Webinars
Series of scientific webinars that provide a forum for discourse on scientific issues.
Live and On-Demand
Case Conferences
Journal Clubs
Grand Rounds
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Online Courses
Evidence-based online courses on a variety of children’s environmental health topics.
Interactive and Self-Paced
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Resource Catalog
Fact sheets, journal publications, reports, and other resources for parents, community members, patients and healthcare professionals.
Topics included: Air Quality, Pesticides, Natural Disasters, BPA, Mold, Lead, Mercury
Health Impacts of Volcanic Emergencies
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Objectives

- After attending this webinar, participants will be able to:
  - List health hazards of volcanic emergencies
  - Discuss toxicological hazards of volcanic emergencies
  - Discuss personal protective measures
  - Discuss patient assessment and management of related toxicological health complaints
Historically, 600 active volcanoes worldwide and 50 eruptions per year

~500 Million people live in areas of volcanic activity

Volcanic eruptions can have potentially devastating consequences in both human and economic losses
Decade Volcanoes – USGS - 1998

Ring of Fire

Decade Volcanoes

Teide  Etna  Santorini  Vesuvius  Unzen  Rainier  Sakurajima  Mauna Loa  Colima  Santa Maria  Galeras  Nyiragongo  Merapi  Taal  Avachinsky-Baykalsky  Ulawun

Myers, USGS/CVD, 1998
Health Hazards from Volcanic Eruptions

- Pyroclastic Flows
- Lahars
- Blast injuries from lava bombs
- Laze
- Tephra fallout
- Toxic gases
- Toxic compounds
- Earthquakes, tsunamis, and lightning
Pyroclastic Flows

- Occur during explosive eruptions
- Hot gases and rock debris are thrown from the volcano
  - Flows move between 50-150 km/h, hugging the ground
  - Initial temperatures estimated to be between 600-900°C, but usually cool rapidly
- Flows represent a massive amount of momentum
  - Can flatten trees and buildings
Pyroclastic Flows

- Flows can extend many kilometers away from the volcano
  - Even at the periphery, temperatures may be hot enough to cause severe burns

- Mt. St. Helen’s eruption in May 18, 1980
  - Trees were flattened up to 27 km from the crater
  - Three loggers suffered 2nd and 3rd degree burns affecting 33% to 47% surface area, 19 km away from the crater
Pyroclastic Flows

- Historically destructive:
  - Mt. Vesuvius (Italy): 10,000-25,000 lives lost
  - Mt. Pelee (Martinique): ~28,000 lives lost

- Evacuation is the key measure to reduce mortality in a pyroclastic event

- Some benefit may be gained by remaining indoors
Lahars

- Lahars are similar to mudflows
  - High temperatures can melt glaciers and snow
  - Any large water source can become a lahar

- Consist of moving water and volcanic debris
  - Can be watery, or as dense as wet concrete
  - Deposited material can alter the course and level of nearby rivers and lakes, leading to flooding

- Volcanic debris can be mobile for years afterward
November 13, 1985 – Armero

- Nevado del Ruiz erupted causing massive lahars 48 km downstream in the town of Armero, Colombia
- 20,000 of the 29,000 inhabitants died in the flooding
- Worst natural disaster in Colombian history
  - Deadliest known lahar
Lahars

Armero Town - Source Wikipedia
Laze plumes forming from Pāhoehoe lava flowing into the Pacific Ocean, Hawaii.

By I, Brocken Inaglory, CC BY-SA 3.0,
https://commons.wikimedia.org/w/index.php?curid=2426614
Blast Injuries

- Explosive eruptions can produce concussive forces and launch large projectiles significant distances.
  - Projectiles may damage, windows, roofs and people
- Small explosive eruptions often occur without warning
  - Represent a danger to volcano tourists and vulcanologists

Blast Injuries

Mt. Etna, Sicily - 1979

- Produced 1 m wide projectiles that traveled up to 300 meters from the southeast crater
- 0.5 meter projectiles were thrown up to 500 meters
- One small explosive eruption killed 9 tourists inside the crater

Lava bomb and crater, Papua New Guinea
Source: Wikicommmons
Tephra Fallout: Respiratory

Particle Size Influences Bioavailability
Tephra Fallout: Respiratory

- Particles smaller than 10 microns in diameter considered respirable
- Acute respiratory symptoms commonly reported by people during and after ash falls
  - Nasal Irritation and discharge
  - Throat irritation
  - Exacerbation of pre-existing respiratory conditions
  - Airway irritation of people with asthma or bronchitis
- Short term effects of ash are generally not considered harmful for people without pre-existing respiratory illness
Prevention

