VECTOR BORNE ILLNESSES

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In epidemiology, a vector is any agent (person, animal, or microorganism) that carries and transmits an infectious pathogen into another living organism. Arthropods form a major group of disease vectors with mosquitoes, flies, sand flies, lice, fleas, ticks and mites transmitting a large number of diseases.
Vector Borne Illnesses On The Rise . . .

- Vector-borne disease cases tripled in the US from 2004 to 2016.
- Nine new pathogens spread by mosquitoes and ticks have been discovered or introduced since 2004.
- Globally, the World Health Organization (WHO) reports that there are more than 1 billion cases and more than 1 million deaths from VBDs annually.
- VBDs including Malaria, Dengue, Lyme disease, Schistosomiasis, Leishmaniasis, Chagas Disease, and Yellow Fever account for more than 17 percent of all infectious diseases.
- About 80% of vector control organizations lack critical prevention and control capacities.
Florida:
Mosquito-borne and tick borne disease cases
2004-2016

CLIMATE CHANGE
AND SPREAD OF VECTOR-BORNE DISEASE
Climatic conditions strongly affect water-borne diseases and diseases transmitted through insects, snails or other cold blooded animals.

Temperatures warm $\Rightarrow$ mosquitoes/warm-weather vectors $\Rightarrow$ move into:

- higher altitudes
- new regions farther from the equator.
Rising global temperatures can lengthen the season and increase the geographic range of disease-carrying insects.

- In the United States, mosquito season has grown in 76% of major cities since the 1980s due to increases in hot and humid weather conditions.
- Climate change is projected to widen significantly the area of China where the snail-borne disease Schistosomiasis occurs.
- The *Aedes* mosquito vector of dengue is also highly sensitive to climate conditions, and studies suggest that climate change is likely to continue to increase exposure to dengue.
When climate change forces human populations to migrate, it increases the threat and risk of:

- Spread of pathogens into new areas
- Spread of certain vector and reservoir species
- Spread of drug resistance
- Matters of immunity vs. non-immunity of moving or resident populations
- Viruses spreading more quickly in overcrowded urban areas without proper sanitation
Human migration exposes people to viruses to which they are not immune. As populations migrate in response to climate change, they bring disease to new regions and urban areas. Infectious diseases spread more quickly in overcrowded urban areas.

Dengue fever, Chikungunya and West Nile virus are emerging in areas where they were previously unknown and there is mounting evidence that this is due, in part, to increasing temperatures, along with other factors, such as increasing global travel and trade.

Changes in human behavior, such as deforestation, dam construction, the extinction of natural predators, and changes in biodiversity, can also accelerate the spread of Zika.

VBDs overwhelmingly and disproportionately impact people living in tropical and subtropical developing countries, though warmer temperatures, migration, travel, and trade increases the risk of these diseases spreading to more temperate climates.
CLIMATE CHANGE AND THE SPREAD OF VBD

- Floods are also increasing in frequency and intensity. Floods contaminate freshwater supplies and heighten the risk of water-borne diseases.

- Increased rainfall, flooding and humidity creates more viable areas for vector breeding and allows breeding to occur more quickly, as eggs hatch faster in hotter climates.
  - Officials braced for an increase in risk for Zika and West Nile virus infections after the massive flooding event in Louisiana in August 2016, which increased the breeding habitats

- More precipitation could provide additional habitat for larvae.
  - An April 2016 study found that the potential habitat range for *Aedes aegypti* could increase up to 13 percent under the RCP 8.5 high greenhouse gas emissions scenario by 2061-2080. Up to 460 million additional people could be exposed under this scenario when translated in terms of today’s population.
Direct Climate Change Effects on Disease Vectors

Temperature
- Changes in distribution boundaries: higher latitudes and altitudes
- Effects on biology and physiology
- Acceleration of pathogen development
- Completion of cycle at higher latitudes and altitudes

Global Wind Patterns
- Changed migration of certain vectors

Global Precipitation Patterns
- Changes in length of season that vectors can survive

Changes in Relative Humidity
- Effect on vector lifespan
- Effect on the genetic composition of vector populations
Indirect Climate Change Effects on Disease Vectors

