Emerging Infectious Diseases and Risk

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Health Risk Solutions
Measuring **Health.** Reducing **Risk.** Delivering **Solutions.**

NAIC National Association of Insurance Commissioners & The Center for Insurance Policy and Research

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VP, CMO LOCKTON

CIPR Spring Event
March 27, 2015
Phoenix, AZ

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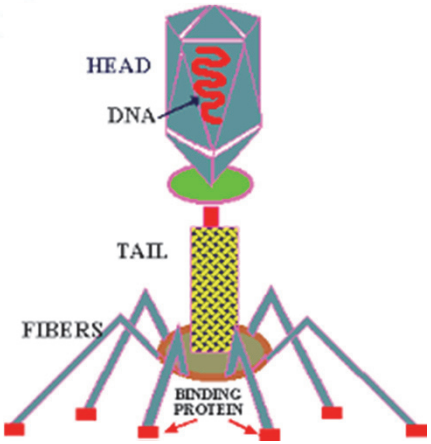
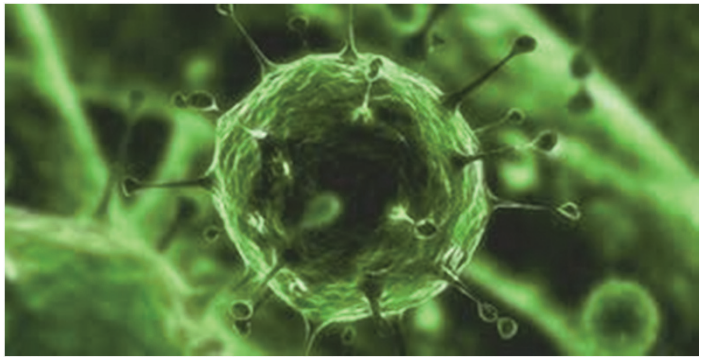
Introduction -- topics

- Brief overview of Viruses

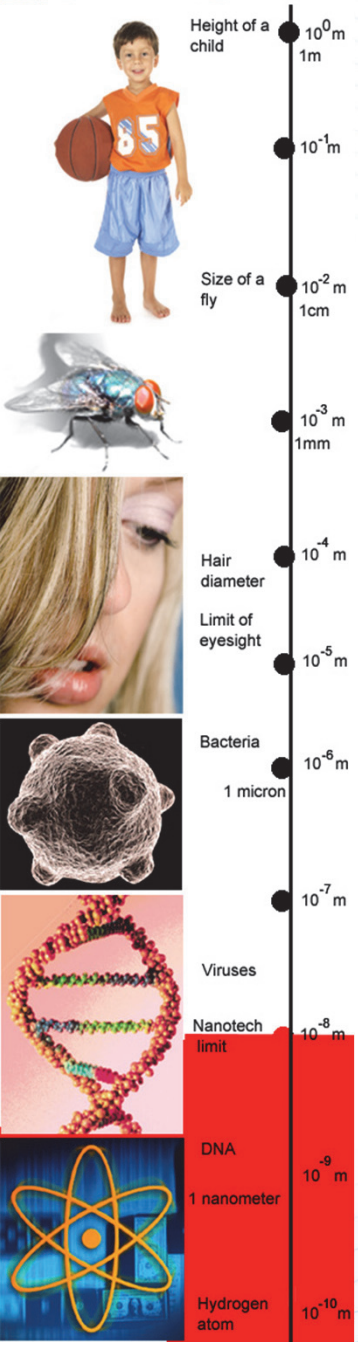




  - Emerging viral disease(s)
  - Clinical elements of viral infections
  - Relationship to costs

Viruses

Virus: A small infectious particle that replicates only inside the living cells of other organisms (any/all life forms)



Two – three key components

- Genetic material: DNA or RNA
- Protein coat
- Lipid coat or envelope over the protein coat
- Viruses also called 'virions'

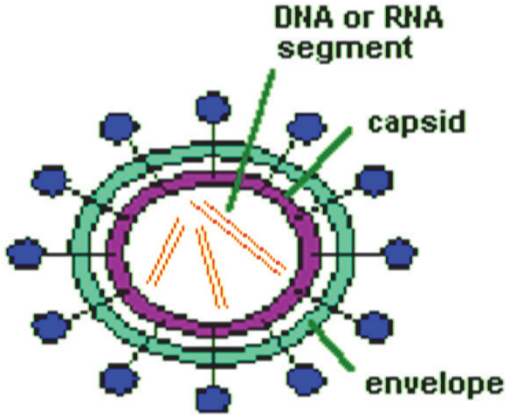
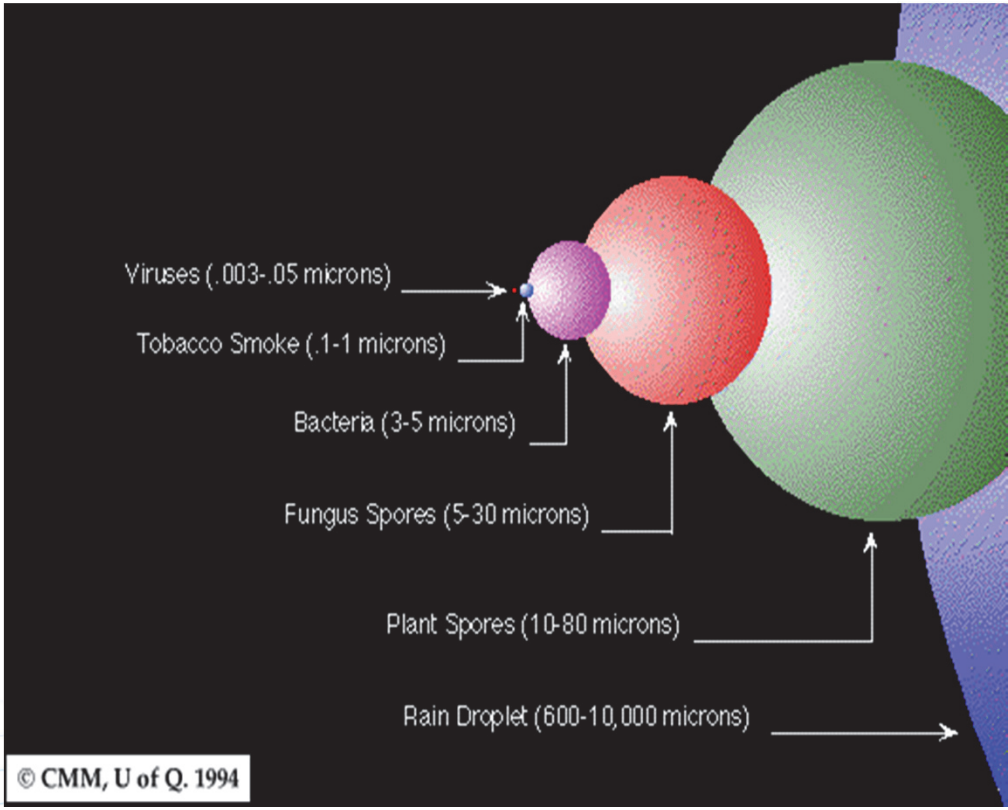
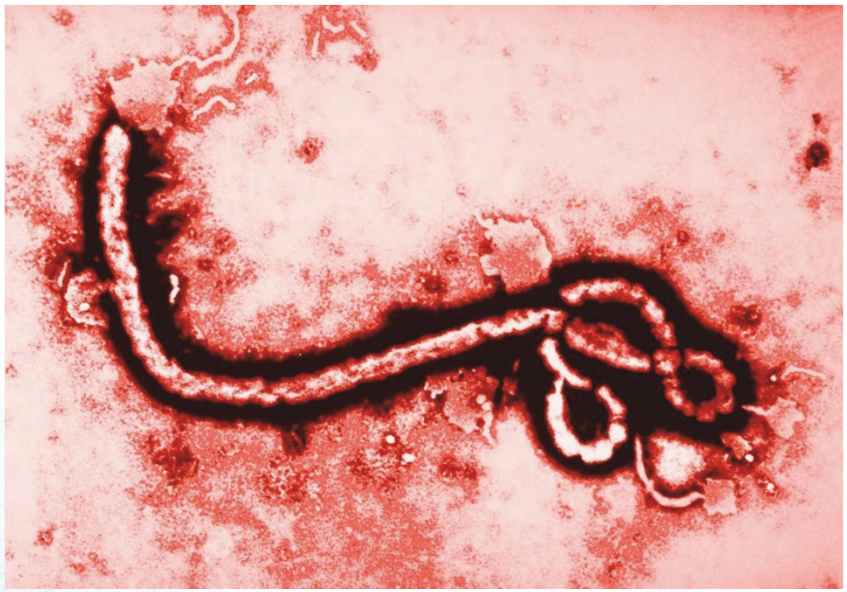


