HERE THEY COME:

NEW DISEASES CAUSED BY FAMILIAR BUGS

EEK: VECTORS AND PUBLIC HEALTH PESTS VIRTUAL CONFERENCE
NATIONAL ENVIRONMENTAL HEALTH ASSOCIATION

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APRIL 13 - 14, 2016
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-- President: Health Promotion Consultants
AGENDA    PREVIEW

– Introduction
– Vector Disease Overview
– Diseases & Their Vectors
– CASE EXAMPLE : Zika Virus
– Future Forecast & Conclusion
AGENDA

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HERE THEY COME: NEW DISEASES CAUSED BY FAMILIAR BUGS

INTRODUCTION — Today’s Discussion Will Demonstrate:

NEW DISEASES CAUSED BY FAMILIAR BUGS because . . . .

– Our World is shrinking due to Travel

– Growing Urban Centers and Concentrations of Humans

– New Habitats and Life-Span Increases for Vectors due to Changes in Climate

– Increasing Need to Strengthen Environmental Health Infrastructure
HERE THEY COME: NEW DISEASES CAUSED BY FAMILIAR BUGS

DISCLAIMER

- TODAY'S DATA comes from a variety of sources (WHO, CDC, etc)
VECTOR-BORNE DISEASES

Vector-borne diseases are illnesses caused by pathogens and parasites in human populations.

Every year there are more than 1 billion cases and over 1 million deaths from vector-borne diseases such as:

- malaria
- dengue
- schistosomiasis
- human African trypanosomiasis
- leishmaniasis
- Chagas disease
- yellow fever
- Japanese encephalitis
- onchocerciasis, globally.
VECTOR-BORNE DISEASES

$60 Billion .......... Annual expected losses due to potential pandemics

$3.4 Billion .......... Annually needed to improve public health systems of low/middle-income countries

The Neglected Dimension of Global Security: A Framework to Counter Infectious Disease Crises
Commission on a Global Health Risk Framework for the Future (2105)
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DEFINITION

VECTORS are living organisms that can transmit infectious diseases between humans or from animals to humans.

Many of these vectors are bloodsucking insects, which ingest disease-producing microorganisms during a blood meal from an infected host (human or animal) and later inject it into a new host during their subsequent blood meal.

Mosquitoes are the best known disease vector. Others include ticks, flies, sandflies, fleas, triatomine bugs and some freshwater aquatic snails.
BLOODYSUCKING INSECT
RISKS PRESENTED BY VECTORS

- Vector-borne diseases account for more than 17% of all infectious diseases, causing more than 1 million deaths annually.

- More than 2.5 billion people in over 100 countries are at risk of contracting dengue alone.

- Malaria causes more than 600 000 deaths every year globally, most of them: children under 5 years of age.

- Other diseases such as Chagas disease, leishmaniasis, and schistosomiasis affect hundreds of millions of people worldwide.

Many of these diseases are preventable via informed protective measures  (Environmental Health Practices).
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  -- CASE EXAMPLE: Zika Virus
  -- Future Forecast & Conclusion
<table>
<thead>
<tr>
<th>VECTORS</th>
<th>Diseases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triatomine bugs</td>
<td>Chagas disease</td>
</tr>
<tr>
<td>Tsetse flies</td>
<td>Sleeping sickness</td>
</tr>
<tr>
<td>Fleas</td>
<td>Plague</td>
</tr>
<tr>
<td></td>
<td>Rickettsiosis</td>
</tr>
<tr>
<td>Black flies</td>
<td>River blindness</td>
</tr>
<tr>
<td>Aquatic snails</td>
<td>Schistosomiasis</td>
</tr>
</tbody>
</table>
VECTORS

Sandflies
- Leishmaniasis
- Sandfly fever (p. lebo-to-mus fever)

Ticks
- Crimean-Congo haemorrhagic fever
- Lyme disease
- Relapsing fever (borreliosis)
- Rickettsial diseases (spotted fever and Q fever)
- Tick-borne encephalitis
- Tularaemia
VECTORS

Mosquitoes
- *Aedes*
  - Chikungunya, Dengue fever
  - Rift Valley fever
  - Yellow fever
  - Zika
- *Anopheles*
  - Malaria
- *Culex*
  - Japanese encephalitis
  - Lymphatic filariasis
  - West Nile fever
**HERE THEY COME:**  NEW DISEASES CAUSED BY FAMILIAR BUGS

