Important Zoonotic Diseases of Zoo and Domestic Animals

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Zoonoses Lecture Overview

- Definitions
- Infectious Agents
  - Viral
  - Rickettsial
  - Chlamydial
  - Bacterial
  - Fungal
  - Protozoal
  - Parasitic

- Other Zoonotic Concerns
- Special Considerations
Definitions

- **Zoonosis**: any *infectious disease* that may be transmitted from *animals* to *humans*, or from *humans* to *animals* (the latter is sometimes called *reverse zoonosis*).

- Reservoirs: +/- signs of disease; balanced relationship beneficial.

- “Dead-end” hosts: unable to transmit infection to others.

- 300+ infectious diseases of humans, 178 of which are zoonotic diseases
During discussion of these diseases consider:

- What is the source and cause of the disease?
- How is it transmitted?
- What preemptive measures can be taken or implemented to limit or prevent transmission?
- What measures should be taken if exposure occurs?
Viral Zoonoses:

- **Pox Viruses**
  - Contagious ecthyma (Orf)- *Parapoxvirus*
  - Monkey pox- *Orthopoxvirus*
Pox Viruses

- Orf Virus (Contagious Ecthyma)
  - Parapoxvirus of sheep, goats, wild ungulates
  - Epithelial proliferation and necrosis of skin and m.m. of urogenital and GI tracts
  - Reservoir: endemic in sheep and goat herds; young animals affected more severely
  - Transmission: humans affected by direct contact with scabs & exudates from lesions
Pox Viruses

- **Transmission**: humans affected by direct contact with scabs & exudates from lesions;
  - fomite transmission possible
  - Extended environmental persistence

- **Clinical signs**:  
  - Animal: Proliferative, pustular encrustations on lips, nostrils, mm of oral cavity & urogenital orifices
Pox Viruses

- Clinical signs:
  - Humans: often solitary lesions on hands, arms, or face; may be several nodules.
  - Masculopapular → weeping proliferative lesion with ventral umbilication → after 3-6 weeks regress with little scarring
  - Regional lymphadenopathy uncommon
Orf (Contagious Ecthyma)

Umbilicated lesion

www.md.ucl.ac.be

Sheep infected

www.acponline.org/bioterro

dolphin.upenn.edu/~pathclub
Arboviruses

- Arthropod vector
- Can cause encephalitis or hemorrhagic disease
- Humans may be dead-end host, or reservoir for infection
Arboviruses

- Arthropod-Borne Viral Diseases (Arboviral)
  - Venezuelan, Western, and Eastern Equine Encephalomyelitis (VEE, WEE, EEE)- Togaviridae (Alphavirus)
  - Dengue, Louping Ill, St. Louis Encephalitis, West Nile Virus, Yellow Fever- Flaviviridae (Flavivirus)
  - California encephalitis, LaCrosse encephalitis- Bunyaviridae (Bunyavirus)
  - Colorado tick fever- Reoviridae (Orbivirus)
  - Vesicular stomatitis- Rhabdoviridae
Hemorrhagic Fevers: Highly unlikely but important to know about

- Marburg Virus Disease
- Flaviviruses- Yellow fever and Dengue
- Ebola/ Filovirus Infections
- Hantaviruses
Marburg Virus

- “Vervet Monkey Disease”- African Green Monkey (*Cercopithecus aethiops*)
- First outbreak in Germany in 1967
- *Filovirus*; natural reservoir has not be determined
- Transmission from direct contact with infected tissues; possibly aerosol
Ebola Virus - Filovirus

- **Ebola-Zaire and Ebola-Sudan**
  - High mortality in NHP (especially Western Lowland gorillas)
  - High mortality in NHP (death in 8-14 days)
  - Humans - clinical disease not recognized, but animal technicians developed antibody response
  - **Reservoir**: Wild giant fruit bats
Hantavirus

- **Transmission:**
  - Inhalation of infectious aerosols
  - Rodents shed virus in respiratory secretions, saliva, urine, feces
  - Animal bite, wound contamination, conjunctival exposure.
Lymphocytic Choriomeningitis Virus (LCM)

