Zoonoses Near and Far

Foreign Animal and Emerging Disease (FAED) Awareness Course

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M. Salah Uddin Khan, DVM, MPH
Lecture Outline

- Zoonotic disease concepts and factors of Emergence
- Zoonotic Disease Examples
- One Health Approach
Zoonoses – infectious diseases transmissible from animals to humans and vice versa

Zooanthroponoses - A zoonosis normally maintained by humans but that can be transmitted to other vertebrates (amebiasis to dogs)

Anthropozoonoses - A zoonosis maintained in nature by animals and transmissible to humans; (rabies, brucellosis)

Saprozoonoses – diseases that do not require a vertebrate reservoir because of their occurrence in water, in soil, on plants, or in food or fodder, whence they are transmitted to vertebrates (including man)
Emerging infectious diseases: infectious diseases whose incidence in humans has increased in the past 2 decades or threatens to increase in the near future. They include:

- **New infections** resulting from changes or evolution of existing organisms
- Known infections spreading to **new geographic areas or populations**
- Previously unrecognized infections appearing in areas undergoing ecologic transformation
- **Old infections reemerging** as a result of antimicrobial resistance in known agents or breakdowns in public health measures

From Emerging Infectious Diseases journal
Red represents newly emerging diseases; blue, re-emerging / resurging diseases; black, a 'deliberately emerging' disease from *Nature* **430**, 242-249 (8 July 2004)
Speed of Global Travel in Relation to World Population Growth

SARS OUTBREAK, 2003: Rapid spread worldwide by movement of people

“Disease is only a plane flight away”
## Factors Influencing Spread of Infectious Diseases

<table>
<thead>
<tr>
<th>Factors</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Microbial adaptation and change</td>
<td>Technology and industry</td>
</tr>
<tr>
<td>Human susceptibility to infection</td>
<td>Breakdown of public health measures</td>
</tr>
<tr>
<td>Climate and weather</td>
<td>Poverty and social inequality</td>
</tr>
<tr>
<td>Changing ecosystems</td>
<td>War and famine</td>
</tr>
<tr>
<td>Human demographics and behavior</td>
<td>Lack of political will</td>
</tr>
<tr>
<td>Economic development and land use</td>
<td>Intent to harm</td>
</tr>
<tr>
<td>International travel and commerce</td>
<td></td>
</tr>
</tbody>
</table>
List of NIAID Emerging & Re-emerging Diseases

Group I—Pathogens Newly Recognized in the Past Two Decades

Acanthamebiasis
Australian bat lyssavirus
Babesia, atypical
Bartonella henselae
Ehrlichiosis
Encephalitozoon cuniculi
Encephalitozoon hellem
Enterocytozoon bieneusi
Helicobacter pylori
Henipah viruses
Hepatitis C
Hepatitis E
Human herpesvirus 8
Human herpesvirus 6
Lyme borreliosis
Parvovirus B19

Group II—Re-emerging Pathogens

Enterovirus 71
Clostridium difficile
Mumps virus
Streptococcus, Group A
Staphylococcus aureus

SARS
Swine influenza
Monkeypox
Hendra virus
Nipah virus
Ebola virus
It has been estimated that 75% of emerging infectious diseases in humans are due to zoonotic pathogens and that zoonotic pathogens are twice as likely to be associated with emerging diseases than are non-zoonotic pathogens.

Published online 14 July 2011 | Nature | doi:10.1038/news.2011.416

**News**

**Respiratory virus jumps from monkeys to humans**

Adenovirus remained infectious after crossing species barrier.

Zoe Cormier

A class of virus has for the first time been shown to jump from animals to humans — and then to infect other humans.

The virus is described in *PLoS Pathogens* today. The team that discovered it might also have found the first human to be infected: the primary carer for a colony of titi monkeys (*Callicebus cupreus*) that suffered an outbreak.

The culprit is an adenovirus, one of a class of viruses that cause a range of illnesses in humans, including respiratory infections and in some cases, gastrointestinal infections.

*Photograph courtesy of Kathy West*
1960s: There's an ice age coming!

1970s: We're going to be hit by an asteroid!

1980s: Global warming!

1990s: Y2K!