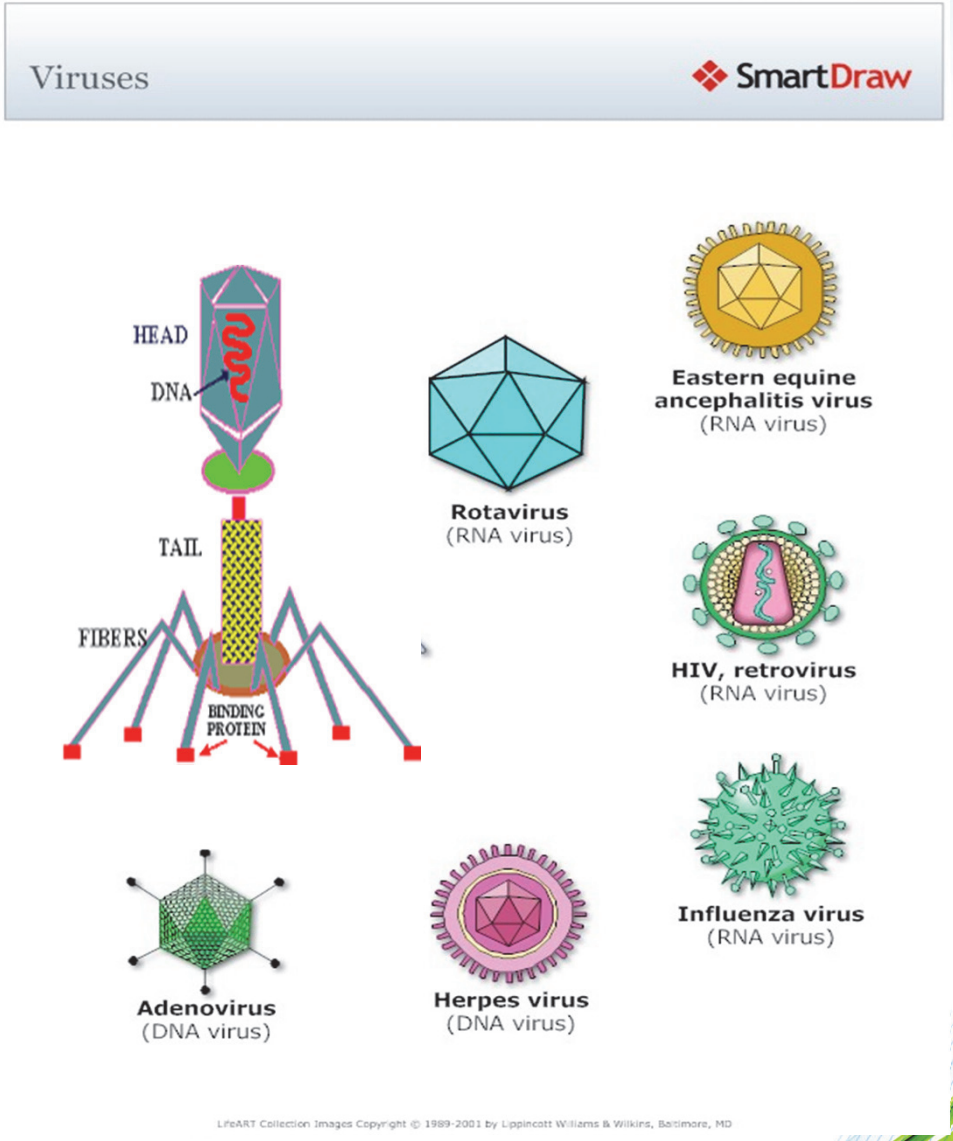
Diagram of a Virion



7 genetic types or categories

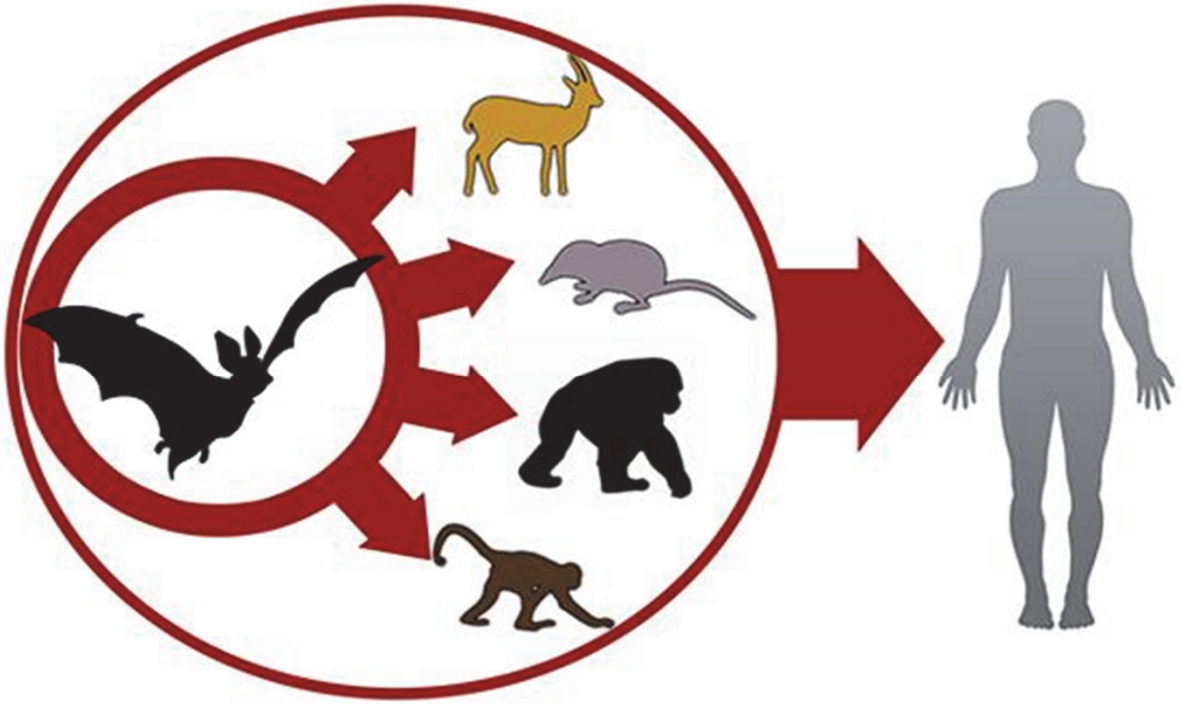
I: dsDNA viruses
II: ssDNA viruses
III: dsRNA viruses
IV: (+)ssRNA viruses
V: (–)ssRNA viruses
VI: ssRNA-RT viruses
VII: dsDNA-RT viruses





Reservoir – long-term live host of an infectious pathogen.

Hosts either don't get the disease or carry the pathogen in a subclinical infectious state without symptoms



Vector is any agent (person, animal or microorganism) that carries and transmits an infectious pathogen into another living organism

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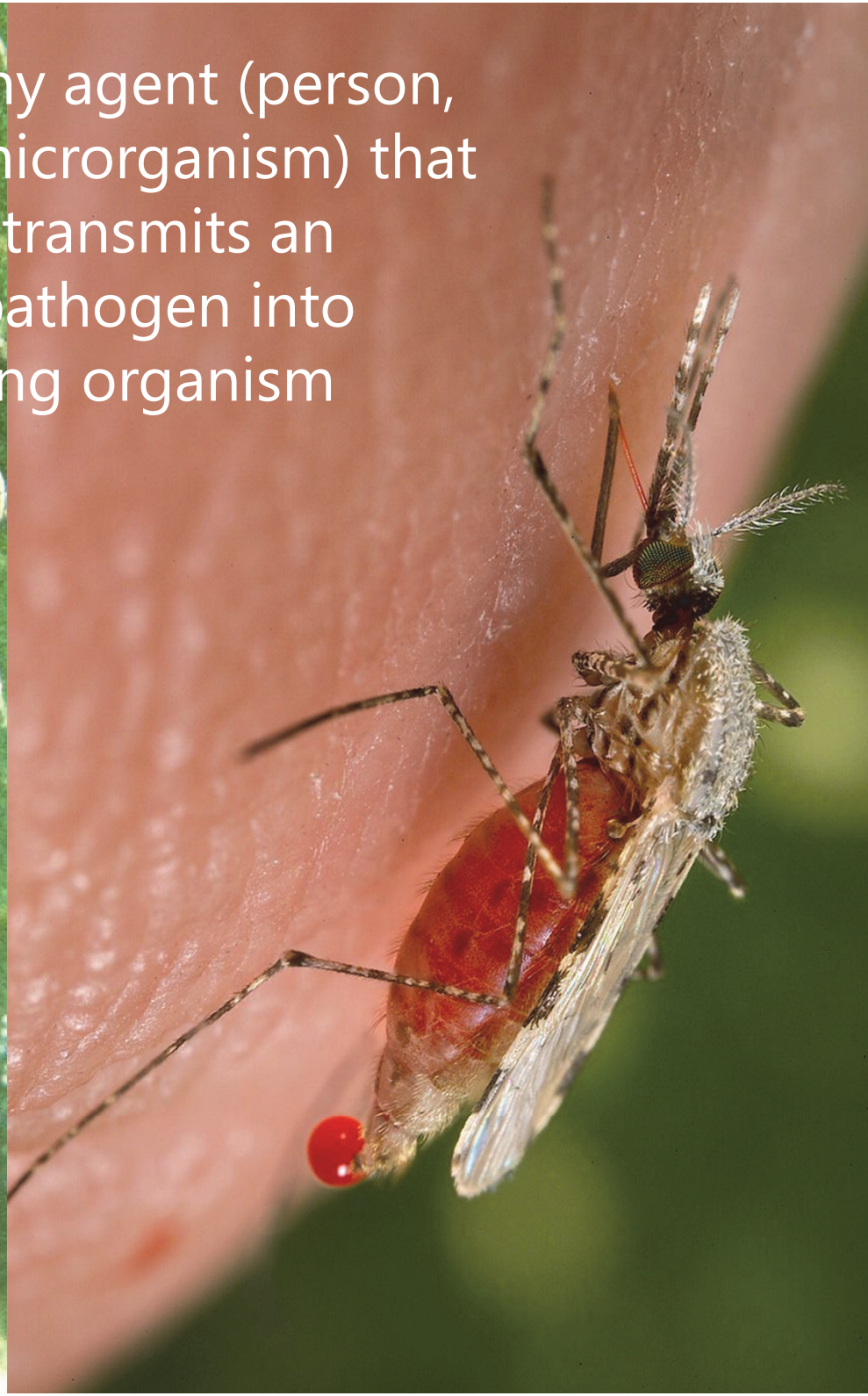
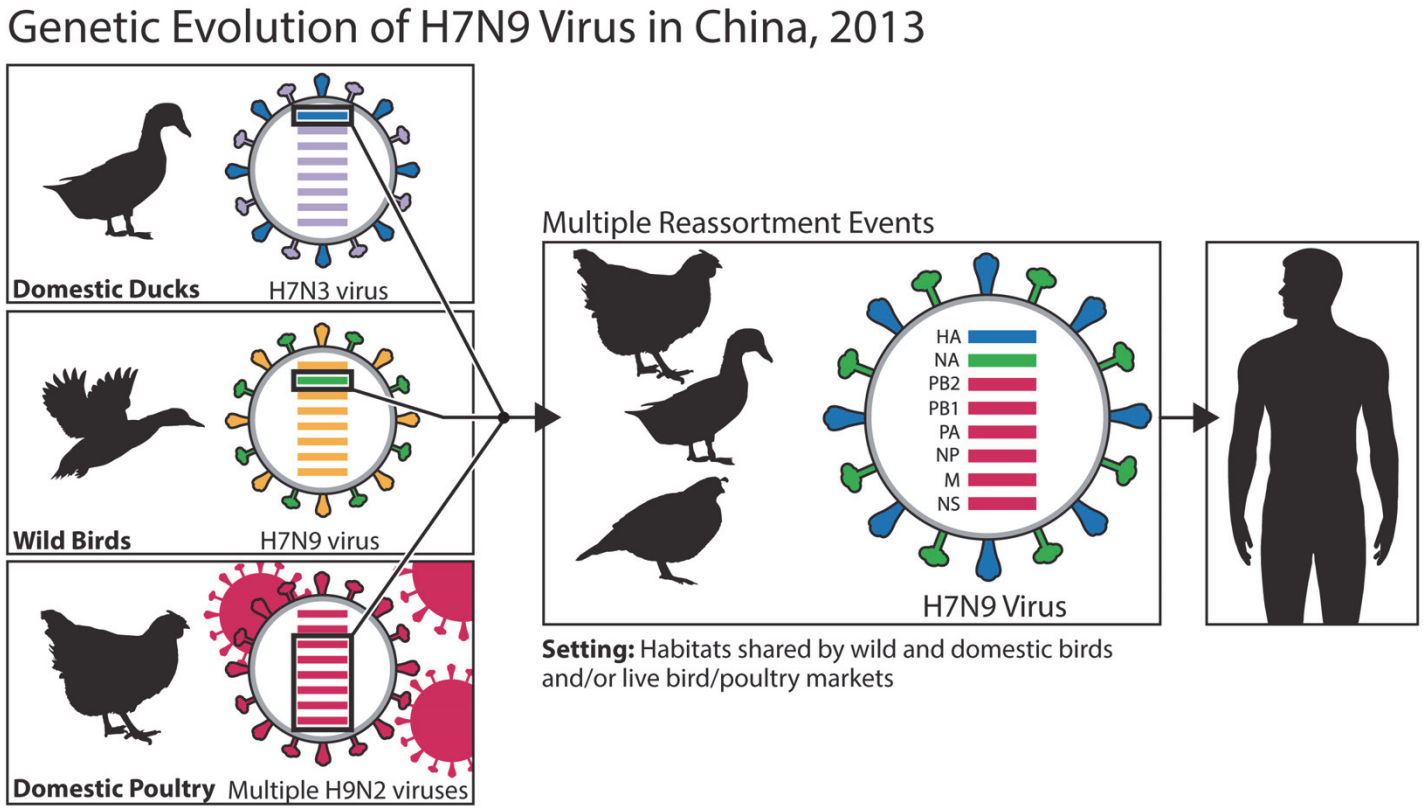


