

# Large Animal Medicine

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Introduction,

There are more than one way to categorize Veterinary Medicine and Veterinary Practice

By species

Large animal, small animal, exotic, equine, bovine, feline, etc.

By animal use categories

- Companion animal medicine  
Small animals primarily  
Horses, cattle, sheep, goats, deer, llamas, etc. can all be companion animals in some situations
- Industrial animal medicine

Industrial veterinary medicine's primary goal is to assist the clients in producing a profit or limiting losses in an animal based business. This goal should also include the cost of accommodation for humane and ethical care of animals used in an industrial setting. Due to the nature of "profit and loss"; there will typically be financial limitations dictating which treatments and procedures are economically reasonable to be used, with respect to the value of the animal.

Expensive procedures may be utilized for a valuable animals if there is an expectation for success and for a reasonable return on the investment made in veterinary therapy, surgery or advanced reproductive techniques.

The typical animals that are found in animal industry are:

Food animals

- Dairy cattle, Beef cattle, Swine,
- Small Ruminants,
- Captured or farmed wildlife such as buffalo, deer, elk, and others
- Camelids,
- Fowl,
- Fish species

Companion animals in breeding operations are considered by many to be industrial animals.

Also considered to be industrial animals are working animals. These include:

- Ranch horses
- Running or trotting race horses,
- Pleasure horse breeding animals,
- Greyhound running dog breeding animals,
- Camelids used as pack animals,
- Film, television, rodeo, circus and animal show performance animals all exist in a working industrial environment.
- Military and police horses and dogs can also be considered in the category of trained working animals.

- Zoo animal medicine

Zoological medicine is a type of veterinary practice that includes exotic, rare and frequently valuable or endangered wildlife animal species. There are fewer economic limitations on the veterinary and husbandry procedures used for these species, compared to agricultural species. A sound knowledge of agricultural practice and experience working with large farm animals can be a good background in preparation for working with large exotic species.

- Laboratory animals

- Can include any species from classical laboratory animal such as mice and primates to large species such as cattle, horses and others.
- Pharmaceutical companies, universities and government entities all utilize animals in research

- Wildlife medicine

This area of veterinary medicine is closely allied to wildlife biology and wildlife management. Wildlife species can act as reservoirs for diseases that are important in domestic livestock species. Wildlife can also harbor zoonotic infectious and parasitic diseases that may be transmitted to humans.

Following are some examples of trans-species diseases:

- Brucella abortus
- Tuberculosis, Mycobacterium bovis has been frequently identified in wild ruminants.
- Equine protozoal myeloencephalitis,
- West Nile virus and other encephalitides from avian species via mosquitos,
- Rabies, from many species to livestock and people,
- Plague, Yersinia pestis, from wild rodents via fleas,
- Hantavirus infection transmitted from rodents,
- Echinococcosis sp. – tapeworms, from domestic and wild carnivores,
- Trichinella – a zoonotic nematode parasites, from bear and swine,
- & many others.

Although not currently considered to be a zoonotic diseases; chronic wasting disease in wildlife and bovine spongiform encephalitis in cattle are considered to be potentially dangerous to human due to their similarity to the human spongiform encephalopathy known as "variant-Creutzfeldt-Jakob Disease" which is abbreviated as: v-CJD.

Usually wildlife veterinary medicine utilizes epidemiological method to evaluate and limit the spread of wildlife diseases to domestic animals and humans. Wildlife veterinary medicine is almost exclusively population level, preventative medicine, with an emphasis on research and public health. Research is being devoted to applying vaccination programs, anti-parasite procedures, and population control procedures that do not require gathering and treating animals individually. There is current research being done on control the spread of Brucella abortus from wildlife to domestic cattle through the use of oral vaccine placed in feed bait. There has also been recent research and actual use of "anti-porcine zona pellucida vaccine on wild and feral horse populations in the western United States to reduce overpopulation by this species.

One other specialized area in wildlife medicine is wildlife rehabilitation. In some situations this could include the rehabilitation of injured large animal species such as deer, elk, and large aquatic mammals.

#### Functional Divisions of veterinary medicine

- Classical Veterinary Medicine –
  - Diagnostics and therapy,
  - Internal medicine,
  - Surgery,
  - Obstetrics, etc

Classical veterinary medicine is what the majority of veterinary education is all about. A good foundation in basic sciences and veterinary medicine is obviously essential in order to effectively perform techniques required for diagnosis, treatment, surgery and rehabilitation of animals in a veterinary practice. Also obvious, is the importance of that same knowledge when implementing effective preventative medicine and production medicine practices. Understanding physiology, anatomy, nutrition and veterinary medicine at the highest level possible is equally valuable for people involved with the husbandry (production, care and breeding) of livestock in unusual or specialized environments; such as horses in competition, cattle in dairy production, hospitalized animals, animals rehabilitating from disease and injury, and even beef cattle on pastures or in feedlots.

- Preventative Veterinary Medicine
  - Vaccination programs, parasite control programs, etc.

Vaccination and anti-parasite control programs (to be discussed later) are the two usual subjects that people think of when they discuss preventative medicine. Preventative medicine really goes beyond that.

- Pre-purchase exam

Pre-purchase examinations, are performed on behalf of the purchaser to verify the suitability and soundness of a prospective animal for its intended purpose. If a prospect is identified as sick, injured or unable to fulfill the buyer's expectations, this exam is certainly a preventative medicine function.

- Pre-sale exam

Pre-sale examinations, these examinations are performed on behalf of the seller. A seller will have an animal or many animals that are to be sold. The seller will have the animals examined in order to verify their soundness for their intended purpose.

An excellent example is a seller having the veterinarian perform breeding soundness exams on a group of bulls that he hopes to sell for use as herd sires. If a bull were not reasonably likely to be successful at breeding cows, it would be foolish for a breeder to offer him for sale, as it would damage his reputation and affect future sales. These exams should be scheduled prior to listing or showing the animals for sale, so that a buyer is not falsely led on by a beautiful, but non-functional animal.

- Quarantine and isolation procedures are used in many disease prevention protocols.

Quarantine, is separation of an animal of unknown or questionable health status for the purpose of observing it for signs of infectious disease. A quarantined animal may have been exposed to a contagious disease, or it may be an apparently healthy new addition to a herd, where the health status in the herd of origin is unknown or suspect. In order to prevent the introduction of an infectious disease, new additions to a herd should be observed for infectious diseases, for a reasonable period of time, prior to incorporation into the herd. Quarantine is derived from the word for forty in Latin languages. Forty in French is "quarante".

A forty-day period of time is reasonable and thirty days is typical. During quarantine a new addition can also be tested for diseases that are of concern. The time can be used to administer initial vaccinations and second booster doses of vaccine to meet minimum herd standards. Internal and external parasite control medication can be administered at the beginning of a quarantine period. For intestinal parasites it is often recommended to administer a second larvacidal dose of anti-parasitic medication at the end of quarantine for an effective reduction in small strongyle ova shedding and contamination of pastures. If an animal becomes ill during quarantine that animal is then held in isolation.

Isolation is separation of an animal that is actively infected with a confirmed, suspected, or unknown contagious disease. Isolation will prevent spreading the disease to other animals in the herd or hospital. Isolation should continue until the animal is unlikely to be contagious.

- Safe handling, keep fences, pens, stalls, chutes, stocks & other animal handling equipment and working facilities clear of protruding, sharp or otherwise dangerous objects or obstructions. Make sure all moving parts are lubricated and working easily. Repair broken fencing and containment structures immediately. Never leave a vertical fence post without a securely attached top rail, as it is possible for a jumping animal to impale itself on such an object. When farm animals are being handled, there are likely to be excitable individuals that may attempt to escape the containment facility, especially if there are weak (and dangerous) points that invite such attempts.
- Proper restraint, when performing a procedure on a large animal it can be dangerous to the animal, and attending humans, if the patient is not properly restrained. An adjustable horse stock with a way to crosstie or otherwise restrain the horse is beneficial with many procedures. A proper cattle chute and head catch serves the same purpose for cattle. Many homemade stocks, chutes or tie-ups are acceptable for both large and small ruminants and camelids.
- Safe housing
  - Ventilation is essential in enclosed barns, when livestock are confined. Ventilation can be of two basic types; active or passive.
    1. Active ventilation uses fans to replace and remove stale air. Air is usually drawn in through side wall vents that are equipped with fans, and air is often exhausted through ceiling vents or vents that are placed higher on the side walls.
    2. Passive convective ventilation uses the natural buoyancy and rising of warmed air from the area around the livestock for exhaust of stale air through vents in the roof, and replace fresh through air inlets low on

the sidewalls of the barn. Regardless of the type, one of the goals of ventilation is to limit air drafts and allow air to pass over a minimal number of animals prior to being exhausted, usually through the roof. This prevents noxious air accumulation and infectious disease transmission. \*\* closed barn design \*\*

3. Poor ventilation can result in many problems. Pulmonary irritation, allergy and due to noxious gas and dust accumulation. Viral and bacterial respiratory disease can also become a problem. Heat stress and many other conditions.
  4. There is no question about ventilating barns in warm or hot weather. Cows are intolerant of heat and susceptible to heat stress at temperatures as low as 72F. In warm weather; fans work well in addition to passive ventilation building design
  5. There is concern about ventilating barns during cold weather. Cows and horses are more cold tolerant than humans and require ventilation even in cold weather. In cold weather it is important to prevent drafts; passive ventilation works best in cold situations.
- Good floors design, i.e. good footing with minimally abrasive surfaces is important when hooved animals are housed on concrete or other hard composite flooring. Grooves, ½" to 1" wide, cut in the floor at an interval of less than ½ the length of the animals stride (~<1') is probably the best. Epoxy surface coating is also good, but can be very expensive. Recycled grounded rubber and urethane can be incorporated into concrete to produce excellent footing but it is subject to rapid wear. A roughened concrete surface is cheap and prevents slipping, but is too abrasive and can do damage to the hoof wall and sole of livestock feet. Roughened concrete, is common, and may be acceptable in area where livestock are only occasionally worked, but it is the least desirable method of concrete treatment in areas were cattle spend significant time. Some cattlemen and horsemen use smooth concrete and rely on handling animals gently on these surfaces. There is a greater risk of injury on smooth or slick flooring, but animals, once used to it, are very easy to handle.
  - Good drainage in buildings, dirt pens and paddocks is also important for a safe and healthy environment. Most modern livestock pens are constructed with high areas where the animals are fed and have access to water and a low swale or ditch for drainage of the pen to a sewage confinement lagoon.
  - Regular manure management or removal is essential especially in low wet areas where animals have access.
- Proper feed storage usually means prevention of weather related feed spoilage. Feed and feeding facilities can also be contaminated by feces, urine and bedding debris of rodents, pets and wildlife species. Farm cats are capable of transmitting Toxoplasmosis. Dogs and perhaps wildlife species can transmit Neospora. Sarcocystis neurona; causing Equine Parasitic Myeloencephalitis (EPM) can be transmitted to horses and ruminant species by opossums. S. neurona, Sarcocystis spp, Toxoplasma spp, Neospora spp and other parasitic organisms can infect farm animals causing illness, abortion and potentially public health risk to the food supply. Dogs, cats and carnivorous wildlife must be prevented from entering and soiling feeding and feed storage areas whenever possible.
  - Proper balanced nutrition. This is an area that would require a text book to cover in any way but superficially. Animal health is, in many ways, pre-determined by the nutritional status of the animal or the animal population.
  - Use of proper administration techniques (i.e. when using injectable vaccines and drugs, intra-nasal vaccines, oral vaccines and medications, topical and pour-on drugs) for preventative and therapeutic procedures.
  - Animal welfare and humane handling of livestock and humane management of livestock are preventative veterinary health measures. Good animal health, proper

nutrition, normal inter-animal interaction, non-excitatory human - animal interactions, limitation of stressful situations and overall animal comfort are required for maximum production, performance, growth and reproduction.

- Good health care and high quality management procedures are usually profitable. Successful cattlemen and horsemen generally understand that healthy and comfortable animals produce and perform better.
- See: <http://www.grandin.com/> for data and insight on humane management practices. Dr. Temple Grandin is a Colorado State University, Animal Science professor; who has dedicated her life to the study of animal behavior and humane management of livestock.
- Personnel that work animals in a rapid, loud, abrupt or abusive fashion should be retrained in animal handling, reassigned to non-animal contact positions or fired.
- Elimination of intractable, wild or disruptive animals is often a tremendous benefit to health and safety of the herd. Wild animals cause stress and influence the behavior of all animals in a herd. Wild animals should be culled from the herd if they adversely influence production from the other animals or if they are a danger to workers or other animals on the farm.
  
- Regulatory Veterinary Medicine
  - In the US, this is a government function; performed by US department of agriculture (USDA) veterinarians, state departments of agriculture (i.e. Colo. Dept. of Ag.) veterinarians, and private practicing veterinarians that are accredited by the U.S. and state departments of agriculture.
    - Regulatory Veterinary Medicine is performed by government and accredited private veterinary practitioners; enforcing state and federal regulations regarding domestic animals. Most of these laws involve farm animals but pets are also regulated in many ways regarding interstate and international movement. Wildlife species can also be covered by federal and state laws regarding harvest and use.
    - One goal of regulatory medicine is to keep the US livestock herd healthy and free of domestic contagious diseases that affect profitability.
    - Examples of economically important domestic diseases that are reportable to the USDA and State Departments of Agriculture are:
      - Cattle
        - Tuberculosis
        - Brucella abortus
        - Trichomonas fetus
        - Vesicular Stomatitis
      - Equine
        - Equine Infectious Anemia
        - Equine Herpesvirus Type 1 resulting in Myeloencephalitis
      - Ovine
        - Brucellosis
        - Scrapie
    - Another goal is the prevention of the introduction of foreign animal diseases into the United States. Foreign animal diseases (also referred to as exotic animal diseases), if introduced into the U.S. can have a dramatic negative effect on animal health. An adverse health issues, such as a reportable disease outbreak, will affect livestock sales, food exports, livestock exports and the profitability of farm animals and food products.
      - For example; the occurrence of a single case of "Bovine spongiform encephalitis" (BSE) in the U.S. in December of 2003 caused a dramatic reduction of beef exports. U.S. beef exports in in 2003 were 1.3 million metric tons to 65 countries. In 2004 beef exports dropped to only 0.32 million metric tons to only a fraction of the U.S. beef customers. That single animal with BSE was actually imported into the U.S. from Canada.

