Emerging Pathogens

Biosafety and Healthcare Preparedness Conference

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Preventing disease, promoting wellness and improving the quality of life of Michigan residents

Agenda

- Overview of previous Emerging Infectious Diseases
- Causes of expansion or emergence of diseases
- Insights into predicting the next (re) emerging infectious disease
- Overview of items to help prevent spread of emerging pathogens
- Example of current emerging pathogen – Zika Virus

Emerging / re-emerging disease	Date identified
HIV1	1983
HIV2	1985
Enterocytozoon bieneusi	1985
Human Herpesvirus 6 (HHV 6)	1986
Hepatitis C virus	1989
Hepatitis E virus	1990
Guanarito virus	1991
Barmah Forest Virus	1992
Bartonella henselae	1992
Sin Nombre Hantavirus	1993
Cyclospora cayatenensis	1994
Sabia virus	1994
Hendra virus	1994
Human herpesvirus 8	1994
Lyssavirus (in Australia)	1996
Nipah virus	1996
vCJD	1996
H5N1 Influenza	1997
West Nile Virus (In the United States)	1999

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Emerging / re-emerging disease	Date identified
Bacillus anthracis - intentional	2001
Crimean Congo Hemorrhagic Fever Virus	2001
SARS CoV	2003
Monkeypox (in the US)	2003
Chikungunya Virus	2005
XDR-Tuberculosis	2006
H5N1 Influenza	2003
Pandemic H1N1 Influenza	2009
H7N9 and H5N6 Influenza	2012
MERS-CoV	2012
Enterovirus D68	2014
Dengue Fever Virus	2012-14
Ebola (largest outbreak)	2014
Zika Virus	2015

It is estimated that between 50-75% of EIDs have a zoonotic component – this emphasizes the importance of "One Health"

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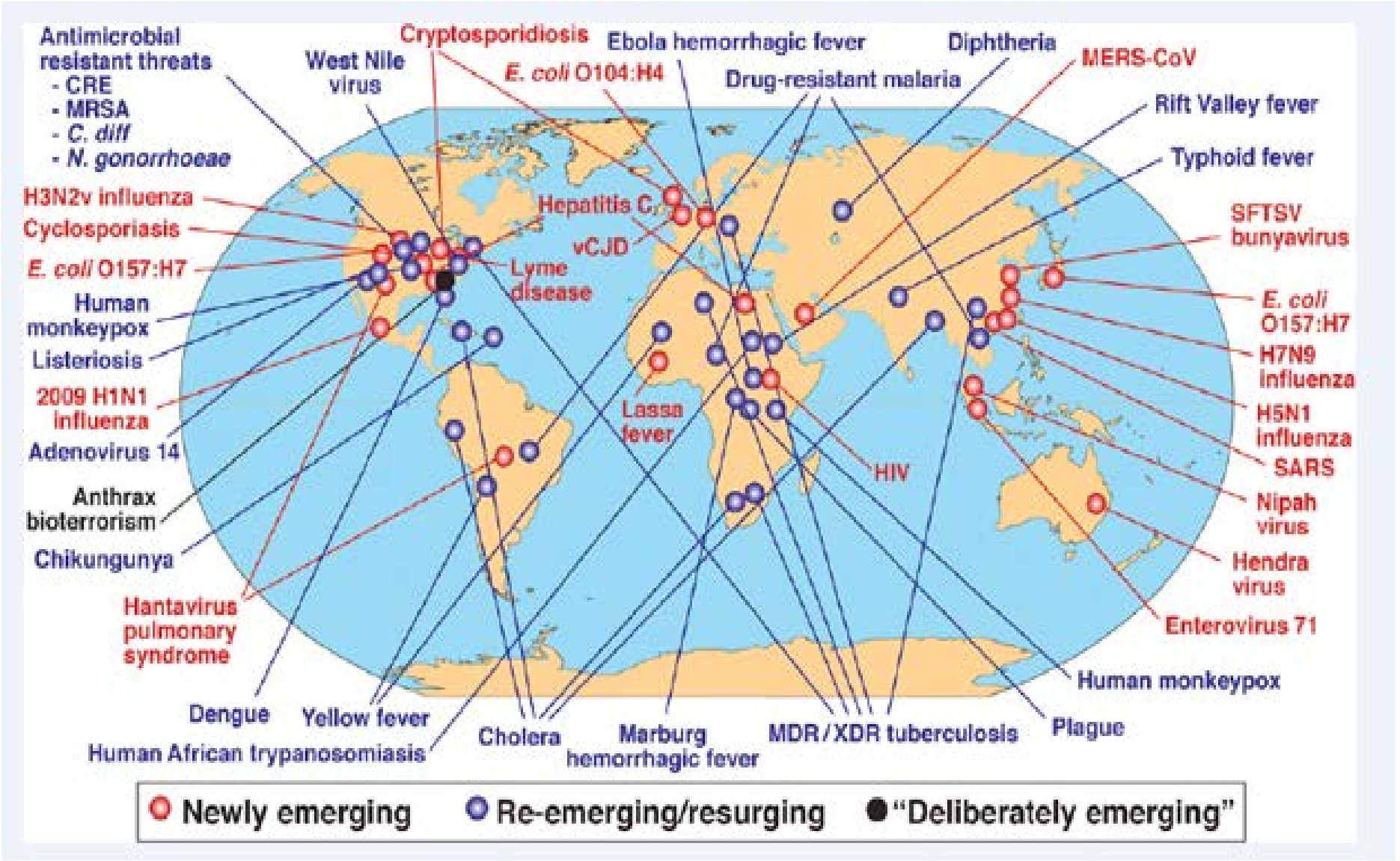