2000s: Bird (cough!) flu!
I'm having trouble taking the new guy seriously...
NEWLY ARRIVED TOURIST FROM...
Meat Animal Production in the United States (Cattle/Calves, Hogs/Pigs, Sheep/Lambs)

Source: USDA National Agricultural Statistics Service, Meat Animals Production, Disposition, and Income Annual Summary
Industrial Farming
# US Animal Worker Projections

<table>
<thead>
<tr>
<th>Occupational Title</th>
<th>SOC Code</th>
<th>2010</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butchers and other meat, poultry, and fish processing workers</td>
<td>51-3020</td>
<td>397,100</td>
<td>413,900</td>
</tr>
<tr>
<td>Animal care and service workers</td>
<td>39-2000</td>
<td>220,400</td>
<td>265,900</td>
</tr>
<tr>
<td>Veterinary technologists and technicians</td>
<td>29-2056</td>
<td>75,000</td>
<td>108,100</td>
</tr>
<tr>
<td>Veterinary assistants and laboratory animal caretakers</td>
<td>31-9096</td>
<td>75,200</td>
<td>90,240</td>
</tr>
<tr>
<td>Veterinarians</td>
<td>29-1131</td>
<td>59,700</td>
<td>79,400</td>
</tr>
<tr>
<td>Farmworkers, Farm, Ranch, and Aquacultural Animals</td>
<td>45-2093</td>
<td>31,880</td>
<td>31,880</td>
</tr>
<tr>
<td>Zoologists and wildlife biologists</td>
<td>19-1023</td>
<td>17,440</td>
<td>20,928</td>
</tr>
<tr>
<td>Zoologists and wildlife biologists</td>
<td>19-1023</td>
<td>17,440</td>
<td>20,928</td>
</tr>
<tr>
<td>Animal Control Workers</td>
<td>33-9011</td>
<td>15,500</td>
<td>17,300</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>909,660</strong></td>
<td><strong>1,048,576</strong></td>
<td></td>
</tr>
</tbody>
</table>
Zoonotic Pathogen Transmission

- Direct contact
- Indirect contact

Zoonotic Disease
The Well-Traveled Salad

Do You Know Where Your Food Has Been?

As consumers, many of us fail to recognize that even our domestic and local food supplies are part of a global network. The daily activity of consuming food directly links our health as humans to the health of crops and produce, food animals, and the environments in which they are produced.

A “One Health” approach to food safety—bringing together expertise and resources from the clinical, veterinary, wildlife health, and ecology communities—has the potential to reveal the sources, pathways, and factors driving the outbreaks of foodborne illness and possibly prevent them from occurring in the first place.

NOTE: Countries are listed in alphabetical order and not by volume of export.
### Foodborne Outbreaks in U.S.

Table 3. Top five pathogens causing domestically acquired foodborne illnesses resulting in hospitalization

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Estimated annual number of hospitalizations</th>
<th>90% Credible Interval</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Salmonella</em>, nontyphoidal</td>
<td>19,336</td>
<td>8,545–37,490</td>
<td>35</td>
</tr>
<tr>
<td>Norovirus</td>
<td>14,663</td>
<td>8,097–23,323</td>
<td>26</td>
</tr>
<tr>
<td><em>Campylobacter spp.</em></td>
<td>8,463</td>
<td>4,300–15,227</td>
<td>15</td>
</tr>
<tr>
<td><em>Toxoplasma gondii</em></td>
<td>4,428</td>
<td>3,060–7,146</td>
<td>8</td>
</tr>
<tr>
<td><em>E. coli</em> (STEC) O157</td>
<td>2,138</td>
<td>549–4,614</td>
<td>4</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td></td>
<td></td>
<td>88</td>
</tr>
</tbody>
</table>

CDC 2011 estimates
Red meat consumption and cancer: reasons to suspect involvement of bovine infectious factors in colorectal cancer

Harald zur Hausen
Deutsches Krebsforschungszentrum, Im Neuenheimer Feld 280, 69120 Heidelberg, Germany