- Regulations: Federal and state departments of agriculture officials draft regulations that protect the U.S. national livestock herd. Many of these officials are specialists in epidemiology or other infectious disease disciplines. All of the Federal regulations are published in the "[Code of Federal Regulations](#) Title 9 - Animals and Animal Products". State regulations are published in similar state laws and regulations publications
- Accreditation: A licensed veterinarian must become accredited by the USDA prior to performing regulatory functions on behalf of the federal or state government. Accreditation requires that a licensed veterinarian pass an accreditation exam covering domestic and foreign animal disease control issues and also must meet continuing education requirements.
- A partial list of regulatory functions would include:
  - Interstate health certificates - The issuing veterinarian must determine that (1) all animals are adequately identified with a permanent ID (cattle and other food animals) or a picture or drawing showing all markings and brands (horses). Food animal identification tags must be approved by the USDA when used for interstate health certificates. (2) that the animals meet all pre-entry requirements for the state of destination, such as brucellosis vaccination, which is required by many states, (3) that the animal is determined to be healthy through a physical exam or visual observation, (4) that suitable results (usually negative) for all required disease tests have been obtained and (5) any treatments or vaccinations required by the state of destination have been administered. Assuming that all entry requirements for the state of destination have been met, the issuing veterinarian can then call the state veterinarians office, in the state of destination, and obtain an entry permit, if one is required. Then a health certificate or "Certificate of Veterinary Inspection" (referred to as a CVI) is completed. The CVI lists the consignor's and the consignee's relevant physical addresses and other contact information. The species, breed and number of animals is noted. The date and method used to transport the animals is noted. The name and address of the person responsible for transportation (usually the person driving the truck) is noted. All animals to be shipped are usually individually listed on the health certificate. All tests performed, including the result, and abnormal health exam findings are listed for each animal. The health certificate should also include a listing of all treatments and vaccinations administered prior to the shipment. The accredited veterinarian who performed the health examinations is responsible for filling out the CVI on the livestock and must sign the health certificate. As soon as possible (certainly within 2 weeks) after the shipment two copies of the CVI must then be mailed to the state veterinarian in the state of origin of the shipment. The state veterinarian then will forward a copy of the certificate to the state veterinarian in the state of destination. Currently electronic CVIs, transmitted via the World Wide Web are being used by many states to streamline interstate movement of livestock. These eCVI documents resemble closely the paper ones and are transmitted as secured unalterable .pdf files.
  - International health certificates – An International Health Certificate is often referred to as an IHC. The requirements for an IHC is similar to, though frequently much more complex, to those required for a CVI issued for interstate purposes. The animals for export and animals producing animal products for export (such as semen, embryos, hides, meat, etc.); require proper identification, testing, quarantine and treatments according to protocols that are dictated by the importing country. It is not uncommon for an importing country to require quarantine or isolation of live animals prior to their importation and during the period of time that all export testing, treatments are performed. Also, animals that are producing animal products for exportation usually must be placed into isolation during the testing and production periods of those products. Once testing and other procedures such as quarantine or production

of the products to be exported is complete; an IHC can be written, documenting all procedures and then the IHC must be approved and endorsed by a USDA veterinarian. At that time the animals or animal products must be exported, in continued isolation during transport, according to the importing countries requirements.

- Brucellosis vaccination - Only heifers should receive a brucellosis vaccination at any time after 4 months of age and prior to the heifer achieving 12 months of age. The heifers must be identified with a proper vaccination tattoo in the right ear's concave area. The tattoo includes an "R" indicating that the RB51 Brucella abortus vaccine strain was used. The tattoo also includes a "US Vaccination Shield" and the last digit of the year of vaccination i.e. "3" for 2013 (and 2003). The tattoo is noted as "RV3" on the vaccination document. Usually a metal vaccination tag is also applied. The vaccination tag that is usually used is an orange metal "clip" tag with a 9 character alpha numeric identification number that is unique in the USA. In Colorado, that number begins with 84, then 3 letters and 4 digits. For example 84VAB1234, the 84 means that the tag is a Colorado origin tag. The V stands for "Vaccinate" and is present on all vaccination clip tags. A sequence of tags, ordered by a veterinarian, are registered to that accredited veterinarian so that an animal can be traced back to the veterinarian and from there back to the farm of origin. Keeping an accurate record of the application of these ear tags is important for the purpose of animal trace-back if it is ever necessary. It is required that all Brucella abortus vaccinations be reported to the State Department of Agriculture.



The vaccination tattoo is applied to the concave skin surface of the right ear. An orange official identification clip tag is usually applied to the right ear. There are also official electronic ID (EID) button tags that can be used.

- Brucellosis testing: All cattle to be sold, moved interstate or moved internationally may be required to be tested for Brucellosis with negative results by the consignee or the consignee's department of agriculture prior to issuing a CVI. Often all cattle on a farm are tested in order to certify that the farm is "Brucellosis Free". This makes sales and interstate movement easier.

- Occasionally when a Brucellosis suspect is identified at slaughter, or a dairy farm has a positive milk ring test; the entire herd of origin will need to be tested to certify that the farm is "Brucellosis Free"; or to locate the animal(s) that test positive.
- All tested animals must have acceptable official USDA identification or else they must be ear tagged with a unique metal, "bright" clip tag. Like the vaccination tag in Colorado the test tag begins with 84, then 3 letters and 4 digits, for example 84ABC1234.
  - A blood test is used for routine testing of beef and dairy individual animals prior to sale, interstate movement or international movement. A blood test can also be used on all animals on a beef or dairy farm for certification of the farm as "Certified Brucellosis Free". A blood sample is also used for diagnostic purposes, usually after a cow has aborted.
  - All tested individual animals must have acceptable official identification or else they will be ear tagged with a unique "bright" test tag with the 84ABC1234 pattern.
  - A Brucellosis "Milk Ring Test" on a milk sample from the milk bulk tank allows a dairy farm to test the entire herd for Brucellosis with a single test. This is for food safety purposes as well as for simple periodic survey testing of the dairy cattle for maintenance of the dairy farm's "Certified Brucellosis Free" status.
  - The brucellosis eradication program also requires all cattle sent to slaughter at registered slaughter plant to be tested for Brucellosis.
- Tuberculosis testing is required for all dairy cattle periodically, usually every other year, to meet FDA and USDA health standard. TB suspects, cattle to be shipped interstate and cattle to be shipped internationally may also be required to be tested for TB.
  - The routine survey test used for tuberculosis is the "Caudal Fold Intradermal Skin Test". Any suspicious reactions to this survey test will require that the animal be tested with the "Comparative Cervical Test" within 2 weeks of the caudal fold test.
  - All tested animals must have acceptable official identification or else they will be ear tagged with a unique "bright" test tag with the 84ABC1234 pattern.
  - The primary method for routine survey of US cattle for tuberculosis is the post mortem exam that all cattle receive at the time of slaughter in registered slaughter plants.
- Trichomonas fetus testing, required for all sale bulls, bulls moving interstate, and bulls used on public lands for breeding purposes. Virgin bulls under 18 months of age may be exempt. "Trich" testing is routinely done primarily on bulls, using a prepuccial scraping and aspiration technique to obtain the sample for culture and PCR test for Trichomonas fetus DNA. Trichomonas culture and PCR testing is done primarily on bulls because bulls will become persistently infected, within the prepuccial cavity, after venereal exposure to an infected cow. It is bulls that maintain the infection within the herd. After a non-immune cow becomes infected she will develop an endometritis and will abort or not become pregnant. She will continue to cycle and transmit the infection to other bulls when she is in estrus. Trichomonas fetus infection in a cow will result in an immune response and eventual clearance of the infection. Once the cow has cleared the infection she is no longer infectious and may go on to conceive and carry a calf to term. Clinically she will have a very late calf, or is simply diagnosed as not pregnant.
- Equine Infectious Anemia (EIA) testing; Testing for EIA requires serum for a serologic AGID "Coggins Test" or an EIA ELISA test. EIA testing is required by all states for interstate movement of horses into their state. An EIA test is also



required by most horse shows and competitive events prior to admittance to the event.

- Testing for or diagnosis of any other disease that must be identified and prevented from being introduced into an importer's state or country by animals or animal products from our clients. These are usually diseases of concern by the importing entity and are spelled out by the state or countries importation requirements.

- Prevention of the introduction of exotic (foreign) animal diseases into the U.S. Probably the most important regulatory functions of the USDA and all veterinarians

The USDA has developed and enforces import requirements for animals and animal products originating in foreign countries that are to be imported into the U.S.

These entry requirements are country of origin specific. They are based on knowledge of the exporting country's status with respect to contagious diseases of concern.

Diagnostics, testing, and quarantine of animals both prior to importation and after importation can assure identification and prevent the importation of exotic animal diseases.

One other concern is the possibility of foreign animal diseases being brought into the U.S. on the clothes and shoes of international visitors. These travelers may have been exposed to contagious animals on farms and food markets in foreign countries. U.S. Immigration and Customs Enforcement and the USDA are addressing this issue during customs inspections upon arrival in the U.S. Any prohibited agricultural product are identified through declarations, interviews and inspections of baggage and shipment arriving in the U.S. Any prohibited or suspicious foodstuffs arriving from foreign countries are confiscated and destroyed. This is particularly important with arrivals from countries that are infected with animal (or plant) diseases and parasites of concern.

The USDA monitors the health status of foreign countries through membership in the World Organization for Animal Health (OIE – French for 'Office International des Epizooties'), along with 178 other countries. All members are required to report epidemiologically significant disease occurrences in their country so that OIE members are aware of international disease status.

- Prevention of contamination of the United States food supply by government employees of the "Animal and Plant Health Inspection Service" (APHIS) of the USDA. APHIS veterinarians and technicians are responsible for meat inspection at slaughter and the prevention of infectious disease, drug residues, pesticide residues or any other condition affecting the wholesomeness of animal origin food.

- Production veterinary medicine –

A scientific approach to animal husbandry and veterinary medicine. The goal of a production medicine program is to increase production and therefore profitability of an animal enterprise. The client served is a "Industrial animal" producer; such as a dairy, beef cow-calf ranch, a beef feedlot, swine producer or feeder, performance horse breeder and any other client that produces animal based products.

Production Veterinary Medicine incorporates any scientific approach to increasing a client's production and eliminating situations, such as disease, which can interfere with production. Production medicine includes all aspect of "Classical Veterinary Medicine" and Preventative Veterinary Medicine. In addition many large animal practices have incorporated other disciplines such as: nutrition, production record systems and

production analysis, phenotypic, genetic and genomic selection assistance and assisted reproduction technologies ranging from artificial insemination to in vitro fertilization. Phenotype trait selection includes selection and culling decisions based on the visible and measurable traits exhibited by an individual animal.

- Phenotypic traits are the result of expression of an animal's genetic makeup and the environmental influences on the expression of the genetics
- In addition to conformation and outward appearance of individuals of any species, phenotypic selection uses measurable phenotypic traits.
- Examples of measurable economically relevant traits in beef cattle include:
  - Birth weight,
  - Calving difficulty score,
  - Growth rate or average daily gain (ADG) over any period of time,
  - Feed efficiency (Lbs. of feed / Lb. of gain),
  - 205 day weaning weight,
  - 365 day yearling weight,
  - Carcass traits can be measured and analyzed for animals that are slaughtered, but a significant development in carcass evaluation is the fact that carcass traits can also be measured on living, non-terminal, breeding animals whose carcass is evaluated using ultrasonography. As a matter of fact; today more carcass data is collected among the beef breeds for selection purposes using ultrasound data than is collected from slaughter plants. The carcass traits of interest include:
    1. Meat quality grade or marbling (% of intramuscular fat),
    2. Ribeye cross sectional area, between the 12th and 13th rib (ribeye area correlates with overall yield of meat in the carcass),
    3. Back fat thickness (a measure of waste; the less back fat the better).These are the same traits that are used by the USDA inspectors in a slaughter plant in designating beef as "Prime", "Choice", "Select" and assigning a yield grade to a carcass.
- In dairy cattle measurable phenotypic traits include:
  - Milk quantity (pounds of milk in a 305 day lactation),
  - Milk fat (lbs. and %),
  - Milk protein (lbs. and %), as well as the composition of important milk proteins,
  - Somatic cell score (white blood cell count in the milk is an indicator of mastitis susceptibility),
  - Body conformation, including udder conformation and feet and leg conformation.
- In horses the measurable phenotypic traits include:
  - Athletic ability such as running speed, measured as a racing speed index,
  - Racehorse breeders and enthusiasts use race results and speed indexes when making breeding decisions for race horses; or which horse to "wager on" at the track.
  - Agility in gymkhana events,
  - Athletic endurance and endurance ride results,
  - Draft ability, ability to pull heavy weight, and work endurance.
- There are numerous numeric analyses that can be used to quantify phenotypic traits and rank an animal's performances for comparison and selection within animals of a contemporary group.

Genetic selection is commonly done by cattlemen using DNA analysis (or genomics) and statistics that have been calculated by breed associations and the USDA; using the actual phenotypic measurements; such as 305 day lactation milk weight, the milkfat % and 305 day fat weight, milk protein % and weight and the protein types in dairy cattle. For beef cattle the measurements are all about the animal's weight, rapid growth ability and carcass characteristics. The relevant genetic statistic for each of the traits are called "Expected Progeny Difference" (EPDs) for beef breeds of cattle and "Predicted Transmitting Ability" (PTAs) for dairy breeds of cattle.

