Lesson Overview

- Definitions
- The Problem
- Causal Factors
- Control Measures
- Example

Definitions

- Pest: Serious or fatal disease (archaic)
- Pestilence: Any, usually fatal, epidemic disease
- Zoonotic Disease: Diseases transmitted from vertebrate animals to humans through various routes
  - Pets
  - Livestock
  - Wildlife
Definitions Continued

Vector:
- An arthropod which carries a pathogen to a new host
- Any organism which helps a pathogen reach a new host
- An animate vehicle

Vectorborne Disease: Diseases transmitted by a vector

Zoonotic Diseases

Table 3.2 Number of Diseases that Human Populations Share with Domesticated Animals

<table>
<thead>
<tr>
<th>Animal</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poultry</td>
<td>26</td>
</tr>
<tr>
<td>Rodents</td>
<td>32</td>
</tr>
<tr>
<td>Horse</td>
<td>35</td>
</tr>
<tr>
<td>Pig</td>
<td>42</td>
</tr>
<tr>
<td>Sheep/Goats</td>
<td>46</td>
</tr>
<tr>
<td>Cattle</td>
<td>50</td>
</tr>
<tr>
<td>Dog</td>
<td>65</td>
</tr>
</tbody>
</table>

Source: McNeil WH. Plagues and People, 1977

Zoonotic Disease Transmission

- Direct Contact
- Transmission by Vectors
**Direct Animal Contact**

- Disease agent found in saliva, blood, other body tissues
- Bites, scratches
- Contact with animal tissues or fluids (open cuts or on mucous membranes)
  - livestock - veterinarians, farmers
  - wildlife - handling dead or ill animals, field specimen collections

**Direct Animal Contact**

- Anthrax - Handling sheep, other animals
- Plague - trappers skinning animals, blood or tissue contact, also flea bites
- Brucellosis - livestock tissue contact
- Ringworm - fungal infection (young kittens, puppies)
- Rabies - bites, scratches (virus found in saliva, salivary glands, nerve tissue only)
- Rat bite fever - (Streptococcal bacterial infection)
- Tularemia - rabbits, hares, rodents (also transmitted via other routes)

**For Example**

- 900 Salmonella cases reported annually in Washington
  - Difficult to identify source of exposure for every case
    - Most probably are foodborne
    - Unknown percentage due to animal contact
    - Some waterborne, some person-to-person
    - Need good thorough investigations
  - Consider animal exposure
Salmonella Sources

- High percentage of reptiles (snakes, lizards, turtles) naturally carry Salmonella without signs of illness
- Serious cases in infants, immunocompromised, elderly
- Any animal food product may harbor Salmonella
- Outbreaks: Denver Zoo, Oregon infant cases, petting zoos

Transmission by Vectors

- Ticks, mosquitoes, fleas, flies acquire disease agent from animal reservoir and transmit it to another host
- Natural host is not affected by the agent
- Accidental host may be severely ill or die
- Washington - low incidence of reported vector-borne diseases

The Vector Problem

- Nuisance
- Property damage
  - Crops
  - Structures
  - Goods
- Human disease
Nuisance

Each year . . .

- American consumers spend $600,000,000 on pest control
- 60% is spent in the residential market
- $2.9 Billion is spent on professional pest control

Economic Impact

Each year . . .

- 1/3 of the world’s crops are destroyed during growth, harvesting and storage
- 25% of home gardener’s crops destroyed
- $20 Billion in crop loss/damage
- Residential damage = ???

Important Zoonotic & Vectorborne Diseases

- Arboviral Encephalitides
- Dengue
- Hantavirus
- Lyme Disease
- Malaria
- Plague
- Rabies
- RMSF
- Tularemia
- Typhus (Epidemic)
- Typhus (Murine)
- Yellow Fever
On the web...

Vectorborne Disease

United States, Selected Years 1990 - 2002

Vectorborne Disease

United States, Selected Years 1990 - 2002
Vectorborne Disease

WNV
Total US Cases, 2003
9,862

Vectorborne Disease

WNV
Total US Cases, 2004
2231

Generalized Vector Cycle

Vector → Human → Host → Agent → Reservoir → Vector
**Vectorborne Disease Ecology**

- The agent becomes established in an animal population
- The animal population comes into contact with man
- (one or the other, or both, move)
- The vector must be able to transmit the agent to humans

**Disease Ecology Continued**

- Epizootic conditions prevail
  - Sufficient numbers of infective vectors
- Appropriate climatic conditions exist
  - Temperature range
  - Humidity
  - Rainfall
- Confluence of all of these factors is necessary