SOURCE: Morens et al., 2004.

Factors of Emergence

- Microbial adaptation/Host susceptibility
- Human demographics and behavior
- Technology & industry (animal practices, food production)
- Economic development and land use
- International travel and commerce
- Breakdown of public health infrastructures
- War and Famine
- Poverty and social inequality
- Climate and weather
- Changing ecosystems
- Intent to harm

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Microbial Adaptation and Change

- A number of microbes utilizing different genetic mechanisms
- Genome sequences show that lateral transfer is common
- High mutation rates in RNA viruses- rapid adaptation
- Quick reproduction resulting in rare mutations building up rapidly

- Efflux pumps
- Conjugation
- AIDS, Influenza
- Viruses, bacteria

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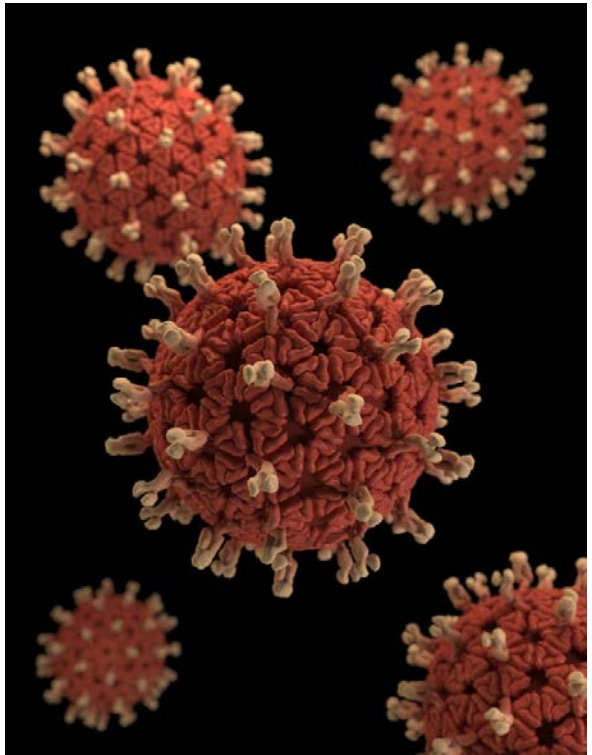
Human Demographics and Behavior

- Increases in the human population
- Urbanization - more people concentrated in cities - often without adequate infrastructure
- Increases in the elderly populations
- Increases in children in daycare: working mothers with young children was 28% in 1970. 2013 census data placed this number at over 66%.