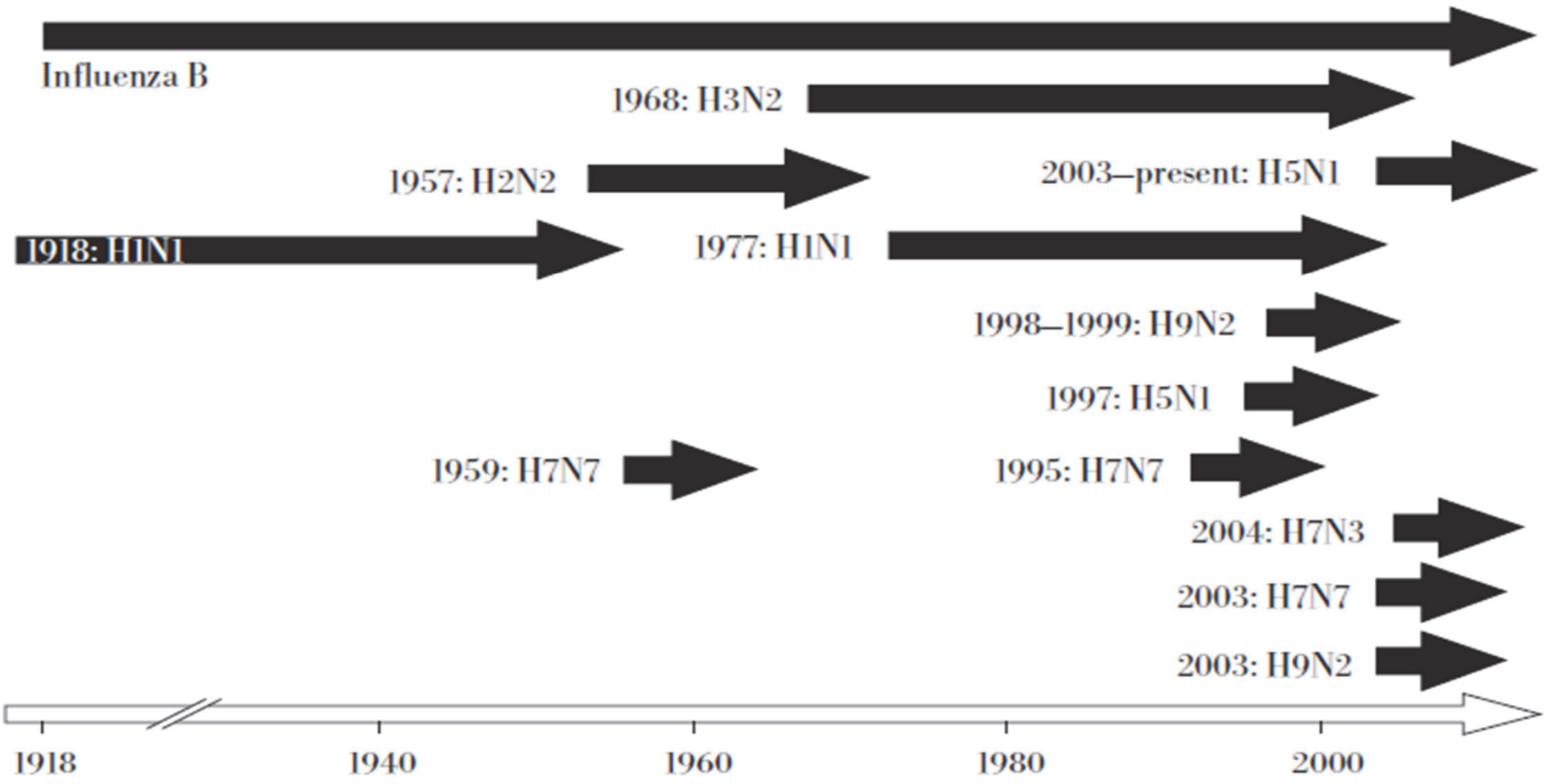
Viral DNA or RNA >>>>> proteins, more DNA/RNA



The eight genes of the H7N9 virus are closely related to avian influenza viruses found in domestic ducks, wild birds and domestic poultry in Asia. The virus likely emerged from "reassortment," a process in which two or more influenza viruses co-infect a single host and exchange genes. This can result in the creation of a new influenza virus. Experts think multiple reassortment events led to the creation of the H7N9 virus. These events may have occurred in habitats shared by wild and domestic birds and/or in live bird/poultry markets, where different species of birds are bought and sold for food. As the above diagram shows, the H7N9 virus likely obtained its HA (hemagglutinin) gene from domestic ducks, its NA (neuraminidase) gene from wild birds, and its six remaining genes from multiple related H9N2 influenza viruses in domestic poultry.

Centers for Disease Control and Prevention
National Center for Immunization and Respiratory Diseases

FIGURE 4: INFLUENZA VIRUS TIME LINE. APPEARANCE OF INFLUENZA VIRUSES INFECTING HUMANS, 1918–2005.

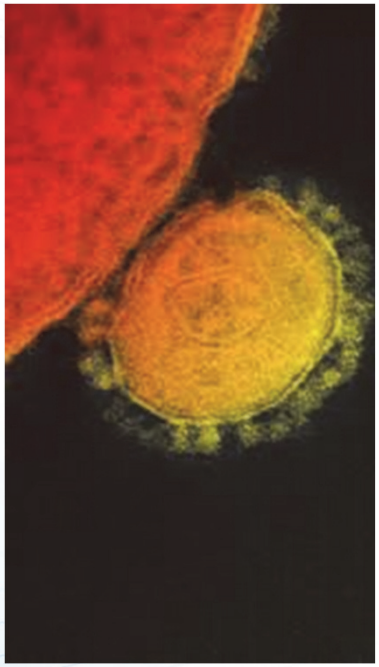


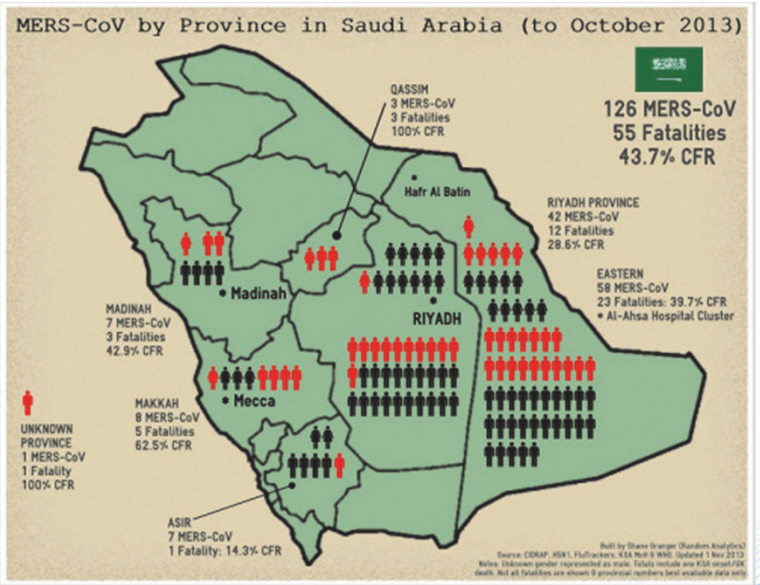
Source: World Health Organization. 2005. Avian Influenza: Assessing the Pandemic Threat; http://www.who.int/csr/disease/influenza/WHO_CDS_2005_29/en/.