- It is proven that it is effective to make selection, breeding and culling decisions based on genomic DNA information (genomics) and genetic statistics such as EPDs. EPD and PTAs help a breeder to predict the performance of the offspring from an animal. Once the breed association has calculated the genetic statistic for an individual, that animal can then be compared for that trait to all animals in the population, regardless of location or management. The population is defined as all animals within the same breed.
  - The PTA and EPD statistics are assigned to individual animals but as the name implies they predict the performance of that animal's offspring. The accuracy of these statistics increase as the animal has more offspring. The final analysis and best use of these statistics is comparing a cow's or a bull's numbers to other animals when making breeding decisions that will maximize improvement in performance of the offspring.
- DNA tests can identify carriers of genetic defects, verify parentage and evaluate genetic variation for several performance traits.
- DNA tests are performed on simple samples such as dry, blood blots on an "FTA" card, or hair samples from large tail hairs that include the hair root. These samples can be stored for years in a file cabinet without refrigeration.
- DNA genomic selection or DNA Marker Assisted Selection of animals with potential for superior performance for certain traits augment the value of traditional phenotypic measurements and computational genetic selection. These genomic tests correlate well with measurable phenotypic traits and in fact would be impossible without phenotypic measurement correlation with the DNA markers. Genomic testing allow for selection of potentially superior animals prior to actual measurement of the individuals performance or the offspring performance.
- Beef cattle with superior growth and carcass traits and dairy heifers (and bulls) with superior milking characteristics can be identified using genomic assisted selection. Animals that have genomic test data on file will have increased accuracy of EPD and PTA statistics.
- Young calves can be identified as superior with respect to a economically important trait, many months before that trait can even be measured phenotypically.
- A list of beef profile genetic tests for "Economically Relevant Traits", (From Igenity, a DNA testing laboratory) include:
  - Residual Feed Intake; a measure of feed efficiency
  - Average Daily Gain;
  - Beef Tenderness; in lbs. – Warner-Bratzler Shear Force (WBSF)
  - USDA Marbling Score
  - % Choice & higher
  - Yield Grade
  - Back Fat Thickness (in)
  - Ribeye Area (in<sup>2</sup>)
  - Heifer Pregnancy Rate (%)
  - Stayability (%)
  - Maternal Calving Ease (%)
  - Docility (%)
- A list of 'Igenity' dairy profile genetic tests for "Economically Relevant Traits" include:
  - Milk Yield
  - Fat
  - Protein
  - Dairy Form (conformation)
  - Productive Life (Longevity)
  - Somatic Cell Score
  - Fertility

Genetic disease (defects) can also be identified when doing genetic testing.

- Equine genetic defect examples:
  - Hyperkalemic Periodic Paralysis (HyPP) - A dominant defect of Quarter Horse descendants of a stallion named "Impressive". These descendants may carry a defective gene that results in HyPP. Heterozygotic animals are moderately affected while homozygotic animals are severely (sometimes fatally) affected. These horses have abnormal sodium channels, with abnormal (slow) sodium expulsion and potassium re-uptake in muscle fibers, causing muscular hyper excitability, and eventually muscular weakness and apparent "paresis". Diagnosis of the HyPP genetic condition is by submitting tail hairs (with good hair follicles intact) to the veterinary genetics laboratory at Univ. California, Davis.
  - HERDA: Hereditary Equine Regional Dermal Asthenia (HERDA) – Is a genetic disease caused by an abnormal simple recessive gene. It causes affected horses to have abnormal skin collagen resulting in hyper-extensible, fragile skin. When the skin is damaged it heals very slowly and scars excessively. These horses frequently are euthanized because of disfiguring scars and skin infections.
  - Cerebellar Abiotrophy (CA): Genetic Cerebellar degeneration. Usually starting shortly after birth, and visibly present by 1 year of age. Result in a stiff ataxic gait. Occurs primarily in Arabian horses but has been reported in some other breeds also.
  - Lavender Foal Syndrome (LFS), is a fatal recessive condition of Arabian horses. It causes neuromuscular dysfunction, obvious at birth, and also a coat color dilution resulting in the "lavender" color. The neurologic symptoms include seizures, opisthotonos, leg paddling, nystagmus and the resulting inability to stand. These symptoms are present in utero, and often cause dystocia.
  - Overo Lethal White Syndrome (OLWS) is a fatal recessive condition of foals that are homozygous for the "frame overo" gene which occurs in the Paint Horse breed. Two copies of this gene cause the solid white coloration and also results in parasympathetic malfunction of the digestive system, preventing normal passage of ingesta through the colon. Foals show profound colic soon after consuming milk, and are usually euthanized or die within a few days of birth.
  - Severe Combined Immunodeficiency (SCID) is a lethal, autosomal, recessive genetic trait that occurs in Arabian horses. Homozygous foals are unable to mount a humoral or cellular immune response to invading bacteria or viruses.
  - Polysaccharide Storage Myopathy (PSSM) is a dominant autosomal genetic mutation that will cause an intermittent, recurring form of tying-up. The typical, and correct, physical diagnosis of an episode of myopathy is exertional rhabdomyolysis, or myoglobinuria. Horses experiencing an episode of PSSM will present with the typical muscle damage, pain, inability to move and myoglobin discoloration of the urine. Not all animals that experience exertional rhabdomyolysis are carriers of this genetic defect.
  - Malignant Hyperthermia
- Bovine genetic defect examples:
  - Arthrogryposis multiplex - A lethal recessive genetic trait that affects peripheral neurological development of a fetus. Homozygous affected fetuses are paralyzed and joint development in-utero is incomplete and joints are locked in place. Occurs in Angus cattle and breeds derived from Angus.
  - Neuropathic hydrocephalus - A lethal recessive genetic trait that affects the Central Nervous Systems development of a fetus. Homozygous affected fetuses have hydrocephalus and lack of bony calvarium development. It occurs in Angus cattle and breeds derived from angus

- Pulmonary hypoplasia with anasarca - A lethal recessive genetic trait that affects pulmonary and vascular development resulting in heart failure in the fetus. Occurs in Dexter, Shorthorn and Maine Anjou cattle.
- Bovine Leukocyte Adhesion Factor Deficiency (BLAD) is an immuno-deficiency caused by the lack of and adhesion factor on the surface of leukocytes. If the leukocytes are unable to adhere to a pathogen an immune response is not initiated.

Parentage verification, using DNA typing technology (previously referred to as DNA “fingerprinting”) is required by breed associations to be used on all artificial insemination sires and on embryo or oocyte donor mares and cows. DNA typing of parents allows for the confirmation of the parentage. If there are discrepancies that bring parentage into question the offspring resulting from ET and AI can be DNA typed to confirm or dis-prove parentage with a 1 in hundreds of thousands chance of error. This is many orders of magnitude more accurate than the previous technology used for parentage verification; blood typing.

- As DNA typing technology has become cheaper, it has been used on commercial (unregistered) offspring from valuable bulls. This allows a rancher to identify a calf’s sire even when multiple bulls have been used for natural breeding in large pastures. This allows for phenotypic and genetic evaluation of the offspring from valuable sires and dams. Parentage verification will also provide important information on fertility and the serving ability (breeding ability) of the sires. Fertility and libido are important genetic traits for natural breeding sires. These traits can be quantified in multi-sire situations by identifying the sire of the calves.

Culling programs;

- Purpose is to remove non-productive or unprofitable animals from the herd.
- Culling can be based on many different criteria.
- Typical criteria are listed below, in an order that reflects the most common reasons on top:
  - Reproduction failure
  - Individual animal reproductive fertility
  - Sickness
  - Health criteria such as disease resistance (brisket disease, metabolic disease in dairy cattle, etc.)
  - Performance
    - Milk production
    - Beef cattle growth performance
    - Carcass quality of offspring
    - Racing & other athletic performance in horses
  - Genetics
    - Carrier of a recessive genetic defect
    - Affected with non-lethal genetic conditions

## 2. Physical Examination

Purposes

- Diagnosis
- Pre-purchase exam
- Insurance exam
- Performance problem analysis

Types

- Physical exam
  - Observation
  - Auscultation
  - Palpation

- Smell
- Special tests
- Surgical, exploratory
  - Laparotomy
  - Laparoscopy
  - Arthroscopy
- Laboratory
  - Hematology
  - Serum Chemistry
  - UA
  - Microbiology
  - Pathology
- Necropsy

Two common approaches to physical exam

- 1. Body systems approach to physical exam; this is always the best approach in most situations. Each body system exam is completed prior to moving on to the next system. The main systems are:
  - Integument
  - Musculo-skeletal
  - CNS
  - Ocular
  - Respiratory
  - Cardiovascular
  - Lymphatic, Immune
  - Digestive
  - Reproductive
  - Urinary
  - Mammary glands
- 2. Regional approach to physical exam; this approach to physical exam is common on large animals. In this approach all systems are examined in a region by region order. The body systems must still be examined thoroughly. Using a systematic physical exam form is helpful when doing a regional physical exam.
  - Head and neck
  - Left Side
    - Legs
    - Thorax
    - Abdomen
  - Perineal area, rectum and genitalia
  - Right Side
    - Abdomen
    - Thorax
    - Legs

Common to all approaches to physical diagnosis

- Complaint, Signalment and History
- Observe from a distance – unrestrained
- Body system examinations

Special tests and procedures for various body systems

Musculoskeletal Systems

Localization of Lameness

- Trotting the horse on a hard surface
- Observation of asymmetrical movement of legs
- Asymmetrical movement of the head in relation to the animal's stride
- Asymmetrical positioning or movement of the rump relative to the hind leg stride
- Identification of the lame leg and sometimes the region of the leg injury

## AAEP System of Grading Equine Lameness

Grade:

0. Lameness not perceptible
1. Lameness difficult to observe; not consistently apparent regardless of circumstances.
2. Lameness is difficult to observe at a walk or while trotting in a straight line, consistently apparent under certain circumstances.

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3. Lameness is consistently observable at a trot under all circumstances.
4. Lameness is obvious; marked head nodding, hitching or shortened stride.
5. Minimal weight bearing in motion and/or at rest, inability to move, "three-legged lame". This type of lameness is often associated with fractures, subsolar abscesses, severe tendonitis, and septic arthritis.

A locomotion score in dairy cattle, is very similar to an equine lameness grade.

1. Normal: The cow walks and stands with a flat back. She walks normally.
2. Slightly abnormal gait: The cow stands with a flat back but arches her back while walking. She walks normally.
3. Moderately lame: The cow stands with an arched back and walks with an arched back. She short-steps while walking.
4. Lame: The cow stands with an arched back and walks with an arched back and walks with decreased weight bearing on one limb (limps).
5. Severely lame: The cow stands and walks with an arched back and refuses to bear weight on a limb.

Nerve blocks / Perineural anesthesia

- By blocking nerves involved in pain perception at different levels of the leg, lameness can frequently be localized to certain areas of the leg
- Always begin a series of nerve block distally in order to de-sensitize the smallest area possible. Typically the 1st injection is in the posterior branch of the digital nerve in the area just above the bulbs of the heel. Injections are usually given both medially and laterally on these distal nerves.
- Usually just clipping the hair and an alcohol prep is all that is required. When injecting near a synovial structure a surgical scrub may be warranted.

Arthrocentesis

- Placing a needle, with sterile technique, into a joint in order to obtain and evaluate the synovial fluid. Sterile injections can be administered subsequent to the aspiration, through the same needle placement.
- Synovial Fluid is a Serum transudate with decreased serum proteins which lubricates and nourishes cartilaginous surfaces. Proteins are primarily glycoprotein polymers
  - Hyaluronin, Lubricin and others
  - These act as lubricants and cushion the articular surfaces
- Normal synovial fluid analysis
  - Color and Clarity: transparent, slightly yellow
  - Protein levels <2.0 g/dl (plasma protein is 5 to 7 g/dl)
  - Cytological analysis: nucleated cells <300 cells/ml
  - High viscosity – the String test or Fluid viscosity observation, - a drop of normal synovial fluid should form a long, 3cm to 10cm string
  - Mucin clot test: Hyaluronic acid and other glycosaminoglycans will form a firm mucous clot when 1 part of synovial fluid is added to 4 parts of 2% acetic acid. This test is used when viscosity of synovial fluid seems to be low. Can be used to identify synovial fluid leaking from a ruptured synovial structure.
- Synovial fluid culture and sensitivity
- Diagnostic intra-articular anesthesia can be performed at the same time as sampling
- Therapeutic agents should be readied for infusion at the same time that a synovial sampling is done.
- Surgical, 3 scrub, preparation should always be used prior to arthrocentesis on farm animals.

#### Arthroscopy

- Imaging of a joint using a small diameter, short endoscope.
- An Arthroscope is a small diameter rigid endoscope,
- Surgical, 3 scrub, preparation should be used prior to arthroscopy.

#### Serum chemistry

- CPK
- AST
- Ca++
- Phosphorus
- K+

Muscle biopsy, using a Vin-Silverman or Tru-Cut biopsy needle

CSF evaluation

Radiography

Ultrasonography in B Mode, or real-time (20-60 video frames per second), cross sectional imaging mode is often used in evaluating portions of the musculoskeletal system

- Primarily muscle, tendon and ligament imaging.
- Imaging skeletal component is not very useful since bone is nearly 100% reflective and thus impervious to sound.
- What is ultrasonography?

An ultrasound machine in "brightness mode" (B mode) is the basis for veterinary ultrasonography. The most popular transducers contain a linear array of ceramic (piezo-electric) crystals. These crystals will vibrate for a short period of time when they receive an electrical charge. That vibration will produce sound frequencies of 3.5 million to 15 million hertz (cycles per second) or 3 to 15 megahertz (MHz) depending on the size and thickness of the crystal. The ultrasound frequency is referred to in a unit called a megahertz. 1 MHz is 1 million cycles per second. The transducer array will emit a "thin sheet" of rapidly repeating ultrasound pulses. The pulse frequency is typically 20 to 60 pulses per second. These short sound pulses will penetrate the tissues that is to be imaged, distal to the probe. Some of the sound will be echoed back to transducer's crystal array, during the relatively long period between the emitted pulses. The transducer's electrically charged piezo electric crystals will receive these echoes and convert that sound back into an electrical signal. That signal, from the reflected sound, will then be interpreted by the machine's CPU and used to produce a video image that represents a two dimension cross sectional, image of the tissues distal to the probe.