1. Desertification and Drought
   - Reduction in density of water-related vectors
   - When drinking water sources become scarce, more chance of Guinea worm transmission
   - Changes in distribution of rodent reservoirs/sandfly, thus affecting black fever

2. Other Changes in Vegetation
   - Affects tsetse fly distribution and risk factors
   - Affects tick distribution, bacterial and viral tick-borne diseases

3. Hydrological Changes
   - Formation of more brackish water lagunae, extending the breeding or brackish water species
   - Changes in riverbeds, affecting tsetse fly ecology

4. Changed Agricultural Practices
   - A wide range of effects on mosquito-borne and snail-borne diseases
   - Changes in irrigation practices, cropping patterns, pesticide application, livestock
HOW CLIMATE CHANGE AFFECTS YOUR HEALTH

VECTOR-BORNE DISEASES

- **Increased Flooding & Storms**
- **Changes in Precipitation**
- **Increased Duration of Warm Season**
- **Changes in Median Temperature**
- **Expanded Geographical Range**
- **Changes in Vector Behaviors**

**42,000 CASES OF WEST NILE VIRUS**
in the U.S. since 1999, of which **more than 1,700 people have died**.

**ABOUT 68% of California will have increased probability for West Nile virus by 2050**.

**Incidences of LYME DISEASE DOUBLED** from 1991 to 2013.

**Increased Cases of Vector-Borne Diseases** such as, Lyme Disease, Malaria, Zika Virus, and West Nile Virus.

As temperature rises, the range of **TICKS CARRYING LYME DISEASE** will expand.

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2. [http://www.cdc.gov/mmwr/preview/mmwrhtml/rr6305a2.htm](http://www.cdc.gov/mmwr/preview/mmwrhtml/rr6305a2.htm)

[climatennexus](http://www.climatenexus.org)
**TRAITS OF INSECT VECTORS**

- Insect vectors have several physical traits that help them take advantage of climate impacts like flooding, increased precipitation, and warmer weather.

- **Body Temperature**: Insects cannot regulate their body temperature and are dependent on external warmth to survive. Rising temperatures may cause vector range patterns to shift, increasing the risk to new populations.

- **Breeding**: Humidity and water is crucial for vector breeding, so more insects can hatch in areas with standing water and high precipitation.

- **Pathogen Incubation**: The incubation period of pathogens within vectors is also temperature-dependent, and becomes shorter in warmer conditions.
According to the WHO, there are three key components that determine the occurrence of VBD’s:

1. vector and host abundance;
2. local prevalence of disease-causing parasites and pathogens;
3. and human population behavior and disease resilience.

Climate change affects these three key components through changes in temperature, precipitation, humidity, and other factors that influence the reproduction, development, behavior, and population dynamics of insects, pathogens, and people.
SEA LEVEL RISE

- As sea levels rise and sea waters get into mangrove swamps and salt marshes (high tide, as well as, hurricanes, winds, or percolate up through the mud at distance from coastline), gives breeding grounds to the mosquito eggs that are already there. They breed by the billions in these environments.

- Species: Black Salt March Mosquitoes. Not a public health threat per se. More so an economic threat (tourism – Jamaica, Cayman, Miami etc).

- Not Aedes Aegypti – do NOT breed in salt water.
VBD cycles are complex because of constantly changing interactions between pathogen, insects, and people. Changes in climate make these interactions less predictable, multiplying the risks of the disease.

In the United States, projected increases in spring, summer and fall temperatures will likely increase the total number of days each year when temperature fall between 50 to 95°F—the temperature window in which mosquitoes thrive. Projections for more heavy downpours may also increase the threat from VBDs.

WHO estimates that rising global temperatures, as well as altered precipitation and humidity linked to climate change, could significantly alter VBDs and their effect on human populations—making epidemics more difficult to predict and control. The changes in VBDs would likely occur as both short-term epidemics and long-term gradual changes in disease trends.
Many policies and individual choices have the potential to reduce greenhouse gas emissions and produce major health co-benefits. For example, cleaner energy systems, and promoting the safe use of public transportation and active movement – such as cycling or walking as alternatives to using private vehicles – could reduce carbon emissions, and cut the burden of household air pollution, which causes some 4.3 million deaths per year, and ambient air pollution, which causes about 3 million deaths every year.