**TOP 10 VECTOR-BORNE DISEASES:**

<table>
<thead>
<tr>
<th>Disease</th>
<th>Countries/Prevalence</th>
<th>Vector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaria</td>
<td>100 countries, 1.2 M deaths</td>
<td>Anopheles Mosquito</td>
</tr>
<tr>
<td>Kala Azar</td>
<td>India, Bangaldesh, Ethiopia, Brazil, Sudan</td>
<td>Sand Fly</td>
</tr>
<tr>
<td>Dengue</td>
<td>50 – 100 M</td>
<td>Aedes Aegypti</td>
</tr>
<tr>
<td>Plague</td>
<td></td>
<td>Rodents, Flea</td>
</tr>
<tr>
<td>Filariasis</td>
<td>120 M</td>
<td>Culex Mosquito</td>
</tr>
</tbody>
</table>
## HERE THEY COME: NEW DISEASES CAUSED BY FAMILIAR BUGS

### TOP 10 VECTOR-BORNE DISEASES:

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<tr>
<td>Chikungunya</td>
<td>Aedes Mosquito</td>
</tr>
<tr>
<td>Lyme Disease</td>
<td>Tick</td>
</tr>
<tr>
<td>Yellow Fever</td>
<td>Aedes Aegypti</td>
</tr>
<tr>
<td>Chagas Disease</td>
<td>Kissing Bug</td>
</tr>
<tr>
<td>Japanese Encephalitis</td>
<td>Culex Mosquito</td>
</tr>
</tbody>
</table>
## Environmental Impacts

### CLIMATE CHANGE

- **Temperature Rise**: 3°C by yr. 2100
- **Sea level Rise**: 40 cm
- **Hydrologic Extremes**

### Urban Heat Island Effect
- **Air Pollution**
  - Respiratory diseases, e.g., COPD & Asthma
  - Malaria
  - Dengue
  - Encephalitis
  - Hantavirus
  - Rift Valley Fever

### Vector-borne Diseases
- **Malaria**
- **Dengue**
- **Encephalitis**
- **Hantavirus**
- **Rift Valley Fever**

### Water-borne Diseases
- **Cholera**
- **Cyclospora**
- **Cryptosporidiosis**
- **Campylobacter**
- **Leptospirosis**
- **Malnutrition**
- **Diarrhea**
- **Toxic Red Tides**

### Water resources & food supply
- **Environmental Refugees**
- **Forced Migration**
- **Overcrowding**
- **Infectious diseases**
- **Human Conflicts**

1. IPCC estimates
Global Warming's greatest threat may also be the smallest.
Relationship between temperature and malaria parasite development time inside mosquito ("extrinsic incubation period" or EIP). EIP shortens at higher temps, so mosquitoes infectious sooner.
HERE THEY COME: NEW DISEASES CAUSED BY FAMILIAR BUGS

Let’s take a look at some Diseases of Concern ......

Hopping across the Globe, starting with the US
HANTAVIRUS
TROPHIC CASCADE HYPOTHESIS (TCH)

Changes associated with El Niño alter weather patterns in U.S. Southwest

Increased winter-spring precipitation leads to increases in vegetation and insect populations

Increases in food and shelter increase size/density of rodent populations

Increases in density alters the quantity/quality of SNV infection in Peromyscus populations

Return to ‘normal weather patterns’ leads to increased contact with humans
Trade Winds & El Niño Effect

Normal conditions

West trade winds keep the warm waters of the central Pacific Ocean in place

El Niño conditions

West trade winds weaken and the warm waters of the central Pacific Ocean move towards the equatorial Pacific until they reach the South American coast
Daily hospitalizations for diarrhea, by daily temperature, Lima, Peru.

Overall estimate from regression analysis: 7% increase in daily cases per 1°C rise

Checkley et al, Lancet 2000 (J. Patz PI)
Central Asia (Kazakhstan)

High levels of plague (*Yersinia pestis*) transmission
Epicenter of Black Death Third Pandemic (1855-1870)
Changing public health and political systems
Each 1°C increase in spring temperature translates to a 59% greater spring plague prevalence in gerbils.

Warmer springs increase flea population past a threshold for active plague transmission.
SCHISTOSOMIASIS - CHINA

Distribution of snail vector
(Oncomelania hupensis)
historically limited by freezing conditions

1960-1990: suitable habitat expanded 40,355 km² putting 20.7 million more people at risk

Presents an additional water resource/quality challenge

Yang et al. Parassitologia (2005)
Zimbabwe:

---a relationship between altitude and malaria.

