Update on Zoonotic Infections & Diagnostics

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ASCLS & the Association of Public Health Laboratories (APHL) Webinar Series!
Abstract

Agents responsible for zoonotic disease play a critical role in the intersection of animal and human health. There is a critical link between the clinical sciences through essential roles in learning for students and professionals, diagnosis and reporting of zoonotic disease, and scientific research. Updates on zoonotic agents and diagnosis will be provided.
Objectives

• Summarize the most common agents of zoonotic infections in humans.

• Review the type of samples to be collected, the guidelines for collection of these samples, and the different laboratory methods used to diagnose zoonotic infections.

• Correlate a patient history (e.g. animal exposure, geography, etc.) with zoonotic disease.
Zoonotic Risk is Increasing

• **1,415 species** of infectious agents reported to cause disease in humans
  – viruses, prions, bacteria, rickettsia, fungi, protozoa, helminthes
  – **868 (61%)** are known to be zoonotic

• **175 species** considered “emerging”
  – **132 (75%)** are known to be zoonotic
Zoonotic Risk is Increasing

- 60% of US Household have ≥1 pet
- Multiple pets in the home
- Human-animal bond is resolute
- Exotic species are increasingly kept as pets
Risk increasing

Entering the U.S.

- Global Air Travel: 730 million people daily
- People: 1.4 million daily, 500 million annually
- Animals: Greater than 38,000 daily
- Trucks: 11.2 million annually
- Rail Cars: 2.2 million annually
- Foreign Ships: 7,500 make 51,000 calls annually
Emerging and Re-Emerging Zoonoses, (Source: WHO)

- Cryptosporidiosis
- West Nile Virus
- Hantavirus pulmonary syndrome
- Lyme Borreliosis
- Leptospirosis
- Venezuelan Equine Encephalitis
- E.coli O157
- E.coli non-O157
- Brucellosis
- West Nile
- Reston virus
- Lassa fever
- Yellow fever
- Ebola
- Rift valley Fever
- Monkeypox
- Equine morbillivirus
- Hendra virus
- E.coli O157
- Influenza A(H5N1)
- Reston Virus
- Nipah Virus
- Ross River virus
Zoonotic Diseases

Terminology

zoology: (Gr) “zoon”= animal; “-ology”= study of..

Study of animals from single-celled Protozoans, to complex multicellular mammals.
Zoonotic Diseases

Terminology

• **Zoonoses:** Those diseases and infections that are naturally transmitted between vertebrate animals and humans.

• **Emerging Zoonoses may include:**
  – Old diseases, new hosts
  – Old diseases, new areas
  – New diseases
Zoonotic Diseases

Terminology

Reservoir Host
An animal that harbors the disease organism

- Types of reservoirs
  - Symptomatic Cases
  - Asymptomatic Carriers
  - Mostly Vertebrates
  - Inanimate objects (fomites)
Zoonotic Diseases

Terminology

Reservoir:

• Vertebrate, or

• Invertebrate
Zoonotic Diseases

Terminology

Arthropod Vectors
Zoonotic Diseases

Terminology

Arthropod Vector Types:

1. Biological: required in order for the pathogen to become infectious before reaching **susceptible host**.

2. Mechanical: physically delivers the pathogen from the **Reservoir** to the **susceptible host**.
Zoonoses

• Do NOT include:
  – Fish and reptile toxins
  – Allergies to vertebrates
  – Diseases in which animal-derived food serves as a vehicle (e.g. hepatitis A contaminated deli meat)
  – Experimentally transmitted diseases
Types of Pathogens

- Viruses
- Bacteria
- Fungi
- Others
  - Rickettsia
  - Protozoa
  - Parasites

Always assume every animal is shedding pathogens.
Viral Zoonoses

• Rabies
• West Nile Virus (WNV)
• Avian flu (cats, dogs, horses)
• Monkeypox
• Eastern Equine Encephalitis
• Hantavirus
• Lymphochooriomeningitis
WNV – TX 2012 outbreak