An increased risk for colorectal cancer has been consistently reported for long-time consumption of cooked and processed red meat. This has frequently been attributed to chemical carcinogens arising during the cooking process of meat. Long-time fish or poultry consumption apparently does not increase the risk, although similar or higher concentrations of chemical carcinogens were recorded in their preparation for consumption. The geographic epidemiology of colorectal cancer seems to correspond to regions with a high rate of beef consumption. Countries with a virtual absence of beef in the diet (India) or where preferably lamb or goat meat is consumed (several Arabic countries) reveal low rates of colorectal cancer. In China, pork consumption has a long tradition, with an intermediate colorectal cancer rate. In Japan and Korea, large scale beef and pork imports started after World War II or after the Korean War. A steep rise in colorectal cancer incidence was noted after 1970 in Japan and 1990 in Korea. The consumption of undercooked beef (e.g., shabu-shabu, Korean yukhoe and Japanese yukke) became very popular in both countries. The available data are compatible with the interpretation that a specific beef factor, suspected to be one or more thermoresistant potentially oncogenic bovine viruses (e.g., polyoma-, papilloma- or possibly single-stranded DNA viruses) may contaminate beef preparations and lead to latent infections in the colorectal tract. Preceding, concomitant or subsequent exposure to chemical carcinogens arising during cooking procedures should result in increased risk for colorectal cancer synergistic with these infections.
Infectious Disease and Cancer?
Reverse Zoonoses (anthropozoonoses)

- 1990 – *Giardia duodenalis* & sheep
- 1999 – MRSA & horses
- 2004 – Human enteric parasites & pet macaques
- 2004 - Human waterborne parasites & zebra mussels
- 2007 - *Cryptosporidium parvum* & cattle
- 2008 - *Candida albicans* & nonmigratory wildlife
- 2009 - *Giardia duodenalis* & colobus monkeys
- 2010 - Pandemic H1N1 & pigs
- 2010 – Pandemic H1N1 & turkeys
- 2010 – Paramyxovirus & primates
- 2012 - *Escherichia coli* clone O25:H4-ST131 & dogs
- 2012- *Pseudomonas aeruginosa* & a cat
Examples of Zoonoses

- Influenza virus
  - Domestic
  - International
- Henipaa viruses
  - International
- Lyme disease
  - Domestic
Examples of Zoonoses

• Influenza virus

Domestic
International
Pandemic influenza timeline

- **1918**: Spanish flu, 25,000,000 deaths
- **1956**: Hong Kong flu, 34,000 deaths
- **1968**: Asian flu, 70,000 deaths
- **2009**: Swine flu, +450 deaths
- **2003**: H5N1, +250 deaths since 2003
- **2013**: H7N9, +132 cases and 37 deaths
Influenza Transmission

- Influenza is highly infectious and easily transmitted.
- The virus spreads via
  - Direct contact with secretions
  - Large respiratory droplets (coughing, sneezing, talking, 6 feet radius)
  - Small respiratory droplets (aerosol transmission)*
  - Indirect contact (fomites)
- Incubation is from 1-4 days

*Aerosol transmission is subject of much current debate
http://pandemicflu.gov/plan/maskguidancehc.html#airborne
Influenza Transmission Among Humans

- Adults typically are infectious **from the day before symptoms** begin through approximately 5 days after illness onset.
- **Children can be infectious for >10 days**, and young children can shed virus for \( \leq 6 \) days before their illness onset.
- **Severely immunocompromised persons can shed virus for weeks or months.**
- **Virus can live on non-porous surfaces for 24-48 hrs**
Influenza Transmission Among Birds

- Birds that survive avian influenza virus (AIV) infections excrete viruses for up to **10 days after infection**
  (www.who.int/mediacentre/factsheets/avian_influenza/en/)
- Rodents, insects (including flies) and wild birds (like sparrows) may act as vectors for AIV
- AIV has been cultured from water for up to **100 days**
  (Avian Dis. 1990 Apr-Jun;34(2):412-8)
- AIV can survive in manure for up to **105 days**.
  (www.vetmed.ucdavis.edu/vetext/INF-PO_AI.html)
- AIV have been cultured from poultry houses for up to **100 days after depopulation**.
  (www.nwhc.usgs.gov/pub_metadata/field_manual/chapter_22.pdf)
How is zoonotic transmission associated?
17 H types – types 1, 2, and 3 established in man