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Technology and Industry

- Blood transfusions and organ transplants save lives but increase risk of infections
- Transportation technology - the ability to rapidly move people and goods
- Industrial changes - mass production of food
- Industrial pollution - increases incidence of TB

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Economic Development and Land Use

- Consumption of natural resources, deforestation, and dam building
- Logging in the rain forest has exposed people to new viruses
- Standing water lead to mosquito breeding grounds
- Historic examples - emergence of Yellow Fever when humans entered the Central American jungle to build the Panama Canal; increase in Schistosomiasis when the Aswan Dam was built on the Nile River; increases in Lyme Disease in US reforested regions

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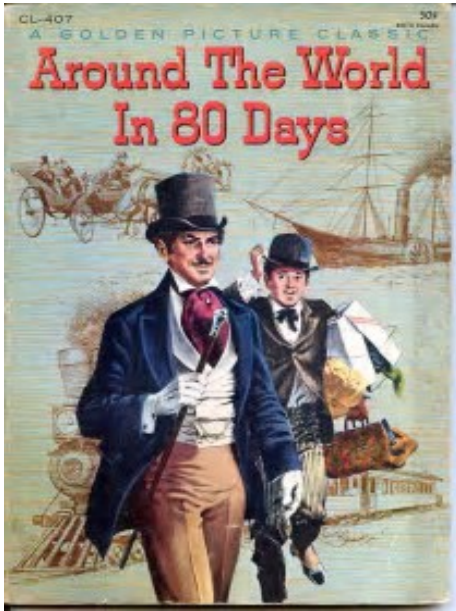
International Travel and Commerce

- Less than 36 hours to circumnavigate the globe
  - 36 hours is faster than many disease incubation periods
- In 2016 the US State Dept. recorded over 72 million trips of citizens outside the US
- Increased incidence of both Tuberculosis and Influenza transmission on long flights



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Breakdown of Public Health

- Late 1970's - World Bank forced reductions in public sector investment, especially in Latin America and Africa
  - World Bank has shown that these countries are economically better off than that time period
  - Reduction in public health sector caused decreased immunization and nutrition levels, and a drop in medical supplies

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War and Famine

- War refugees are over 1% of the global population
- War refuges are forced onto new areas where they are exposed to new microbes from vectors and people.
- War and famine are closely linked
- In 2001, tracking 16 countries with “food emergencies”, showed that 9 were because of civil unrest – this is prior to the numerous armed conflicts since that period
- Famine is also caused by social, economic, political forces, and weather

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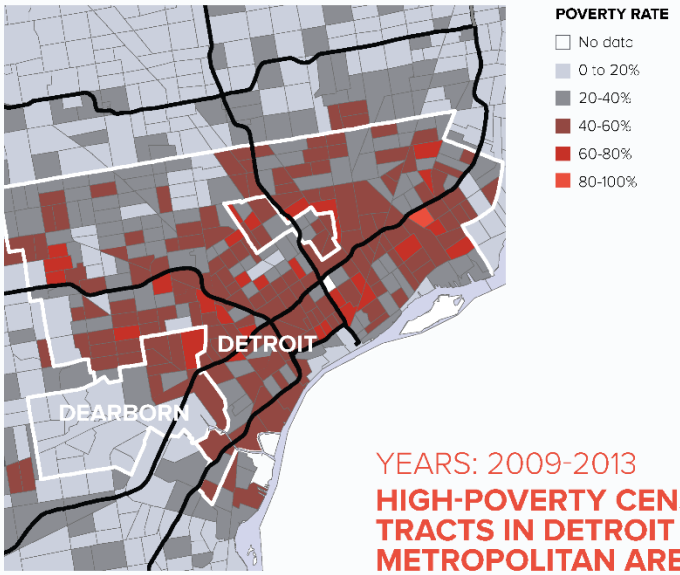
Poverty and Social Inequality

- **Mortality from infectious diseases correlates with income**

- **Factors**
  - **malnutrition, lack of clean water and sanitation, poor housing, ignorance of risky behaviors, lack of transportation, lack of funds for out-of-pocket healthcare expenses.**



