and represent a catastrophic disaster are more difficult to predict. That having been said, the location of major populations near the Cascadia Subduction Zone fault off the coast of Washington State is of particular concern to geologists and emergency planners. Geologists have predicted that this fault will produce a major earthquake (up to magnitude of 9.0), as well as various types of less major but potentially damaging earthquakes in the future.

Some more specific estimates from the report include a 6.5 or greater earthquake approximately every 1,000 years, the last being around the year 900AD. Modelling of similar event in today's environment yielded:

[A] scenario for a magnitude 6.7 event on the Seattle fault showed such a quake would result in extensive or complete damage to more than 58,000 buildings with a loss of \$36 billion, more than 55,000 displaced households, and up to 2,400 deaths and 800 injuries requiring hospitalization.

It is important to note that this estimate was made for the Seattle Fault, which runs directly through the city, while other similar events would likely have some protection due to geographic distribution of force; they are more likely with estimates of this magnitude or greater occurring anywhere in the region every 350 years.

Flood—Flooding is a significant hazard in Washington State with state-level major flooding events estimated at approximately every two years and county-level major flooding events every two to 11 years, depending on the county. There is a history of loss of life and major property damage secondary to flooding in the state with western Washington. The magnitude of the flooding risk and mitigation projects is such that the subject represents 22% of Washington State's Overview, Risk Assessment, and Natural Hazard Profiles, the largest of any single risk. Prediction modelling is extensive and flooding can be anticipated based on rainfall to a specific area. An overview of specific watershed areas, rivers, and coastal areas is available with risks and mitigation activities. Crop damage from flooding is a frequent, severe economic impact from the hazard.

Landslide—Steep slopes, development, and heavy rain fall make landslides an annual event. While loss of life from these events is not common, significant property damage is common, with loss

of transportation corridors adding to direct economic costs. Predictive modeling and mitigation activities are extensive. A major landslide occurred in 2015 Oso in Western, Washington and involved extensive involvement of the health care system. Landslides are also associated with other hazards, including flooding and earthquakes, so may represent a secondary hazard.

Severe Storm—Severe storms, defined as a combination of heavy precipitation (rain or snow), thunderstorms, hail, wind storms (40+ MPH), lightning, or a tornado, are an annual event in Washington State. While loss of life is uncommon, economic impacts due to property and crop damage are frequently in the range of tens of millions of dollars. The relationship between severe storms, global warming, and el niño affects is a topic of debate.

Tsunami—There have been seven tsunamis in the past 3,500 years affecting Washington State, and there is a prediction of 10%–14% chance of another occurring in the next 50 years. The tsunami inundation zone is located in the four coastal counties of Washington State with a population of 42,000. A tsunami has the possibility of being a catastrophic event with significant loss of life and economic impacts.

Volcano and Lahars—Washington State has five major volcanos, all in the Cascade Range in the western portion of the state: Mount Baker, Glacier Peak, Mount Rainier, Mount St. Helens, and Mount Adams. Washington State will also be affected by eruptions of volcanos in California (USA), Oregon (USA), and British Columbia (Canada), in particular Mt Hood in Oregon. All regional volcanos are composite or strato volcanos, which are steep sided and known to erupt explosively, resulting in significant destruction. Eruption of these volcanos is inevitable. Historically when these eruptions have occurred, they are associated with pyroclastic and lava flows, ash, and mudflows called Lahars, and ash clouds. While the impact of these events cannot be completely predicted, some things are considered highly likely; these include: complete destruction within 10 miles of the volcano, significant lahars within the valleys in a radius of 50 miles from the volcano, and falling and drifting clouds of ash affecting populations hundreds to thousands of miles away. Tephra, or the material ejected from the volcano including the ash, is of particular concern as it damages engines resulting in the need to cease industrial and transportation activity in the area, as well as exacerbating respiratory illness.

All of Washington State's volcanos have been active in the last 4,000 years and are anticipated to be active in the future. The annual probability of future events runs from one in 100 for small events, such as a small Lahar, to less than one in 1,000 for a major event, such as an eruption. Thankfully, timely prediction of events is possible as major events are preceded by smaller eruptions and earthquakes. Extensive monitoring of the volcanos occurs by multiple private, local, state, and federal agencies and groups. The lead agency is The National Volcano Early Warning System (NVEWS) of the US Geological Survey (USGS; Reston, Virginia USA). Lahar early warning planning is also extensive and includes monitoring of rivers and calculations of timing of when the lahar will reach specific communities.

Planning, including evacuation plans, occurs at the local level in affected counties and at the level of the state. Public information and education are extensive and targeted towards likely to be affected populations. Health care delivery will likely be impacted due to a number of factors, including but not limited to: large-scale

social disruption, injuries, interrupted transportation, and respiratory illness.

Wildfire—Washington State has approximately 800 wildfires annually burning approximately 23,000 acres. Seventy percent of these occur in the eastern portion of the state, with an annual cost of 28 million dollars in the state's expenses and damages. Historically, the state has had very large fires, including the Okanogan Complex fire in 2015 that burned over 300,000 acres.