Emerging infectious disease

Emerging: *Newly identified, previously unknown infectious agents that cause public health problems locally or internationally*

Example: MERS Coronavirus or Middle Eastern Respiratory Syndrome Coronavirus (identified in 2012)



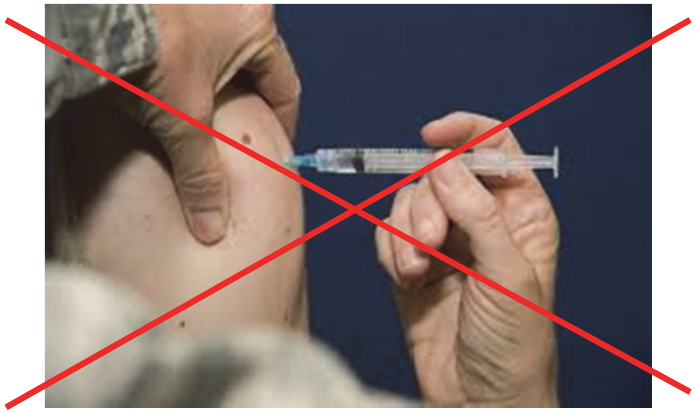


Re-emerging (or resurging) infectious disease

Re-emerging: *Infectious disease known for decades or centuries that now returns in a different form or location.*

Examples: West Nile virus in Western Hemisphere, dengue now in South America and the Caribbean, Monkeypox in the USA

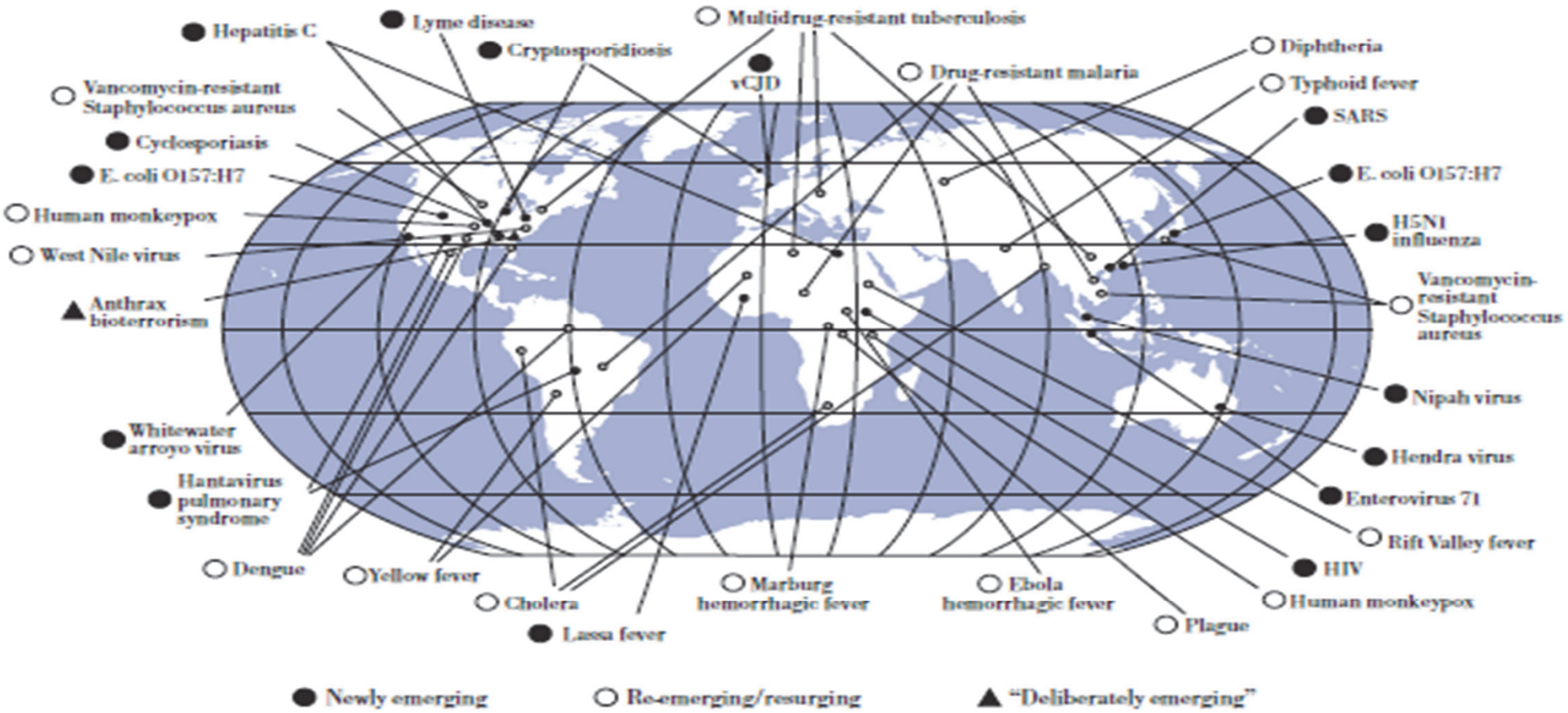
Add to the list: resurgence of measles and other preventable infectious diseases



- Note: 'deliberately emerging' is bioterrorism, i.e. Anthrax

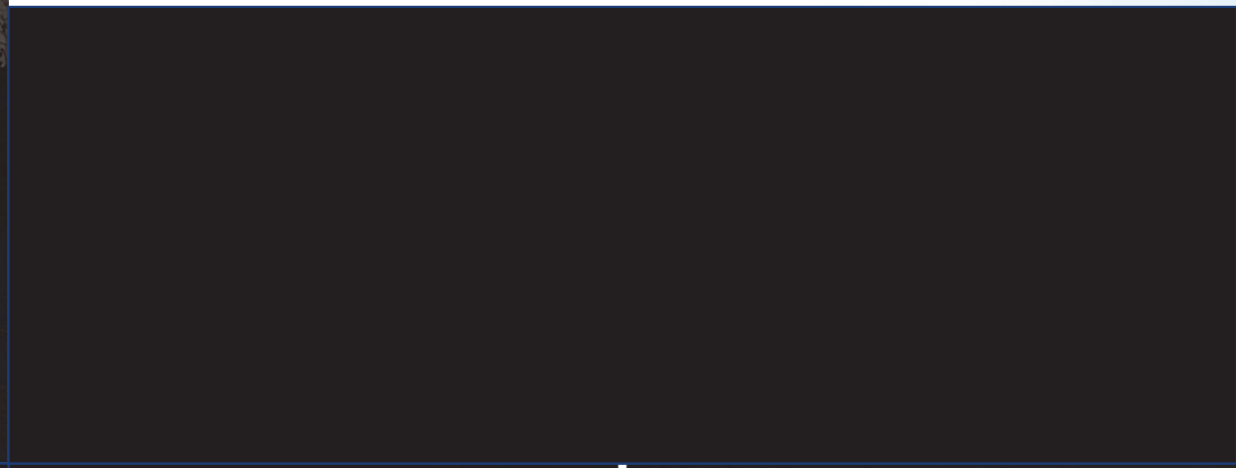
Map of Emerging/Re-emerging Diseases (2004)

FIGURE 1 EXAMPLES OF EMERGING AND RE-EMERGING INFECTIOUS DISEASES THROUGHOUT THE WORLD.

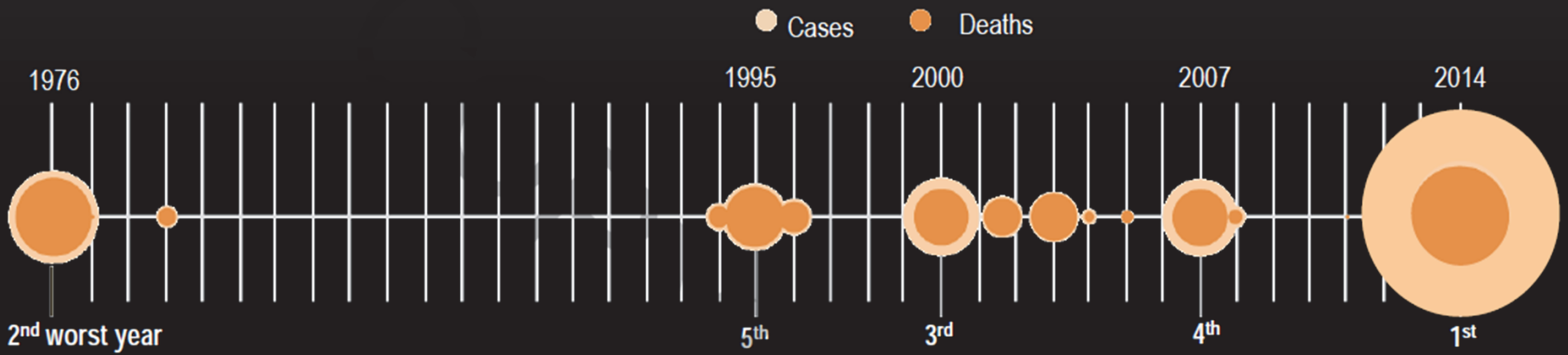


Adapted from Morens, D.M., et al. 2004. The Challenge of Emerging and Re-emerging Infectious Diseases. *Nature* 430:242–49.