- Only virus of mice that naturally infects humans
- Arenaviridae (also includes Lassa Fever)
- Widely present in wild mouse population throughout world.
- Animals most commonly affected: mice, hamsters, guinea pigs, NHPs, swine, dogs.
Lymphocytic Choriomeningitis (LCM)

- Latent infection in mice for period of time
- Callitrichid hepatitis - LCMV is etiologic agent; suckling mice fed to tamarins and marmosets to supplement diet.
- Mice and hamsters - may have in utero infection
Lymphocytic Choriomeningitis (LCM)

- Pantropic infection: virus present in blood, CSF, nasopharyngeal secretions, feces and tissues;
- Fomite (e.g. bedding material) transmission
- Humans infected:
  - By parenteral inoculation, inhalation,
  - contamination of m.m. or broken skin;
  - organ transplant*. 
Lymphocytic Choriomeningitis (LCM)

- Clinical signs (humans):
  - Flu-like illness (fever, malaise, myalgia, headache) → macupapular rash, lymphadenopathy, meningoencephalitis, orchitis, arthritis, epicarditis
  - CNS involvement may cause death
  - Potential infection of fetus *in utero*, causing severe birth defects.
Herpesvirus 1, CHV-1): Unlikely to encounter in a zoo setting but important to know about

- In **macaques**, produces mild disease similar to human *H. simplex*.
  - 1° infection- lingual and/or labial vesicles or ulcers that heal in 1-2 wks; +/- corneal ulcer or keratoconjunctivitis.
  - Latent infection in trigeminal genital ganglia.
  - Reactivation of viral shedding when stressed physically or psychologically; immunosuppressed
  - Endemic infection in some colonies- up to 100%
B-Virus Infection

- Transmission to humans: exposure to contaminated saliva (bites, scratches), ocular m.m. exposure, needlestick, exposure to tissues, fomites (cages), human-to-human (1 case)
- Incubation 2 days to 2-5 wks.
- Clinical signs: herptiform lesion at site of inoculation → myalgia, fever, headache, fatigue → progressive neurological disease → death (80% fatality rate)
- Herpes simplex ("Cold Sores") of humans can cause illness and or death in NHP, especially lesser and greater apes.
B-Virus Infection

- Handle all macaques as potentially Herpes-B positive!!
- Strict PPE in place; SOPs developed.

www.researchtraining.org
Rabies

- *Lyssavirus*, family Rhabdoviridae
- Worldwide distribution
- Infects all mammals, but main reservoirs are wild and domestic canines, cats, skunks, raccoons, and bats.
Rabies

- **Transmission**: bite of rabid animal, or introduction of virus-laden saliva on skin wound or mucous membranes
  - Corneal transplant from infected person
  - Airborne transmission in lab setting, and in caves where rabid bats roost.
Rabies

- **Incubation:**
  - 1-3 months (varies 9 days to >8 months)
  - Prodromal → acute neurologic → coma → death
    (rarely recovery)

- **Diagnosis:** Negri bodies (hippocampus), rabies virus antigen (Direct FA)

- **Prevention:** Avoid contact and vaccination—both very effective
Viral Hepatitis Infections

- Hepatitis A - human enterovirus of family Picornaviridae
  - Primary reservoirs are humans;
  - NHP infections are from humans or other infected NHPs
  - Humans have been infected from newly imported chimps
  - Transmission: fecal-oral route
Viral Hepatitis Infections

- Clinical signs:
  - Generally less severe than in humans, frequently subclinical
  - Clinical disease in chimps, owl monkeys, marmosets- malaise, vomiting, jaundice, ↑ liver enzymes
  - Humans- mild to severely debilitating; fever, malaise, anorexia, nausea, jaundice (no chronic carrier state)
Hepatitis A

- Vaccine now available - recommended for high-risk individuals
Retroviruses

- **Simian Immunodeficiency Virus (SIV)**
  - Lentivirus, infects Old World primates
  - Clinical syndrome in macaques (parallels AIDS)
  - Horizontal and vertical transmission
  - Seroconversion in people- no clinical disease

- **Simian Foamy Virus Infection**
  - New and Old World NHPs
  - Close homology to human foamy viruses
  - Seroconversion, no disease
Measles Virus (Rubeola, Giant Cell Pneumonia)