Injuries, burns, and respiratory complications from the scene are common. Additionally, respiratory complications may be well-removed from the fire site and affect large portions of the state. There may be significant social and psychosocial health presentations due to loss of infrastructure and displacement of populations.

Loss of Infrastructure

Potential effects on the population from a health care perspective.

Washington State Planning and Response Overview

State Government

In Washington State, the main organizing body for planning and response to disasters is the Washington Military Department Emergency Management Division. Establishing an emergency operations center at Fort Murry, outside of Tacoma, the division is responsible for multiple emergency support functions, not just health care. Its main public health branch is the Washington State DOH, which gathers and disseminates information, provides support and guidance, and works with local and federal agencies to assist in all phases of the disaster cycle.

Local Government and Public Health Departments

Local government and public health departments have variable abilities and resources regarding planning and response to events. This ranges from robust organizations capable of mounting an epidemiological investigation, managing policy, and implementation of public health measures in real-time to very under-funded and under-resourced departments capable of working with other organizations and agencies to support their population.

Health Care Coalitions (HCCs)

Health Care Coalitions are federally mandated organizations tasked with coordinating and supporting health care related disaster management in each region. The interagency organization has variable membership, but is intended to include hospitals and other health care institutions, prehospital care organizations, public health, and emergency management organizations. In many instances, they also include peripherally affiliated groups such as social service organizations, pharmacies, tribal organizations, and others. Tasked with a variety of activities from disaster education and awareness to tracking of disaster-related resources, the responsibilities of the organizations are structured into four capabilities.¹¹ Within each capability are defined objectives and activities to meet the needs of their constituent organizations.

Capability 1: Foundation for Health Care and Medical Readiness—This encompasses the organization and governance of the HCCs, risk assessment, education and training, disaster drilling, and sustainability.

Capability 2: Health Care and Medical Response—Utilizing their role as an interagency group, HCCs develop communications frameworks to allow information sharing, coordination, and facilitation of disaster response. In order to achieve this, HCCs

must establish the appropriate strategy, platforms, and governance to allow the disparate organizations to communicate and coordinate affectively.

Capability 3: Continuity of Health Care Service Delivery—This function of the HCCs involves establishing what is needed to keep health care functional in the face of a disruptive event. It includes establishing an understanding of what is needed for essential functioning of health care delivery, planning around potential disruptions, and when necessary, contingency planning considering disruptions. The concept is wholistic, including human and material resources, financing and administration, and when necessary, relocation of services.

Capability 4: Medical Surge—Preparation for and understanding of medical surge is the greatest challenge to health care delivery organizations, and as such, is a main component of the work of HCCs. This involves planning for medical surge from disruption of services, increased volume and needs, events such as chemical disasters, specific populations such as pediatrics, and planning for alternatives to health care delivery and changes in the standards of care.

Federal Response in Disasters

Federal Disaster Declaration

The state is the controlling government agency with regards to disasters, until the federal government has been "invited" to respond at the behest of the governor. Legislation and declaration of different levels of response is complicated and does not directly affect health care delivery when the coordination of activities between different levels of government goes as planned. This ideal representation involves an evolving cascade of resources from local to federal as the disaster progresses or understanding of needs progresses.

FEMA

The Federal Emergency Management Agency is the main branch of government charged with ensuring the well-being of the population in the event of a disaster. As such, its role is to provide an organizing structure, interagency coordination, response facilitation, and expert input in all stages of the disaster cycle. This involves activities as diverse as community-level education, real-time disaster response coordination and logistics, recovery, and mitigation activities.

HHS

Working with FEMA, the HHS Assistant Secretary of Disaster Preparedness and Response and the National Disaster Medical System support many aspects of health care related disaster management. These include, but are not limited to, disaster planning, monitoring, coordination of affiliated agencies, and deployment of federal resources to provide medical care. One component of this system is the Disaster Medical Response Teams (DMATs), which are federal assets that deploy to support existing health care infrastructure. This comes in the form of resources, expert consultation, individual providers, and self-contained field hospitals.

US Military and Reserves

Use of National Guard resources at the behest of the government and federal military resources at the behest of the president is a far more complicated event with regards to policy and procedure. Additionally, further federal resources such as the United States Public Health Service Commissioned Corps are also available in the event of a disaster. While these resources are more complicated

in terms of their indication and procedures for involvement, their ability to respond is also far more robust than other levels of response.

Limitations

It is beyond the scope of this work to provide a comprehensive review of the concepts of disaster medicine, health care related emergency management, or the scope and response of disaster events, response, and recovery in Washington State.

Conclusions

Washington State has many unique features that make disasters affecting health care delivery inevitable. Additionally, the management of disasters in the state is quite complex, and an understanding of the basics of emergency management maybe helpful for health care providers in the state to understand. While wind storm is the most common natural hazard event in Washington State, geophysical events represented one-half of the historical economic losses from natural hazards.

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