Trends in Emerging Infectious Disease: The Threat of Vector Borne and Zoonotic Diseases

Challenges for Emergency Management

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Overview

- Background
- Vector borne diseases – carried by insects or animals
- Zoonotic diseases – carried by animals
- Public health and emergency management of disease outbreaks
Colonial Public Health Events
Charles Town in 1739

An English engraver produced this prospect of the harbor at Charles Town (now Charleston), South Carolina, in 1737. It was almost a decade after the city was founded in 1670. It was by then the principal port of the southern colonies. The city's original waterfront (or battery), pictured here, looks much the same today as it did in the eighteenth century.

— Philip Noss, South Carolina Historical Society, New York Public Library
Yellow Fever Epidemics in South Carolina

1699 First yellow fever epidemic in Charleston

1700’s Yellow fever epidemics were recorded in Charleston in 1706, 1711, 1717, 1718, 1719, 1730-1739, 1745, 1748, 1790-99

1800’s Yellow fever epidemics were recorded in Charleston in 1800, 1802, 1804, 1817, 1820, 1821, 1824, 1827, 1828, 1838, 1839, 1849, 1852, 1854, 1856, 1858, 1864, 1871, and 1876.
Malaria
Doctor. “Any of your boarders got the malaria?”
Landlady. “Malaria! If you mean lying down and sleeping and eating and grumbling and going to bed late and don’t get up at all mornings—if that’s the disease, they’ve all got it bad.”
AT THE GATES.
Our safety depends upon official vigilance.
Centers for Disease Control and Prevention

- On July 1, 1946 the Communicable Disease Center (CDC) was created with headquarters in Atlanta, Georgia.
- It began as wartime agency: Malaria Control in War Areas (MCWA). The CDC initially focused on fighting malaria by killing mosquitoes.
- Most of the 400 original employees were entomologists and engineers. CDC had only seven medical officers on staff in 1946.
- DDT, available since 1943, was its primary weapon, and the CDC's early challenges included obtaining enough trucks and sprayers to wage the war on mosquitoes.
- In its initial years, over 6.5 million homes were sprayed.
- CDC’s first budget was under $10 million. (Source: CDC website, http://www.cdc.gov/about/history/ourstory.htm)
That was then, this is now

Emerging Vector Borne and Zoonotic Diseases for the 21st Century
1992: “…the United States has no comprehensive national system for detecting outbreaks of infectious disease. Outbreaks of any disease that is not on CDC's current list of notifiable illnesses may go undetected or may be detected only after an outbreak is well under way.”

“Although many local and regional vector-control programs can effectively combat small and even medium-size outbreaks of vector-borne disease, they are not equipped to deal with outbreaks that are national in scope.”

“The significance of zoonoses in the emergence of human infections cannot be overstated.”

Roger S. Nasci, Ph.D., Arboviral Diseases Branch, Division of Vector-Borne Infectious Diseases, Centers for Disease Control and Prevention

Emerging Infectious Diseases

- Three trends:
  - Population growth
  - International travel
  - Climate change
World Population in 2013 was 7.1 billion. Fastest growth is in less developed countries.

Population Reference Bureau, 2013
**WORLD TOURISM**

Total International Tourist Arrivals .......................... 990 million (2011)
Total International Tourist Spending * .................. $1,033 billion (2011)

Source: United Nations World Tourism Organization
Travel-related health problems are self-reported by 22%–64% of travelers to the developing world; most of these problems are mild, self-limited illnesses such as diarrhea, respiratory infections, and skin disorders. Approximately 8% of the more than 50 million travelers to developing regions, or 4 million people, are ill enough to seek health care, either while abroad or upon returning home.

<table>
<thead>
<tr>
<th>Health Issue</th>
<th>Probability</th>
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<tbody>
<tr>
<td>Travelers’ diarrhea</td>
<td>20%–40%</td>
</tr>
<tr>
<td>Malaria (no chemoprophylaxis West Africa)</td>
<td></td>
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<tr>
<td>Influenza A or B</td>
<td>1%</td>
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<tr>
<td>Dengue infection (symptomatic)</td>
<td></td>
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<tr>
<td>Animal bite with rabies risk</td>
<td></td>
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<tr>
<td>PPD conversion</td>
<td>0.1%</td>
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<tr>
<td>Hepatitis A</td>
<td></td>
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<tr>
<td>Typhoid (South Asia, N/W/Central-Africa)</td>
<td></td>
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<tr>
<td>Tickborne encephalitis (rural Austria)</td>
<td>0.01%</td>
</tr>
<tr>
<td>Hepatitis B</td>
<td></td>
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<tr>
<td>Typhoid (other areas)</td>
<td></td>
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<tr>
<td>HIV-infection</td>
<td></td>
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<tr>
<td>Fatal accident</td>
<td>0.001%</td>
</tr>
<tr>
<td>Cholera</td>
<td></td>
</tr>
<tr>
<td>Legionella infection</td>
<td></td>
</tr>
<tr>
<td>Japanese encephalitis</td>
<td>0.0001%</td>
</tr>
<tr>
<td>Meningococcal disease</td>
<td></td>
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<tr>
<td>Poliomyelitis</td>
<td></td>
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Climate-related threats to human health