**Important Vectors**

- Arthropods
  - Mosquitoes
  - Other flies
  - Fleas
  - Ticks
  - Lice
  - Mites
- Other Animals
  - Rats
  - Mice
  - Bats
  - Birds
Lesson 9: Zoonotic Diseases

Transmission

- Mechanical
- Biological

Tickborne Diseases

- Lyme disease
- Relapsing fever
- Tularemia
- Ehrlichiosis
- Babesiosis
- Rocky Mountain Spotted fever
- Tick paralysis (intoxication)

Rocky Mountain Spotted Fever

Number of Cases

Year
Diseases Transmitted by Flies

- Tularemia - deer fly bites
- Mechanical transmission of enteric bacteria (Salmonella, Shigella, Campylobacter)

Tularemia

1990-2000
- 1,368 cases of
- from 44 states
- ~ 124 cases/year
- Range = 86-193

Tularemia

Photo CDC file

Tularemia

Figure 1. Finger of patient infected with tularemia
Lesson 9: Zoonotic Diseases

Tularemia

Tularemia in Washington

Fleaborne Diseases

- Bartonellosis - formerly cat scratch fever
- Tapeworms
- Plague - (1984) one human case in Washington

Plague

- Early 1330s an outbreak of bubonic plague occurred in China
- Spread to western Asia and Europe
- Sicily, October of 1347
Plague

- 1348: spread as far north as England
- 25 million people died in 5 years

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Plague

- Estimated population of Europe from 1000 to 1352:
  - 1000 ~ 38 million
  - 1100 ~ 48 million
  - 1200 ~ 59 million
  - 1300 ~ 70 million
  - 1347 ~ 75 million
  - 1352 ~ 50 million

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London, 1665-1666

- Disappeared after 1352
- Until the mid-17th century
Plague in the U.S.

So What?

Plague: Distribution
Plague in the U.S.


Plague: Incidence

Number of Human Plague Cases
United States, 1970 - 1995

Plague Incidence

[Graphs and data showing plague incidence over time and geographical distribution.]
Plague

- **Agent:** *Yersinia pestis* (bacterium)
- **Vector:** *Xenopsylla cheopis* (Oriental Rat Flea)
- **Reservoir:** *Rattus Norvegicus* and *Rattus rattus* (Norway and Roof Rats)
- **Onset:** 2-6 days after being bitten
- **Disease:** Bubonic, Pneumonic & Septicemic

Bubonic Plague

- High Fever
- Toxemia
- Petechiae
- Shock
- Buboes

Plague: Agent

*Yersinia pestis*
Plague: Vectors - Cont'd.

Life cycle of the flea

Reservoir

Urban

Rural

Mosquitoborne Diseases

- Western equine encephalitis virus
- St. Louis encephalitis virus
- Both have occurred in Washington but no reported cases since early 1980's
- West Nile virus
  - detected in 1999 in New York City
  - human and horse deaths, dead birds
  - progressing to other states in 2000
  - Planned surveillance effort in Washington
West Nile Virus

Mosquito vector
Incidental infections
Bird reservoir hosts

Arboviral Diseases
United States 1964 - 1996
Lesson 9: Zoonotic Diseases

SLE Cases

Human St. Louis Encephalitis Cases State by State, 1964-1998

4,478 confirmed cases

St. Louis Encephalitis Virus Transmission Cycle

Mosquito vectors (Culex species)

Virus

Vertebrate reservoirs

Bird and bat hosts

Courtesy CDC
Causal Factors

- A “good” vector must:
  - Be able to harbor the agent
  - Be able to spread the agent
  - Be mobile
  - Survive long enough to:
    - Reproduce
    - Disseminate the agent
  - Have wide zonal tolerances

Emerging Diseases
**Protecting the Public's Health**

- Surveillance
- Personal Protection and Education
- Vector Control

**Zoonotic Disease Program**

- Education/technical assistance
- Prevention information
- Case investigation (human and animal)
- Surveillance
  - Human and animal cases
  - Animal reservoir, arthropod vectors

**Personal Protection**

- Wear long sleeves & pants in mosquito-infested areas
- Use repellent containing DEET (N,N-diethyl-3-methylbenzamide) and follow directions carefully
- Limit outdoor activities at dawn and early evening
- Repair holes in door & window screens
Lesson 9: Zoonotic Diseases