Gaschen, L, Diagnostic Imaging, In: Bassett J, McCurnin's Clinical Textbook for Veterinary Technicians, 2014, pp 551-556

Important relationships between ultrasound frequency & other Parameters:

1. Sound Frequency - Wavelength relationship  
Frequency is Inversely Proportional to the Wavelength.  
The wavelength of 10MHz sound in tissue is 0.15 mm  
The wavelength of 3.5 MHz sound in tissue is 0.44 mm
2. Sound Frequency - Image Resolution relationship  
The frequency is Directly Proportional to the Resolution  
A 10.0 MHz transducer will resolve structures as small as 0.3 mm  
A 3.5 MHz transducer will only resolve structures greater than 1.0 mm
3. Sound Frequency - Tissue Penetration (& Image Size) relationship  
The frequency is Inversely Proportional to depth of the image  
A 10.0 MHz transducer will only penetrate structures up to 5.0 cm  
A 3.5 MHz transducer will easily penetrate structures up to 15.0 cm

Echogenicity:

1. Hyperechogenic or Hyperechoic are terms used in describing the comparison of two adjacent tissues relative echogenicities. When one of the tissues is brighter, or echoes a larger volume of sound than the adjacent tissue; it is said to be hyperechogenic.



2. Similarly, Hypoechoic or Hypoechoic are terms used to describe a tissue that is darker or echoes a lower volume of sound than the adjacent tissue.
3. Isoechoic or Isoechoic means that the two tissues appear to echo equal volumes of sound and appear to have identical brightness.
4. Nonechoic or Non-echoic are terms that are usually used to describe a completely homogenous substance or an aqueous solution that contains no (or very few) particles that echo sound and therefore creates a totally black image on the ultrasound monitor.

Leg lift restraint to assist in examination and treatment

- Lift the left front leg when working on the right front leg; and visa-versa
- Lift the right front leg when working on the right rear leg
- It is highly recommended to not lift a rear leg for restraint purposes due to the strength of the rear legs.

Conformation and Lameness, 03-12-13

Conformation: the proportional and symmetrical shape of the body

- Conformation defects
  - Many are merely blemishes or unsightly
  - May or may not predispose to lameness
  - Defects in the legs are most common
    - Greatest likelihood of causing unsoundness
  - Defects in spinal conformation
    - Less common but occasionally detrimental
    - Excessive Lordosis
    - Kyphosis
    - Scoliosis
    - Individual vertebra deformities

Conformation Front Limbs

- Normal forelimbs
  - Center of hoof lies directly below a vertical line from point of shoulder

#### Conformation Defects Front Limbs

- Base Narrow
  - Center of hoof lies inside a vertical line from point of shoulder
- Base Wide
  - Center of hoof lies outside a vertical line from point of shoulder
- Toe In
  - Pigeon toed, toe points toward midline
  - Toe in defects may result from un-corrected varus defect as a foal
  - Base Wide Toe In
  - Base Narrow Toe In
- Toe Out
  - Splay foot, toe points away from midline
  - Toe out defects may result from un-corrected valgus defect as a foal
  - Base Wide Toe Out
  - Base Narrow Toe Out, this conformation is most likely to result in interference between contralateral limbs

#### Conformation – Foot Path

- Straight Toe
  - Straight foot path
- Toe out
  - Winging
  - Foot swings toward midline

- Causes interference between opposite legs
- Toe In  
Paddling  
Foot swings away from midline

#### Conformation, Rear Limbs

- Normal Rear limb (lateral view)  
Posterior side of cannon is directly below posterior point of tuber ischii (butt)  
Proper angulation in tibia, hock, fetlock, pastern and hoof
- Normal Rear limb (AP view)  
Center of cannon and hoof directly below posterior point of ischium

#### Conformation, Rear Limb Defects

- Standing Under Behind or Camped Under (lateral view)  
Posterior side of cannon is anterior to vertical line from posterior point of ischium  
Can be the natural conformation or  
Can be induced by pain in front feet
  - Causes horse to assume this conformation
  - Laminitis of front feet is most common condition
- Camped Behind (lateral view)  
Posterior side of cannon is posterior to vertical line from posterior point of ischium (butt)
- Base Narrow (A-P view)  
Center of cannon and hoof inside of vertical line from posterior point of ischium (butt)
- Cow Hocked (A-P view)  
Medial deviation of hock joint and lateral deviation of the metatarsal so that the hock lies inside of vertical line from posterior point of ischium, while hoof lies on or outside of the vertical line  
May result from valgus deformity in hock as a foal
- Post Legged (lateral view)  
Decreased angle (from vertical) of the tibia (gaskin), such that the stifle and hock are too straight and upright.  
Increased concussive trauma to hock and other structures  
Associated with too straight or upright pastern
- Sickie Hock (lateral view)  
Increased angle in the hock  
Increased tension and strain on Achilles tendon, posterior flexor tendons and ligaments of the hock

#### Structure and Conformation of the hoof

- Ventral structures of the normal hoof
  - Heel
  - Bulbs
  - Quarter
  - Toe
  - Frog
  - Collateral Sulci
  - Central sulcus
  - Sole
  - Bar
  - Hoof wall
  - Angle of wall
  - White line
- Hoof and pastern angle  
A – normal, 47 degrees front, 52 degrees rear  
B - too small an angle (from Horizontal), shallow slope

## C – Too large an angle from horizontal, steep slope

### Relationship to soundness

- Too small an angle (from Horizontal), shallow slope
  - Places excess strain on suspensory ligaments
  - Strain on flexor tendons (esp. superficial flexor tendon)
- Too large an angle from horizontal, steep slope
  - Increased concussive force to joints in the lower limb
  - Increased incidence of traumatic osteoarthritis in the joints of the lower leg (i.e. Ringbone, Osselets, Etc.)

Correctable angular and flexor limb defect seen initially in foals

- Calf- Kneed  
Posterior deviation at carpus  
Due to carpal joint laxity  
May be associated with genetic defects such as "Contractural Arachnodactyly" in Angus cattle.
- Buck-kneed and contracted tendons  
Anterior flexor deviation at carpus  
Due to tension in flexor tendons and suspensory ligaments  
Sometimes in large fetuses the long bones grow faster than the tendons causing the relative "contraction" of the tendons.  
It is also thought to sometimes be related to uterine positioning.

Medial and lateral angular limb deformity (front or rear legs)

- **Valgus Angular limb deformity (front or rear legs)**  
Knock kneed or cow hocked defect  
May appear as a "medial deviation", BUT in fact it is actually a lateral deviation of the leg distal to the area of the angular defect. The angular defect usually originates in the carpus or tarsus areas but can also occur at the fetlock or any other leg area.  
Frequently associated with lateral toe rotation (toe out)  
Correctable with restricted exercise, splints or surgery
- **Varus angular limb deformity (front or rear legs)**  
Bow-legged defect  
May appear as a "lateral deviation", BUT in fact it is actually a medial deviation of the leg distal to the area of the angular defect. Once again the angular defect usually originates at the carpus or tarsus but can occur at any other leg area.  
Frequently associated with medial toe rotation (toe in)
- Common causes of valgus or varus deformities include;  
Incomplete ossification in a joint causing joint laxity  
Abnormal growth at a long bone growth plate
- These defects are often correctable with:  
Restricted exercise, for joint laxity and contracted tendons  
Splints, for joint laxity and contracted tendons
- Surgical correction of angular limb deformities  
Useful for deformities that originate in a growth plate or where conservative treatment has failed
  - Temporary growth plate stapling or bridging on the convex side; suppresses growth on the stapled side allowing the other side to "catch up" in length
  - Periosteal stripping at the growth plate on the concave side; stimulates new bone growth and lengthening

Lameness

Definitions:

- Lameness:  
A departure from normal stance or gait. A structural or functional disorder in one or more limbs. Manifested in the standing position or during progression.

- Sound:  
Exhibiting normal health; free of injury or disease; having the capacity to perform the function intended for that animal.
- 
- Unsound:  
Not sound; not healthy; characterized by injury or disease that interferes with normal, desirable function of that animal.
- Blemish:  
An injury affecting appearance but not function
- Peracute:  
Very rapid onset
- Acute:  
Recent, sudden onset
- Subacute:  
Active or progressive disease process
- Chronic:  
Long duration, lingering
- Convalescent:  
Recovering
- **Sprain:**  
Trauma to a joint  
Injury to the joint capsule, ligaments and associated soft tissues.  
Pain, swelling and palpable heat in area
- **Strain:**  
Stretching injury to tendon or muscular  
Overstretching of a muscle or tendon  
Due to excessive tension or over-use.
- Granulation Tissue:  
Tissue formed in repair of soft tissue wounds  
Fibrous connective tissue  
Vascular tissue
- Proud Flesh:  
Excessive proliferation of granulation tissue when wounds heal via second intention  
Common on lower limbs of horses, where the skin is tight and tension stretches the skin, re-opening granulating wounds  
Treatment consists of surgical removal of excess granulation tissue and immobilization of the skin or even the limb  
When proud flesh will not heal in spite of treatment it may be the result of Habronema spp infestation (summer sore)
- Synovial Fluid  
Serum transudate with decreased serum proteins  
Lubricates and nourishes cartilaginous surfaces  
Proteins are primarily glycoprotein polymers
  - Hyaluronin, Lubricin and others
  - These act as lubricants and cushion the articular surfaces
 Normal synovial fluid analysis
  - Protein levels <2.0 g/dl (plasma protein is 5 to 7 g/dl)
  - Nucleated cells <300 cells /  $\cdot$ l
  - High viscosity – a drop will form a 3 to 5 cm string
  - **Mucin clot test positive**
    - A tight mucous clot will form when acetic acid is added
    - Vinegar
  - Culture and sensitivity

Causes of lameness:

- **Trauma**

- Fractures
  - Contusion
  - Lacerations with injury to joints, ligaments and tendons
  - **Congenital or acquired neonatal anomalies**
    - Hoof and bone deformities
      - Club foot, congenital or acquired
      - Angular limb deformities, see above
    - Arthrogryposis
      - Fetal paresis/paralysis results in faulty development and of joints in one or more legs
      - Genetic, toxic plants, idiopathic causes
    - Spinal deformities
      - Cervical Vertebral Malformations (CVM or Wobbler Syndrome)
        - Cervical Vertebral Malformation (CVM) result in ataxia and is referred to Wobbler Syndrome
        - Subluxation and vertebral canal stenosis result in neurologic deficit
      - Spinal Bifida and deformed sacral-pelvic s, congenital defect seen in cattle
      - Lordosis, Kyphosis, Scoliosis
  - **Poor conformation**
    - Concussive joint injury (straight legged conformation)
    - Tendonitis due hyperextension (low slope on pastern)
    - Repetitive trauma due to interference
  - **Circulatory disorders**
    - Aortoiliac Thrombosis (saddle thrombus)
      - Thrombosis at the bifurcation (really a quadrifurcation) of the aorta to the 4 iliac arteries
      - Possible causes include degenerative arterial disease and parasitism
      - Signs relate to decreased blood flow; primarily weakness and ataxia in the hind legs when worked
- Exertional rhabdomyolysis (exertional myopathy)**
- Myositis and myolysis as a result of exertion after a period of several days rest
  - Also called "Monday morning disease", "Tying Up"
  - Severe pain, sweating, stilted gait or recumbency
  - Musculature of back, hind quarters, shoulders
  - Causes;
    - Aberrant glycogen storage & use
      - Excess glycogen storage allows prolonged anaerobic metabolism of muscle cells causing local lactic acidosis, occurring if horse is not properly "warmed-up"
      - Local lactic acidotic condition causes arterial constriction and decreased muscle circulation which will exacerbate the acidotic condition.
    - Circulatory dysfunction in muscles
    - Electrolyte imbalance
    - Genetics:
      - Polysaccharide Storage Myopathy (PSSM) is a dominant autosomal genetic mutation found in many draft and light breeds of horses. It will cause an intermittent, recurring form of tying-up.
      - Malignant hyperthermia (MH) is another genetic mutation is found in Quarter Horse and Paint Horse breeds. It is noted for causing post-anesthetic emergencies in affected horses. It may also be involved with causing more severe forms of tying-up and Exertional Rhabdomyolysis.
  - Diagnosis
    - Clinical signs;
      - Stiff stilted gait
      - Reluctance to move

- Recumbency
  - Elevated CPK (>1000 IU/L), LDH and AST
  - Myoglobinuria, or a brownish discoloration of the urine
  - DNA test for PSSM
- Treatment
  - Tranquilization (Acepromazine is a mild vaso-dilator)
  - Confinement to a stall and prevent excitement and excessive movement
  - Anti-inflammatory drugs

#### Navicular disease

- Degenerative disease of the distal phalangeal sesamoid bone (navicular bone)
- Navicular bone lies posterior to the P2 – P3 joint (coffin joint)
- Frequently bilateral front limb lameness
- Multiple syndromes not a single entity
- Erosion of articular cartilage if frequently present (DJD)
- Osteopathy of sesamoid
  - Can be due to thrombosis of veins draining the bone
  - Ischemic necrosis of bone
- Diagnosis,
  - Hoof tester
  - AP & DV radiographs (pack hoof or water bath)
  - Digital nerve block
- Treatment
  - NSAID
  - Corrective shoeing
    - Raise heel 2 to 4 degrees
    - Elevated heel on shoe with rolled or rocker toe
  - Anticoagulants (warfarin)
  - Beta adrenergic vasodilator Isoxuprine
  - Digital neurectomy for chronic cases

Laminitis, see below under hoof disorders

- Metabolic disorders
  - Hypocalcemia, tetany and/or muscle weakness
  - Hyperkalemic Periodic Paresis, in Quarter Horses
    - Descendants of a QH stallion named "Impressive"
    - An autosomal dominant gene results in an inability to control blood K level.
    - When blood K is too elevated, it causes Persistent depolarization of muscle cells, resulting in muscle fasciculations at first followed by profound muscle weakness (paresis)
    - Treatment; IV Dextrose and Na Bicarbonate or IV Calcium
- Nutritional deficiencies leading to osteodystrophies
  - Nutritional secondary hyperparathyroidism (Low Ca:P ratio)
    - Animals kept on a high phosphorous and deficient calcium diet
    - Ca depletion of bone in order to maintain normal blood Ca level
    - Demineralization of bone results in bone thickening, pathologic fractures, pain and various lamenesses

#### Osteochondrosis

- An important problem in all domestic species
- Affect juvenile animals that are genetically capable of rapid growth and large mature height and weight. Affect animals on a high plain of nutrition.

