Are Animal-Borne Diseases on the Rise?

- Tennessee Public Health Assoc. One Health
- Sept. 12, 2012

Dr. Doug Balthaser
Staff Veterinarian
Tenn. Dept. of Agriculture

Summer of 2012

- 3 people died & 8 were infected with Hantavirus at Yosemite
- 2 Missouri men infected with a never-before-seen virus
- A Colorado girl contacted plague from flea bites while camping
- Nearly 2000 people across the US have had West Nile virus
The number of new diseases crossing from animals to people has increased in recent years

- From fewer than 20 in the 1940s to about 50 in the 1980s
- 75% of emerging human diseases are Zoonotic.

10 million Persons a Year are Affected by Zoonotic Diseases Worldwide

Approximate Mortality per year

- Rabies  55,000 (99% of Human transmission is from dog bites)
- Dengue Virus  5,000 caused by an arbovirus
- Japanese Encephalitis Virus  3,000
- Lassa Fever  1,000 West African virus-fatal
- Yellow Fever  500
- Rift Valley Fever
- Swine Influenza (H1N1) 2009
- Avian Influenza (H5N1) 2003-2011
### USDA APHIS VS Animal Diseases

#### “Top Ten List”

<table>
<thead>
<tr>
<th>Disease</th>
<th>Animal Affected</th>
<th>Public Health Threat</th>
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<tbody>
<tr>
<td>HP Avian Influenza</td>
<td>Poultry</td>
<td>Yes, may be lethal</td>
</tr>
<tr>
<td>Foot &amp; Mouth Disease</td>
<td>Cattle, swine, sheep</td>
<td></td>
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<tr>
<td>Rift Valley Fever</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nipah Virus</td>
<td>Swine</td>
<td>Yes, may be lethal</td>
</tr>
<tr>
<td>Hendra Virus</td>
<td>Horses</td>
<td>Yes, may be lethal</td>
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<tr>
<td>Classical Swine Fever</td>
<td>Swine</td>
<td>Yes, may be lethal</td>
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<tr>
<td>African Swine Fever</td>
<td>Swine</td>
<td>Suspected</td>
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<tr>
<td>Bovine Spongiform Encephalopathy</td>
<td>Cattle</td>
<td></td>
</tr>
<tr>
<td>Japanese Encephalitis</td>
<td>Equine, swine</td>
<td>Yes, may be lethal</td>
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<tr>
<td>EEE &amp; WEE</td>
<td></td>
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</table>

Besides the Public Health Threat, why would the introduction of many of the Foreign Animal Diseases be so devastating in the United States?
U.S. Agriculture - a National Resource

<table>
<thead>
<tr>
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<th>1.9 Million</th>
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<tbody>
<tr>
<td>No. Of Farms</td>
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<tr>
<td>Farm Gate Value</td>
<td>$202 Billion</td>
</tr>
<tr>
<td>Value Toward GDP</td>
<td>$600 Billion or 13.1% of GDP</td>
</tr>
<tr>
<td>Direct and Related Employment</td>
<td>16.9% or 1 in 6 Jobs</td>
</tr>
</tbody>
</table>

"Most reliable, secure and safe supply of food at a reasonable cost that the world has ever known"

Source: Agricultural Statistics Board (National Agricultural Statistics Service)

What is a Foreign Animal Disease

- Any disease that is not presently found in the United States

What is an Emerging Disease

- Any new disease which is caused by a new pathogen or a pathogen that is known but is now acting differently by causing a more **severe** disease
Most Foreign Animal Diseases are caused by **Viruses**

- Viruses consists of a strand of genetic material (DNA).
- The virus pokes its way into a host cell and hijacks the resources of the host cell.

