Financial Relationships With Commercial Entities

- Dr. Schooley serves as a consultant to CytoDyn. He is a stockholder in Antiva Biosciences and has stock options from CytoDyn. He serves as a Scientific Advisory Board Member (honoraria remitted to the University of California) for Gilead Sciences, Inc and LabCorps. (Updated 05/25/2017)

Learning Objectives

After attending this presentation, learners will be able to:

- Outline the major potential health effects of the warming earth on the human population
- Describe the changing epidemiology of infectious diseases and the impact this shift has on all areas of medicine
- Discuss how the impact critical health effects might be reduced
Multiple Choice Question

A warming climate may accelerate global pathogen spread by:

1. Increasing the geographical range of vectors that transmit pathogenic organisms
2. Accelerating maturation of pathogens within transmission vector
3. Increasing the number of flooding events
4. Resulting in population displacement
5. All of the above

Climate Change and Human Health

- Is the world warming?
- If so, what are the factors driving this change?
- How do these changes adversely affect humans?
  - General effects
  - Infectious disease related morbidity and mortality
- What can we do?
Weather and Climate: Related but not the Same

70,000 Excess Deaths
In Europe in the Summer of 2003

Is the World warming?

Ice Age

Is the World Warming?

Global Temperature
2000 CE

Little Ice Age
1350 – 1850 CE

Global Temperature
0.6 degrees
Climate Change and Human Health

- Is the world warming? Yes
- If so, what factors drive climate changes?
  - How do these changes adversely affect humans?
    - General effects
    - Infectious disease related morbidity and mortality
  - What can we do?

The Milankovitch Cycles

- One of the myths that is often used to counter the argument that human activities are largely driving the global warming we are observing is that extra-planetary factors including the relationships of the earth and the sun have been changing. These relationships termed the “Milankovitch Cycles” include factors such as whether the earth orbit is more circular or elliptical and the extent to which the poles point toward the sun.

Milankovitch Cycle Interactions

These cycles have been ongoing for hundreds of thousands of years and can account for only a miniscule variation in the temperature of the planet.

Ergo: We need to look to changes on the planet itself to explain most of the observed differences.
Natural Planetary Factors

- Factors that release particulate matter into the atmosphere
  - Volcanic activity
  - Meteors
- Changes in Ocean Circulation
  - El Nino Southern Oscillation (ENSO)

El Nino/La Nina Cycles

Human Factors: Energy Use

Human Energy Use =

Global Population x Energy Use per Person
Greenhouse Gasses: Why do they Warm Us?

Greenhouse Gas Release Sources

Climate Change and Human Health

- Is the world warming? **Yes**
- If so, what are the factors driving this change? **Human Energy Use**
- How do these changes adversely affect humans?
  - General effects
  - Infectious disease related morbidity and mortality
- What can we do?
Infectious Disease and Climate Change

- Pathogen Range Expansion
- Vector Range Expansion
- Increase in vector efficiency
- Natural catastrophes (floods, droughts and others)
**Climate, Chitin and Cholera**

- Optimal conditions for *V. cholerae*
  - Warm water, high pH, abundant chitin
- Warm water: enhances growth rate and is associated with greater detection of *V. cholera*
- Agricultural fertilizers increase nitrogen runoff into rivers
  - This leads to increased nutrients for blue green algae (cholera reservoir)
- Algae -> phytoplankton -> zooplankton
- Crabs, lobsters and shrimp: *Eubacterium, Chitin*
- Marine bacteria, including vibrios are responsible for degradation of chitin and *are greatly expanded when chitin is available*

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**Southern North Sea: Surface Temperature, Phytoplankton and Vibrio Index**

![Graph showing temperature and vibrio index in the Southern North Sea.]

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**Southern North Sea: Surface Temperature, Phytoplankton and Vibrio Index**

![Graph showing temperature and vibrio index in the Southern North Sea.]

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Southern North Sea: Surface Temperature, Phytoplankton and Vibrio Index

Seawater Capable of Supporting V. Cholera (2016)

Seawater Capable of Supporting V. Cholera (2100)
Outbreak of *Vibrio parahaemolyticus*
Gastroenteritis Associated with Alaskan Oysters

Joseph B. McLaughlin, M.D., M.P.H., Angelo DePaola, Ph.D., Cheryl A. Bopp, M.S., Karen A. Martinek, R.N., M.P.H., Nancy P. Napoli, B.S., Christine G. Allison, B.S., Shelley L. Murray, B.S., Eric C. Thompson, B.S., Michele M. Bird, M.S., and John P. Middaugh, M.D.