- Disturbance of cellular differentiation in growth cartilage associated with bone development
- Decreased ossification at the osteo-condral interface
- Disturbance in vascularization of new bone
- Causes are complex and still unclear
  - Mineral deficiency or imbalance in mineral nutrition involving: Ca, Zn, Cu, Mn, and CA:P ratio (<1.5:1)
  - All meat diet in carnivores
  - Feeding a high energy, concentrate (grain) ration which is high in phosphorous and deficient in calcium and/or trace minerals
- **3 syndromes:**
  - **Osteochondritis Dessicans**
    - Disturbed ossification and formation of subchondral bone
    - Detachment of surface cartilage from subchondral bone
    - Exposure of subchondral bone
    - Detached cartilage and bone fragment in joint causing further damage
    - May resolve itself, require surgery to remove joint mouse, or lead to degenerative joint disease
  - **Subchondral bone cysts**
    - Decreased ossification of subchondral bone results in micro-fractures. The micro fractures result in bone cyst formation.
    - Etiology is similar to OCD, but without joint surface fragmentation.
    - May lead to clinical OCD when the joint surface does fragment.
  - Physitis or epiphysitis
    - Delayed ossification of bone at growth plate of long bones
    - Marked widening of the physeal cartilage
    - Thickening of the long bones occur near the physis to compensate for weakness in the area.
    - Gross appearance of a thickened bone adjacent to the joint.
- Joint injury and disease
  - Luxations and sub-luxations
    - Causes
      - Trauma
      - Tearing a ligament
      - Avulsion fractures at attachment of ligaments
      - Advanced DJD with weakening of periarticular structures
    - Diagnosis:
      - Obvious deformity of joint, marked lameness (Luxation)
      - Palpation of laxity in joint, variable lameness (sub-luxation)
      - Radiography
      - Blood in synovial fluid analysis
    - Treatment
      - Casting, surgery, etc

#### **Degenerative Joint Disease, arthritis**

- DJD is a common abbreviation or acronym
- Causes
  - Chronic, repetitive injury to a joint, from concussive forces, interference,
  - Intra-articular fractures
  - Ligament damage, sub-luxation, etc.
- Degeneration of joint result in:
  - Thinning of articular cartilage
  - Erosion of articular cartilage
  - Exposure of subchondral bone
  - Synovial & periarticular Inflammation

- Osteophyte formation; at margins of the joint capsule initially and later the osteophytes may invade the joint
- Some common examples of DJD include:
  - **Osselets:**
    - Traumatic arthritis of the fetlock joint
    - Common in young horses starting training
    - Can result from hyperextension of the fetlock joint with bruising trauma or fracture of the extensor process of P1
    - Can also be a result of concussive trauma from too steep a slope in the hoof and pastern
  - **Ringbone:**
    - DJD of interphalangeal joints
    - Exostosis or new bone growth on P1, P2 or P3
    - High ringbone, DJD of P1 – P2 (pastern) joint
    - Low ringbone, DJD of P2 – P3 (coffin) joint
    - Usually is the result of concussive trauma; from riding too hard (trotting or loping on paved surfaces and perhaps too steep a slope in the hoof and pastern)
  - **Bone Spavin:**
    - DJD of intertarsal and tarsal metatarsal joints (lower half of the hock)
    - Can result from bad conformation of the hock joint such as sickle hock or post legged.
    - Can also be a result of concussive trauma from too steep a slope in the hoof, pastern, and hock (post-leggedness)

#### Sprains, Strains and Traumatic Inflammation of Synovial Structures

- **Bog Spavin**
  - Synovial and effusion of the tibio-tarsal joint
  - Frequently associated with osteochondrosis
  - Can also be caused by sprains, synovitis or other trauma
  - Often asymptomatic, with no lameness, when examined
  - Treatment unrewarding
- **Windpuffs**
  - Fetlock, Hock, Knee
  - Swelling around joint capsule
  - Swelling in tendon sheath or bursa
  - Result from a sprain, OCD, synovitis or trauma
  - Often asymptomatic and only a blemish rather than a lameness

#### Septic Synovitis and Arthritis

- **Causes**
  - **Navel ill**
    - Septic arthritis secondary to neonatal navel infection
    - Septic arthritis due to navel infection is sometimes called "joint ill".
    - Common bacteria include
    - E. coli and other gram negative coliform bacteria
    - Pasteurella spp.
    - Gram positive cocci
  - Trauma from laceration or puncture injury with introduction of infection
  - Iatrogenic from intra-articular procedures and injection
  - Infectious disease agents
    - Mycoplasma spp.
    - Brucella abortus
    - Borrelia burgdorferi, a spirochete causing, Lyme Disease
- **Diagnosis:**
  - Enlarged, painful joint, bursa or tendon sheath
  - Synovial effusion



- Grade 5 lameness
- Radiography, gas in peri-articular tissues may evident
- Synovial fluid analysis & culture
- Treatment:
  - Eliminate the organism
  - Remove harmful material in the joint,
    - flush joint
    - install a drain tube
- Neurologic disorders
  - Viral encephalitis and myelitis, equine encephalitis viruses, rhinopneumonitis virus
  - Equine Protozoal Myeloencephalitis (EPM) caused by *Sarcocystis neurona*, a parasite with the opossum as the definitive host and source of infection
  - Otitis media, otitis interna
- Disorders of the Sole and frog
- Sole Bruise
 

Probably the most common cause of limping (or walking tenderly)

Trauma from stones and other objects

Cleaning with a hoof knife will reveal blood staining, bruising and darkening of sole

Treatment is shoeing with pads

Cattle can suffer from this condition also, especially large bulls
- Subsolar abscess
 

Infected puncture wounds on sole

Treatment

  - Open wound and establish drainage
  - Lavage
  - Antibiotics
  - Tetanus toxoid, etc.
- Gravel
 

Infection of the white line

Dissecting infection travels up the hoof wall

Abscess opens at coronary band

Caused by stone bruising or puncture

Treatment same as sole abscess

  - Establish drainage
  - Lavage.
  - Antibiotics
  - Tetanus toxoid
- Thrush
 

Bacterial infection in the sulci of the frog

Cause:

  - Moist environment
  - Dirty, manure packed feet

Treatment:

  - Move to dry environment
  - Removal of necrotic frog and sole
  - Topical Kopertox (copper naphthalate)
  - Antibiotics are indicated if animal is lame due to a deep or extensive infection
- Foot Rot (Interdigital Pododermatitis and Phlegmon)
 

Bacterial infection in the interdigital cleft in cattle, other ruminants and swine

Cause:

  - Trauma to the interdigital skin, abrasion, etc., which becomes infected
  - Dirty, wet environment
  - *Fusobacterium necrophorus* is the most common pathogen
  - Infection can be superficial (dermatitis)
  - Or the infection can gain access to deep fascial layers (phlegmon)

Treatment:

- Move to dry environment
  - Removal of necrotic skin and establish drainage
  - Topical Kopertox (copper naphthalate)
  - Antibiotics
- Hoof Wall Injury and Disease
  - Hoof cracks
    - Develop at any point on the hoof
    - Cracks will frequently migrate upward into the coronet
    - Predisposing factors
      - White feet
      - Uneven trimming of hoof wall or untrimmed hoof
      - Use of an unshod horse on rough terrain
    - Treatment:
      - Treatment aimed at preventing crack from migrating into coronary band, resulting in a permanent growth defect of hoof
      - Score or drill proximal end of crack (prevents migration)
      - Debride and smooth crack using dremmel tool
      - Debride down to sensitive lamina
      - Use wire to reinforce crack
      - Pack debrided crack with acrylic cement (Technovit or other)
      - Apply shoes with clips to support crack (prevents spreading of hoof)
  - Acute Laminitis
    - Inflammation of the sensitive lamina of the hoof wall
    - Laminitis can affect all species of hoofed animals
    - Separation of the hoof wall from the sensitive lamina
    - Typical Stance in horses
      - Camped under behind
      - Holding front leg out in front
      - Stance will remove weight from the front feet
    - Common causes:
      - Overeating, "grain founder", "grass founder"
        - Overeating or eating excess concentrate feed
        - Bacterial proliferation and starch fermentation in cecum and colon
        - Lactic acid & other volatile fatty acid production, acidemia, diarrhea
        - Endotoxin release from gut
        - Inflammatory mediators in general circulation
      - Pneumonia, metritis and other infectious diseases
      - Endotoxemia & circulating inflammatory mediators
      - Black Walnut toxin in wood shavings bedding
    - Pathogenesis – varies with the cause
      - Early increase in blood flow in all cases
      - OLD THEORY
        - Foot edema and increase pressure inside hoof
        - Later; blood flow decrease
        - Ischemic necrosis of the lamina
      - NEW THEORY
        - Matrix Metaloproteinase (MMP) enzyme activity increases due to inflammatory mediators
        - MMP enzyme results in lamellar breakdown
      - Actual pathogenesis probably incorporates old and new
      - Separation of the hoof wall lamina from the sensitive dermal lamina of the third phalanx
      - Rotation of the coffin bone due to separation of lamina layers
      - Loss of support for coffin bone leads to pressure on sole
      - Coffin bone will actually rest directly on sole (dropped sole)

- Perforation of sole and exposure of the coffin bone is possible
- Chronic laminitis
  - Laminitis leads to decreased hoof wall growth due to the separation of the hoof wall (epidermis) from the sensitive lamina (dermis)
    - If the toe and quarter areas of the hoof are affected by separation while the heel remains relatively intact, the toe and quarter hoof wall growth is dramatically decreased, while the heel hoof wall growth remains fairly normal. This results in "differential growth" of the hoof wall.
    - The degree of hoof wall deformity due to differential growth depends on severity that different areas of the hoof wall are affected
    - Results in laminitis rings on hoof wall
    - Leads to "slipper foot"
      - Decreased hoof wall growth on anterior hoof relative to heel
      - Dropped sole anteriorly
  - Treatment of Acute Laminitis
    - Emergency medical management
      - Clear the intestinal tract, using mineral oil; in "foundered" horses
      - Treat primary inciting disease, such as a retained placenta or metritis
      - Ice or cold water soak of affected feet
        - Intermittently for 24 hours if possible
      - NSAIDS (phenylbutazone, flunixin, etc.)
    - Eliminate grain, lush pasture and legume hay
    - Soft deep bedding in a small stall
  - Treatment of Chronic laminitis
    - Corrective trimming, shoeing
      - Heart Bar Shoe moves weight bearing to rear of foot / frog
    - Hoof wall resection
      - Allows for resolution of severely rotated third phalanx
- Sidebone
  - Ossification of the collateral cartilages in the heel area of the horse's hoof
  - Frequently see mild swelling with no signs of lameness
  - Some ossification occurs in many horses with aging
  - Fractured collateral cartilage is a possible sequela – severe lameness
- Splints
  - Disruption or ossification of the interosseous ligament
  - Usually medial
  - Swelling in area of second metacarpal bone
  - Must be differentiated from splint bone fractures
  - Trauma from interference
    - Winging of opposite limb
  - Lameness goes away with time
  - May leave a permanent blemish
- Bucked shins
  - Periostitis and stress fracture of the cranial aspect of the cannon bone
  - Very painful
  - Heals in time
- Sweeney
  - Result from trauma to the suprascapular nerve
  - Common in draft horses
  - Use of poorly fitted draft collars
  - Atrophy of the supraspinatus and the infraspinatus muscles

## Alimentary System

### Mammalian Digestive physiology

- Carbohydrate digestion:
  - Monosaccharides are a single sugar molecule. The main biological sugars are hexose - 6 carbon - sugars; and pentose - 5 carbon - sugars. Examples are  
Hexose: Glucose, Galactose, Fructose  
Pentose: Ribose, Deoxyribose
  - Disaccharides are polysaccharides that are a polymerization of two monosaccharide. The important nutritional disaccharides are:  
Sucrose: is a disaccharide polymer of the monosaccharides glucose and fructose. Sucrose is primarily produced by plants.  
Lactose: also is a disaccharide polymer of the monosaccharides glucose and galactose. It is produced by mammals and is present in milk.  
Maltose is another disaccharide. It consists of two glucose molecules. It is present in many cereal grains, sweet potatoes, molasses and barley malt used for beer production. But, it is primarily a breakdown product of starch degradation in these high starch foods, and in mammalian digestion of starch.
  - Complex Polysaccharides are important nutritional, metabolic and structural component of living organisms. Large polymers of glucose are the primary nutritional and metabolic polysaccharides. These are  
Starch is a large polymer of glucose where adjacent glucose molecules are joined by a 1-4-alpha glycosidic bond into very long chains of glucose that is called amylose. Adjacent chains are cross linked with 1-6-beta bonds forming amylopectin which is a synonym for starch  
Glycogen is the animal version of starch utilizing the same glycosidic bonds. Glycogen is the storage molecule for glucose in muscle cells.  
Cellulose is a complex polymer of glucose where adjacent glucose molecules are joined by a 1-4-beta glycosidic bonds. These bonds are not digestible by mammals. Many bacteria, fungi, yeast and protozoa are able to digest cellulose with species specific cellulase enzymes.
- Protein Digestion
  - Breakdown of proteins into component amino acids
- Lipid or fat digestion
  - Breakdown of triglycerides into fatty acids and glycerol

### Basic herbivore digestive physiology

- Equine
- Simple stomach

### Stomach tube

- Used simultaneously for diagnosis and therapy
- Always be prepared to obtain gastric decompression samples
- Equine stomach tubes are passed through a nostril into the nasal pharynx and then into the esophagus. This is referred to as a naso-gastric tube.
- It is common for the N-G tube to enter the trachea, by accident. Extra caution should be exercised to ascertain that the NG tube is in fact in the esophagus before forcing the tube further, and certainly before administering any medication. So how do you tell if the tube is in the trachea? If the tube is in the trachea air will move in and out, through the tube, with nearly no resistance. If the tube is in the esophagus there is greater resistance to air being blown into the tube and essentially no air can be sucked out of the tube, since the esophagus collapses over the distal end of N-G tube due to the negative pressure. (Yes use your mouth to suck on the stomach tube). These techniques, i.e. blowing and sucking on the stomach tube while passing the tube into the esophagus, work equally well on horses and cattle.
- Mineral oil for instance, administered into the lungs, even in a small 1-3 ounce dose, will cause severe and occasionally fatal foreign body pneumonia.