**Zoonotic Viral Agents**

- Avian Influenza
- Rift Valley Fever
- Hantavirus
- Hendra Virus
- Nipah Virus
- Rabies
- West Nile Virus *
- **Viral encephalitis (VEE,EEE,WEE)** *
The Influenza Virus

Orthomyxovirus

• Enveloped RNA Virus
  • Single stranded
• Major surface proteins
  • Hemagglutinin (H1-H16)
  • Neuraminidase (N1-N9)
  • 144 potential combinations

Influenza Classification

Type A, B and C

Type A viruses: More virulent
Reservoir: Aquatic Birds
Host: Affects multiple species-Domestic and wild birds, marine mammals, swine, horses and humans

Type B-Humans

Type C-Humans & Swine
Influenza: The Agent

- Influenza A viruses
- All known subtypes of Influenza A viruses circulate among wild birds—natural hosts (reservoirs)
- Avian influenza (AI) strains (H5N1) circulating in Asia. Close proximity of poultry, people and other animals allows reassortment (mixing) when co-infections occur.

Avian Transmission
Natural Reservoirs of Influenza A Viruses

- Wild aquatic birds
- Majority are represented by two Orders
  - Anseriformes (ducks, geese, and swans)
  - Charadriiformes
    - Gulls
    - Terns
    - Shorebirds
- No clinical disease

Species Affected

Genetic Reservoirs

Intermixing

H1-12, H14-15, H1-2, 4-7, H9-13, 15-16

Other Aquatic Birds?

H1-12, H14-15

H1, H3, H4, H7, H13

H3, H7

H10

H1, H3, LMBs, Others

H1, H3

HLN1

Modified from D. Swayne
Bird flu is very contagious and can cause severe illness or death in domesticated birds including chickens, ducks, and turkeys.

Most human cases of bird flu have resulted from contact with infected poultry or contaminated surfaces.

Signs & Symptoms of Influenza

Symptoms in humans have ranged from typical flu-like symptoms to pneumonia.

Signs range from fever, chills, headache, muscle ache, fatigue to severe respiratory signs.
Signs of Influenza in Poultry

- Mild to severe, in fowl plague (highly pathogenic form).

Signs – coughing, sneezing, lacrimation, sinus infection, facial edema, cyanosis, nervous disorder and diarrhea.

Influenza Pandemic

1918 Spanish Flu
In just over 18 months it is estimated that 400 million people became infected.

Between 30 – 40 million died.

675,000 Americans died.
(200,000 died in October of 1918 alone).

I had a little bird, Its name was Enza.
I opened up the window, And in-flu-enza
Influenza A (H3N2) Variant Virus Outbreaks

- Since July 2012, 297 people from 10 states are reported to have been infected with an influenza A H3N2 variant virus (H3N2v)

- This H3N2v virus contains the matrix (M) gene from the 2009 H1N1 pandemic virus
Influenza A (H1N2) Variant Virus found in Minnesota

- The swine-origin H1N2 variant virus (H1N2v) found in 3 Minnesotans last week carries the matrix gene from the 2009 H1N1 pandemic virus.

- The H1N2v is different from the H3N2v. But the two are alike in that both picked up the pandemic virus’s matrix gene.

Take Home Message

- DON’T PET THE PIG!
Rift Valley Fever

- RNA arbovirus
- Currently in Africa

- 5 to 20 year epizootic cycles.
- Livestock abortions and neonatal deaths
- Death and blindness in humans

Rift Valley Fever

- Agent the Rift Valley virus
- Route of Transmission: mosquitoes (species that have been identified in the United States)
- Clinical Signs: Flu like signs; hemorrhage; fever, encephalitis and death—approximately 50% mortality
It is called the Sin Nombre virus.

All known hantaviruses have a rodent reservoir (i.e. mice, rats, or voles). The Deer mouse is considered the primary reservoir.

The virus is carried in rodent saliva, urine, and feces. Rodents can shed the virus for several weeks to a year.
Hantavirus: The Disease

- Hantavirus Pulmonary Syndrome
- Typically, flu-like symptoms start: fever, muscle aches, headaches.
- After a few hours to a few days, coughing & lung irritation
- Pulmonary capillaries are damaged & fluid begins to leak into the lungs.
- Death results from cardiac failure
Hantavirus: Companion Animals

- Domestic pets can expose people if they bring rodents into the house
- Hantavirus has been isolated from 3 cats in China.