9 N types – types 1 & 2 found in man
### Subtype Origin

<table>
<thead>
<tr>
<th>Subtype</th>
<th>Waterfowl</th>
<th>Humans</th>
<th>Swine</th>
<th>Equines</th>
<th>Other mammals</th>
</tr>
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<tbody>
<tr>
<td><strong>H subtype</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H1</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>H2</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>H3</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>H4</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>H5</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes (seal)</td>
</tr>
<tr>
<td>H6</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>H7</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>H8</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>H9</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes (seal)</td>
</tr>
<tr>
<td>H10</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>H11</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes (mink)</td>
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<tr>
<td>H12</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>H13</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>H14</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>H15</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes (whale)</td>
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<tr>
<td><strong>N subtype</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>N1</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>N2</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes (whale)</td>
</tr>
<tr>
<td>N3</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes (mink)</td>
</tr>
<tr>
<td>N4</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>N5</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>N6</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes (seal)</td>
</tr>
<tr>
<td>N7</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>N8</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>N9</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes (whale)</td>
</tr>
</tbody>
</table>
Mechanisms of Influenza Virus Antigenic “Shift”

17 HAs
9 NAs

Non-human virus

DIRECT

Human virus

Reassortant virus
Influenza A

- **Key epidemiology features** – Influenza epidemics are due to changes in the HA and NA glycoproteins
- a major change (e.g. change in H type) is termed an **antigenic shift** (rare event, influenza A only); antigenic shift may lead to pandemics
- a minor change is termed an **antigenic drift**
Hong Kong H5N1

- In May 1997, investigations revealed 18 (H5N1) human cases (6 deaths) by the end of 1997, all of them in Hong Kong. Exposure to birds the major risk factor

- This led to the culling of 1.2 million birds and cost the government 245 million in Hong Kong dollars in compensation.
### Recent Avian Influenza Outbreaks that have Infected Man

<table>
<thead>
<tr>
<th>Years</th>
<th>Avian Influenza A</th>
<th>Place of Origin</th>
<th>Number of humans</th>
<th>Number of deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>H5N1</td>
<td>Hong Kong</td>
<td>18</td>
<td>6</td>
</tr>
<tr>
<td>1999</td>
<td>H9N2</td>
<td>Hong Kong</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>2002</td>
<td>H7N2</td>
<td>Virginia</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>2003</td>
<td>H5N1</td>
<td>Hong Kong</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2003</td>
<td>H7N7</td>
<td>The Netherlands, Belgium</td>
<td>89</td>
<td>1</td>
</tr>
<tr>
<td>2003</td>
<td>H9N2</td>
<td>Hong Kong</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>2003</td>
<td>H7N2</td>
<td>New York</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>2004</td>
<td>H7N3</td>
<td>Canada</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>2004</td>
<td>H10N7</td>
<td>Egypt</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>2004+</td>
<td>H5N1</td>
<td>Numerous</td>
<td>Many</td>
<td>&gt;50%</td>
</tr>
<tr>
<td>2013</td>
<td>H7N9</td>
<td>China</td>
<td>132+</td>
<td>37</td>
</tr>
</tbody>
</table>

Data derived from various CDC and WHO reports
H7N9: New Pandemic Threat?
Examples of Zoonoses

- Influenza virus
  - Domestic
  - International
- Henipa viruses
  - International
Henipavirus distribution

Geographic distribution of Henipavirus outbreaks and fruit bats of Pteropodidae Family

Source: www.who.int
Successful trials of a horse vaccine against the Hendra virus were announced by Deborah Middleton at May’s AVA Annual Conference in Adelaide.

The vaccine
The Hendra virus attaches to host cells via the attachment glycoprotein G. The experimental horse vaccine generates
Nipah virus

• Member of Paramyxoviridae
  • Enveloped spherical virus
  • Single strand negative sense RNA
  • Related to Hendra and Measles virus

Image source: C.S. Goldsmith and P.E. Rollin (CDC), and K.B. Chua (Malaysia).
Nipah Virus in Malaysia
September 1998 – May 1999
283 human cases of acute encephalitis
- 109 deaths
- Case fatality rate 39%
Paul Chua isolated a novel paramyxovirus from a patient in Sungai Nipah village
Nipah Clinical Features

Symptoms:

**Moderate**
- high fever
- headache
- myalgia
- vomiting
- drowsiness
- dizziness

**Severe**
- encephalitis including
  - disorientation
  - hallucinations
  - seizures/convulsions
  - coma

**Respiratory symptoms:**
- 14% non-productive cough
- 6% of chest radiographs mild focal abnormalities

How did people contract Nipah Virus in Malaysia?

• The outbreak was concentrated among pig farmers
  – 92% of cases reported contact with pigs

• Compared to controls, persons with Nipah encephalitis were
  – 5.6 times more likely to have close contact with pigs.
  – 3.7 times more likely to have contact with sick pigs.
How did Nipah transmit between pigs?