- *Morbillivirus*- cause infection in wide variety of Old and New World NHP species.
- Humans serve as reservoir for infecting NHPs
- Disease spreads rapidly thru infected colonies; New World monkeys more vulnerable, less likely to survive
- Transmission: Aerosol and direct contact with respiratory secretions
Measles Virus

- Clinical signs (humans and NHPs):
  - Fever, conjunctivitis, coryza, cough, Koplik’s spots on buccal mucosa
  - Erythematous rash develops face, then generalized
  - Complications: bronchopneumonia, otitis media, diarrhea, encephalitis
  - Prevention: Vaccination
Koplik’s Spots

Measles rash

www.imcworldwide.org
Influenza

- **Humans are reservoir** for human influenza virus.
- Many different antigenic strains in other species: avian, swine, horses, ferrets, minks, seals
- Animal reservoirs contribute to emergence of new human strains by passage of avian flu thru pigs; multiple mutational or re-assortment occurs.
- Ferrets very susceptible to human strains (animal model)
Cycle of Avian Influenza
Viruses in Animals & Humans

- Natural avian influenza cycle
- Domestic birds
- Pandemic disease cycle
- Mammals (primarily swine)
- Direct bird to human transmission is also possible

www.ehagroup.com
Rickettsial Diseases - caused obligate intercellular bacteria

- Murine typhus (Endemic Typhus)
- Rocky Mountain Spotted Fever
- Rickettsial Pox
- Coxiella burnetti (Q fever)
- Ehrlichiosis (Anaplasmosis)
Q Fever
Coxiella burnetti

- Domestic animal cycle mostly involves sheep, goats and cattle
- Also found in cats, wild rabbits, birds, others
- Transmission: Shed in urine, feces, milk, placental tissue of domestic ungulates that are asymptomatic
- Highly infectious- 10 organisms can cause disease
- Sporelike form highly resistant to desiccation; persists in environment
Q Fever

- Varies in severity and duration; may be asymptomatic
- Often flu-like illness- fever, frontal headache with retro-orbital pain, chest pain, pneumonia
- Serious extrapulmonary complications: acute or chronic hepatitis, nephritis, epicarditis, endocarditis
Bacterial Zoonoses: Chlamydial Conjunctivitis

- **Chlamydophila psittaci** in bird host, esp. psittacines; most frequent source of infection
- **Birds**: Conjunctivitis, pneumonitis, air sacculitis, pericarditis, hepatitis, meningoencephalitis, endometritis, abortion
- **Humans**: usually upper respiratory infection; may have severe complications
Leptospirosis

- Many serotypes:
  - *Leptospira interrogans*, *L. ballum*, *L. icterohaemorrhagiae*, *L. hardjo*, *L. canicola*, *L. autumnalis*, *L. bratislava*, *L. pomona*
- **Reservoirs**: rodents, rabbits, livestock, raccoons
- **Transmission**: handling infected animals and their secretions (especially urine), aerosol exposure, rodent bites
Leptospirosis

- Clinical signs:
  - Varies form inapparent to severe infection and death
  - Bi-phasic disease:
    - First: Weakness, headache, myalgia, chills and fever, leukocytosis
    - Later: Conjunctival suffusion, +/-rash, renal, hepatic, pulmonary, GI involvement, jaundice

- Prevention: Avoid exposure. Vaccination +/- effective
Leptospirosis - Jaundice
Enteric Diseases

- **Campylobacter jejuni** and **C. coli**
  - many lab animal species; fecal-oral

- **Helicobacteriosis**

- **Salmonellosis**
  - 2400 serotypes
  - Ubiquitous in nature; food and water contaminated by carriers
Shigellosis

- **Shigellosis- NHP zoonoses**
  - *Shigella flexneri, S. sonnei, S. dysenteriae*
  - Humans are main reservoirs of disease
  - **Transmission:** Fecal-oral, direct contact
  - **Clinical signs:**
    - Asymptomatic to bacillary dysentery (Blood and mucus in feces, abdominal cramping, tenesmus, weight loss, anorexia)
    - Survivors can remain carriers
Tuberculosis