Prevention: Do not stir up dust by sweeping up mouse droppings, urine or nesting materials. Instead wet the area with detergent to deactivate the virus.

Viral Equine Encephalitis (VEE, EEE & WEE)

VEE viruses are transmitted among equines and rodents by a variety of mosquito species. VEE causes flu-like signs; nausea vomiting, encephalitis; seizures, coma and death.

At the present time, direct human-to-human transmission has not been proven.
West Nile virus (WNV)

WNV is the leading cause of arbovirus encephalitis in horses and humans in the United States.

Since 1999, over 25,000 cases of WNV encephalitis have been reported in U.S. horses.

Horses represent 96.9% of all reported non-human mammalian cases of WNV disease.

Zoonotic Viral Agents

- Avian Influenza * chicken, turkey, wild birds, waterfowl
- Viral encephalitis viruses * horses, birds (VEE,EEE, WEE)
- Hantavirus rodents
- Hendra Virus horses, guinea pigs
- Japanese encephalitis pigs
- Nipah Virus pigs, dogs, cats
- Rabies *
- Rift Valley Fever * cattle, sheep, goats
- West Nile Virus 1999 62 Cases in New York state
- 2002 Human Illness 4156 cases, 284 deaths in 40 states.
- 2012 1993 Cases nationwide, including 87 deaths
Non-Zoonotic Viral Diseases

- Foot & Mouth Disease *

African Horse Sickness
- African Swine Fever
- Bluetongue Virus (exotic)
- Classical Swine fever (hog cholera)
- Heartwater
- Malignant Catarrhal Fever (exotic)
- Newcastle Disease
- Rinderpest  “Cattle Plague” Has just been eradicated from Africa

Foot and Mouth Disease Facts

- Most infectious virus known.

- Forms blisters on tongue, lips, feet, teats and internally

- Vaccine for one type does not protect against another

- Vaccine can carry live pathogenic virus - causing further outbreak
Transmission of FMD virus

Mode of transmission:
1. Direct contact
2. Infected animal products
3. Contaminated fomites (animate and inanimate)
4. Aerosol
5. Carriers

Conjectured Status of FMD

- Red: Endemic
- Yellow: Intermediate, sporadic
- Black: Free with vaccination
- Light yellow: Free. Virus present in game parks
- Dark yellow: Free

Endemic
Intermediate, sporadic
Free with vaccination
Free. Virus present in game parks
Free
Foot & Mouth Disease in Cattle

Foot and Mouth Disease

Hooves Slough - Pigs Cannot Walk
Non-Zoonotic Viral Diseases

- Foot & Mouth Disease *Cattle, goats & pigs
- African Horse Sickness Horses, donkeys, mules
- African Swine Fever Pigs
- Akabane virus Cattle, sheep & goats
- Bluetongue (exotic) Sheep, goats, cattle, deer, elk
- Classical Swine fever (hog cholera) Pigs
- Heartwater cattle, sheep, goats
- Malignant Catarrhal Fever (exotic) cattle
- Newcastle Disease Poultry
- Rinderpest “Cattle Plague” cattle

Human Disease from Bacterial Agents

- Anthrax *
- Clostridium esp. botulism
- Plague *
  - Tularemia *
  - Brucellosis melitensis
  - Glanders
  - Q Fever
  - E. coli and Salmonella

* Potential Bioterrorist Agents
Anthrax

- Bacteria: Bacillus *anthracis*
- Forms Spores that can last decades

Human disease (four types)
- Skin
- Intestinal
- Inhalational
- Septicemia & death
Anthrax Spore

- Spore is magnified 137,000
- Lethal Human Dose is 2500-55,000 Spores.