- In cattle a frick speculum is placed in the mouth prior to passing the stomach tube. This protects the N-G tube from the cow's teeth and the inevitable chewing damage that would occur to the plastic tube, if no frick speculum was used.

#### Hematology and serum chemistry

- Liver enzymes,
- pancreatic enzymes

#### Abdominocentesis

- Usually performed on a horse with progressive colic or other acute abdomen symptoms.
- Usually a single 16 to 18 gauge, B bevel needle is inserted on the ventral midline at the most ventral location, or 5 to 10 cm posterior to the xyphoid cartilage.
- Prep is usually 2 or 3 pre-surgical scrubs, and then alcohol.
- Cytological evaluation
- Chemical composition
- Culture samples
- Gram stain

#### Glucose absorption testing for malabsorption

- Oral monosaccharides require no digestion prior to absorption from intestines. 10% Glucose is administered via stomach tube to the horse after a 12 hour fast, 10 ml/kg. A baseline blood glucose level must be obtained prior to dosing.
- Serial blood glucose concentrations taken every 30 minutes
- 50% increase over baseline in 2 to 4 hours in normal horses

#### Lactose absorption testing for lactose intolerance in foals

- Lactose is a disaccharide, which requires lactase for digestion, prior to absorption from the small intestines.
- Serial blood glucose concentrations taken every 30 minutes
- 35 mg/dl increase in 1 to 2 hours in normal foals

#### Liver biopsy

- Percutaneous route for general hepatic disease and diagnostics
- Laparoscopic or laparotomy for biopsy of specific lesions

#### Rectal exam

#### Endoscopy

- Esophagus
- Stomach, especially in diagnosis of gastric ulcers
- Colonoscopy
- Laparoscopy

#### Exploratory laparotomy

### 3. Gastro-Intestinal Tract

#### The Equine GI Tract and Physiology

- Lips
- Teeth
- Esophagus
- Stomach

Simple stomach divided into two regions

Cardiac region is lined with a non-glandular, squamous epithelium, similar to the mucosa of the mouth, and esophagus.

- This is the area where most gastric ulcers occur.
- This is the location where *Gasterophilus intestinalis* and *G. nasalis* fly larvae emerge and live in the fall and winter, and release to pupate in the spring. These parasites cause gastritis, mucosal damage and perforating ulcers.

Glandular fundus, the lower half of the equine stomach is the fundus which contains the secretory gastric mucosa. Gastric ulcers can also occur here

Pyloric region

- Small Intestines
  - Ileocecal junction
  - Cecum originates in rear dorsal quadrant of the right side of the abdomen. From there it proceeds ventrally, medially and anteriorly. It lies between the right and left portions of the ventral colon. The apex, or tip of the cecum, lies just behind the sternal flexure of the ventral colon adjacent to the ventral body wall.
  - Cecocolic junction
  - Large Colon is divided into a ventral colon and a dorsal colon
- Ventral Colon is divided into: several sections
- Analogous to the Ascending Colon)
  - The Origin of the large colon, starting at the cecocolic junction, high in the right posterior quadrant of the abdomen is the:
  - The Right Ventral Colon which descends to the lowest and most anterior location of the abdominal cavity, adjacent to the sternum. It forms a flexure called the:
  - Sternal flexure which is the most ventral section of the large colon. This flexure is the location where the ventral colon crosses the midline near the sternum and turns rearward as the:
  - Left ventral colon
- Pelvic flexure
- Separates the Ventral Colon from the Dorsal Colon
  - Easily palpated via the rectum
  - The most common location for fibrous impaction in the
- Dorsal Colon
- Analogous to the Transverse Colon
  - Divided into three sections
  - Left dorsal colon
  - Diaphragmatic flexure
  - Right dorsal colon

Small Colon (also called the Descending Colon)

- Rectum

## Ruminant Stomach, GI Tract and Physiology

### Four divisions of the ruminant stomach

- Reticulum (1st compartment)

Functions in concert with the rumen in fermentative digestion of fibrous feed components. Sometimes referred to as the "first stomach". The reticulum, along with the rumen are the "proventricular" or cardiac region of the ruminant stomach. The reticulum, rumen, and the omasum are lined with a squamous epithelium, similar to the esophagus and cardiac region of other mammalian species. The main function of the reticulum, similar to the rumen; is bacterial fermentation of roughages feeds.

The reticulum lies directly below the esophageal entry point, and heavy items usually end up in the reticulum,

- Boluses, magnets, telemetry devices, and metallic hardware are usually found in the reticulum.
- Wire, nails and other sharp metallic items are the cause of "hardware disease"

### Common Condition

- Hardware Disease - A wire or other sharp metallic items swallowed mistakenly by a cow will usually end up in the in the reticulum where it is able to abrade and irritate the reticular mucosa leading to a traumatic reticulitis.
  - Wire may perforate the reticulum during a peristaltic wave and cause peritonitis
  - A wire may continue to migrate through the diaphragm; leading to pleuritis and perforation of the pericardial sac causing purulent pericarditis. Pericarditis can then lead to cardiac tamponade and congestive heart failure.
  - Clinical Signs and diagnostic tests:

A moderate fever if peritonitis is present, 103.5 to 105 degrees F. The animal may be non-febrile before reticulum perforation occurs. The animal may also be non-febrile late in the disease process

Loss of appetite, weight loss, ruminal ileus upon auscultation, and a gaunt appearance to the abdominal area.

Abdominal pain due to peritonitis causes a reluctance to walk, a reluctance to lay down or rise, and the animal will assume an arched back posture. The animal's posture will not return to a flat backed or lordotic posture when the skin of the back is pinched. The animal will have a positive "Grunt Test" when sudden upward pressure is applied to the sternum.

Peripheral edema, and other signs of congestive heart failure will appear if pericarditis is present

Blood work reveals leukocytosis & elevated fibrinogen if peritonitis is present.

Radiographs to identify metallic objects in the reticulum & pericardial areas

➤ Treatments:

If a cattleman or veterinarian thinks; maybe it is remotely possible. Na! Well Maybe! The animal could have hardware disease?? : GIVE THE ANIMAL A MAGNET!

If the animal is febrile use antibiotics to treat for peritonitis

Surgery can be used. A Rumenotomy may be performed to remove hardware from the reticulum. Pericardial Marsupialisation can be performed on animals with pericarditis.

- Rumen (2nd compartment)

The largest part of the ruminant stomach

Is actually a large fermentation vat

- Cows do not masticate the feed that they eat very well. The feed is masticated only well enough to form a feed bolus that is swallowed.
- The un-masticated, partially saliva saturated feed is less dense than fully masticated feed that is fully saturated with saliva. The feed bolus that is swallowed will float on the surface of the rumen fluid layer.
- After a ruminant finishes eating, the feed on the surface of the rumen ingesta is regurgitated and re-masticated. This is called "chewing the cud".
- When the cud is swallowed it is saturated with saliva and due to its density it will fall into the lower layers of the reticulum and rumen contents.
- One very important aspect of chewing the cud is the large amount of saliva that is added to the feed. This saliva acts as a buffer to lowering of the pH caused by volatile fatty acid products of fermentation.

Common conditions

- Bloat - Due to the bacterial fermentation that occurs in the ventral sac of the rumen volatile fatty acids and gases are produced by the microbes. The gas accumulates in the dorsal sac of the rumen. On a regular basis the ruminant animal will eructate a portion of the gas that accumulates there.

➤ There are three basic types of bloat

Esophageal obstruction, Often a feed item such as a turnip or a sugar beet top that gets stuck at any location such as the larynx, the esophagus at the base of the heart or the cardiac orifice of the rumen.

Treatment usually involves oral exam and removal of observable obstructions. If the obstructing object was swallowed it can be pushed with a stomach tube into the rumen

Frothy Bloat, This form of bloat occurs when an animal eats fresh young legumes that are highly fermentable, low in fiber, high in soluble carbohydrates, and high in protein (18 to 24% protein). The high protein and rapid fermentation cause a rapid production of stabilized gas bubbles, rising from the fermenting fluid layer that form a stable

froth in the dorsal sac of the rumen. Cattle are unable to eructate the gas trapped in froth. Regurgitation may sometimes reveal what looks like a large volume of frothy saliva running from the mouth. When passing a stomach tube no gas is released from the rumen, only froth is seen in the tube. Treatment involves administering a defrothing agent that will lower the surface tension of the gas bubbles. FDA approved pharmaceuticals for this purpose are Poloxalene and Simethacone. Mineral oil can be used if it is all that is available.

Vagal indigestion and chronic (repeated) bloating occurs occasionally in weanling calves (and older animals less frequently). Vagal indigestion is a condition that occurs secondarily to pleuritis. Pleuritis itself is a secondary condition to bronchopneumonia in cattle. The vagus nerves run down each side of the mediastinum, immediately underneath the visceral pleura. If infection extends into the nerve itself it will affect conduction in both sensory and motor neurons. This may result in decreased peristalsis at any level of the GI tract and it may reduce sensory perception of fullness. Lack of sensory perception causes animals to overeat, covering the esophageal orifice, preventing regurgitation. Lack of motor function may interfere with ruminal - omasal transit and gastric emptying. The pathogenesis is complex and can vary from animal to animal. Treatment simply involves passing a stomach tube and if the animal turns into a chronic bloater, it should be isolated and limit fed an adequate diet.

- Ruminal Acidosis
  - Causes: Overfeeding soluble carbohydrates (grains, potatoes or other high starch crop residues) with inadequate quantity of forage. Feeding the grain component of a diet separate from and prior to feeding the forage component of the ration. This allows grains to sink in the fluid layer of the rumen to the floor of the reticulum and rumen. This creates local areas in the reticulum and ventral sac of the rumen with extremely low pH under 5.0. A pH <5.5 is considered to be a low grade ruminal acidosis. A pH <5 is severe acidosis even if only locally in the ventral rumen.
  - Prevention: decreased carbohydrates in the ration. Replace carbohydrate with fat in high energy requirement situations. Always feed the hay component of the ration prior to feeding grains. This causes an increase in rumen buffering due to salivation stimulated by consumption of forage. Also forage consumption creates a buoyant forage mat for the grain to remain suspended in. Do not feed a component ration. It is always better if it is possible. To feed Total Mixed Ration (TMR) instead. A TMR prevents local areas of low pH.
  - Pathogenesis: When the pH is too low in the rumen it will cause a shift in the rumen microbes population to more acidophilic species that may not be as beneficial to the animal. Also during the increase in acid in the gut bacteria will die or sporulate as the bacteria cannot live in their own waste products. When bacteria die they release endotoxins and exotoxins that can cause subclinical disease and poor performance. Frank disease such as "Enterotoxemia" caused by sporulation and lysis of *Clostridium perfringens* organisms is also a possibility.
  - Treatment: Prevention is the best treatment, but buffers in the feed such as sodium bicarbonate can be used. Acute acidosis is usually treated with magnesium oxide. In a severe acute case of overeating grain (i.e. She broke into the grain storage room!) a rumenotomy can be performed to manually remove the grain. Intravenous sodium bicarbonate may be needed in patients such as this.



- Omasum (3rd compartment)
  - Round basketball sized organ
  - Mucosal folds form interdigitating leaves
    - Mucosal leaves fill entire lumen
    - Very large mucosal surface area for absorption
  - Main functions:
    - Dehydration of rumen contents
    - Absorption of volatile fatty acids (end products of fermentation)
  - Common condition
    - Impaction
      - Undigestible materials such as baler twine can easily cause impaction and obstruction of the omasum
      - Torsion
  
- Abomasum (4th compartment)
  - "The true stomach" actually the fundus region of the ruminant stomach
  - Acid and enzymatic digestion of ingesta
  - Anatomy is similar to the simple stomach of other species
  - In addition to digesting consumed feed:
    - Bacteria and protozoa from rumen fermentation are digested, greatly increasing the protein and nutrient quality of the ingesta
    - Ruminal microorganisms can convert ammonia, urea and other nitrogenous compounds into protein
  - Common condition: Displaced Abomasum (DA) there are two different types with many variations regarding etiology and pathogenesis. Displaced abomasum is not a primary condition. It is secondary to some other condition that causes the animal to go off feed.
    - Left displaced abomasum (LDA) is a simple displacement without volvulus or torsion.
    - Right displaced abomasum (RDA) is an actual 180 degree counterclockwise (viewed from behind) abomasal torsion. It has been reported that the torsion can occur proximal to the omasum abomasum paired unit, or commonly the torsion occurs at the omasum - abomasum junction. It results in stasis of the abomasal contents an accumulation of chloride in the abomasal lumen.
    - The etiology of DA, regardless of the side of the displacement, is that the displacement is secondary to any condition that causes the animal to be "off feed", (anorexic), have GI ileus, reduced ingesta volume and relative increased gas volume in the rumen. This allows ruminal gas to pass into the abomasum causing buoyancy of both the rumen and abomasum. The decreased rumen size, buoyancy of the stomach compartments, and a tendency for sick cows to lay fully recumbent; allows movement of the abomasum away from the ventral, right, paramedian, normal position in the abdomen.
    - The main predisposing factors for a DA include: hypocalcemia, mastitis, metritis, ketosis & fatty liver syndrome, ruminal acidosis, laminitis and other lameness. These conditions have their highest incidence in the immediate post-partum period, therefore the highest incidence of DA is also post-partum.
    - Initial treatment is directed at the initial predisposing factors. Simultaneous or subsequent abomasal replacement surgery with an abomasopexy, a pyloropexy or an omentopexy must be performed to secure the abomasum in its proper position. An RDA is an emergency surgery that must be done on a Stat. basis due to the hypochloremia and metabolic alkalosis that occurs in conjunction with the abomasal torsion. An LDA surgery should be scheduled within one day or two. Timely surgery will prevent adhesion formation which may interfere with successful LDA surgery if it is delayed for too long.

