Arthropod Vectored Diseases

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Routes of Transmission

• Spread of disease agents
  – Animal ➔ animal
  – Animal ➔ human
• Different modes of transmission
  – Aerosol ➔ Oral
  – Direct contact ➔ Vector-borne
  – Fomite ➔ Zoonotic

Vector-borne Parasites

• A vector is an agent which transfers a parasite from one host to another
• Typical parasite vectors: fleas, ticks, mites, mosquitoes, flies, and other insects
• Animals become infected when a vector picks up the parasite from an infected animal and infects a human
Vector Borne Diseases

- In medical and veterinary entomology, a vector is an arthropod responsible for the transmission of parasites (not diseases) among vertebrate hosts.
- When a parasite injures its host and causes disease, it is referred to as a pathogen or disease agent.

Vector Borne Diseases

- A vector borne disease is an illness caused by a pathogen that is transmitted by an arthropod.

Vector Borne Disease

- Obligate parasites are totally dependent upon their host(s) to provide their requirements for life.
- Facultative parasites have both a free-living and parasitic forms.
Components of Transmission

• A parasite that can multiply within both vertebrate and invertebrate host tissues
• A vertebrate host(s) that develops a level of infection with the parasite that is infectious to a vector
• An arthropod-host or vector that acquires the parasite from the infected host and is capable of transmission

The Vertebrate Host

• Amplification refers to the general increase in the number of parasites present in a given area.
• An amplifying host increases the number of parasites and theoretically also the number of infected vectors.
• A reservoir host supports parasite development, remains infected for long periods, and serves as a source of vector infection, but usually does not develop acute disease.

The Vertebrate Host

• Accessibility
• Susceptibility
• Transmissibility
The Arthropod Vector

- Successful vectors usually include the ability to:
  - Seek out host effectively
  - Infect a host
  - Transmit by re-feeding on multiple hosts

Arbovirus Transmission Cycle

Mechanical

- Mechanical transmission occurs when the parasite is transmitted among vertebrate hosts without amplification of development within the vector.
- Ex: Pinkeye and face flies
Biological

- Biological transmission occurs when the parasite is transmitted among vertebrate hosts with amplification and/or development within the vector.
- Ex: Anaplasmosis and ticks

Each Pathogen

1. Location (geography)
2. Main vector
3. Reservoir/alternative hosts
4. Signs of disease/impact

List of viruses

- Bluetongue (Ceraotopogonidae)
- Vesicular stomatitis virus (Psychodidae, Ceratopogonidae, Simuliidae)
- Others
**Bluetongue (BLU)**

- Found worldwide
- Transmitted by Ceratopogonidae: Calicoides spp. (no-see-ums)
- Sheep and wild ruminants/ungulates
- Causes severe disease in young cattle (more serious in sheep)
- AKA "Soremuzzle"—many more are infected than show signs of disease (5%)
- Signs are fever, lethargy, sores on mouth/muzzle. Rarely fatal, but cattle serve as a reservoir host for sheep

**Vesicular Stomatitis Virus (VSV)**

- Found in Western Hemisphere, esp. western NA
- Transmitted by Psychodidae (sand flies), and other Diptera. AND directly transmitted
- Wide host range of mammals (including people)
- Not severe in cattle, but can cause weight gain loss. Sores in mouth a common sign, but must be distinguished from foot and mouth disease
- Leads to secondary infections

**List of Bacteria**

- Anaplasma: Ticks
- Ehrlichia: Ticks
- Conjuctivitis: Flies
- Q-fever: Lice
- Borrelioses: Ticks
Anaplasma spp.

- Found worldwide, common in OK
- Ticks most common vector, but mechanical transmission is possible via tabanids
- Infects many ungulates (wild and domestic)
- Intracellular bacteria of several related species
- Untreated fatality rate can be 50% in cattle (but usually lower). Causes abortions, weakened immune systems, secondary infections
- Can be zoonotic

Schematic of the development cycle of A. marginale in cattle and ticks.

The high A. marginale levels in acute rickettsemia (>10^9 ml^-1) are resolved after the development of a primary immune response, but the emergence of antigenic variants results in persistent infection.
How do cattle become infected?

- A number of ruminants such as cattle, deer, and elk can be carriers of the anaplasmosis agent. These species can carry the agent all or most of their lives and serve as a reservoir for infection of other animals. The transfer of the agent from a carrier animal to a susceptible animal can occur by a number of routes.
- One of the most common ways is via ticks.
- Ear-tagging instruments, tattoo tools, needles, ear implant tools, castrating instruments, dehorning instruments, etc., can all easily transmit the agent.