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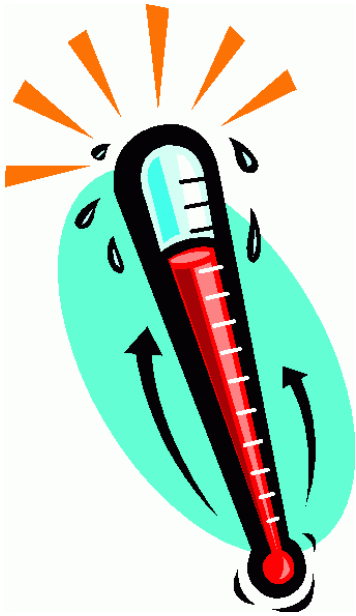
Climate and Weather

- **Elevated rainfall and increased overall temperatures lead to expanded or new breeding habitats for mosquitoes**
  - **Spread of mosquito-borne illnesses (Zika, Malaria, Chikungunya, Dengue)**
  - **decreases salinity which can increase toxic bacteria**
  - **increases vegetation which increases rodents (Sin Nombre Hanta virus outbreak)**
  - **increases runoff into drinking reservoirs (Cryptosporidiosis outbreak)**
  - **Higher ocean temps increase Vibrio parahaemolyticus (shellfish)**



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Changing Ecosystems

- **Ecological changes can increase the risk of infection by altering human exposure or pathogen distribution.**
- **Rainforest destruction forests reduce while cropping increases humidity**
- **Urban development increases atmospheric particles and increases air temperatures**

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Intent to Harm

- Bioterrorism
  - Anthrax attacks in DC metro area
  - Salmonella in OR
  - Select Agents are high risk

  Will discuss in later conference sessions
- Chemical terrorism – may lead to reduce immune responses to protect from infectious agents

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Preventing Emerging Infectious Diseases

- **Surveillance and Response**
  - **Detect, investigate, and monitor emerging pathogens, the diseases they cause, and the factors influencing their emergence, and respond to problems as they are identified.**
- **Applied Research**
  - **Integrate laboratory science and epidemiology to increase the effectiveness of public health practice.**
- **Prevention and Control**
  - **Ensure prompt implementation of prevention strategies and enhance communication of public health information about emerging diseases.**
- **Infrastructure and Training**
  - **Strengthen public health infrastructures to support surveillance, response, and research and to implement prevention and control programs.**
  - **Provide the public health work force with the knowledge and tools it needs.**

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Predicting Emerging Diseases

- Federal, State, and Local Partners track diseases that arise in other countries
  - Respiratory usually travels from Asia to US
- Clinical laboratories and public health laboratories share information of increasing disease trends
- Impact on Clinical Labs: predictions allow for time to get Emergency Use Authorizations (EUA) from FDA on diagnostic assays
  - Public health labs can help off set delays in diagnostics
- Reduction of hospital outbreaks or in some cases nosocomial infections
- Appropriate treatment of patient through antimicrobials or other treatment regimens.

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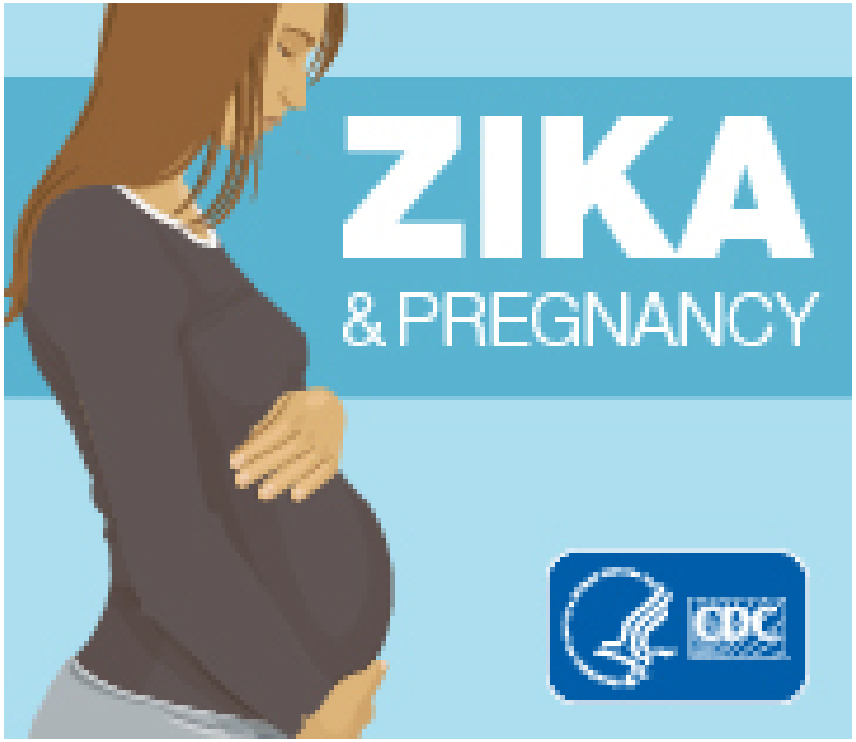
Example of a recent ongoing re-emerging disease - Zika Virus