A Mammalian Example



23 EBOLA OUTBREAKS, 1976-PRESENT



602 cases
431 deaths
71.5% mortality

315 cases
254 deaths
80.6% mortality

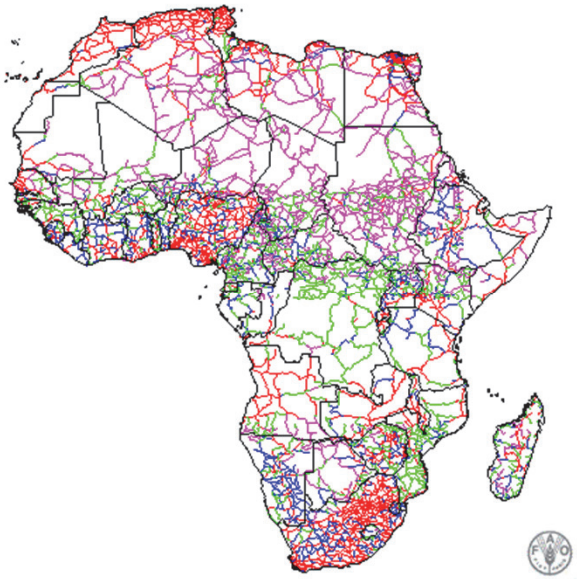
425 cases
224 deaths
52.7% mortality

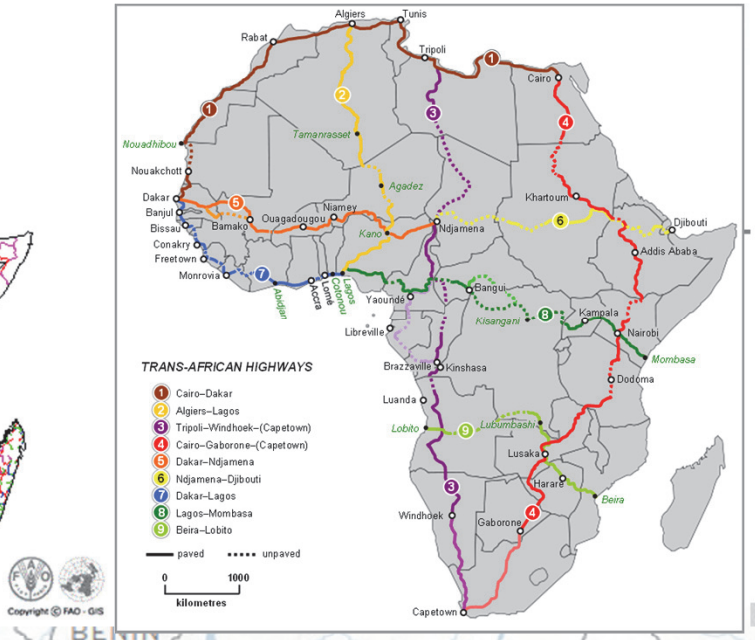
413 cases
224 deaths
54.2% mortality

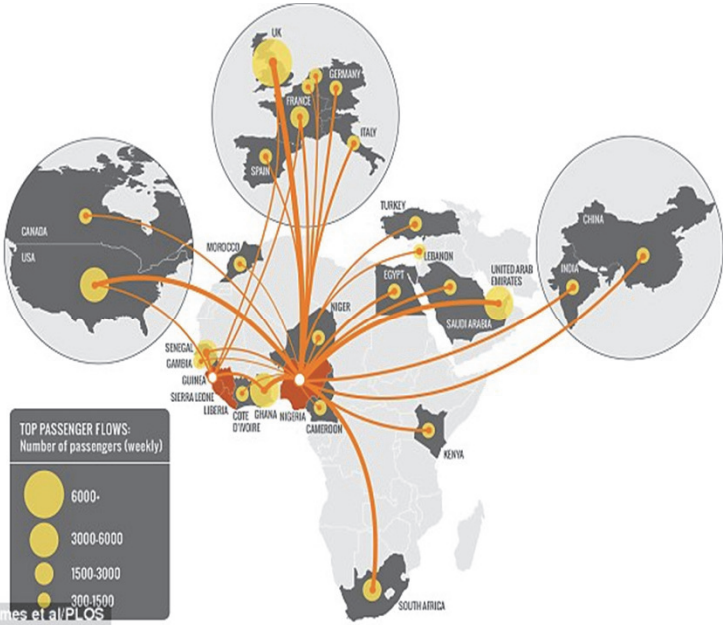
16899 cases*
5987 deaths
35.4% mortality

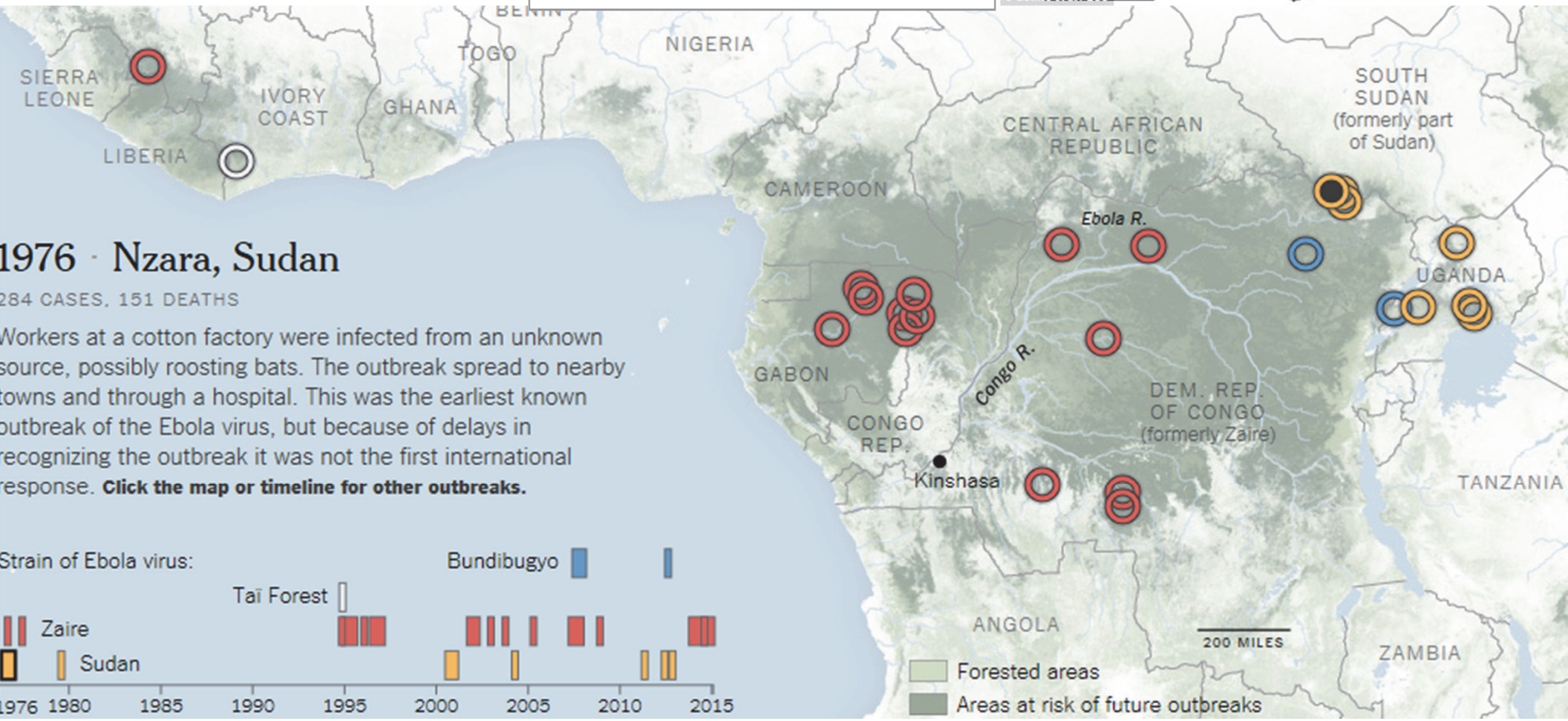
*10553 lab confirmed cases; Number includes Presumed/Probable Cases
As of November 28, 2014

Adapted from NYTimes:.com http://www.nytimes.com/interactive/2014/07/31/world/africa/ebola-virus-outbreak-qa.html




Algiers
Tunis
Rabat
Tripoli
Cairo
Nouadhibou
Tamanrasset
Nouakchott
Agadez
Dakar
Banjul
Bissau
Bamako
Ouagadougou
Niamey
Kano
Ndjamena
Khartoum
Djibouti
Conakry
Freetown
Monrovia
Addis Ababa
Abidjan
Lagos
Cotonou
Accra
Yaounde
Bangui
Kisangani
Kampala
Nairobi
Libreville
Mombasa
Brazzaville
Kinshasa
Dodoma
Luanda
Lobito
Lubumbashi
Lusaka
Harare
Beira
Windhoek
Gaborone
Capetown
TRANS-AFRICAN HIGHWAYS
1 Cairo–Dakar
2 Algiers–Lagos
3 Tripoli–Windhoek–(Capetown)
4 Cairo–Gaborone–(Capetown)
5 Dakar–Ndjamena
6 Ndjamena–Djibouti
7 Dakar–Lagos
8 Lagos–Mombasa
9 Beira–Lobito
paved
unpaved
0
1000
kilometres