- The total number of fatalities is now 78. Mean age of fatalities is 76.4; the median is 79.7. Age range = 25.4 – 100.1 years. (**as of 10/26/12**)
- The number of WN illnesses reported for 2012 is now 1,711 (785 WNND and 926 WN fever).
- Mean age of WNND cases is 57.2 years. Age range = 11 days to 100.1 years. Mean age of WN Fever cases is 50.4 years. Age range is 3 months to 93.0 years.
- The total number of asymptomatic blood donors reported is 103.
- Majority of all counties with a foci in DFW area; large numbers of horses and positive mosquito pools
WNV – TX 2012 outbreak

A *Culex pipiens*, common house mosquito, the species most likely to carry West Nile virus.

http://www.dshs.state.tx.us/news/updates.shtm
WNV – TX 2012 outbreak

At a Glance (labtestsonline.org)

Why Get Tested?
To determine the cause of viral meningitis or encephalitis that occurs during the summer season; to detect the presence of West Nile Virus (WNV) and to track its spread in the community and across the United States; to screen for WNV in donated units of blood, tissues, or organs

When to Get Tested?
When someone has symptoms suggesting WNV such as headache, fever, stiff neck, and muscular weakness and a diagnosis of encephalitis and/or meningitis

Sample Required?
Cerebrospinal fluid collected from a spinal tap and/or a blood sample drawn from a vein in your arm

Laboratory tests. If you are infected, a blood test may show a rising level of antibodies to the West Nile virus. Antibodies are immune system proteins that attack foreign substances, such as viruses. A positive ribonucleic acid (RNA) test for the West Nile virus also is an indicator that you have the virus.
Monkeypox

• Carriers
  – Rats, prairie dogs and rabbits
  – Especially when imported from Africa
• Transmission – direct contact
• Symptoms (carrier)
  – Listlessness, respiratory infection
  – Patchy hair loss with scabs
• Symptoms (people)
  – Fever and pox-like rash 1-2 weeks after handling rodents
Monkeypox

• Most laboratories do not have the reagents to do this testing, so state labs or the CDC will need to process the samples to establish a definitive diagnosis. These tests are based on detecting antigenic structures (usually from skin or pox samples or occasionally serum) specific to either monkeypox virus or immunoglobulin that reacts with the virus. PCR (polymerase chain reaction), ELISA techniques (enzyme-linked immunosorbent assay), or Western blotting tests (immunoblotting) are the main tests used.
Bacterial Zoonoses

- *Bartonella sp.* – Cat Scratch Fever
- *Bordetella bronchiseptica* – Kennel Cough
- *Borrelia burgdorferi* – Lyme Disease
- *Brucella canis* – Undulant Fever
- *Campylobacter spp.*
- *Chlamydia spp.* – Parrot Fever
- *Clostridium tetani* - Tetanus
- *Capnocytophagia* - DF2 (dysgonic fermenter 2)
Bacterial Zoonoses

- *Escherichia coli*
- *Francisella tularensis* - Tularemia
- *Leptospira interrogans* – Weil’s Disease
- *Mycobacterium spp.* – Leprosy and Tuberculosis
- *Pasteurella multocida*
- *Salmonella spp.*
- *Shigella spp.*
- *Spirillum minus* – Rat Bite Fever
- *Yersinia pestis* – Bubonic Plague
Lyme Disease

- *Borrelia burgdorferi*
- Affects dogs and humans (not cats)
- Prevalent only in certain areas – check with your vet
- Transmission
  - deer ticks - *Ixodes spp.*
  - must be attached for at least 24 hours, to cause infection
Lyme Disease

• Symptoms
  – Early
    • Skin rash at the tick bite
    • Fever, muscle aches, enlarged lymph nodes
  – Late
    • Neurologic, Kidney, Heart disease
    • arthritis
Lyme Disease

- Treatment - antibiotics
- Prognosis
  - Difficult to cure dogs
  - People treatable if treated early
  - Difficult to cure chronic infections in people
- Prevention
  - control ticks
  - Non-core vaccine available for dogs
# Lyme Disease