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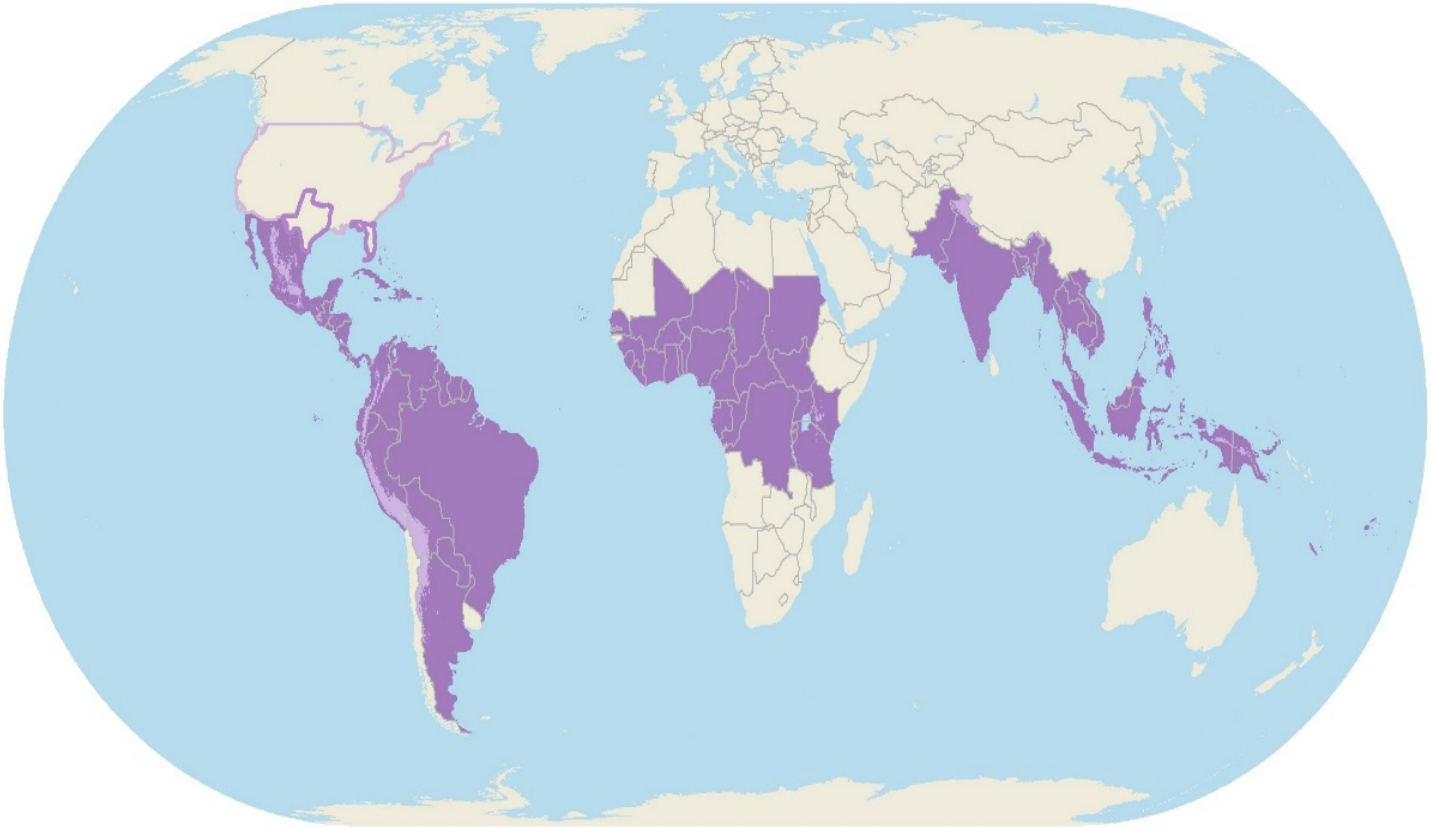
World Map of Areas with Risk of Zika