- **Event types:**
  - Heat waves/air pollution
  - Extreme rainfall events
  - Winter storms
  - Floods
  - Drought
  - Wildfires
  - Tornados
  - Hurricanes
  - Sea level rise and coastal flooding

- **Potential impacts:**
  - Direct health effects
    - heat stroke, asthma, cancer, injuries, deaths
  - Climate-sensitive diseases
  - Vector borne diseases
  - Fresh water supply
  - Food production and food safety issues
  - Migration
Current and potential health impacts

- Frequency, type, severity and duration of extreme weather events
  - Subtle impacts of climate change
- Vulnerable populations
  - Intersection of chronic illness and climate change
  - Food security
- Change in type and distribution of vector-borne, food-borne and water-borne diseases
- Impacts of sea level rise
Vector borne diseases

- Mosquitos
  - Malaria
  - Yellow fever
  - Dengue fever
  - Chikungunya virus
- Arboviral encephalopathies:
  - Eastern Equine Encephalitis
  - Western Equine Encephalitis
  - Venezuelan Equine Encephalitis
  - St. Louis Encephalitis
  - Lacross Encephalitis
  - Japanese Encephalitis
  - West Nile Encephalitis
Aedes albopictus

Distribution in 2000
Vector borne diseases

- Ticks
  - Rocky Mountain Spotted Fever and other spotted fevers
  - Lyme Disease
  - Powassan Encephalitis
  - Ehrlichiosis
West Nile Virus

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Just another Exotic - Invasive Species

Any species capable of propagating, that is not native to that ecosystem; and whose introduction does or is likely to cause economic or environmental harm or harm to human health.

Roger S. Nasci, Ph.D.
Arboviral Diseases Branch
Division of Vector-Borne Infectious Diseases
Centers for Disease Control and Prevention
Emergence of West Nile Virus

- West Nile virus was first isolated in the West Nile District of Uganda in 1937.
- Recognized as a cause of severe human meningitis or encephalitis
- Outbreak in Israel in 1957
- Equine disease was first noted in Egypt and France in the early 1960s.
- West Nile virus has been found in Africa, Europe, the Middle East, west and central Asia, Oceania, and most recently, North America.
- Frequent outbreaks of WNV encephalitis in humans have occurred in these areas
- WNV first appeared in North America in 1999, with encephalitis reported in humans and horses, and large-scale bird kills.
- Since 1999, over 39,000 reported WNV cases in the US and 1,663 reported deaths
‘An Excess Of Caution’
Giuliani Defends City’s Extensive Attack on Mosquitoes
Suspected Encephalitis Cases Now Total 62 / Page A5

LET US SPRAY!
Citywide war on mosquitoes
PAGES 4-7
Culex Pipiens. West Nile virus has been transmitted mainly by Culex species, but 36 species of mosquito have been shown to be infected. 27 species of mammals and 126 species of birds have been shown to be susceptible.
West Nile Virus 2000
West Nile Virus 2002
West Nile Virus 2003

The map shows the distribution of West Nile Virus cases across the United States in 2003. The map is color-coded to indicate the number of cases: red represents human disease cases, and yellow indicates avian, animal, or mosquito infections. The map highlights the states with the highest number of cases, with New York having the most cases at 71. The map also shows cases in other states such as California, Texas, and Florida, among others. The CDC logo is visible on the map, indicating it is a CDC publication.
West Nile Virus 2004
West Nile Virus 2012

- No WNV activity
- Any WNV activity*
- WNV human disease case
- WNV presumptive viremic blood donor†
West Nile Virus 2013: Counties with human cases in pink
Established in 2000 to track WNV cases, monitor spread

Capture environmental surveillance from State Health Departments
  - Birds (dead, sentinel), Mosquitoes, Horses, other vertebrates

All arboviruses of public health importance added in 2003
  - WNV, SLE, EEE, WEE, LAC, POW

Nationwide Comprehensive Arbovirus surveillance System
Emergence of Dengue Fever

- Dengue infection is a leading cause of illness in the tropics and subtropics.
- Dengue has emerged as a worldwide problem only since the 1950s. It rarely occurs in the continental United States. It is endemic in Puerto Rico, and in many popular tourist destinations in Latin America and Southeast Asia.
- More than one-third of the world’s population lives in areas at risk for transmission.
- As many as 100 million people are infected yearly.
- Dengue is caused by any one of four related viruses transmitted by mosquitoes.
- There are not yet any vaccines to prevent infection with dengue virus (DENV) and the most effective protection is to avoid mosquito bites.
- Early recognition and prompt supportive treatment can substantially lower the risk of developing severe disease.
World Health Organization – Dengue is on the rise
WHO – The Impact of Dengue