<table>
<thead>
<tr>
<th>ELISA screen, human</th>
<th>Serum</th>
<th>0.5-1 ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human Western Blot confirmation (Trinity Biotech)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IFA screen/titer, canine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canine Western Blot confirmation (Immunetics)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Rickettsial Zoonoses

- Rickettsia – small bacteria like organism that lives inside the cells of its host. Often carried by ticks or fleas.
- *Rickettsia ricketsii* – Rocky Mountain Spotted fever
- *Wolbachia spp.* – a rickettsia that infects the canine heartworm, causing significant inflammation in the dog
- Typhus
- Many think Lyme Disease is a rickettsia, but it is a large bacteria
Rocky Mountain Spotted Fever

- Transmission – ticks (*Dermacentor* spp.)
- Symptoms (dogs)
  - Fever, back pain, lethargy
  - Swollen ears, nose, face, under belly
  - Kidney failure
  - Low platelet count
- Symptoms (people)
  - Fever, headache, muscle pain
  - Skin rash (red dots – petechiae)
  - Nausea, vomiting
Rocky Mountain Spotted Fever

• Treatment – antibiotics, cortisones
• Prognosis
  – Can be fatal to dogs if not treated
  – Dogs who are treated early do very well
  – 5-10% fatal to people
• Prevention
  – Control ticks
# Rocky Mountain Spotted Fever

<table>
<thead>
<tr>
<th>Material</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>IFA (IgG, IgM), human IFA</td>
<td>Serum</td>
</tr>
<tr>
<td>IFA, canine</td>
<td>0.5-1 ml</td>
</tr>
</tbody>
</table>

![Image of a hand with rash]
Fungal Zoonoses

- *Blastomyces* – systemic fever
- *Coccidioides* – bone infection
- *Cryptococcus* – skin lesions
- *Dermatophytes* (ringworm) – skin lesions
- *Histoplasma* – systemic fever
- *Sporothrix schenckii* – skin lesions, fever
Fungal hyphae on infected hair
Protozoal Zoonoses

- Protozoon – microscopic parasite
- *Coccidia* spp.
- *Cryptosporidium parvum*
- *Giardia* – Beaver Fever
- *Toxoplasma gondii*
- *Encephalitozoon cuniculi*
Helminthes Zoonoses

• Helminthes = worm
• *Ancylostoma caninum* - hookworms
• *Bayliascaris procyonis* – raccoon roundworm
• Tapeworms
  – *Dipilydium caninum*
  – *Echinococcus granulosa* – Hydatid disease
  – *Taenia spp.*
• *Toxocara cati* – roundworm
• *Uncinaria spp.* - hookworm
Arthropod Zoonoses

• Arthropod = bugs (insects & arachnids)
  – Arachnids = ticks and spiders
• Chyletiella (Walking Dandruff)
• Fleas & Ticks
• Sarcoptes scabei – dog scabies
• Lice on birds, deer, cattle, etc.
• Lice on cats and dogs are rare
Arthropod Zoonoses
Case study

- A Louisiana FFA instructor at rural high school routinely harvested and butchers feral swine for his meat science class.

- Symptoms included several weeks of repetitive “fevers and chills,” including soreness and muscle fatigue, severe headaches, and overall weakness.

- He reports to his family physician and discusses his history (occupation, travel in his own state for FFA functions recently, and other typical items – diet, family, recreation).

- The physician takes a blood sample and submits it to the medical laboratory.

- At this point, what do you think the physician suspects in his differential diagnosis?
Case study (LA)

- At the laboratory, the blood sample is plated to multiple selective/differential media and also aerobic and anaerobic blood bottles are inoculated.
- After 24h of incubation, the aerobic blood bottle sounds an alarm for a positive.
- Gram stains are performed and it’s plated on blood agar.
Case study (LA)

- Short, coccobacillus faintly stained GN rods that are non-motile are observed.
- Small, smooth, convex, transparent and non-hemolytic colonies form after 5 days on blood agar.
- Oxidase/catalase/urea positive & weakly H₂S positive.