- Pig respiratory secretions contained Nipah virus
- 2.4 million pigs in peninsular Malaysia
- Active pig trade
  - Distributed infected but asymptomatic pigs throughout the country
- As the PRES epidemic spread
  - “fire sale” of sick pigs markedly increased mixing of sick and well pigs

[Image of a truck with a pig on the back]

http://www.xanga.com/c_lar_a
From where did the pigs get Nipah?
Nipah wild animal studies

- Numerous wild animals trapped and tested
- 8 different species of fruit bats sampled
  - 4 of the 8 species had antibodies against Nipah virus
- Nipah virus isolated
  - Urine from *Pteropus hypomelanus* in Malaysia
  - Urine from *Pteropus lylei*
    - In Cambodia
    - In Thailand
Malaysia Outbreak Control

• Outbreak ceased following the culling of over 900,000 pigs
  – Fruit trees no longer permitted above pig pens
  – Pork industry decimated

• No subsequent cases of Nipah recognized in Malaysia from people or animals

Photo: www.fao.org
Nipah virus in Bangladesh
2001
Siliguri 66 cases 49 deaths
Meherpur 13 cases 9 deaths

2002
No cases

2003
Naogaon 12 cases 8 deaths

2004
Rajbari 31 cases 23 deaths
Faridpur 36 cases 27 deaths

2005
Tangail 12 cases 11 deaths

2006
No cases

2007
Thakurgaon 7 cases 3 deaths
Kushtia 8 cases 5 deaths
Nadia 5 cases 5 deaths

2008
Manikgonj 4 cases 4 deaths
Rajbari 6 cases 5 deaths

2009
Rangpur, Gaibandha, 4 cases 1 death
Rajbari, Nipahmari

2010
Faridpur, Rajbari, 17 cases 15 deaths
Gopalganj, Kurigram

2011
Lalmonirhat, Dinajpur, 28 cases 28 deaths
Comilla, Nilphamari, Faridpur, Rajbari

2012
Joypurhat, Rajshahi 13 cases 10 deaths

Total 266 cases 204 deaths
**Pteropus giganteus** in Bangladesh

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bats Tested</td>
<td>92</td>
<td>81</td>
<td>218</td>
</tr>
<tr>
<td>Nipah IgG+</td>
<td>48</td>
<td>15</td>
<td>107</td>
</tr>
<tr>
<td>% positive</td>
<td>52%</td>
<td>19%</td>
<td>49%</td>
</tr>
</tbody>
</table>

How does Nipah virus transmit from wildlife to humans in Bangladesh?
Pathways for transmission

- Zoonotic
- Human-to-human
## Outbreak investigations

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>No. and % of cases with this risk factor</th>
<th>No. and % of controls with this risk factor</th>
<th>Odds Ratio</th>
<th>95% confidence limit</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical contact with sick animal</td>
<td>5 (42)</td>
<td>5 (14)</td>
<td>4.4</td>
<td>0.9, 20.4</td>
<td>0.09</td>
</tr>
<tr>
<td>Physical contact with sick chicken</td>
<td>3 (25)</td>
<td>3 (8)</td>
<td>3.7</td>
<td>0.5, 24</td>
<td>0.16</td>
</tr>
<tr>
<td>Killed a sick animal</td>
<td>1 (8)</td>
<td>2 (6)</td>
<td>1.6</td>
<td>0.05, 22</td>
<td>1.00</td>
</tr>
<tr>
<td>Ate any sick animal</td>
<td>1 (8)</td>
<td>2 (6)</td>
<td>1.6</td>
<td>0.05, 22</td>
<td>1.00</td>
</tr>
<tr>
<td>Seen fruit bats during daytime</td>
<td>3 (25)</td>
<td>5 (14)</td>
<td>2.1</td>
<td>0.34, 11</td>
<td>0.39</td>
</tr>
<tr>
<td>Seen fruit bats during nighttime</td>
<td>8 (67)</td>
<td>13 (36)</td>
<td>3.5</td>
<td>0.9, 15.4</td>
<td>0.06</td>
</tr>
<tr>
<td>Drank raw date palm sap</td>
<td>7 (58)</td>
<td>6 (17)</td>
<td>7.0</td>
<td>1.6, 31</td>
<td>0.01</td>
</tr>
</tbody>
</table>
Date Palm Sap Collection