United States areas

State Reporting Zika:

No Known Zika:

International areas

Area with risk of Zika

Area with minimal risk of Zika

No Known Zika:

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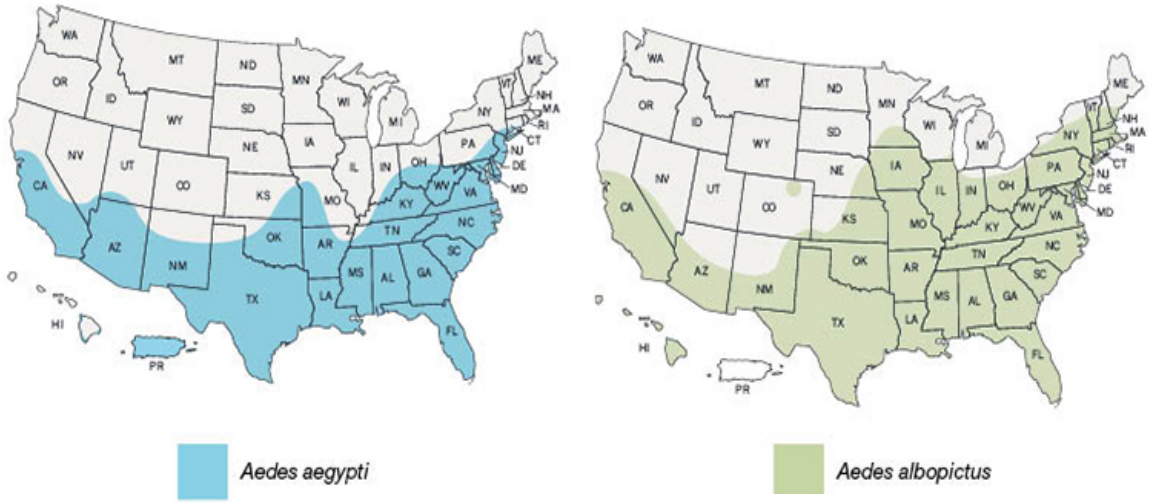
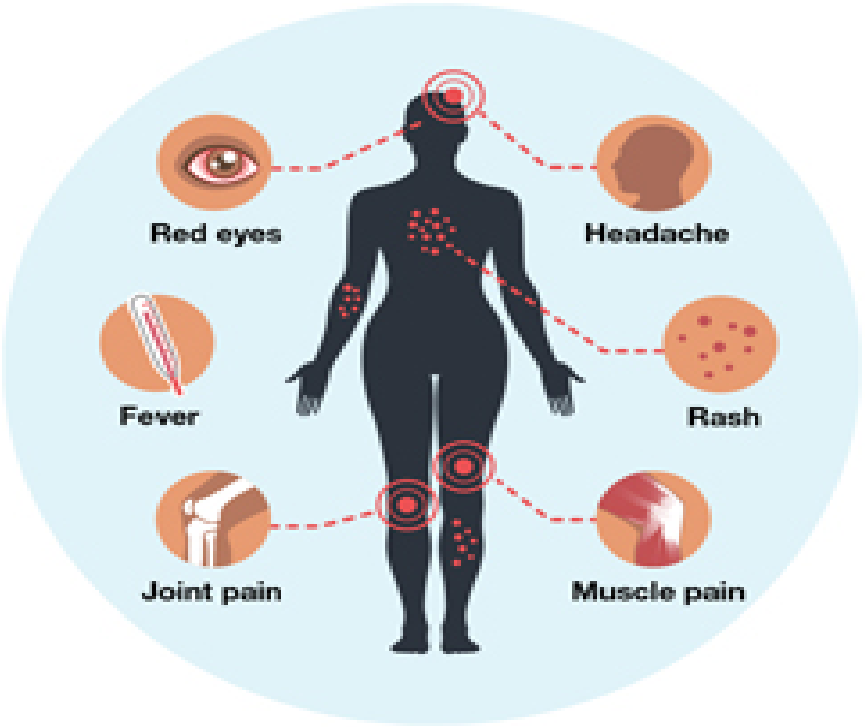
Zika virus



- Non pregnant patients must have at least one of the following symptoms to obtain approval for testing at MDHHS:
- -Fever
- -Rash
- -Arthralgia
- -Conjunctivitis



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MDHHS Bureau of Laboratories began testing in May, 2016.