What happens when an animal becomes infected?

- If the animal is a calf under the age of 12 months, virtually nothing is noticed. The calf undergoes an incubation period of about 45 to 90 days, has a very mild illness, which is rarely noticed, and becomes a carrier for life.
- Cattle that become infected between 1 and 2 years of age become ill after the incubation period, with severity increasing with age.

What happens when an animal becomes infected? (cont.)

- Cattle over 2 years of age become very ill and approximately 50 percent die unless treated.
- The older the animal and the better shape they are in—the sicker they get!
- Usually, once the cattle become infected, and if they survive, they stay infected for life.
- They are "immune carriers"—they do not get sick; but, act a reservoir for other susceptible animals.
What determines if a herd will have problems with anaplasmosis?

- The location of the herd is important in determining whether or not problems will occur. The cattle and deer that might be reservoirs and the ticks that naturally transmit the disease are the primary factors.
- Ex: Heavily wooded pastures

Conjunctivitis (Pink-eye): *Moraxella bovis*

- Found worldwide
- Mechanically transmitted by a variety of flies (Musciidae)
- Cattle probably only major host
- Causes pink-eye...can result in blindness, reduced feeding

Pink-eye

- Pinkeye, also known as infectious bovine keratoconjunctivitis (IBK), is one of the most common diseases of beef cattle. It is a highly contagious disease, causing inflammation of the cornea (the clear outer layer) and conjunctiva (the pink membrane lining the eyelids) of the eye.
- The incidence of pinkeye increases in spring, peaks in the summer and decreases in the fall.
Causes of Pinkeye

• The primary infectious agent for pinkeye is the bacterium *Moraxella bovis*. This bacterium is found in the eyes of many recovered and apparently normal cattle.
• Other sources of eye irritation are tall grasses rubbing the eyes as cattle walk and graze, dust and foreign objects in the eye. Ultraviolet (UV) sunlight also increases the chances of disease development.
• Breeds lacking pigment on their eyelids (Herefords, Hereford crosses, Charolais, and some Holsteins) are more susceptible to pinkeye because of their increased sensitivity to sunlight and a decreased immune response in the eye.

Clinical Signs

• **Stage I:**
  – Cattle have excessive tearing and increased sensitivity to light.
  – Cattle will often seek shade, which will decrease their grazing time.
  – Stage I will progress to a small ulcer in the center of the cornea which appears as a small white spot.
  – The cornea develops a slightly cloudy grey appearance due to inflammation.

Clinical Signs

• **Stage II:**
  – As more inflammation occurs, the cornea becomes increasingly cloudy.
  – At this point, some of the dark color of the iris can still be seen.
  – Blood vessels from the outside portion of the cornea begin to grow across the cornea to help with healing.
  – These blood vessels make the cornea appear pink, which is how the disease received its name.
Clinical Signs

- **Stage III:**
  - The inside of the eye fills with fibrin, which is a pus-like substance that gives the eye a yellow appearance versus the typical brown appearance.

Management decisions that help prevent pinkeye

- Fly control is essential, but can be difficult as face flies are only on the animal for a small percentage of the time. Therefore, addressing the egg and larval stages of the fly as well as the adults is most effective. A moderate to heavy fly infestation is when there are 10 to 20 flies per animal during the middle of the day. A single fly-control program will not work on every farm, so it often takes multiple methods of control to achieve good results.

By irritating the eye tissues with their prestomal teeth, they obtain tears with more proteins (immunoglobulins)
Face Flies

- Face flies do not bite cattle, but congregate almost exclusively around the eyes and nose.
- Because of their feeding habits around the eyes they have been implicated in the transmission of pinkeye.
- Face flies have complete metamorphosis, and the larvae develop only in fresh cow manure.
- Insect growth regulators can be used to help control larvae in the manure.
- Adult face flies are generally not resistant to pesticides and can be controlled with insecticidal ear tags.
Female Face Fly  Male Face Fly

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Tick Paralysis

- Common in NA and Australia
- NOT an infectious agent
- Reaction to components of tick saliva
- Serious problems in high infestation areas
- Mostly from Dermacentor spp.
- Limb paralysis 2-7 days after exposure; can lead to death (1000s of cases in the last 25 years)