- Late November through March/April
  - Sap harvesters cut a tap into the tree
    - In the evening they place a clay pot under the tap
    - Each morning the pot is removed
  - Most sap is made into molasses
  - Some sold fresh early in the morning
    - A local delicacy
Manikgonj Outbreak 2008

- 7 trees where implicated date palm sap was collected
- 7 nights of observation
- Mean 15 bat visits per night
- Bats licked the sap mean 8.4 times per night
- 49% of bats were *Pteropus sp.*
## Date palm sap transmission of NIV

### Epidemiological Evidence

<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>Cases Exposed (%)</th>
<th>Controls Exposed (%)</th>
<th>Odds Ratio</th>
<th>95% Confidence Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>Tangail</td>
<td>58</td>
<td>17</td>
<td>7.0</td>
<td>1.6, 31</td>
</tr>
<tr>
<td>2008</td>
<td>Manikgonj</td>
<td>100</td>
<td>25</td>
<td>18</td>
<td>2.2, inf</td>
</tr>
<tr>
<td>2010</td>
<td>Faridpur</td>
<td>69</td>
<td>30</td>
<td>5.2</td>
<td>1.2, 26</td>
</tr>
<tr>
<td>2011</td>
<td>Lalmonirhat</td>
<td>68</td>
<td>11</td>
<td>17</td>
<td>4.0, 70</td>
</tr>
</tbody>
</table>
What contact was associated with Nipah transmission?

Faridpur Cohort Study

- Touching a Nipah patient who later died (RR 15.0, 95% CI 4.0, 65)
- Touching an unconscious patient (RR 4.5, 95% CI 1.7, 12)
- Touching a patient with respiratory symptoms (RR 5.0, 95% CI 2.0, 14)
- Washing hands after contact with Patient F (RR 0.20, 95% CI 0.03, 0.90)

## Bat Visits

<table>
<thead>
<tr>
<th></th>
<th>Bamboo</th>
<th>Dhoincha</th>
<th>Jute</th>
<th>Polyethylene</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bat visits on and around tree</td>
<td>176</td>
<td>45</td>
<td>125</td>
<td>112</td>
<td>4630</td>
</tr>
<tr>
<td>% landed on the tree</td>
<td>20</td>
<td>18</td>
<td>43</td>
<td>11</td>
<td>78</td>
</tr>
<tr>
<td>Number contacting date palm sap</td>
<td>0</td>
<td>0</td>
<td>11</td>
<td>0</td>
<td>3556</td>
</tr>
<tr>
<td>% contacting sap</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>0</td>
<td>76</td>
</tr>
</tbody>
</table>

**Community acceptance and uptake of the intervention?**

Examples of Zoonoses

- Influenza virus
  - Domestic
  - International
- Nipah virus
  - International
- Lyme disease
  - Domestic
Lyme Disease

• The most common tick-borne infection in both North America and Europe

• First cases in 1975
  • Lyme and Old Lyme, CT
  • 50 cases pediatric arthritis
  • EIS investigation

• Borrelia burgdorferi
  • Gram (-) spirochete
  • Discovered 1982
Background

• *Ixodes* spp.
  • *I. scapularis* (Eastern, North-Central US)
  • *I. pacificus* (Pacific Coast)

• Common Names
  • Black-legged tick
  • Deer tick

• Ecology
  • Floor of deciduous forests
  • Brush
  • High humidity

• Life-Cycle
  • Complex
  • Egg → Larva → Nymph → Adult
Signs and Symptoms

3 Stages

- **Early Localized Stage (3-30 days P.I.)**
  - Rash called erythema migrans (EM)
  - Distinct Bull’s Eye appearance
  - Fatigue, chills, fever, headache, muscle and joint aches, and swollen lymph nodes

- **Early Disseminated Stage (days-weeks P.I.)**
  - Facial or Bell's palsy
  - Severe headaches/neck stiffness
  - Joint pain/swelling
  - Heart irregularities

- **Late disseminated stage (months-years P.I.)**
  - Chronic arthritis (60%)
  - Neurological abnormalities (5%)
Vector Life-cycle

- Eggs
- Nymph
- Eggs
- Larva
- Adults

Risk of human infection greatest in late spring and summer.
Established* and reported** distribution of the Lyme disease vectors *Ixodes scapularis (L. dammini) and Ixodes pacificus, by county, United States. 1907-1996