Suspicions?
Brucella suis

- Free: United Kingdom, Canada
- Eradicated: Holland, Denmark
- Low Incidence in Middle East & North Africa.
- Prominent wildlife reservoir in Southern U.S. = feral swine
Laboratory Diagnoses:

Laboratory criteria for diagnosis:

• Isolation of *Brucella* from a clinical specimen; or,

• Fourfold or greater rise in *Brucella* agglutination titer between acute- and convalescent-phase serum specimens obtained 2+ weeks apart and studied at the same laboratory; or,

• IgG titer of greater than 80 indicates active infection; or,

• Demonstration by immunofluorescence of *Brucella* species in a clinical specimen.
<table>
<thead>
<tr>
<th>Species</th>
<th>Biovar/Serovar</th>
<th>Natural Host</th>
<th>Human Pathogen</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>B. abortus</em></td>
<td>1-6, 9</td>
<td>cattle</td>
<td>yes</td>
</tr>
<tr>
<td><em>B. melitensis</em></td>
<td>1-3</td>
<td>goats, sheep</td>
<td>yes</td>
</tr>
<tr>
<td><em>B. suis</em></td>
<td>1, 3</td>
<td>swine</td>
<td>yes</td>
</tr>
<tr>
<td>&quot;</td>
<td>2</td>
<td>hares</td>
<td>yes</td>
</tr>
<tr>
<td>&quot;</td>
<td>4</td>
<td>reindeer, caribou</td>
<td>yes</td>
</tr>
<tr>
<td>&quot;</td>
<td>5</td>
<td>rodents</td>
<td>yes</td>
</tr>
<tr>
<td><em>B. canis</em></td>
<td>none</td>
<td>dogs, other canids</td>
<td>Yes (but of low virulence)</td>
</tr>
<tr>
<td><em>B. ovis</em></td>
<td>none</td>
<td>sheep</td>
<td>no</td>
</tr>
<tr>
<td><em>B. neotomae</em></td>
<td>none</td>
<td>Desert wood rat</td>
<td>no</td>
</tr>
<tr>
<td><em>B. maris/ B. pinnipedia</em></td>
<td>none</td>
<td>marine mammals</td>
<td>yes</td>
</tr>
</tbody>
</table>
Virulence Continuum: (humans)

B. melitensis > B. suis > B. abortus > B. canis

B. maris?

Spectrum of Reservoirs
Case comments

- Undulant fever may have daily periodicity (rising in afternoon and falling at night – patient drenched in sweat)
- Immunity usually good post-recovery; treatable with Abx (tetracycline, streptomycin, and ampicillin – intracellular nature requires extended treatment)
- *Brucella* is a potential bioterror agent and brucellosis is a nationally reportable disease.
- Appropriate authorities (local, state HD, CDC) must be notified and the original specimen preserved (for a criminal investigation) if an isolate is presumptively identified as *Brucella*. 
Resources

• Diagnostic Test List (TX example)
  – Diagnostic agents/tests/methods
  – Types of specimens to collect
  – Quantity

• NASPHV Compendium of Veterinary Std. Precautions for Zoonotic Disease Prevention in Veterinary Personnel
  – JAVMA, Vol 237, No. 12, December 15, 2010
Resources

• **Zoonotic Disease Table**
  – TX 1990 – 1999
  – Reportable Human Diseases in TX

• **Zoonotic Disease Table**
  – TX 2000 – 2012
  – Reportable Human Diseases in TX
References & Acknowledgements

• Web Resources
  – www.wendyblount.com
  – Animal and Zoonotic Disease Diagnostic Tests

• NASPHV Compendium of Veterinary Std. Precautions for Zoonotic Disease Prevention in Veterinary Personnel
  – JAVMA, Vol 237, No. 12, December 15, 2010

• Texas Department of State Health Services
  – Zoonosis Control Division, Jim Schuermann (epidemiologist)
  – http://www.dshs.state.tx.us/idcu/health/zoonosis/default.asp

• Dr. Terry Conger (DVM), Terry.H.Conger@aphis.usda.gov
Thanks & Questions?

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