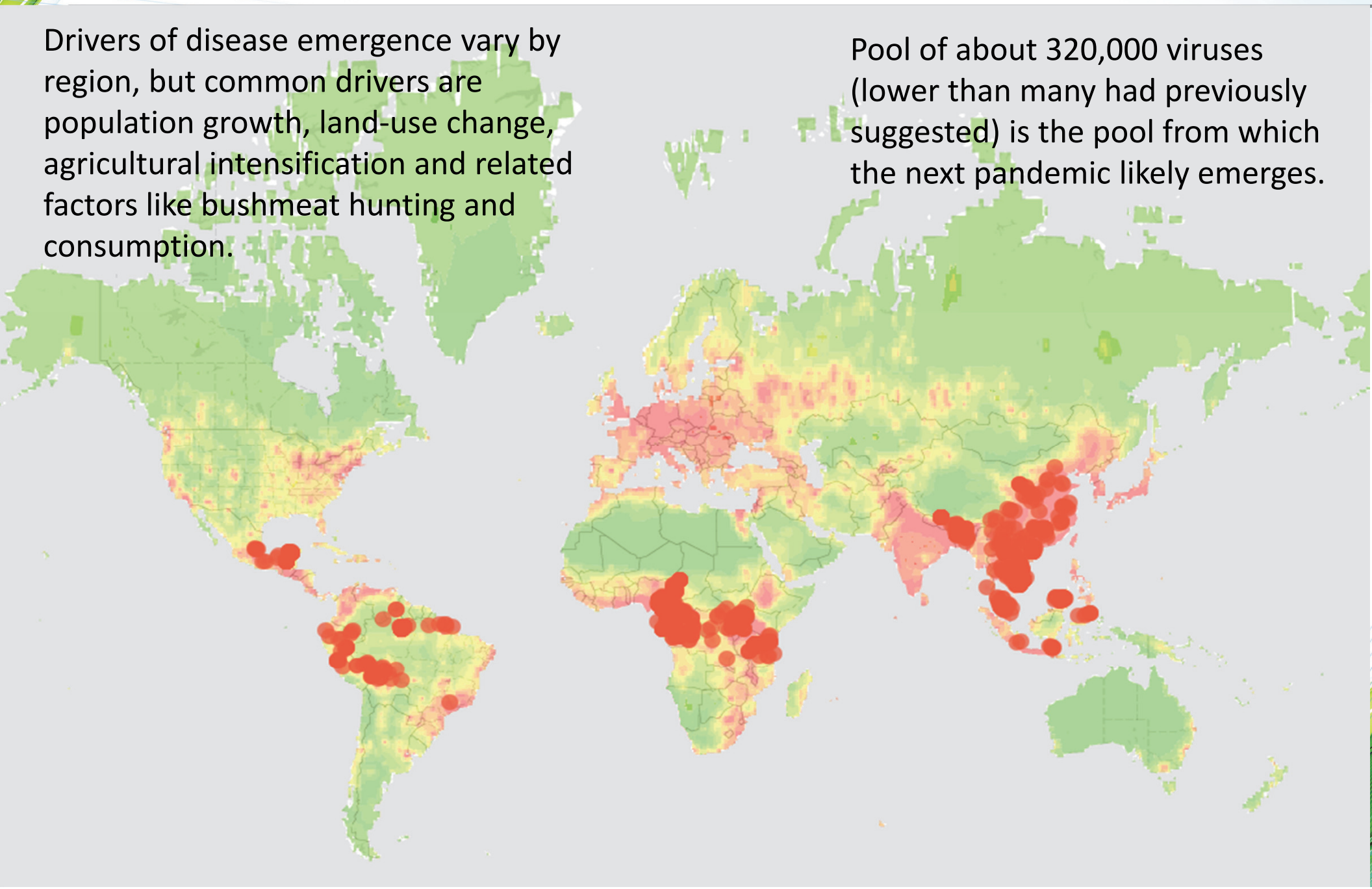

UK
GERMANY
FRANCE
ITALY
SPAIN
CANADA
USA
TURKEY
MOROCCO
LEBANON
EGYPT
UNITED ARAB EMIRATES
CHINA
INDIA
NIGER
SAUDI ARABIA
SENEGAL
GAMBIA
GUINEA
SIERRA LEONE
LIBERIA
COTE D'IVOIRE
GHANA
NIGERIA
CAMEROON
KENYA
SOUTH AFRICA
TOP PASSENGER FLOWS:
Number of passengers (weekly)
6000+
3000-6000
1500-3000
300-1500
© Gomes et al/PLOS


SIERRA LEONE
LIBERIA
IVORY COAST
GHANA
TOGO
NIGERIA
CAMEROON
CENTRAL AFRICAN REPUBLIC
SOUTH SUDAN (formerly part of Sudan)
Ebola R.
UGANDA
GABON
CONGO REP.
Congo R.
DEM. REP. OF CONGO (formerly Zaire)
Kinshasa
TANZANIA
ANGOLA
ZAMBIA
200 MILES
Forested areas
Areas at risk of future outbreaks
1976 · Nzara, Sudan
284 CASES, 151 DEATHS
Workers at a cotton factory were infected from an unknown source, possibly roosting bats. The outbreak spread to nearby towns and through a hospital. This was the earliest known outbreak of the Ebola virus, but because of delays in recognizing the outbreak it was not the first international response. Click the map or timeline for other outbreaks.
Strain of Ebola virus:
Bundibugyo
Taï Forest
Zaire
Sudan
1976
1980
1985
1990
1995
2000
2005
2010
2015

PREDICT (USAID): 320,000 unknown viruses in wildlife

Drivers of disease emergence vary by region, but common drivers are population growth, land-use change, agricultural intensification and related factors like bushmeat hunting and consumption.

Pool of about 320,000 viruses (lower than many had previously suggested) is the pool from which the next pandemic likely emerges.



Emergence/Re-emergence: Key Factors

SOME POSITIVES:

- Sanitation
  - Urban/sewage
- Improved housing
  - Less crowding
- Hygiene
- Anti-sepsis
- Vaccinations
- Medical care
  - antibiotics

Microbial agent – genetic mutation(s)

Host – nutrition, immuno-compromised, aging, chronic dz.

Environment – climate, ecosystems, deforestation

Social/Political – war, civil unrest, lack of political will

Clinical Aspects

Ebola hemorrhagic fever can cause:

Acute phase:

- Multiple organ failure
- Severe bleeding
- Jaundice
- Delirium
- Seizures
- Coma
- Shock
- Hair loss

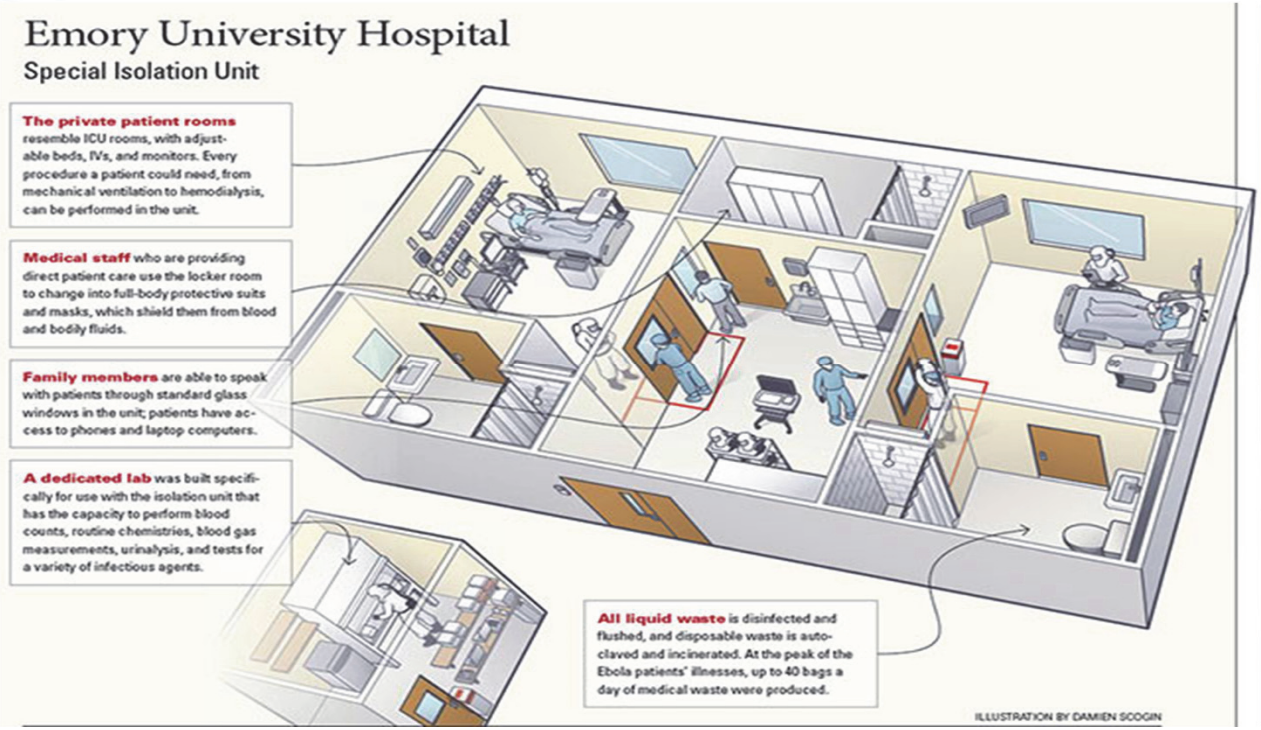
Sequelae:

- Sensory changes
- Liver inflammation (hepatitis)
- Weakness
- Fatigue
- Headaches
- Eye inflammation
- Testicular inflammation
- joint pain, muscle pain
- skin peeling
- alopecia- hair loss