- Avoid unnecessary exposure
- Stay indoors
- Keep all outside doors and windows closed
- Set HVAC systems to minimize outdoor air intake
- Use HVAC filters optimized for trapping small particles (e.g., MERV 11 or higher)
Tephra Fallout: Respiratory

- Prevention-adults
  - Adults should wear an appropriate dust mask when outdoors
    - N95 mask
    - Size appropriate for face
    - Eye protection also?
  - People with lung diseases should remain inside

Source: GNS Science

www.ivhhn.org
Tephra Fallout: Respiratory

- Prevention-children
  - N95 masks sized for children <3yr not available
  - Child N95 masks may not be readily available
  - Adult sizes too large for most children
- Children without masks may be best served by staying indoors
Tephra Fallout: Respiratory

- Silica Inhalation
  - Some volcanoes disperse large amounts of free crystalline silica in respirable sizes
  - No documented cases of silicosis from volcanic ash
- Long term effects of ash inhalation are unknown
  - Chronic exposure to ash may result in adverse health effects
Tephra Fallout: Ocular

- Volcanic ash is abrasive and can irritate the eyes
  - Particularly people wearing contact lenses
- Acute conjunctivitis and corneal abrasions are among the more common serious ocular complaints
- No chronic effects have been noted
The weight of volcanic ash on roofs can lead to the collapse of weaker buildings and directly injure inhabitants. 

Damage to Clark Air Force Base airplane hangers collapsed under the weight of wet volcanic ash from the eruption of Mount Pinatubo in 1991. 

Source: Public domain
Tephra Fallout: Water

- Hydrogen Chloride
- Hydrogen Fluoride
- Acidic rain
- Acidic water in rivers
- Potential hazard: High fluoride content in drinking water

Hekla Eruption Iceland 1980
High F content in Water from 1970
Source wikicommons
Volcanic Gases and Toxicological Hazards

- Sulfur Dioxide
- Hydrogen Sulfide

Volcanic Smog (vog) produced from $\text{SO}_2$ gas
Source: USGS
Volcanic Gases and Toxicological Hazards

Sulfur Dioxide

- Degassing of volcanoes
- Denser than air
- Colorless gas with a characteristic and irritating smell
- Irritant gas
- Health effects are secondary to respiratory and mucus membrane irritation

Nelson's Column during the Great Smog of 1952

By N T Stobbs, CC BY-SA 2.0, https://commons.wikimedia.org/w/index.php?curid=4094275
Fig. 1. Mean values for specific airway resistance before (bottom of bars – SEM) and after (top of bars + SEM) inhalation of 0.5 and 1.0 ppm SO₂ for 1, 3, and 5 min, and before (bottom of bars – SEM) and after (top of bars + SEM) inhalation of filtered, humidified air for 5 min, in 8 subjects with asthma.
Volcanic Gases and Toxicological Hazards

Hydrogen Sulfide

- Hazardous near vents in volcanoes
- Dense, Irritant, Toxic
  - Smells like “Rotten Eggs” at low concentrations
  - Poor warning properties
- Cellular asphyxiant
Hydrogen Sulfide

- With high-level exposure, neurological sequelae have the greatest impact
- Acute respiratory effects can also occur
- Chronic low-level exposure may actually be protective re: asthma risk

Associations of ambient hydrogen sulfide exposure with self-reported asthma and asthma symptoms

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Volcanic Gases and Toxicological Hazards

- Carbon Dioxide
  - Dense, Toxic, Asphyxiant
- Carbon Monoxide
- Helium, Radon

Lake Nyos Disaster
Public Domain
CDC Experience and Resources
Volcanic eruptions produce various complex hazards some of which are not familiar to the public or responders/emergency managers/public health professionals/health care providers.

- Toxicological effects are primarily from the irritant effect of chemicals.
- Public and clinician education are of important to mitigate the health impacts.
Main Source

- Volcanoes (Chapter 9) by Peter J. Baxter. The Public Health Consequences of Disasters by Noji, Eric K. Published by Oxford University Press, USA 1st (first) edition (1997) Hardcover
• Nicholas Byron Pitts, MD
• Carl Baum, MD
• Mark Miller, MD
• Edwin M Kilbourne, MD
Resources

The Centers for Disease Control and Prevention
https://www.cdc.gov/disasters/volcanoes/index.html

The Environmental Protection Agency
https://www.epa.gov/natural-disasters/volcanoes

Hawaii Department of Public Health http://health.hawaii.gov

The International Volcanic Health Hazard Network
www.ivhhn.org

GNS Science https://www.gns.cri.nz
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