Control

→ Usually involves controlling the vector
  - Habitat reduction / modification
  - Sanitation
  - Larvaciding
  - Adulticiding
  - Integrated Pest Management (IPM)

To Control Vectors

→ Deny them:
  - Water
  - Food
  - Harborage
  - Warmth

Surveillance

→ What does it mean?
  - Human and animal cases
    - who, when, where, how
  - Prevalence studies
    - reservoir animals
    - arthropods (ticks, mosquitoes)
  - Population monitoring
  - Species distribution
For Example

WNV Surveillance:
- Dead birds
  - Especially crows, jays, magpies
- Mosquitoes
- Captive sentinels (e.g. chickens)
- Veterinary surveillance
- Human surveillance

Estimated Sensitivity of WNV Surveillance Methods

<table>
<thead>
<tr>
<th>Time</th>
<th>Disease Activity</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Human cases</td>
</tr>
<tr>
<td></td>
<td>Veterinary cases</td>
</tr>
<tr>
<td></td>
<td>Mosquitoes</td>
</tr>
<tr>
<td></td>
<td>Sentinel hosts</td>
</tr>
<tr>
<td></td>
<td>Dead birds</td>
</tr>
</tbody>
</table>

EVS Mosquito Traps

Packed with dry ice in preparation for trapping.
Setting the trap in proper location.

In operation.

### WNV Mosquitoes in Washington

<table>
<thead>
<tr>
<th>Mosquito species</th>
<th>Counties (39)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Aedes cinereus</em></td>
<td>29</td>
</tr>
<tr>
<td><em>Aedes vexans</em></td>
<td>27</td>
</tr>
<tr>
<td><em>Culex pipiens</em></td>
<td>28</td>
</tr>
<tr>
<td><em>Culex restuans</em></td>
<td>1</td>
</tr>
<tr>
<td><em>Culex tarsalis</em></td>
<td>35</td>
</tr>
<tr>
<td><em>Anopheles punctipennis</em></td>
<td>26</td>
</tr>
<tr>
<td><em>Coquilletidia perturbans</em></td>
<td>10</td>
</tr>
<tr>
<td><em>Ochlerotatus canadensis</em></td>
<td>5</td>
</tr>
<tr>
<td><em>Ochlerotatus japonicus</em></td>
<td>1</td>
</tr>
</tbody>
</table>

Mosquito species that have been found in Washington.
Control Measures

- Appropriate for pest
- Acceptable to community
- IPM approach
- Good records

Control Measures Continued

- Arthropods
  - Sanitation
  - Environmental modifications
  - Pesticides
    - Larvicides
    - Adulticides
  - Repellants

Control Measures Continued

- Rodents
  - Sanitation
  - Environmental modifications
    - Rodent proofing
  - Trapping
  - Rodenticides
Integrated Pest Management (IPM)

- Physical Control
- Mechanical Control
- Biological Control
- Chemical Control

IPM

- Physical Control
  > Sanitation
  > Environmental modification
- Mechanical Control
  > Trapping

Habitat Reduction

- Eliminate standing water (flower pots; tires; wheelbarrows; wading pools)
- Change the water in bird baths at least weekly
- Aerate and chlorinate swimming pools and hot tubs; cover if possible
- Consider mosquito-eating fish for your pond
- Keep gutters clean to prevent standing water
- Spread the word: educate your friends and neighbors
**IPM Continued**

- **Biological Control**
  - Use resistant species
  - Natural enemies
  - Sterile males
  - Biological insecticides
    - Insect Pheromone
    - Bacteria

- **Chemical Control**
  - By Application
    - Larvicides
    - Adulticides
  - By Mode of Action
    - Stomach poisons
    - Contact poisons

- **Chemical Control Continued**
  - By Chemistry
    - Inorganics
    - Organochlorine compounds
    - Organophosphate compounds
    - Carbamate compounds
    - Pyrethrins & Pyrethrroids
Cooperation / Coordination

- Federal
- State
- Local
- Private sector (PCOs)

Questions

Summary

- Historically vectorborne diseases have been a major threat
- Well controlled in industrialized world since WW/II
- Remains a problem in developing world
- Emerging problem for the entire world
Lesson 9: Zoonotic Diseases

Next Lesson

Food Protection

Resources

- Web Resources:
  - Dengue Fever
  - Lyme Disease
  - Plagues
  - Arboviral Encephalitides
  - West Nile Virus
  - Japanese Encephalitis
  - Yellow Fever
  - Tularemia
  - www.doh.wa.gov/WNV