Treatment Costs

- Nebraska: $30K/day
- NIH: $50K/day
- Range: $8.5K -- $50K+ per day
- 30+ Nurses for 24 hours ICU coverage
- Several $1 million patients

- PPE costs
- Opportunity costs
- Training costs for 100s or 1,000s of hospital workers to use PPEs
- Building or enhancing clinical facilities for bio-containment



Ebola Specific Therapy

- AVI-7537; Phase II
- CMX-001, brincidofovir
- TKM-Ebola,Phase I
- Zmapp, Phase I
- Perimavir (BCX4430)
- 5+ agents in pre-clinical status or earlier

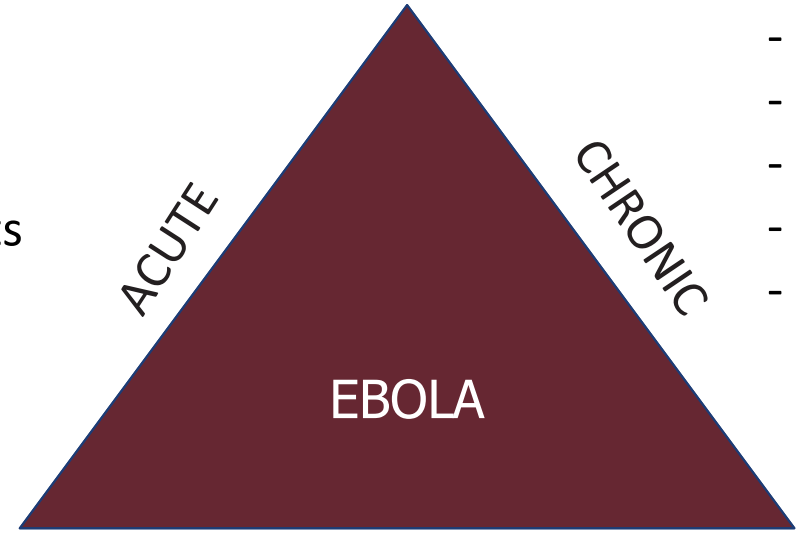
- 60-80% NHP Survival
- Phase III
- 100% NHP Survival
- 100% NHP Survival
- NHP studies underway

Research/Govt. >>>>>>>>>> MED/PHARMA Claims

USA Cost per treatment: HIGH vs LOW?

- pricing model for newer Hepatitis C drugs

Medical Care Costs
- Diagnostic
- Supportive Therapy
  - ICU Plus
  - New Treatments



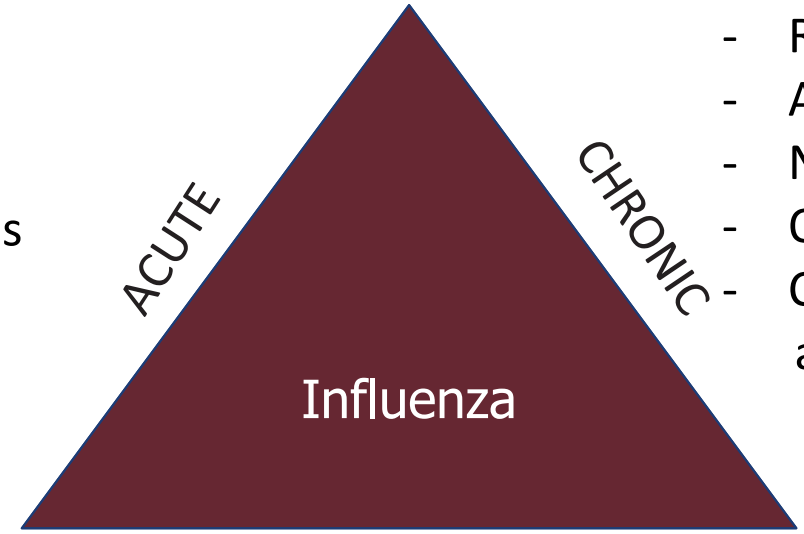
Continuing Medical Costs
- Related to organ failure
- Joint pain
- Fatigue
- Others
- Combination of Diagnostic and Treatment Costs

COFACTORS

- Age
- Nutritional Status
- Co-morbidities
- Access
- SES
- Others

Generally lead to worsened Outcomes but hard to predict.

Medical Care Costs
- Diagnostic
- Supportive Therapy
  - ICU
  - Ventilator status



Continuing Medical Costs
- Related to organ COPD
- Asthma
- Nosocomial infection
- Others
- Combination of FU Diagnostic and Treatment Costs

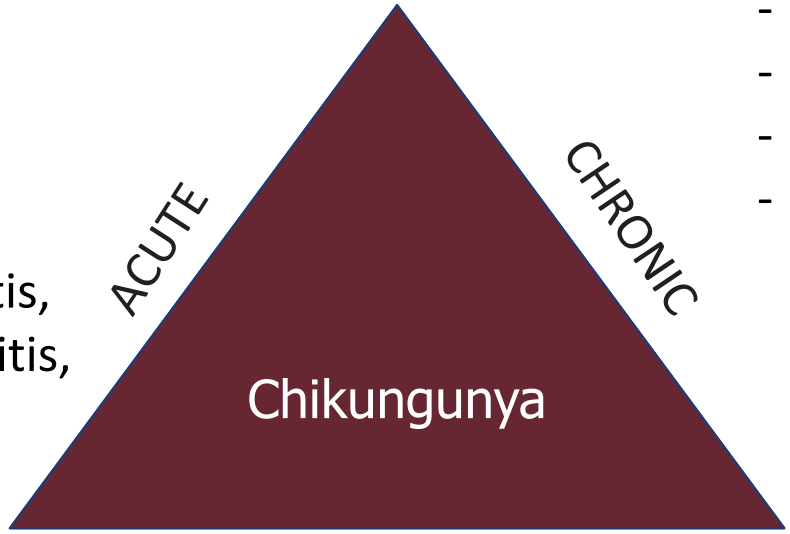
COFACTORS

- Age
- Nutritional Status
- Co-morbidities
- Access
- SES
- Others

Generally lead to worsened Outcomes but hard to predict.

Medical Care Costs
- Diagnostic
- Supportive Therapy
  - Pain meds OTC
  - Fever control

Complications: uveitis, retinitis, myocarditis, hepatitis,arthritis, G-B Syn, cranial n. palsy



Continuing Medical Costs
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- Others

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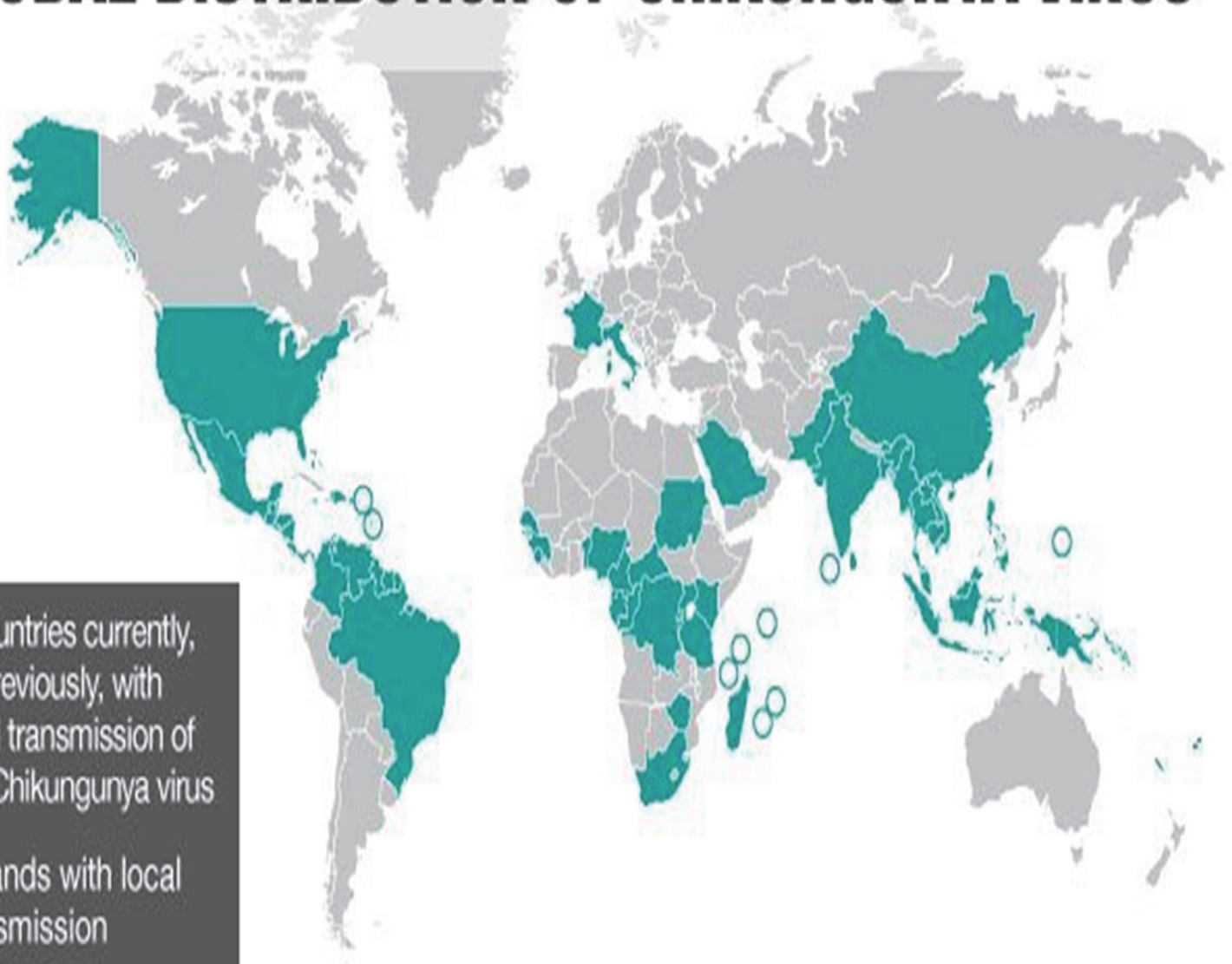
Chikungunya Virus (formerly Dengue)