Altitude can be a good surrogate for temperature
[ because average temperature decreases with height ]

6 degrees C per 1000 meters

Source: Taylor and Mutambu, 1986
There is clear evidence that Climate Change is a factor in a string of disease outbreaks affecting both animals and humans.

These include:

- the spread of **Malaria** into highlands of eastern Africa
- increased **Lyme Disease** in North America
- expansion of **Blue Tongue** into parts of Europe
  (areas where it was too cold to thrive previously)

**Blue Tongue** is a serious livestock affliction.
Blue Tongue moving north in Europe
Related to warming trends?

Rogers et al. 2007
Warming trend East Africa and modeled mosquito abundance (1970 – 2000)
RIFT VALLEY FEVER (RVF)

What is Rift Valley Fever (RVF)?

Rift Valley Fever (RVF) is an acute viral disease that can cause severe disease in domestic animals (such as buffalo, camels, cattle, goats and sheep) and humans.

Disease in these species is characterized by fever, severe illness, abortions, and a high morbidity and mortality rate.

The virus which causes RVF belongs to the genus Phlebovirus in the family Bunyaviridae. Many of the related Bunyaviridae viruses can cause fever and encephalitis.

Another commonly known Bunyaviridae virus is the Hantavirus. RVF is a disease listed under the World Organization for Animal Health (OIE) Terrestrial Animal Health Code and must be reported to the OIE (OIE Terrestrial Animal Health Code).
Persistence of above normal NDVI = risk of RVF (red) in endemic areas (green) based on RS data
EMERGING DISEASES

Why should we be concerned about the spread of infectious diseases?

New and emerging diseases are a real problem. *We exist in a buggy world.* Viruses are lurking out there, and they jump, and they find new ecological niches. It’s what happened with *Ebola.*

*HIV* is another great example. The virus jumped from primates to humans, adapted to humans, and then caused a pandemic. We are in the middle of all of these pandemics.

*Viruses* may have always existed with us, and we figured out how to live with them, but now they are getting to us in *new ways* and causing new problems.

*Zika Virus* has been center-stage in the media of late. Unfortunately, it serves as a good example of the spread of Vector-borne Disease.
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CASE EXAMPLE: ZIKA VIRUS INFECTION

First:

Permit me to say that West Nile Virus serves as one of the best examples of illustrating disease transmission directly via the vector (mosquito).

Over the course of a 3 year period, one can easily track its dramatic spread from the East Coast across the country to the West.
CASE EXAMPLE: ZIKA VIRUS INFECTION

West Nile:
That distribution process is directly attributed to humans being bitten by infected mosquitoes.

Zika Virus:
At present – EVERY case in the US is connected to an over-seas exposure/bite.
CASE EXAMPLE: ZIKA VIRUS INFECTION

DISCOVERED:

1947 Uganda Forest

Today 23 countries (and increasing)
CASE EXAMPLE: ZIKA VIRUS INFECTION

All U.S. (current) Cases --- from mosquito bites (non-US)

Symptoms/Effects
- Mild illness/cold symptoms
- Sexual Transmission/Pregnancy
- Microcephaly
- Miscarriages
- Guillain-Barre Syndrome
CASE EXAMPLE: ZIKA VIRUS INFECTION

U.S. Cases --- from mosquito bites (elsewhere)

Virus Found In:
Saliva               Urine
Blood               Bodily Fluids
CASE EXAMPLE: ZIKA VIRUS

2015 – 1st year of widespread contact in North and South America

2013 - 2015 1.7 M Infected: Chikagunya and Zika combined
CASE EXAMPLE: ZIKA VIRUS

In the U.S.:

March 2016 – 82 Infections (history of travel)
  14 cases (sexual transmission)
  12 cases (still under study)

Now: A Reportable Disease to CDC
CASE EXAMPLE: ZIKA VIRUS

Travelers to/from –

American Samoa  Mexico
Brazil  Honduras
El Salvador  Haiti
Guatemala  Samoa
Puerto Rico
Places with active Zika virus transmission:

- Haiti
- Dominican Republic
- Puerto Rico
- U.S. Virgin Islands, Saint Martin, Guadeloupe, Martinique, Barbados,
- Guyana
- Suriname
- French Guiana

Not shown: Samoa in the Pacific Ocean and Cape Verde in the Atlantic Ocean

Source: CDC
Scientists are studying: *Mountain-Tops in Tropical Regions*

- Niche home for several *rare* and *ancient* plant species

**PREDICTIONS** (due to warming climate trends):

- Possible extinction of 8 – 12 species

(2016)
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FUTURE FORECAST AND CONCLUSIONS

Action — Legislative Activity

Biology — Insect Life Cycles

Etiology — Infection Pathways

Exposures - Human Habits and Lifestyles
In 2016 legislatures introduced 129 bills on pesticide control, with 18 being enacted.