TESTS AVAILABLE

- Zika IgM
  - CDC's MAC-ELISA
- Dengue and Chikungunya IgM
  - InBios
- Zika, Dengue and Chikungunya PCR
  - CDC's Trioplex
- Zika and Dengue types 1 & 2 PRNT
  - CDC PRNT Assay

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Specimen Type

- Serum (≥1 ml)
- Urine (≥1 ml)
  - CSF & Amniotic fluid (must be accompanied with serum)

- Ship frozen or refrigerated with frozen ice pack
  - Do not send at room temperature

*TAT: 1-2 weeks (results usually available within 1 week)

-Specimen DOC must be within 12 weeks of symptom onset/exposure/travel
(Exposure may include unprotected sex with a partner who traveled)

-Travel must be to an area of localized transmission of Zika

-Patient must be either pregnant or symptomatic

-MDHHS BOL Test Requisition and Zika Supplemental Questionnaire must be completed

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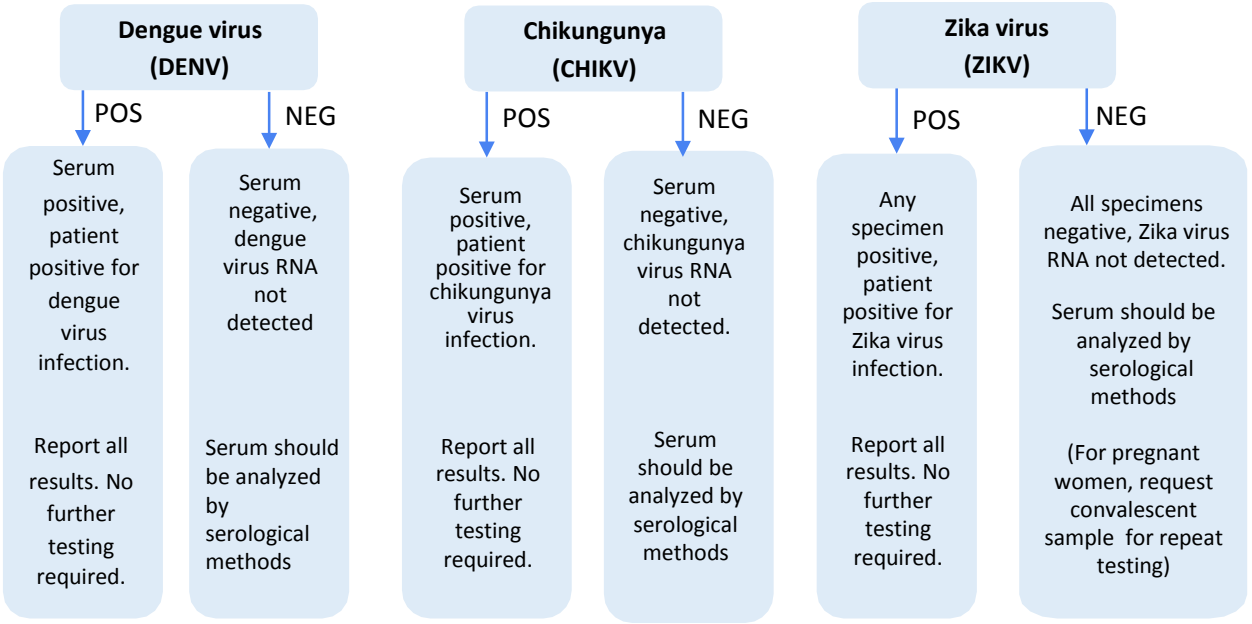
Algorithm for Testing Pregnant or Symptomatic Patients:

Serum and urine collected ≤ 14 days after symptom onset

(CSF or amniotic fluid for some tests)

Test all specimens by **Trioplex rRT-PCR**

Note: Urine and amniotic fluid testing are authorized only for ZIKV.