Surface Water Temperature and *V. parahaemolyticus*

![Graph showing surface water temperature and *V. parahaemolyticus*](image)


![Graph showing mean daily water temperature](image)
Mean Daily Surface Water Temperature at Shellfish Farm A

Vector Range Expansion

Extension of Vectors into Warming Regions

- Northern Spread of Tick Born Encephalitis: Sweden
- Transmitting vector: *Ixodes ricinus*
- Ticks survive for 3 years and may transmit TBE virus transovarially
- Three blood-sucking stages: larvae, nymphs and adults
- Ticks are dormant in the winter and emerge when night temperatures rise above 4 – 5 degrees Celsius
**Relationship between TBE and Altitude: Slovakia**

![Graph showing relationship between TBE and altitude in Slovakia.](image)

**Relationship between Spring and Winter Temperatures and TBE Incidence**

![Graph showing relationship between spring and winter temperatures and TBE incidence.](image)

**Dengue and Temperature**

- Dengue virus survival threshold: 11.9 degrees Celsius
- Anopheles aegypti feeding threshold: 17 degrees Celsius
- Amplification of dengue in the mosquito: >18 degrees Celsius
- Eclipse period in the mosquito shortens as the temperature rises

![Graph showing Dengue and Temperature.](image)
Recorded Outbreaks of Dengue, 1970-1996

Projected Areas at Risk for Dengue (1990-2085)

Increase in Pathogen or Vector Efficiency
Increase in Pathogen or Vector Efficiency

- Higher temperatures -> Increased pathogen replication rates
  - Pathogen expansion: Pathogenic Vibrios
- Higher temperatures -> Increased vector replication rates
  - Mosquitos and ticks
- Increased population density -> increased opportunity for transmission among susceptible humans

Natural catastrophes (floods, droughts and others)

Climate Change has not been Uniform
Impacts of Climate and Weather on the Human Population are Not Evenly Distributed

• Disproportionate effects on
  • Those in the extremes of age
  • Those in less affluent circumstances
  • Those with less food security (the homeless)
  • The Immunocompromised

Drought Drives People from Farms to Cities

Weather Extremes: Floods in Haiti, Mozambique and Elsewhere
Impact of Natural Disasters on Emerging Infectious Diseases

- Flooding
  - Cholera and ETEC: Bangladesh 1998 and 2004
  - Norovirus, salmonella, V. cholera: Hurricane Katrina in US 2003
  - Leptospirosis: Taiwan, 2001 and Brazil, 1996
- Crowding:
  - Measles: Philippines after M. Pinatubo and Pakistan after 2005 earthquake
  - Meningitis: Pakistan after 2005 earthquake
- Vectorborne Diseases:
  - Malaria: multiple locations after flooding and earthquakes
- Others
  - Tetanus and Mucormycosis following natural disasters and trauma: multiple locations
  - Coccidiodomycosis: California following dust storms triggered by earthquake driven landslides
- Interruption of Services

US/Mexico Border: The Wall

Cross Border Sexual Networks: San Diego<>TJ
Multifactorial Contributors to the Zika Outbreak in Brazil

Climate Change and Human Health
- Is the world warming? Yes
- If so, what are the factors driving this change?
- How do these changes adversely affect humans?
  - General effects
  - Infectious disease-related morbidity and mortality
- What can we do?

Combating Infectious Morbidity From Climate Change
- Climate independent interventions
  - Epidemic surveillance and mobilization capacity
    - LOCAL and multinational
  - Maintaining vaccination status
  - Food security
  - Reductions in Displacement
  - Prevention and treatment of HIV/AIDS
- Climate specific interventions
  - Knowledge
  - Concerted and Coordinated Action
  - Political mobilization
Combatting Infectious Morbidity From Climate Change

• Climate independent interventions
  • Epidemic surveillance and mobilization capacity
    • LOCAL and multinational
  • Maintaining vaccination status
  • Food security
  • Reductions in Displacement
  • Prevention and treatment of HIV/AIDS

• Climate specific interventions
  • Knowledge
  • Concerted and Coordinated Action
  • Political mobilization

Climate Science: Two Views

• The fact that the future might be like the past is what makes science possible, while the fact that the future might not be like the past is what makes science necessary.

Richard Levins and Richard Lewontin in The Dialectical Biologist

• "We’re not going to be spending money on that any more."

Mike Mulvaney, US Director of the Budget in the Trump Administration
Concerted and Coordinated Action

- More prudent energy use
  - Global energy use is a function of population growth and energy use per capita
- Personal and country specific actions
  - Shift energy generation from fossil fuels to renewable resources
  - Beware the “Tragedy of the Commons” (William Foster Lloyd, 1833)

Political Mobilization

Million Women’s March, Washington, DC, 2017
Political Mobilization

Million Women's March, Washington, DC, 2017

Multiple Choice Question

• If the current projections for climate change are realized patients with HIV infection will:

1). Not be adversely affected
2). Not be as badly impacted as the general population
3). Will be affected more severely than the general population
Multiple Choice Question

- Why will our patients be more adversely affected than the general population?

- 1). They are immunocompromised
- 2). They might disproportionately live in adverse housing conditions
- 3). They might have less access to health care
- 4). All of the above

Acknowledgements
Our Warming Planet: Is the HIV-1 Infected Population in the Crosshairs

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