NHP usually acquire disease from humans

**Transmission:** aerosol, ingestion of bacterium

**Clinical signs:** usually pulmonary; may include weight loss, fatigue, fever, chills, cachexia

Tuberculous Granuloma
Monkey- Positive TB Reactor
Tularemia

- “Rabbit Fever”, “Deer Fly Fever”
- *Francisella tularensis*- small gram-neg. coccobacillus w/ thin lipid capsule.
- Intracellular bacteria of macrophages; inhibits phagosome/lysosome fusion.
- Highly infectious with low infectious dose, ease of dissemination, this makes organism a potential biological weapon.
Tularemia
Francisella tularensis

- World-wide, with wide range of hosts.
- Syndromes depend on route of exposure.
- Transmission: aerosol (respiratory or conjunctival), ingestion, and via wounds
Tularemia
Rat Bite Fever

*Streptobacillus moniliformis* - Streptobacillary fever; Haverhill Fever (ingested of contaminated food, water or raw milk)

*Spirillum minus* - causes Sodoku or Spirillois

**Symptoms:** fever, lymphadenopathy, inflammation, flu-like symptoms +/-rash; Arthritis in 50% of *S. moniliformis* infections.
“Cat Scratch Disease”

*Bartonella henselae*
- bitten or scratched by cat
- most <20 yrs. old
- Organism also shed in feces of flea (cat-to-cat, cat-to-human transmission)
Mild fever, erythematous pustule, regional lymphadenopathy.
Regresses in 6 wks.; usually benign
- Occasionally systemic illness
*Capnocytophaga canimorsus*

“Dog Bite Fever”

- Fever, cellulitis, septicemia, purulent meningitis and endocarditis develop.
- Patient is asplenic.
- 7 days after bite, patient dies. (True story)
Other Infectious Zoonotic Agents

- **Fungal Diseases:**
  - Dermatophytosis (Ringworm) - *Microsporum*, *Trichophyton mentagrophytes*

- **Parasitic Diseases:**
  - Protozoa -
    - Leishmaniasis - *Leishmania* species
    - Babesiosis - *Babesia microti* (in U.S.)
    - Toxoplasmosis - *Toxoplasma gondii*
    - Amoebiasis - *Entamoeba histolytica*
    - Cryptosporidiosis - *Cryptosporidium parvum*
    - Giardiasis - *Giardia lamblia* (G. duodenalis)
Ringworm (*Microsporum*)
Ringworm (Human)
Infectious Zoonotic Agents

- Parasitic Diseases:
  - Nematodes:
    - Hookworms- *Ancylostoma* spp.
    - Roundworms- *Toxocara* and *Baylisascaris* spp.
    - Capillary liver worm (*Capillaria hepaticus*)
    - Heartworm- *Dirofilaria immitis*
  - Cestodes: (Tapeworms)
    - Cystic Hydatid Disease- *Echinococcus granulosis*
    - Alveolar Hydatid disease- *E. multilocularis*
    - Beef and pork tapeworm(*Taenia saginata* and *T. solium*); Cysticercosis is larval stage of *T. solium*
Hookworm
(“Creeping Eruption”)

![Image of a skin condition resembling a creeping eruption caused by hookworm]
Roundworms - Dog
Leukocoria ("White eye")
from Visceral Larval Migrans
Tapeworm- *Taenia*

Cysts in a rabbit
Other Zoonotic Concerns

- Ectoparasites
  - Flea and tick bites; bee sting; flea allergy dermatitis; mange

- Allergies
  - fur, dander, insect bites

- Trauma
  - Bites, scratches, snake bites
Special Risk Considerations

- Environment (rural vs urban, hi vs low income)
- Immune Status (children, immunocompromised)
- Pregnancy (teratogens, *in utero* infections)
- Special Interests/Hobbies (hiking- tick exposure)
- International travel (tropical diseases)
- Veterinarians (high risk for bites, exposure to agents)
- Animal Care Personnel
Zoonoses Lecture Wrap-up

- Definitions
- Infectious Agents
  - Viral
  - Rickettsial
  - Chlamydial
  - Bacterial
  - Fungal
  - Protozoal
  - Parasitic
- Other Zoonotic Concerns
- Special Considerations
Resources

- Government Agencies:
  - Centers for Disease Control and Prevention (CDC)
  - State Health Agencies

- Texts:
  - Control of Communicable Disease Manual J. Chin (editor) APHA 2000