Algorithm for Testing Symptomatic Patients:

Serum and/or CSF collected ≤12 weeks within symptom onset

Serological testing

Test serum specimen by:

- Zika MAC-ELISA
- dengue IgM assay (InBios)
- chikungunya IgM assay (InBios)

POS NEG

Any test **presumptive positive, equivocal or inconclusive.**

Report results.

Forward for confirmation by PRNT

All tests **negative**, no evidence of recent virus infection.

Report results.

No further testing of specimen required.

Serum tested by PRNT
POS=Evidence of Zika infection
NEG=No evidence of Zika infection

Report results.

Combine results with results of other diagnostic tests to determine overall interpretation.

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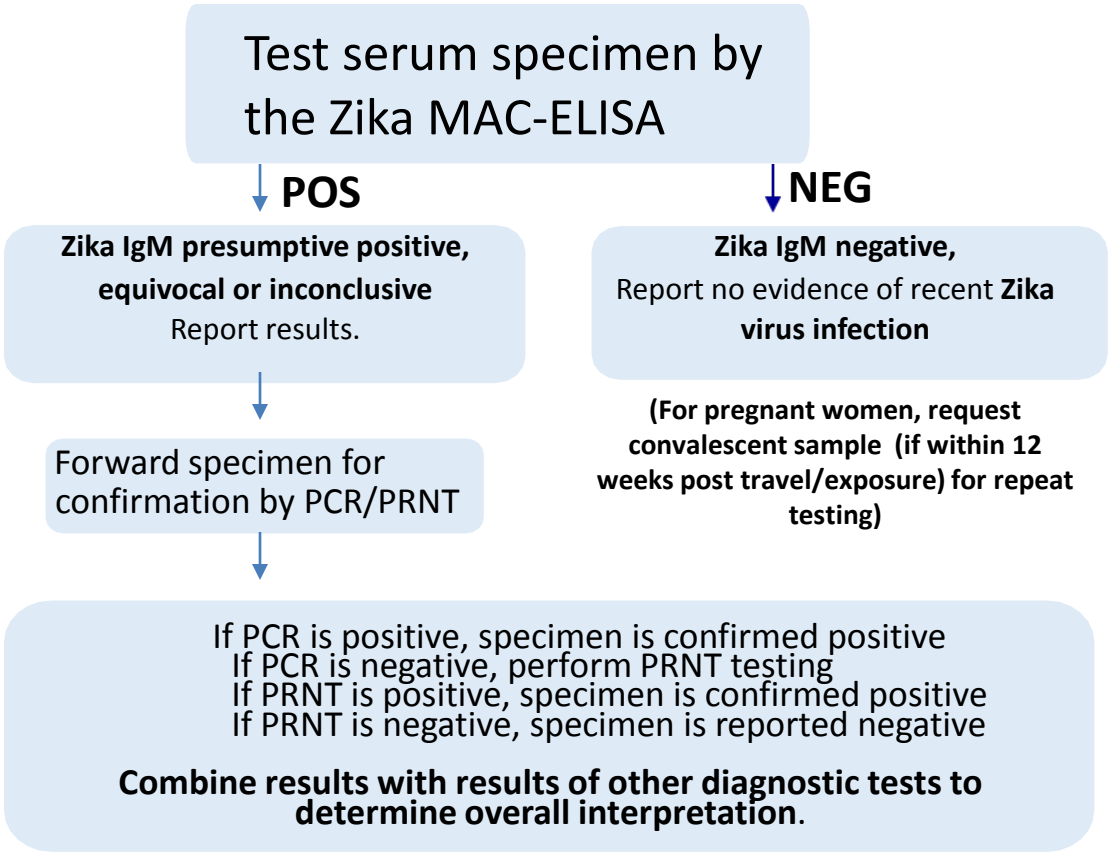
Algorithm for Testing Asymptomatic Pregnant Women:

Women residing in an active Zika transmission area or ≤12 weeks after travel to an active Zika virus transmission area or sexual contact with a person confirmed to have Zika virus infection.



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QUESTIONS?