Vector presence
- Red: Established *Ixodes scapularis
- Blue: Reported *Ixodes scapularis
- Green: Established *Ixodes pacificus
- Yellow: Reported *Ixodes pacificus

*at least 6 ticks or 2 life stages (larvae, nymphs, adults) identified.
**at least 1 tick identified.
Epidemiology

• Cases are geographically clustered
  • North Central US
  • North Eastern US

• Incidence
  • Aprox. 22,000 new cases 2010
  • Steady increase
  • Most infections occur during summer months
Interventions

• **Prevention**
  - Protective clothing
  - Repellants (DEET, Pyrethrin)
  - Environmental management
    - Controlled burns
    - Landscaping

• **Acaricides**
  - Broad-application
  - Reservoir targeted

• **Vaccines**

• **Therapy**
  - doxycycline, amoxicillin, or cefuroxime axetil for 2-3 weeks
Protective Clothing
Environmental Management

- Wood chips along stone wall & under foundation plantings
- 3' wide or greater barrier
- Wood pile
- 3 yard tick migration zone
- Vegetable garden with deer fence
- Meadow grasses, wildflowers
- Tick Safe Zone
- Tick Zone
- Mail box
- Deck
- Swing Set
Contraversies

• Some groups argue that the prevalence is much greater than reported
• Conspiracy theorists suggest Lyme disease is clandestinely connected with biological warfare
• Clinical diagnostic criteria and laboratory testing methods are a focus of criticism
Understanding and controlling zoonotic diseases can be vastly complicated.
The Problem

- No one discipline is trained to engage such complex one health problems
- No one agency or organization can control such problems
Poor cooperation

Frustration
About the One Health Initiative

The One Health concept is a worldwide strategy for expanding interdisciplinary collaborations and communications in all aspects of health care for humans, animals and the environment. The synergism achieved will advance health care for the 21st century and beyond by accelerating biomedical research discoveries, enhancing public health efficacy, expeditiously expanding the scientific knowledge base, and improving medical education and clinical care. When properly implemented, it will help protect and save untold millions of lives in our present and future generations.

"May there never develop in me the notion that my education is complete but give me the strength and leisure and zeal continually to enlarge my knowledge."
- Maimonides -

One World-One Medicine-One Health

**Addressing the connections between health and the environment—Accelerated biomedical research discoveries—Enhanced public health efficacy—Expanded scientific knowledge base—Improved medical education and clinical care**

-- ADVANCING HEALTH CARE for the 21st century --
Humans & Animals
Collaborative-Synergistic-Enlightening
ONE HEALTH

One Health is the collaborative effort of multiple disciplines to attain optimal health for people, animals, and our environment.

OBJECTIVE
MISSION
RATIONALE
GOALS
CASE STUDIES
LEADERSHIP
NEWS
SUMMIT
CONTACT
COMMUNITY EXCHANGE

American Veterinary Medical Association

One Health:
A New Professional Imperative

ONE HEALTH COMMISSION

The convergence of people, animals, and our environment has created a new dynamic in which the health of each group is inextricably interconnected. The challenges associated with this dynamic are demanding, profound, and unprecedented.

Despite spectacular achievements in microbial genetics and genomics, we know relatively little about how such zoonotic agents are maintained in nature or how they respond to environmental (often anthropogenic) changes. Improvements are needed in our ability to detect and respond to emerging zoonotic agents, particularly those that appear suddenly and are capable of spreading over large areas. In order to more effectively prevent or control zoonotic diseases, it will be necessary to better understand the ecology of their respective etiologic agents.

The One Health Commission is a call to action for collaboration and cooperation among health science professions, academic institutions, governmental agencies, non-governmental organizations, and industries toward improved assessment, treatment, and prevention of cross-species disease transmission and mutually prevalent, but non-transmitted, human and animal diseases and medical conditions. A changing environment populated by interconnected animal and human contact creates significant challenges. These challenges require integrated solutions and call for:

One Health Newsletter

A quarterly newsletter highlighting the interconnections of animal and human health