In the 1800’s, dengue was a sporadic disease that caused epidemics at long intervals. Today, dengue is the most important mosquito-borne viral disease in the world. In the last 50 years, incidence has increased 30-fold. An estimated 2.5 billion people live in over 100 endemic countries. Up to 50 million infections occur annually with 500,000 cases of dengue haemorrhagic fever and 22,000 deaths, mainly among children. Prior to 1970, only 9 countries had experienced cases of DHF; since then the number has increased more than 4-fold and continues to rise.
Dengue Vectors

- *Aedes aegypti* is the principal mosquito vector of dengue viruses
- Another important mosquito vector of dengue is *Aedes albopictus*
Dengue in North and South America
Emergence of Chikungunya Virus

- Chikungunya virus was first isolated in Tanzania in 1953.
- Has caused numerous epidemics in Africa and Asia and most recently in limited areas of Europe.
- Chikungunya virus is not currently found in the United States.
- **First cases in Caribbean in December 2013 in St. Martins. January 2014: cases spread to several Caribbean islands**
- No preventive vaccine or specific treatment for chikungunya fever; care is based on symptoms.
- Chikungunya fever is not usually fatal.
Chikungunya in the Caribbean 2014

St. Martin/Sint Maarten
Martinique
Guadeloupe
St. Barthelemy
British Virgin Islands
Dominica

COMMUNICABLE DISEASE THREATS REPORT
Week 7, 9-15 February 2014
Zoonotic Diseases

- E Coli O157:H7
- Monkeypox
- Severe Acute Respiratory Syndrome (SARS)
- Middle Eastern Respiratory Syndrome coronavirus (MERS-cov)
- Influenza H7N9
E. coli is a large and diverse group of bacteria. Present in the intestines of people and animals. Many strains have no harmful effects. Some cause diarrhea, urinary tract infections, respiratory illness or other illnesses. Strains that produce Shiga toxins like E. coli O157:H7 are responsible for the most severe diseases and can result in kidney failure, internal hemorrhage and bloody diarrhea, and in some cases, death. There are an estimated 265,000 Shiga-toxin producing E. Coli (STEC) infections in the US each year.
Esherichia Coli O157:H7

- Recognized as a pathogen in 1982, linked to ground beef
- Most common exposure pathway through contaminated foods
- Outbreaks have occurred due to contaminated beef, raw milk, unpasteurized juice, spinach, lettuce, peppers
- Person-to-person transmission at child care centers
- May be transmitted through contact with infected animals, for example at petting zoos, fair exhibits
Emergency Management of E. Coli O157H:7 Outbreaks

- Laboratory confirmation
- Epidemiological investigation: who, who else, where, when, source of infection and spread of infection
- Traceback investigation: identification of the food product, and tracing its handling, processing, and growing from the fork to farm
- Product recall and public information
CDC Recent Case: Ready-to-Eat Salad, October-November 2013

- 33 persons infected from four states: Arizona (1), California (28), Texas (1), and Washington (3).
- 32% of ill persons were hospitalized. Two ill persons developed hemolytic uremic syndrome (HUS), and no deaths were reported.
- The STEC O157:H7 PFGE pattern combination in this outbreak was new to the PulseNet database.
- Epidemiologic and traceback investigations conducted by local, state, and federal officials indicated that consumption of two ready-to-eat salads, Field Fresh Chopped Salad with Grilled Chicken and Mexicali Salad with Chili Lime Chicken, produced by Glass Onion Catering and sold at Trader Joe’s stores, was the likely source of this outbreak.
- Glass Onion Catering voluntarily recalled numerous ready-to-eat salads and sandwich wrap products that may be contaminated with STEC O157:H7.
With emerging zoonotic diseases, you never know what to expect...
Monkeypox !?! June 2003

Wisconsin
Illinois
Indiana...
South Carolina (not)
Severe Acute Respiratory Syndrome SARS

- Worldwide
  - November 2002, SARS appears in Guangdong Province, China
  - In 8 months, 8,098 cases and 774 deaths in 29 countries
The Outbreak