California: that April 19 through the 25, 2015 is West Nile Virus and Mosquito and Vector Control Awareness Week, was the only bill adopted on mosquito control (ACR 51).

Arizona enacted provides licensure requirements for use of pesticides; amends certification requirements for political subdivision employees under certain circumstances (S 1078; Act No. 80).

California requires the landlord or the landlord's authorized agent, to provide a tenant with notice of the use of pesticides at the dwelling unit (S 328; Act No. 278).

Florida increases the amount of funding for mosquito control (S 428; Act No. 2015-8).
Hawaii established a full-time temporary program manager position in the department of agriculture for the pesticide subsidy program for coffee growers (H 482; Act No. 2015-152).

Maine repeals notification and reporting provisions for forest insect aerial pesticide spray projects (S 291; Act No. 58)

Mississippi extends the date of repeal from December 31, 2015, to December 31, 2018, on the provision of law that authorizes the city of Indianola, Mississippi, to provide services for mosquito and pest control (H 1423; Act No. 904).

New Jersey authorizes a county board of chosen freeholders to establish a mosquito reserve fund (S 2115; Act No. 2015-22)

Texas modifies the state’s abatement of public nuisance on undeveloped land to address weeds likely to attract or harbor mosquitoes (HB 1643; Act No. 441).
1,000 YEAR FLOOD EVENTS
Six since 2010 (NOAA):

2010, May -- Tennessee Flooding
2011, Aug. -- Hurricane Irene
2013, Sept. -- Colorado Springs Flooding
2014, Aug. -- Baltimore Deluge
2015, Mar. -- Nebraska
2015, Oct. -- South Carolina Flooding
VECTOR-BORNE DISEASE

Vector-borne diseases account for over 17% of all infectious diseases.

Distribution of these diseases is determined by a complex dynamic of environmental and social factors.
Globalization of travel and trade, unplanned urbanization and environmental challenges such as climate change are having a significant impact on disease transmission in recent years.

Some diseases, such as dengue, chikungunya, and West Nile virus, are emerging in countries where they were previously unknown.

Changes in agricultural practices due to variation in temperature and rainfall can affect the transmission of vector-borne diseases.

Climate information can be used to monitor and predict distribution and longer-term trends in malaria and other climate-sensitive diseases.
ADAPTING BACTERIA

-- Gene (NDM – 1)

    Produces an enzyme which disables antibiotics

-- Enzyme (KPC – klebsiella pneumoniae carbapenamase)
VECTOR-BORNE DISEASE -- FUTURE CONTROLS

Genome Sequencing --

Dengue and Chikungunya
VECTOR-BORNE DISEASE -- FUTURE CONTROLS

Vaccine Development --

Dengue and West Nile Virus

Zika
VECTOR-BORNE DISEASE -- FUTURE CONTROLS

Aedes aegypti Mosquito -- Biological changes

Chikungunya, Dengue, and Yellow Fever
Commonwealth of Virginia

DECREASES IN BEE HIVES:

Historically: 10% failure rate (tracking since 2001)

Since the late 80’s: Higher rates of lost hives **

2015: 46%

**

Invasion of 2 parasites: tracheal mites, Varroa destructor mites
GREAT STRIDES over the last fifteen years (2000 - 2015):

**Decreases in:**

- Incidence: 37%
- Mortality: 60%
HERE THEY COME: NEW DISEASES CAUSED BY FAMILIAR BUGS

In Our Discussion Today We Covered:

NEW DISEASES CAUSED BY FAMILIAR BUGS because ....

- Our World is shrinking due to Travel

- Growing Urban Centers and Concentrations of Humans

- New Habitats and Life-Span Increases for Vectors due to Changes in Climate

- Increasing Need to Strengthen Environmental Health Infrastructure
HERE THEY COME: NEW DISEASES CAUSED BY FAMILIAR BUGS

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- CDC and other Federal Agencies: data, reports, and research

- Dr. J Patz and his Agency at University of Wisconsin, Madison

- WHO and their divisions, etc.

- The other Sources, Authors, and Researchers as noted
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