Summer 2008

Volume 1, Issue 3

In This Issue

Efficacious “One Health” Implementation

Bruce Kaplan, DVM

This newsletter was created to lend support to the One Health Initiative and is dedicated to enhancing the integration of animal, human, and environmental health for the benefit of all.
Which human, animal, and environmental risk factors predict disease?
Table 1. Organizations that have endorsed the *One Health* Initiative as of July 2011

<table>
<thead>
<tr>
<th>Organization</th>
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</tr>
</thead>
<tbody>
<tr>
<td>American Association of Veterinary Laboratory Diagnosticians</td>
<td>Immuno Valley Consortium in The Netherlands</td>
</tr>
<tr>
<td>American Association of Wildlife Veterinarians</td>
<td>Indian Veterinary Public Health Association</td>
</tr>
<tr>
<td>American College of Veterinary Microbiologists</td>
<td>Institute for Preventive Veterinary Medicine and Food Safety Lazio and Tuscany Regions [Italy]</td>
</tr>
<tr>
<td>American College of Veterinary Pathologists</td>
<td>Institute of Tropical Medicine, Department of Animal Health, Antwerp, Belgium</td>
</tr>
<tr>
<td>American College of Veterinary Preventive Medicine</td>
<td>International Zoonosis Research Institute - Islamabad, Pakistan</td>
</tr>
<tr>
<td>American Medical Association</td>
<td>Italian Society of Preventive Medicine</td>
</tr>
<tr>
<td>American Nurses Association</td>
<td>National Association of State Public Health Veterinarians</td>
</tr>
<tr>
<td>American Physiological Society</td>
<td>National Environmental Health Association (NEHA)</td>
</tr>
<tr>
<td>American Phytopathological Society</td>
<td>National Park Service (USA)</td>
</tr>
<tr>
<td>American Society for Microbiology</td>
<td>New Zealand Centre for Conservation Medicine</td>
</tr>
<tr>
<td>American Society of Tropical Medicine and Hygiene</td>
<td>Nigerian Biomedical and Life Scientists</td>
</tr>
<tr>
<td>American Veterinary Medical Association</td>
<td>Nigerian Veterinary Medical Association</td>
</tr>
<tr>
<td>Association of Academic Health Centers</td>
<td>Praecipio International</td>
</tr>
<tr>
<td>Association of American Medical Colleges</td>
<td>SAPUVET III Project</td>
</tr>
<tr>
<td>Association of American Veterinary Medical Colleges</td>
<td>Society for Tropical Veterinary Medicine</td>
</tr>
<tr>
<td>Association of Schools of Public Health</td>
<td>State Environmental Health Directors</td>
</tr>
<tr>
<td>Conservation through Public Health</td>
<td>United States Animal Health Association (USAHA)</td>
</tr>
<tr>
<td>Corporation Red SPvet, Bogota-Columbia</td>
<td>Veterinarians without Borders/ Vétérinaires sans Frontières - Canada</td>
</tr>
<tr>
<td>Council of State and Territorial Epidemiologists</td>
<td>World Association of Veterinary Laboratory</td>
</tr>
<tr>
<td>Croatian Society for Infectious Diseases</td>
<td>Diagnosticians Zoonotic and Emerging Diseases, Edinburgh, UK</td>
</tr>
<tr>
<td>Delta Society</td>
<td></td>
</tr>
<tr>
<td>Department of Molecular and Comparative Pathobiology, Johns Hopkins University School of Medicine</td>
<td></td>
</tr>
<tr>
<td>Exuberant Animal</td>
<td></td>
</tr>
<tr>
<td>Federation of Veterinarians of Europe (FVE)</td>
<td></td>
</tr>
<tr>
<td>Global Alliance for Rabies Control</td>
<td></td>
</tr>
</tbody>
</table>

One Health Training Elements (Tools)

- Environmental health
- Modern laboratory techniques
- Epidemiology
- Biostatistics
- Food safety
- Animal science
- Meat science
- Soil and water engineering

- Modern animal production
- Human and animal ecological studies
- Agriculture engineering
- Climate change
- Geographical information systems
- Zoonotic infections
- Toxicology
Our One Health Vision

- To train professionals to conduct “one health” investigative and experimental research
- Certificate, Master’s, & PhD programs
- To attract outstanding US and international researchers to such a training program

http://egh.phhp.ufl.edu
Academic Programs

- PHD in Environmental & Global Health
- MPH in Environmental Health
- Certificate in Emerging Infectious Disease Research

http://egh.phhp.ufl.edu
Thank You