## The Ruminant Hind Gut (Intestines)

- Small Intestines
- Cecum
- Large (or Spiral) Colon
  - Centripetal Spiral Colon
  - Centrifugal Spiral Colon
- Descending Colon
- Rectum

## Equine Digestive Disturbances

### Primary categories

- Gastritis
    - Parasitic gastritis
      - Bot fly larva
      - Stomach worms
      - Both parasites perforate and cause lesions to gastric mucosa
    - Gastric ulcers
      - Primarily a disease of young horses
      - Decreased appetite and poor performance are main symptoms
      - Colic and other signs are rarely seen
      - Up to 50% of foals may be afflicted
      - Gastric perforation and hemorrhage are occasional life-threatening sequela
      - Helicobacter infection has not been proven but may be a factor
    - Proximal Enteritis
      - Extension of a small intestinal disease discussed below
  - Enteritis (small intestinal)
    - Small intestinal enteritis frequently causes diarrhea in neonatal foals.
    - Adults will seldom display diarrhea due to the fluid absorbing capacity of the large colon.
    - Adults are more likely to show colic like signs as main sign of small intestinal enteritis.
    - Bacterial enteritis
      - Gram-negative coliform bacteria, E. coli and Salmonella spp.
      - Gram positive anaerobic bacteria, Clostridium perfringens
    - Proximal enteritis
      - Enteritis of Duodenum and Jejunum
      - Frequently extends proximally into the stomach
        - Ileus in the small intestine allows gas and ingesta to flow both proximally and distally
        - Marked fluid and gas accumulation distends intestines and stomach causing marked pain
      - Usually severe colic symptoms
      - Can mimic volvulus or intussusception of small intestine
      - Often associated with presence of Clostridium perfringens
    - Viral enteritis,
      - In foals and calves these viruses result in diarrhea
        - Rotavirus, most common virus
        - Coronavirus
        - Adenovirus
        - Parvovirus
      - Viral enteritis causes atrophy (necrosis of enterocytes) of the intestinal villi, referred to as "Villous Atrophy"
        - Decreased intestinal surface area results in decreased fluid and nutrient absorption capacity
        - Malabsorption results in fluid and nutrient losing diarrhea
- All of the above small intestinal infectious processes may also cause disease of the colon

- Colitis
  - Salmonella, E. coli, see above
  - Ehrlichia risticii (Potomac Horse Fever), will be discussed later
  - Colitis X
    - Cl. perfringens and other clostridia
  - Parasitism (large and small strongyles)
- Malabsorption
  - Parasitism, due to lesions in the intestinal epithelium
  - Viral infection, due to villous atrophy
  - Granulomatous enteritis
    - Mycobacterium avium var. paratuberculosis
    - Other Mycobacteria
  - Enteric lymphosarcoma, invading the intestinal mucosa
  - Complications secondary to intestinal resection

GI disorders that are associated with colic

Colic is really a symptom of disease and not a disease entity

Colic – Abdominal pain that is severe enough to elicit symptoms and signs

Many GI diseases can cause colic in horses, including disorders listed above.

- Impaction / Constipation
  - Fibrous Impaction
    - Secondary to initiating causes
      - Dehydration
        - Most common in the winter
        - Horses naturally do not drink as much in the winter
        - Water sources may freeze
        - Insufficient water supply for other reasons
      - Coarse feeds
      - Bad teeth and poor mastication
      - Coarse dry forage
      - Altered gut motility due to other digestive disease
        - Parasitism
        - Sand accumulation in colon
        - Gastric ulcers
    - Most common locations
      - Pelvic flexure
      - Stomach, Secondary to ileus, foreign material, parasites
      - Ileum and Ileo-cecal orifice
      - Cecum, primary neurogenic problem
      - Small Colon impaction (constipation)
    - Symptoms
      - Mild colic symptoms early
      - Depression, weakness, anorexia later
      - Scant mucoid feces
    - Treatment
      - Rehydration therapy
        - Balanced IV fluids 10 to 25 liters initially
        - Oral fluids
      - Mineral oil or other intestinal lubricants
      - Bran in diet
      - Pain medication

Sand Impaction

- Horses eating short grasses on sandy soil
- Eating hay off of the ground on sandy soil

- Sand accumulates in ventral portions of the cecum and colon
- If sand accumulates rapidly in the colon, partial or even full obstruction can occur
- Symptoms
  - Mild and intermittent colic symptoms
  - Depression, weakness, anorexia if obstruction is complete
  - Scant mucoid feces
- Treatment
  - Rehydration therapy is occasionally needed
  - Mineral oil or other intestinal lubricants
  - Bran in diet
  - Psyllium in diet
  - Pain medication
- Prevention:
  - Do not allow animals to graze grass shorter than 3" on sandy soil
  - Never feed hay or grain on sandy ground, even in a feed tub or hay rack, horses love to spill their feed
  - Feed on a concrete pad, rubber mats, dry manure pack, anything other than sandy ground
  - Feed psyllium in grain mix if sand continues to be a problem

#### Retained Meconium

- An impaction of the fetal feces at the rectum
  - Occurs in about 5% of foals born
  - The first feces in a newborn foal is called meconium
    - Consists of semi-digested material ingested and produced by the GI tract during fetal life
      - Amniotic fluid and cells
      - Sloughed epithelial cells
      - Bile and pancreatic secretions
      - Mucous, etc.
  - Foals typically do not defecate during fetal life
  - Meconium fills the rectum and small colon
  - Cause of meconium impaction:
    - Neurologic immaturity
    - Related to late initiation of suckling
  - Signs:
    - Straining to defecate
    - Sometime in a suckling foal a scant diarrhea like fluid is expressed around the impaction and mis-diagnosed as foal scours
  - Rare occurrence in calves
  - First defecation should occur within 2 hours of birth usually after the first suckling
  - Treatment simply consist of an enema if caught early
  - Many horsemen administer an enema to every foal born prophylactically (Fleet, 4.5oz enema)
- Physical injury to bowels
    - Twisting or other anatomic malposition of the bowels will result in:
      - Obstruction of the bowel lumen
      - Vascular disruption of the bowel
        - Occlusion of the venous return,
        - Venous pooling and ischemia
        - Rarely, occlusion of the arterial supply
    - Typical injuries include
      - Intestinal incarceration, strangulation
        - Pedunculated lipoma
        - Inguinal hernia
        - Umbilical hernia

- - Volvulus
    - A twist in a bowel around it's mesenteric suspension
  - Torsion
    - A longitudinal twist in a section of bowel
  - Intussusception
    - Telescoping of a section of bowel inside adjacent bowel
- Spasmodic colic
  - Parasites
  - Circulatory disturbances
    - Strongylus vulgaris causes Verminous Arteritis (VA)
      - Aneurisms
      - Abscesses
      - Thrombosis
    - VA & Thromboembolic ischemia of intestines
  - Moldy feed occasionally
- Tympany
  - Gas accumulation in a section of bowel
  - Causes
    - Altered gut motility or ileus
    - Peritonitis, causing ileus
    - Obstruction
      - Volvulus/Torsion i.e. large colon
      - Intussusception, ileocecal, jejunal
      - Strangulation, abdominal lipoma, gastrosplenic ligament defects
  - Most common locations
    - Cecum
    - Large colon
    - Stomach
    - Small intestines
- Equine Colic Treatment
  - Treatment of colic implies pain management
  - Beyond pain treatment, treat underlying cause
  - Prevent injury to horse and handler
  - Refer if indicated
  - Surgical management
  - Medical management
    - Hand walking, prevent horse from rolling and injuring itself or others
    - Fluid and electrolyte therapy
      - Intravenous
      - Per Os
    - Intestinal lubricants
      - Mineral oil
      - D.S.S.
      - Carboxymethylcellulose
    - Intestinal protectants
      - Activated charcoal
      - Bismuth subsalicylate
      - Kaolin / pectin
    - Analgesics (can mask signs)
      - NSAIDS, best all around pain control with few side effect in colic cases. Added benefit of reversal of endotoxin effects.
        - Banamine
        - Ketofen

- Narcotic agonists
  - Pentazocine, (Talwin), (never with impaction)
  - Butorphanol, (Torbugesic), (never with impaction)
  - Alpha-2 adrenoreceptor agonists
  - Xylazine, (Rompun), (never with impaction)
  - Detomidine, (Dormosedan), (never with impaction)
- Tranquilizer
  - Acepromazine as a vasodilator
- Therapy geared toward specific problems
  - Antiserum for bacterial infection
    - Endotoxin antiserum
    - Enterotoxin antiserum
  - Antimicrobial treatments
    - Antibiotics for specific infections
    - Metronidazole (Flagyl) for gram positive anaerobic bacterial enterocolitis
  - Enema for meconium retention
  - Antacids for gastric ulcers
    - Sucralfate coats stomach lining (specifically ulcerated areas) protecting against the activity of acid and enzymes
    - H2 blockers to suppress acid production
  - Plasma or blood transfusion if patient is hypoproteinemic or anemic from parasitism, Protein losing enteropathy, malabsorption or chronic blood loss
  - Plasma to treat low blood immunoglobulin levels
  - Gastric decompression and emptying
    - Stomach tube
- Equine Colic Preventative measures
  - Routine dental care
  - Deworming
  - Good feeding and watering methods
    - Feed off the ground
    - Use only good quality forages
    - Make no sudden feed changes
    - Adhere to regular feeding schedule
  - If sand is a problem
    - Psyllium or bran in the feed
  - Regular exercise
  - Minimize stress
  - Endotoxin vaccine

#### Diarrheal Diseases

- Neonatal Diarrhea (Scours) calves and foals
  - Factors which contribute neonatal diarrhea
    - Pathogen burden in environment
    - Colostrum consumption (quantity)
    - Colostrum quality
    - Maternal immunity to specific pathogens
    - Low blood immunoglobulin IgG levels due to "Failure of Passive Transfer" (FPT)
      - Low blood IgG level result from inadequate consumption or poor quality of colostrum
      - Several tests are available to assay IgG levels:
        - Radial immunodiffusion (RAD)
        - Zinc sulfate turbidity
        - CITE IgG (probably the best quick screening test as it can be done on the farm quickly)

- A crude estimate of antibody transfer can be made by simply doing a total plasma protein with a refractometer
  - <=5gm/dl is indicative of FPT, while >=7gm/dl is normal
- Treatment of FPT include administration of donor colostrum to neonates less than 24 hours of age and administration of blood plasma (1 to 3 liters) to older neonates

Must establish a diagnosis if possible

- Enables prevention against specific pathogens
- Determine antibiotic sensitivity

Methods of making a diagnosis

- Fecal or rectal cultures, sensitivity
- Fecal virology, usually electron microscopy (EM)
- Necropsy
  - Allows sampling for virology and bacteriology
  - Gross and histopathology findings are helpful
  - Sampling liver for evidence of malnutrition
- Fecal floatation – coccidiosis
- Microbiology – careful interpretation is essential
  - Culture and sensitivity testing

Etiology – variable

Bacterial

- E. coli is the most common pathogen
  - E. coli and other coliform bacteria must come in close contact or attach to intestinal epithelium. This allows the endotoxin on the surface of the bacterium to affect the enterocytes.
  - E. coli with K99 pili antigen are particularly pathogenic
  - The K99 pili antigen allows the bacterium to tightly attach to enterocytes, facilitating the effects of the bacterial endotoxins on enterocytes
  - Endotoxin effects include hypersecretion of fluid and electrolytes from enterocytes, cell membrane disruption, cell death
  - Endotoxins may increase capillary and small vessel permeability, causing fluid loss
  - Invasion of mucosa, submucosa and vasculature can result in systemic septicemia and endotoxemia
  - Hypersecretion of fluid and capillary leakage results in diarrhea in foals
  - Occurs typically in neonates under 1 week of age
  - Associated with “Failure of passive transfer of immunity”
  - Endotoxemia
  - Septicemia
- Salmonella spp. and other coliform bacteria behave similarly to E. coli
  - Salmonella is a potential zoonotic disease
  - Clinically similar to E. coli in most respects
  - May cause a more bloody diarrhea than E. coli
- Clostridium perfringens
  - Causes enterocolitis (small and large intestines)
  - Can occur at any time during lactation but usually occurs between 1 and 3 months of age (peak lactation)
  - Occurs in calves nursing cows with excessive milk
  - Can occur in older animals also, associated with “overeating”, sheep and cattle in feedlots vulnerable
  - Bacteria proliferate in a carbohydrate rich environment
  - Other bacteria and viruses predispose
  - Cl. perfringens may be normal inhabitant of gut, but proliferates and causes disease when there is excess consumption of starch and sugars causing excessive volatile fatty acid accumulation in the gut lumen and decreased

oxygen content of ingesta. Other GI disorders and antibiotic therapy may also predispose to *Cl. perfringens* overgrowth by upsetting normal gut flora.

- Enterotoxin (actually an exotoxin) are released from bacteria causing necrosis of intestinal epithelium, vascular damage, intestinal hemorrhage, ileus and other toxic effects.
- Gas accumulation in bowel from bacterial fermentation
- Enterotoxin in the peripheral circulation cause circulatory collapse, shock and death, referred to as Enterotoxemia
- The neonate may die before diarrhea is even evident
- Treatment difficult as cases are frequently peracute
- Exotoxin release is hastened by the use of oral bactericidal antibiotics. Antibiotic treatment may be of limited value in treating enterocolitis. Metronidazole (Flagyl) may be of benefit in treatment. Also probiotic therapy and supportive therapy are beneficial.
- Prevention includes vaccinating the dam and neonates with *Cl. perfringens* C&D toxoid and administration of antitoxin to vulnerable animals

#### Viruses

- Infect enterocytes
- Induce villus tip atrophy due to enterocytes loss (death of cell)
- Villus atrophy causes a decrease in intestinal surface area and marked decrease in fluid and nutrient absorptive capacity (malabsorption)
- Malabsorption results in fluid and nutrient loosing diarrhea
- Rotavirus
  - Most widespread virus that causes diarrhea
  - Disease may be mild to severe
  - Epidemics of rotavirus are common
- Coronavirus,
  - More serious damage to intestines than rotavirus
  - Less common
  - Can affect adults also
- BVD
  - Typically calves over 30 days of age
  - Congenitally infected calves may not show diarrhea but die
- Diagnosis of these viruses usually requires electron microscopy
  - It is essential to obtain fecal sample for EM from a neonate that has just started scouring within the last 12 to 24 hours.