Introduction

- Names
  - Human: Malignant carbuncle, Woolsorter’s Disease
  - Veterinary: Splenic fever, Charbon, Milzbrand
- Transmission
  - Human: direct contact with infected livestock
  - Livestock: grazing within endemic areas
- Disease is caused by toxins
- Category A critical biological agent
**Epidemiology**

- **Worldwide**
  - Hyperendemic areas in U.S.
    - SD, OK, NB, Southwestern TX
- **Epizootics associated with drought, flooding, or soil disturbance**
  - Many years may pass between outbreaks
- **Environmental persistence of spores: Increased with high**
  - soil nitrogen, soil alkalinity (>pH6), and ambient temp (>60°F, 16°C)

*Dead wood bison, NWT, Canada, ‘saw horse’ posture*

**Clinical Signs**

- **I.P.: 3-7 days (1-14 days)**
- **Humans:**
  - Cutaneous (skin) form: 95% human cases
  - CFR: <20% Cutaneous, <50% Gastro, <95% Inhalational
- **Ruminants:**
  - Sudden death: bloated 'saw horse’ - Hemorrhage from orifices, bloating, incomplete rigor
- **Horses: Bloody diarrhea**
  - Colic and death in 48-96 hr
- **Pigs: can get all 3 forms**
- **Dogs & Cats: gastrointestinal**
Cutaneous Anthrax
Source: ER1.org

Anthrax skin lesion

Progressive cellulitis and blistering in cutaneous anthrax.

Inhalational Anthrax

Mediastinal widening due to lymphadenopathy (JAMA 1999:281:1735)

Mediastinal widening and pleural effusion
The letter sent to Tom Brokaw contained coarse granules capable of causing skin infections. The deadlier ‘weapons-grade’ anthrax was sent in letters to Senators Daschle and Leahy.

Anthrax the Disease

- Dogs
  - Relatively resistant
  - Pharyngitis
  - Gastroenteritis
  - Edema of lips, face, head and neck
  - Sudden death
**Clostridium**

- *Cl. Botulinum*: Gr +, spore forming, anaerobe
- Animals ingest toxin in decaying rodent tissue, maggots, grass/hay/silage/grain
- 7 toxins: A-G produced by Cl botulinum
  - A: chickens & mink;
  - B: cattle, horses & chickens;
  - Alpha C: waterfowl,
  - Beta C: cattle, horses, mink and dogs,
  - D: cattle, sheep & horses,
- Most toxic compounds known
  - Oral toxic dose: 1 ng/kg
  - Aerosol toxic dose: 3 ng/kg

**Summary**

- Most species are susceptible
- Humans: 3 natural forms:
  - Food borne; Wound (rare); Intestinal descending flaccid paralysis
  - Treatment: antitoxin, which is only available from 2 sources
- CDC: A/B/E and A/B/C/D/E • US Army: all 7 types
2. Botulism

Seventeen-Year-Old Patient With Mild Botulism

Two Mallards with ‘Limber Neck’.

Northern Pintail ducklings dead of Type C Botulism. Each had fed heavily on maggots just prior to death.

Source: Canadian Cooperative Wildlife Health Service
Plague-Black Death

- *Yersinia pestis*: Gr - rod, bipolar
- Occurs worldwide
- Hosts: >200 spp of mammals
  - Cats, (domestic and wild), *Prairie Dogs*, Ground Squirrels, Rabbits, Hares, Rats
  - Dogs and Carnivores are fairly resistant
  - 31 species of fleas are proven vectors
    - directly from ill cats: 6 were vets/staff

'State of Illinois' Map

Summary

- Endemic W & SW USA
- Most common route: flea bite
- Cats easily transmit to humans
- I.P.: Cats: 1-2 days; Man: 1-10 days
- Cats, Prairie Dogs & Humans:
  - Bubonic, Pneumonic and Septicemic
  - Cats: enlarged Submandibular l.n.
- Dogs: Fever, rapid recovery
3. Plague: ‘Black Death’