In 2015, the WHO Executive Board endorsed a new work plan on climate change and health. This includes:

- **Partnerships:** to coordinate with partner agencies within the UN system, and ensure that health is properly represented in the climate change agenda.

- **Awareness raising:** to provide and disseminate information on the threats that climate change presents to human health, and opportunities to promote health while cutting carbon emissions.

- **Science and evidence:** to coordinate reviews of the scientific evidence on the links between climate change and health, and develop a global research agenda.

- **Support for implementation of the public health response to climate change:** to assist countries to build capacity to reduce health vulnerability to climate change, and promote health while reducing carbon emissions.
GLOBAL RESPONSE

- Countries with less means (Haiti, Central America etc.) may not have the resources to gather data for reporting. They don't have the economic resources to investigate fully.

- People may not have the resources (money, insurance, access to healthcare) to go to the doctor. They just live with the symptoms until they resolve. Hinders reporting.

- Mosquito control is very variable throughout the world. Poorer countries may not have the money and resources to try to control outbreaks with insecticides. The problem is cyclical so countries may not want to invest the money.

- Some countries (Brazil) have good reporting and adequate resources but the problem is so large it is still hard to control.

- Control in airports using heat sensors – picks up higher temperatures but doesn’t differentiate VBD vs. Influenza for example. What about returning citizens?
Miami-Dade Response

- Fortunately money has been pumped into the Mosquito Control Division of Miami-Dade as a result of the 2016 Zika outbreak.

- The staff has grown from 12 to approximately 60 people. Money, resources and staff are being allocated for the division.

- Increased media and public outreach. They are doing more education via outreach to schools, community events, health fairs etc.
Aedes Aegypti is resistant to most of the chemicals available. Some organophosphates still work for AA but they are not the preferred treatment. Less harsh chemicals don’t work.

Can be beneficial if applied properly, at the proper rate and with the correct equipment.

Highly regulated in the United States. Public health risk of the insecticide is low compared to the risk of disease.

Need to look at other methods of control. Considering using a bacterium that makes the male sterile. It is scientifically sound and cleaner than insecticide. The problem is how to scale it’s use up to the size of a city like Miami. The technology is not there yet.
AEDES AEGYPTI

Public Enemy #1
AEDES AEGYPTI

- Carries Zika, Dengue, Chikungunya, Yellow Fever
- Bites during the DAY. Not night time biters.
- ONLY bites humans.
- Only breed near peoples homes. Highly adapted to living alongside humans.
- Females lay eggs in different places, not all together in one location.
- The *Aedes* vectors breed in containers where fresh water is collected, and their eggs can survive for long periods in a dormant state waiting for rainfall.
ZIKA VIRUS
ZIKA VIRUS

- First identified in Zika Forest of Uganda in 1947 in rhesus monkeys
- Later identified in humans in 1968 for the first time in Nigeria.
- Outbreaks of Zika virus disease have been recorded in Africa, the Americas, Asia and the Pacific.
- In Brazil in May 2015, the Pan American Health Organization (PAHO) issued an alert regarding the possible association between Zika infection and microcephaly
ZIKA VIRUS

- single-stranded RNA virus of the Flaviviridae family, genus Flavivirus
- transmitted to humans primarily through the bite of an infected Aedes Aegypti species mosquito
- *Zika* virus is a tropical disease spread by *Aedes* mosquitoes, which also carry West Nile virus, as well as yellow and dengue fever.
- Virus is found in tears, breast milk, vaginal fluid, semen. Can still be found in semen months after a man has been infected. Does cross the placenta.

Can be spread by
- Mosquito bite
- Unprotected sex (penile-vaginal, penile-anal, probably oral)
- *Probably transfusion*
- *Possibly by body fluids to healthcare workers—Standard precautions*
ZIKA SYMPTOMS

• Fever (acute onset)
• Maculopapular Rash
• Arthralgia (Joint pain)
• Conjunctivitis (red eyes)
• Vomiting

Other symptoms include:
• Myalgia (Muscle pain)
• Headache
ZIKA AND PREGNANCY

The virus, which can be transmitted from mother to fetus during pregnancy, has been linked to an increase in miscarriages, and deaths in newborns, and birth defects, especially a condition known as microcephaly, in which the brain does not fully develop and babies are born with abnormally small heads.