- November 2002 - Guangdong Province, China
- January 2003 - pneumonia in Guangzhou, capital city
- February 2003 - WHO reports 305 cases, 5 deaths in Guangdong. A Hong Kong family, returning from Fujian province, has fatal H5N1 infection. SARS index patient, 65 yr. old doctor from Guangdong, checks into the Metropole Hotel in Hong Kong. Infects at least 17 persons. Some travel to Vietnam, Singapore, and Toronto. Outbreak begins in Hanoi.
- March 2003 Outbreaks in Hong Kong, Toronto, Singapore, Taiwan, Beijing, Vietnam. WHO issues global alert and travel warnings. By the end of the month, the causative agent is identified as a novel coronavirus
- May 2003, cases peak in China. Over 29,000 quarantined.
- By June 2003, estimated 8,500 cases in 29 countries
- July 2003, WHO declares outbreaks over
- December 2003, Last known case in a laboratory scientist in Taiwan.
Toronto SARS Outbreak

- 361 cases, 43 deaths
- 109 health care workers contracted SARS
- Over 10,000 people quarantined
Toronto, April, 2003
Severe Acute Respiratory Syndrome
Lessons

- Infection control measures and quarantine were important for breaking the chains of transmission.
- Relatively low transmission rates (not like influenza).
- “Super-spreaders” – a few individuals infected numbers of others at a hotel, an apartment complex, and in-flight.
- Challenging to differentiate from other respiratory illnesses.
- Wide-ranging economic and political impacts.
- Animal reservoirs may trigger future outbreaks.
That was then... What is happening now?

Middle Eastern Respiratory Syndrome – Corona virus
MERS-cov
Influenza H7N9 Avian Influenza Emerging as a Human Pathogen in China
Middle Eastern Respiratory Syndrome – Coronavirus Emerging Now, 2012 - 2014

- Severe respiratory illness: fever, cough, shortness of breath
- Some mild cases.
- No vaccine, no treatment: supportive care for symptoms
- Human cases first reported in April 2012
- As of February 7, 2014
  - 182 lab confirmed human cases reported to World Health Organization, 79 deaths
- MERS-cov isolated in camels and bats
MERS

- Cases in Jordan, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates
- Imported Cases in France, Germany, Italy, United Kingdom
- All cases linked to travel to Middle East or exposure to a patient originating in Middle East
- 32 Health care workers have contracted the disease
Distribution of confirmed MERS-CoV cases by place of reporting, March 2012 – February 13, 2014
Influenza H7N9 Emerging in China, 2013 - 2014

- There are many types of avian influenza viruses that affect wild birds and domestic poultry.
- A few humans come down with avian influenza due to their exposure to infected birds. Usually these are mild cases of respiratory illness or eye infections.
- Sometimes the disease is more serious.
- Sometimes the virus undergoes genetic changes that make it easy to transmit from person-to-person.
- That can mean big trouble: a human epidemic or even a worldwide pandemic of a novel strain of flu to which few people are immune.
- So when a few people in China get sick from an avian H7N9 influenza, the world takes notice.
H7N9 in China

- First wave of human infections occurred from February to May 2013: 133 cases, 24 deaths
- Second wave, October 2013 to present (2/17/2014), 224 cases, 49 deaths
- Infection rate appears to be slowing, no sustained human to human transmission, most cases are due to bird-human contact
- Has not spread internationally
Cases of H7N9 Influenza in China by Week of Onset (Feb 17, 2014)
357 Total Cases: 73 Deaths
Date of Onset Missing for 20 Cases

Source: Provincial CDC (China), National China CDC, WHO, and news reports
COMMUNICABLE DISEASE THREATS REPORT Week 7, 9-15 February 2014
A CDC Scientist harvests H7N9 virus that has been grown for sharing with partner laboratories for research purposes.
Health Care Providers Must Be Prepared to...

- Correctly diagnose patients
- Implement infection control
- Implement emergency disease control measures
- Provide urgent medical care in widespread outbreaks
- Support health care workers
- Properly report cases to public health authorities
Public Health Must Be Prepared to...

- Conduct emergency operations planning for the full range of potential emerging diseases
- Maintain effective disease surveillance, epidemiology and outbreak response capabilities
- Communicate accurate information to the public and healthcare providers
- State and local vulnerability assessment and strategic planning for public health programs and health care
Emergency Managers Must Be Prepared to...

- Understand the nature of the emergency and the particular hazard posed by the specific epidemic disease
- Work closely with the public health agency and the medical sector
- Depending on the circumstances, change activation levels and implement emergency plans
- Coordinate emergency support functions
- Coordinate federal support and mutual assistance
You Check the Weather Every Day...Keep an Occasional Eye on the Disease Reports Too

- DHEC Health Alert Network
  https://www.scdhec.gov/health/disease/han/

- Centers for Disease Control Health Alert Network
  http://emergency.cdc.gov/han/

- Center for Infectious Disease Research And Policy (CIDRAP)
  http://www.cidrap.umn.edu/

- International Society for Infectious Diseases Program for Monitoring Infectious Diseases (Pro-Med)
  http://www.isid.org/promedmail/promedmail.shtml

- Health Map - maps of disease reports near you
  http://healthmap.org/en/
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