Patients With Naturally Occurring Plague  Source: jama.ama-assn.org

Summary

- Pneumonic form fatal if not treated within 1 day
- Disinfectant: Iodophor, Bleach (1:5)
  Incinerate animal, syringes, PPE
  Prevent with Frontline, Advantage, etc.
- No vaccine
- Reportable in man and animals

- Bioterrorism
  - Most efficient exposure route: aerosol
  - Aerosols infect humans and cats easily
  - Cluster of pneumonic cases
• Sylvatic plague increasing in SW U.S. • Last 20 years - 300 cases in cats, 30 cases in humans

regular outbreaks in prairie dogs every 4-5 years

Plague in Cats

• Same forms of disease as in humans
• Most cases BUBONIC, with lesions around head
• Secondary pneumonic form reported - DANGER
Tularemia: The Disease

- Sheep, young pigs, horses, dogs, cats
- Sudden fever, lethargy, stiffness prostration, and death
- Wildlife-usually found dead
- Rabbits behave strangely
- Cattle, older pigs resistant.

Tularemia

- WHO estimates 50 kg agent: city population 5 million
  - 250,000 ill & 19,000 deaths
- Stable
- Aerosolized
- Low infective dose via inhalation
- Mortality 21-49% if untreated
### Brucellosis

- Gram negative bacteria
- Ingestion, inhalation, or direct contact
- Clinical signs-Humans: cyclic fever and flu-like symptoms
- Animals: reproductive signs

<table>
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<tr>
<th>Species</th>
<th>Natural Host</th>
<th>Human Pathogen</th>
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<tbody>
<tr>
<td>B. abortus</td>
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<td></td>
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<tr>
<td>B. melitensis</td>
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<tr>
<td>B. suis</td>
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<tr>
<td>B. canis</td>
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<tr>
<td>B. ovis</td>
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<td>No</td>
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<tr>
<td>Cattle</td>
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<td>Goats, sheep</td>
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<tr>
<td>Pigs, reindeer</td>
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<tr>
<td>Dogs</td>
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<tr>
<td>Sheep</td>
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</table>
Human Disease from Bacterial Agents

- Anthrax *cattle, sheep, goats, horses
- Clostridium esp. botulism cattle, sheep, goats, birds
- Plague *cat
  - Tularemia *sheep, less severe in horses
  - Brucellosis melitensis sheep, goats, cattle
- Glanders horses, donkeys, mules
- Q Fever cattle, sheep, goats (moderate)
- E. coli and Salmonella

* Potential Bioterrorist Agents

“No, I wouldn’t call you a mad cow exactly—I’d say you’re a cow with issues.”

© 2001 MARLETTE—NEWSOAY
Prions

- They are very unusual infectious agents. They cause “spongiform encephalopathy”

- Prion is an infectious protein. It doesn’t have any DNA to replicate itself. Prions get into the body by ingestion. In the neurons they accumulate in big bundles and “clog” the cell.

The Causative Agent of BSE

- PrPSc converts PrPc to PrPSc
  - PrPSc accumulates – causing nerve cell lysis
Spongiform Encephalopathies
- Bovine spongiform encephalopathy- BSE or mad cow disease
- Scrapie (a disease of sheep)
- Chronic wasting disease (a disease of elk & deer)
- Creutzfeldt-Jakob disease of humans

Response to a Biological Disaster
- The response is similar whether the disease is naturally occurring or intentional (Terrorist)
- There is a local response from the animal owner, veterinarian or County Extension Agent in notifying the USDA or Tennessee Department of Agriculture of a suspicious disease.
- If the disease is zoonotic, it warrants a different response because of the Public Health threat, the Department of Health would be activated.
Response to a Potential Biological Disaster

- A specially trained Foreign Animal Disease Diagnostician (FADD) is sent to investigate the animals as soon as possible. (There are 7)

- The FADD determines if the disease conforms to a Foreign Animal Disease (FAD) and will call the Nashville offices if it does

- The TDA/USDA will notify TEMA & The farm is quarantined until the tests results are known