Zika Congenital Syndrome – microcephaly, impaired vision and hearing.

In August 2016, the CDC warned pregnant women against traveling to Miami-Dade County in Florida, where more than 14 cases of local transmission of Zika virus had been confirmed.
ZIKA

• Only about 1 in 4 persons with Zika infection develop symptoms 2-7 days after acquiring infection.

• Symptoms generally last for up to a week.

• Nucleic acid disappears from bloodstream within 7 days

• Risk of transmission by sex or to fetus appears to end after 8 weeks

• Treatment is symptomatic and illness typically resolves within a week.
DIFFERENTIAL DIAGNOSIS

- Dengue
- Leptospirosis
- Malaria
- Rickettsia
- Group A streptococcus
- Rubella
- Measles
- Parvovirus
- Enterovirus
- Adenovirus

- Alphavirus infections including:
  - Chikungunya
  - Mayaro
  - Ross River
  - Barmah Forest
  - O’nyong-nyong
  - Sindbis viruses
ZIKA DIAGNOSIS

- Preliminary diagnosis is based on the patient’s clinical features, places and dates of travel, and activities.

- Laboratory diagnosis is generally accomplished by testing serum or plasma to detect virus, viral nucleic acid, or virus-specific immunoglobulin M and neutralizing antibodies.

- There are no commercially available diagnostic tests for Zika virus disease. Zika virus testing is performed at the CDC Arbovirus Diagnostic Laboratory and some state or local health departments.

- During the first week after onset of symptoms, Zika virus disease can often be diagnosed by performing reverse transcriptase-polymerase chain reaction (RT-PCR) on serum.

- Virus-specific IgM and neutralizing antibodies typically develop toward the end of the first week of illness; cross-reaction with related flaviviruses (e.g., dengue and yellow fever viruses) is common and may be difficult to discern.
As an arboviral disease, Zika virus is a nationally notifiable condition. Healthcare providers are encouraged to report suspected cases to their state or local health departments to facilitate diagnosis and mitigate the risk of local transmission.

State or local health departments are encouraged to report laboratory-confirmed cases to CDC through ArboNET, the national surveillance system for arboviral disease.
DENGUE
DENGUE

- Dengue is a disease caused by any one of four closely related dengue viruses (DENV 1, DENV 2, DENV 3, or DENV 4).

- In the Western Hemisphere, the *Aedes aegypti* mosquito is the most important transmitter or vector of dengue viruses.

- It is estimated that there are over 100 million cases of dengue worldwide each year.

- There is no specific medication for treatment of a dengue infection.
DENGUE: SIGNS & SYMPTOMS

- Symptoms of dengue fever:
  - high fever
  - severe headache
  - severe pain behind the eyes
  - joint pain, muscle and bone pain
  - Rash
  - mild bleeding (e.g., nose or gums bleed, easy bruising).

- Generally, younger children and those with their first dengue infection have a milder illness than older children and adults.
DENGUE HEMORRHAGIC FEVER

- Dengue hemorrhagic fever is characterized by a fever that lasts from 2 to 7 days, with general signs and symptoms consistent with dengue fever. When the fever declines, symptoms including persistent vomiting, severe abdominal pain, and difficulty breathing, may develop. This marks the beginning of a 24- to 48-hour period when the smallest blood vessels (capillaries) become excessively permeable (“leaky”), allowing the fluid component to escape from the blood vessels into the peritoneum (causing ascites) and pleural cavity (leading to pleural effusions). This may lead to failure of the circulatory system and shock, followed by death, if circulatory failure is not corrected. In addition, the patient with DHF has a low platelet count and hemorrhagic manifestations, tendency to bruise easily or other types of skin hemorrhages, bleeding nose or gums, and possibly internal bleeding.
DENGUE HEMORRHAGIC FEVER

- If you get Dengue twice (two different serotypes) you are at increased risk for DHF.