FIGHT THE BITE

GLOBAL DISTRIBUTION OF CHIKUNGUNYA VIRUS*



SOURCE: Centers for Disease Control (CDC)

*as of December 2, 2014

CDC Flu models

- FluSurge 2.0: http://www.cdc.gov/flu/pandemic-resources/tools/flusurge.htm
  - Models the surge in demand for hospital-based services
  - Part of Pandemic Flu Preparedness Tools
  - Also Excel SS models called
    - Community Flu 2.0 –simulates the spread of influenza through a model community and the impact of potential interventions and some cost calculations
    - FluAid 2.0 – modeling for Pediatric age (<18 years)
    - FluLabSurge 1.0 – models surge in flu related laboratory services
    - FluWorkLoss 1.0 – models flu related work loss
    - Influenza Risk Assessment Tool (IRAT) – assess risk for influenza A

Step 1: Determine population of locale by age groups:

Age Group	Population
0-19 yrs	1,350,707
20-64 yrs	2,106,171
+ 65 yrs	1,153,154

View or Change Assump-tions

Step 2: Determine basic hospital resources:

Total licensed non-ICU beds:	7,300
% licensed non-ICU beds staffed:	100%
Total staffed non-ICU beds:	7,300
Total licensed ICU beds:	759
% licensed ICU beds staffed:	100%
Total Staffed ICU beds:	759
Total number of ventilators:	691
% ventilators available:	100%
Total number of ventilators available:	691

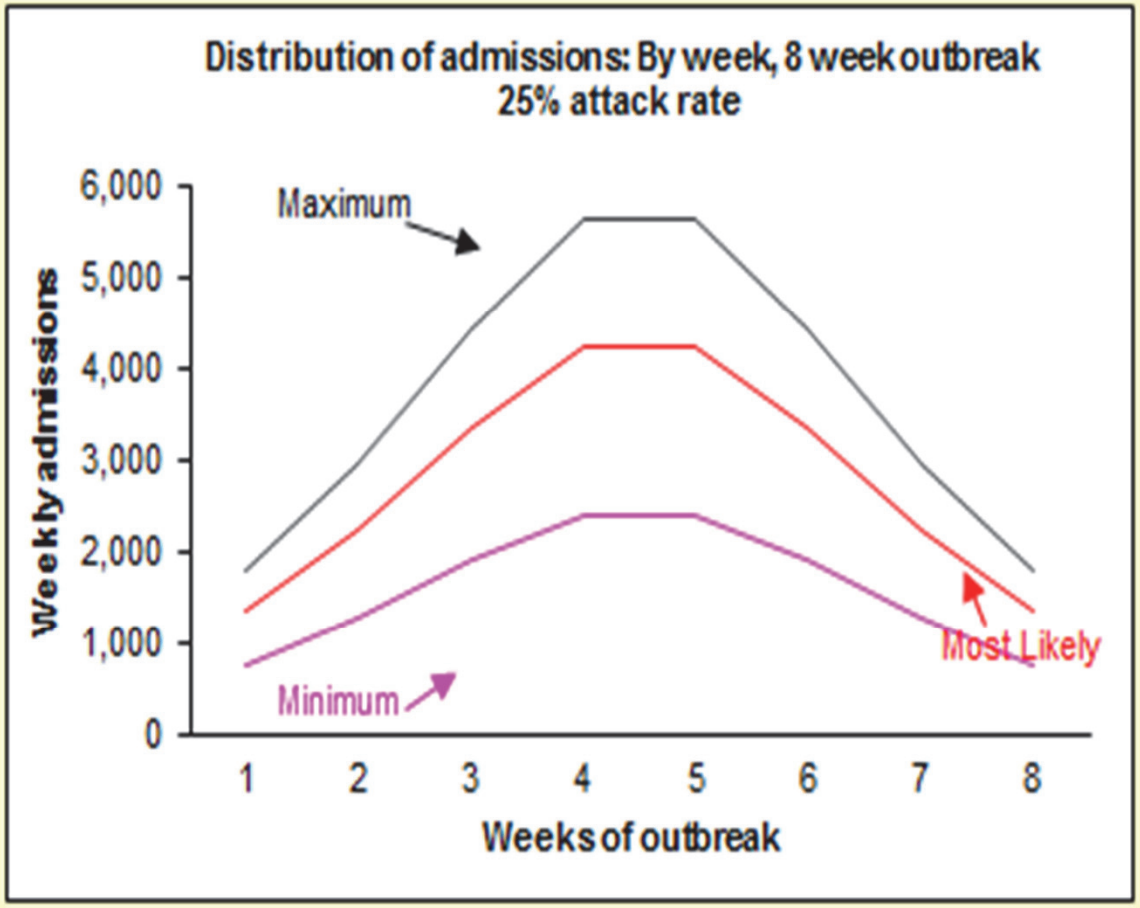
Step 3: Determine duration (6, 8, or 12 weeks) and attack rate (15%, 25% or 35%) of the pandemic:

Duration: 8

Attack rate: 25%

Step 4: Click to View Results

Pandemic Influenza Impact / Attack Rate	25%
Total Hospital Admissions	
Most Likely Scenario	22,200
Minimum Scenario	12,605
Maximum Scenario	29,504
Total Deaths	
Most Likely Scenario	5,378
Minimum Scenario	4,293
Maximum Scenario	7,814



Hosp Adm. / Week	1	2	3	4	5	6	7	8
Most Likely Scenario	1,332	2,220	3,330	4,218	4,218	3,330	2,220	1,332
Minimum Scenario	756	1,261	1,891	2,395	2,395	1,891	1,261	756
Maximum Scenario	1,770	2,950	4,426	5,606	5,606	4,426	2,950	1,770

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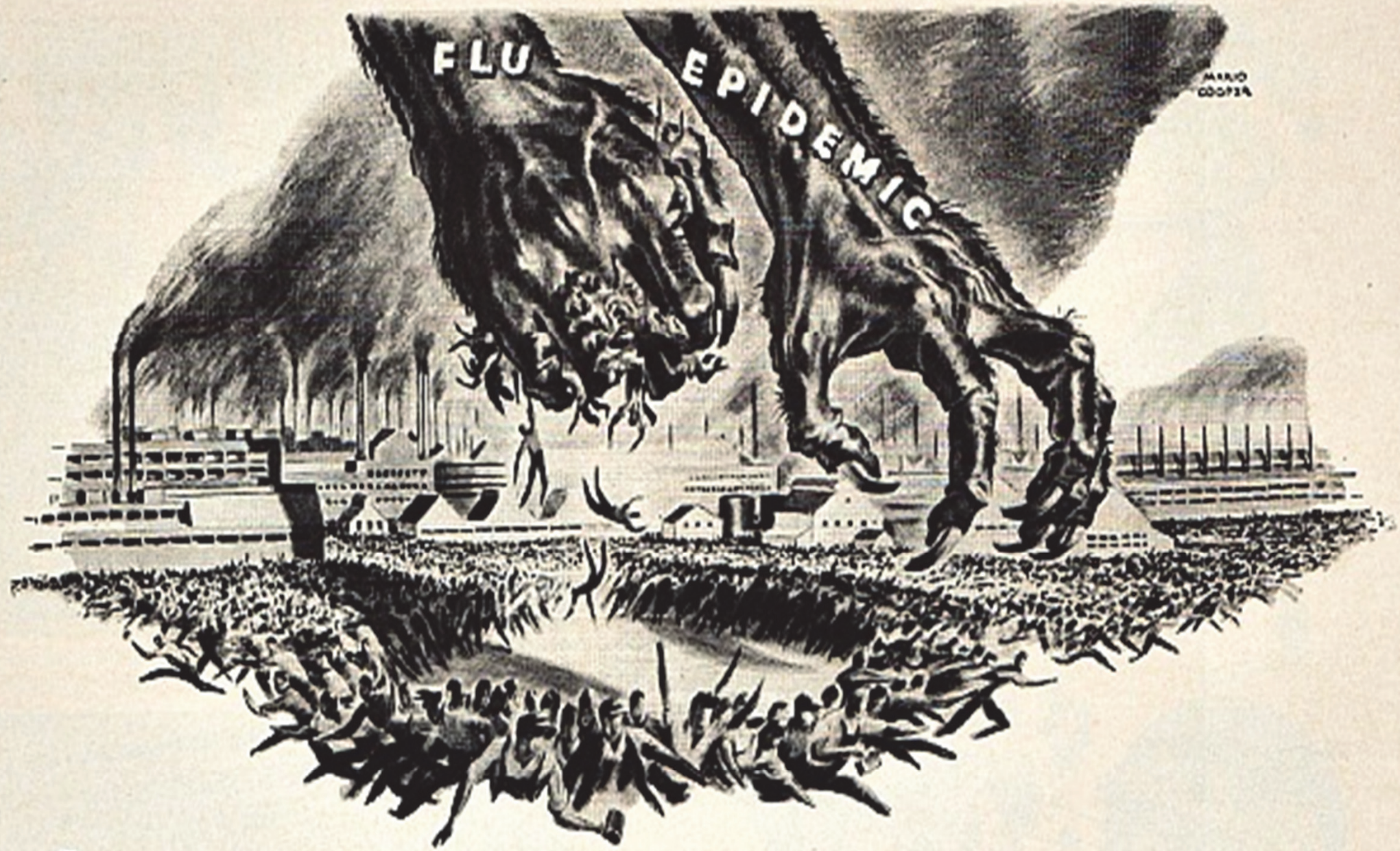

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