- We now have all four (and possibly a fifth serotype) circulating nearby – S. America, C. America, the Caribbean.
CHIKUNGUNYA VIRUS

- Chikungunya fever (CHIK) is an infection caused by the Chikungunya virus (CHIKV). The virus is spread through the bite of an infected mosquito Aedes Aegypti.

- The Chikungunya virus was first identified during an outbreak in 1952 in southern Tanzania, although it is suspected to have been present in Africa and Asia for much longer.
Countries and territories where chikungunya cases have been reported* 
(as of April 22, 2016)

*Does not include countries or territories where only imported cases have been documented. This map is updated weekly if there are new countries or territories that report local chikungunya virus transmission.
CHIKUNGUNYA: SIGNS AND SYMPTOMS

- An infected person will typically become ill three to seven days after the mosquito bite, but symptoms can begin anywhere from two to 12 days post-bite.

- These symptoms can last 3-10 days.

- Up to 28% of people who are infected will not have any symptoms (asymptomatic), although they can still be infectious to mosquitoes for a short time if bitten.

- Complications are rare, but more common in:
  - 1. Infants (<1 year)
  - 2. Elderly (>65 years)
  - 3. People with other chronic conditions such as: diabetes, hypertension, etc.

- Treatment is symptomatic or supportive.

- Symptoms may include:
  - Sudden high fever (usually > 102°F) which may be continuous or intermittent
  - Severe joint pain that commonly involves the hands and feet
  - Joint swelling
  - Back pain
  - Rash usually 2-5 days after fever starts
  - Other symptoms may include headache, body ache, nausea, vomiting, and redness around the eyes. In unusual cases, infection can involve the brain, eyes, heart, kidney and other organs.
  - Fatal infections are rare, however many patients have chronic joint pain, arthritis, loss of energy and depression lasting weeks to years.
CHIKUNGUNYA VS. DENGUE

• It is important to note that a person can be infected with CHIK and dengue viruses at the same time as they are both carried by the same types of mosquitoes. Therefore, it is important that providers consider both dengue fever and CHIK when evaluating suspect cases with travel to areas where both viruses are present.

• Testing is the only way for a health care provider to definitively differentiate CHIK and dengue fever.
Current Outbreaks

- No circulating Zika, Chikungunya, Dengue in Miami. Just sporadic cases imported from countries with disease.
- West Nile Virus and Equine Virus is already here in Miami circulating in the environment.
- Venezuela has a Dengue outbreak currently, as well as, Malaria in the south.
- Italy has Chikungunya.

- Serious outbreaks of Dengue in Cuba, Jamaica, Puerto Rico, Central America, Colombia, Venezuela, Mexico – 320,000 cases of Dengue since January.
- 12,000 cases of Chikungunya and Zika in Rio De Janeiro.
- Yellow Fever outbreak in Brazil with approximately 400 deaths in the past year. False vaccine produced in Africa, W. Africa and Brazil – public health problem because unknown who received the true vaccine.
- Dengue is probably going to be a serious issue for South and Central America and the Caribbean as all 4 serotypes are seen in these regions.
Key Points

• There is a lot of disease insurgence in South and Central America, the Caribbean, SE Asia and Africa.

• We have to keep our eye on the world, not just Miami.

• Vulnerable populations – homeless, those living in poverty (lack of AC therefore opening windows, broken screens, sitting outside etc.).

Vector Borne Disease and climate change is a complex picture with moving parts:

- Political
- Medical
- Environmental
- Social
- Financial
• WHO (World Health Organization) Climate Change and Health February 1, 2018.

• Philos Trans R Soc Lond B Biol Sci. 2015 Apr 5; 370(1665): 20130552. Climate change and vector-borne diseases: what are the implications for public health research and policy?

• Climate Nexus: Climate Risk and Spread of Vector-Borne Diseases

• Centers for Disease Control www.cdc.gov.

• Earth Institute at Columbia University

• Dr. Petri – Director of Mosquito Control Division for Miami-Dade County. Dept. of Solid Waste Management.
“Climate change is no longer some far-off problem; it is happening here, it is happening now.”

Barack Obama on Climate Change
President of the United States of America
THANK YOU . . .

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