#### Misc. protozoan organisms

- *Cryptosporidia parvum*
  - A protozoan parasite similar to coccidiosis
  - Affects calves over 2 weeks of age
  - Causes malabsorptive diarrhea
  - Zoonotic risk
- *Giardia* - Calves over 2 weeks of age

#### Pathogenesis

- Dehydration
  - If severe enough, dehydration results in
  - Hypovolemia
  - Azotemia
- Acidosis
  - Primarily lactic acidosis secondary to hypovolemia
  - Metabolic acidosis possible in moribund neonate
- Hypoglycemia
- Intestinal mucosa damage and blood loss
- Septicemia
- Endotoxic shock secondary to septicemia
- Enterotoxin from *Cl. perfringens* causes intestinal necrosis and circulatory collapse



### Assessment of the neonate

- Volume and consistency of diarrheic stool
  - The more watery the stool is, the faster the patient will deteriorate
- Dehydration
  - Skin elasticity test for dehydration
  - Eye ball position in orbit (sunken?)
- Evaluation of base deficit (acidosis)
  - Blood gas analysis – or –
  - Physical evaluation
    - Loss of suckle reflex but ambulatory (mild acidosis)
    - Sternal recumbency and unwilling to rise (moderate acidosis)
    - Lateral recumbency and inability to rise (serious acidosis)
- Circulation – Shock and Hypothermia
  - Subjective evaluation of oral temperature
    - Oral temperature inversely proportional to degree of shock
    - Cold mouth generally means a calf has lost ability to maintain body temperature (developing shock and probably acidosis), especially serious when temperature is below freezing
- Evaluation of blood glucose for hypoglycemia / hyperglycemia

### Treatment

- Oral electrolytes
  - Non-alkalinizing oral electrolytes in early treatment
    - Fluids that do not contain sodium bicarbonate
    - Sodium bicarbonate will neutralize gastric acid and interfere with milk curd formation (necessary for normal milk digestion)
    - For calves with diarrhea but minimal dehydration and no signs of acidosis OK to leave calf or foal on dam
  - Sodium bicarbonate (alkalinizing) oral electrolyte solutions for more severely affected calves
    - 3-5% dehydration or mildly acidotic
    - Best to not allow calves to nurse while on these solutions
- IV electrolytes
  - .9% NaCl
  - 1.3% Na Bicarbonate to reverse acidosis
  - Avoid lactate in oral or IV solutions for calves w/ lactic acidosis
  - Don't use lactated ringers solution
- IV or oral Dextrose to treat hypoglycemia
- Other treatments
  - Oral colostrum supplements
  - Antitoxins (Clostridial)
  - Kao Pectate, activated charcoal and other absorptive / protective compounds are beneficial
  - Antibiotics
  - NSAID to treat endotoxemia

### Prevention

- Reducing exposure to pathogens
  - Clean calving facilities
- Increasing herd resistance to disease
  - Vaccination of dam with Rotavirus, Coronavirus, E. coli K99 antigen, and Cl. Perfringens type C, vaccine - ScourGaurd 3K C (Pfizer)
    - Vaccinate dam with 2 doses with second dose 2 to 4 weeks pre-calving, annual booster 2 to 4 weeks pre-calving
    - Improves colostrum antibodies against the following:
      - Rotavirus and Coronavirus

- E. Coli K99 antigen
  - Cl. perfringens bacteria and toxin
  - Assure adequate colostrum consumption
  - Reduce stress; Provide bedding for newborn calves. Housing in inclement weather.
  - Vaccinations and treatments of the neonate at birth
    - Use "Calf Guard" oral MLV Rotavirus and Coronavirus vaccine within 2 hours of birth
    - Use E. coli K99 antibody preparations if necessary
    - Vaccinate for Cl. perfringens type C&D
    - Use Cl. perfringens antitoxin if necessary
    - Use preventative antibiotics only as a last resort
- Potomac Horse Fever (Equine monocytic ehrlichiosis, Equine Ehrlichia Colitis)
  - Etiology
    - The pathogen that causes PHF was formerly known as Ehrlichia risticii
    - The revised name is Neorickettsia risticii
  - Transmission
    - Transmission studies using N risticii infected caddis flies have reproduced the clinical disease. The most likely route of exposure is the consumption, while grazing, of aquatic insects or snails that are infested with a metacercarial (larval) stage of a trematode (flake) that is, in turn, infected with the N risticii bacterium.
    - Sporadic incidence and the fact that infected clinical patients do not transmit the disease to stable-mates leads one to conclude that the infected fluke larva is an obligate intermediate host. More research is needed to really make that conclusion though. Other methods of transmission are possible.
  - Pathogenesis:
    - Infects monocytes, macrophages & glandular epithelium
    - Obligate intracellular bacterium
    - Acute colitis, typhlitis
    - Inflammation, fluid loss into the lumen of the intestine and thus diarrhea
  - Symptoms
    - Profuse watery diarrhea
    - Depression
    - Anorexia
    - Fever
    - Ileus
    - Hypovolemic shock
    - Colic and laminitis are common
    - Signs are clinically difficult to distinguish from Salmonella
  - Diagnosis
    - IFA
    - Response to therapy can be diagnostic
  - Treatment
    - Supportive care
    - IV fluids
    - Oral fluids
    - Antibiotics, Oxytetracycline
  - Prevention
    - Vaccinate
    - Reduce tick load
    - Regular parasite control

- Respiratory System
  - Common conditions of the respiratory system
    - Pharyngitis, Laryngitis,
    - Tracheitis, Bronchitis
    - Pneumonia
      - Bronchopneumonia is primarily of bacterial etiology and is often secondary to viral respiratory infection or physical insult to the lungs such as dust, toxic gas, or allergens.
        - Pneumonia is defined as pulmonary infection which occurs within the alveoli. In bronchopneumonia the infection reaches the alveoli most commonly via the tubular respiratory tree, including the trachea, bronchi and bronchioles.
        - Bronchopneumonia causes lung consolidation, or filling of the alveoli and bronchioles with inflammatory fluids. This results in a decrease in normal respiratory gaseous exchange,
        - Red hepatization: pneumonia. Acute inflammation causes edema, vascular congestion and filling of the alveoli and terminal bronchioles with exudate; including blood and serum. The acute inflammatory state imparts a red appearance to the areas with pneumonia.
        - Grey hepatization: occurs in chronic pneumonia and is the result of infiltration of inflamed areas of lungs with leukocytes. Areas that are affected with gray hepatization can progress to pulmonary abscessation if there is still active infection.
        - The respiratory signs, or dyspnea, caused by bronchial pneumonia is variable depending on the percentage of lung that is affected. With early pneumonia affecting less than 10% of the lung there may be minimal dyspnea. As the percentage of affected lung increases, the dyspnea can progress to severe "inspiratory dyspnea" (rapid shallow respiration and inability to inhale adequate fresh air).
    - Fibrinous pneumonia
      - Inflammation in the pleural cavity
    - Interstitial pneumonia
      - Inflammation in the interstitial space (between the bronchioles and alveoli. Causes a shortness of breath that is characterized as "expiratory dyspnea". There are numerous causes all leading to interstitial pneumonia including:
        - Atypical interstitial pneumonia of cattle caused by the toxic effects of 3 methyl-indole,
        - Viral Interstitial pneumonia in cattle, usually caused by parainfluenza viruses,
        - Heaves in horses which is an allergic asthma like condition.
    - Pleuropneumonia,
      - There are many potential causes of pleuritis; chest trauma, hardware disease in cattle, and others; but pleuropneumonia is by definition an infectious form of pleuritis reaching the thoracic cavity via extension of a pneumonic condition from the lung into the pleural cavity. Similar infectious processes can reach the pleura or via the blood stream in the case of septicemic disease.
      - Pleuropneumonia can be caused by several bacterial species. A contagious and reportable pleuropneumonia of cattle caused by *Mycoplasma mycoides* subsp. *mycoides* is "Contagious bovine pleuropneumonia". The same organism causes "Contagious caprine pleuropneumonia". Some other bacterial species causing pleuropneumonia in cattle are *Mycoplasma bovis*, *Histophilus somni*, *Pasteurella multocida* and *Streptococcus equi* others.

- Laryngeal hemiplegia, Damage to the left recurrent laryngeal nerve results in paresis or paralysis of most of the muscles of the left half of the larynx including the abductor muscles of the arytenoid cartilage (the cricoarytenoideus muscles).
- "Strangles" is the abscessation of pharyngeal lymph nodes secondary to Streptococcus equi pharyngitis or other upper respiratory infection. It is primarily a horse infection but can infect humans. The most recognized syndrome is abscess formation resulting in lumps in the inter-maxillary space, the laryngeal area of the neck and posterior to the ramus of the mandible.

#### Percussion

- Detect consolidated areas of the lungs
- Detect fluid level in the thoracic cavity

#### Endoscopy, using a flexible endoscope

- Naso-pharynx
- Guttural pouch opening and guttural pouch
- Larynx
  - Laryngeal hemiplegia is a common cause of exercise intolerance in horses. It is referred to as "Roaring".
  - Damage to the recurrent laryngeal nerves, innervating the abductor muscle of the arytenoids cartilage, is one cause of laryngeal obstruction
- Trachea
- Bronchi

#### Hematology

#### Radiology

- Particularly useful in smaller animals under 400 pounds
- Large horses require a LARGE X-ray machine

#### Blood gasses

#### Transtracheal wash and Bronchoalveolar Lavage

- Culture samples
- Gram stain
- Cytological evaluation

#### Thoracocentesis

- Culture samples
- Gram stain
- Cytological evaluation
- Chemical composition

#### Ultrasonography

#### Guttural pouch catheterization

- Cardiovascular System

#### Electrocardiography

#### Echocardiography

- Ultrasonography
- 2 dimensional, real time image of heart
- 1 dimensional X time image of specific area of heart, M-mode
- Doppler real time imaging reveals rate and turbulence in blood flow (using color enhancement of fluid flow)

#### Exercise testing, tread mill

#### Radiography

#### Cardiac catheterization

- Pulmonary Arterial Pressure test (PAP test), in cattle
  - Hypoxia that occurs at high elevation causes increased cardiac output
  - Genetic predisposition to thickened pulmonary arteries with decreased elasticity leads to elevated PAP especially at altitudes over 5000 feet
  - Chronically Elevated PAP causes right heart failure

- Right heart failure in cattle living in the mountains is called “Brisket Disease” or “High Mountain Disease”
  - Peripheral edema especially ventral edema, dyspnea and weakness are main symptoms. Brisket edema is common.
  - PAP testing bulls and elimination of those with elevated PAP reduces the incidence of this deadly condition
- Reproductive System
    - Vaginal Speculum exam
      - Caslick Speculum for mares (too large for most cattle)
      - Frick Speculum for cattle and mares
      - Modified Balfour retractor with 8”-10” blades for intravaginal surgery
    - Microbiologic exam, vagina, uterus, male urethra, semen
      - Gram stain of exudate, and discharge
      - Culture of exudate, vaginal / uterine discharge and semen
      - Tiegland culture swab for uterine culture
    - Visual and direct palpation
      - Labia, and vaginal exam
      - Cervix exam
      - Scrotum, external preputial skin and the internal preputial skin of the extended penis
    - Indirect palpation
      - Male Examination
        - Testicular exam through the scrotal skin, should include palpation of testicle parenchyma (seminiferous tubules and rete testis and efferent ducts); head, body and tail of the epididymis and the origin of the vas deferens; spermatic cords; cremaster muscles and the external inguinal rings.
        - Examination of the penis through the preputial mucosa and the skin over the prepuce and perineal area.
        - Internal genitalia and bladder via rectal exam. Internal genitalia include internal inguinal ring, terminal vas deferens and ampulla, seminal vesicles, the prostate glands, root of the penis and the colliculus, proximal urethra, bulbourethral gland, the ischial muscles and retractor muscles of the penis.
      - Female Rectal exam, the most common reproductive exam done in large animal medicine
        - Indirect palpation of many structures through wall of the rectum
        - Female: Cervix, Uterus (and the embryo or fetus in pregnant animals), Oviduct and Ovaries
        - Pregnancy diagnosis (Preg. check) is the most common reproductive exam performed. Manual palpation to detect the pregnancy is the most common method to Preg. check cattle. Pregnancy can be palpated by most experienced clinicians by the time that the pregnancy has reached 40 days in both mares and cows. A primigravid pregnancy can often be diagnosed by manual palpation as early as 30 days in cattle
- Ultrasonography, in recent years this is probably the second most common reproductive procedure that is done in LA medicine
- Most reproductive ultrasonography is done via the rectum, using a straight linear array probe in B-Mode. Advanced pregnancies (> 4 months) can be examined through the abdominal wall, sheep and swine can be examined trans-rectally or trans-abdominally
  - Early pregnancy diagnosis (as early as 11 days in the mare, 25 days in cattle)
  - Another advantage of early ultrasound pregnancy diagnosis in horses is that a twin pregnancy can be identified. Twinning in mares rarely results in two or even one live foal being carried to term. With an early pregnancy exam, performed at about 13 to 15 days after heat, one of the twins can be eliminated in order to cause a single birth. The easiest time to do this is prior to embryo fixation, while the

embryos are still mobile in the uterus. The twin that is to be eliminated is manipulated away from the other and ruptured using digital pressure. The maximum number of days that should pass, after the animal ovulates or goes out of heat, in order to accomplish this is 15 days. There are other more invasive methods that can be used at later stages of gestation to eliminate one member of a twin pregnancy. Another simple method that can be used prior to 30 days is to simply administer prostaglandin F2 alpha in order to cause the mare to return to heat. This will result in elimination of the twins, and the mare can then be re-bred at that heat.

- Fetal age estimation can be done using various measurements
  - Amnion diameter
  - Crown nose length
  - Crown rump length
  - Thoracic diameter
  - Orbit diameter
- Fetal sex determination
- Ovulation prediction and detection of ovulation, especially important in mares
- Ovarian pathology
- Uterine pathology
- Testicular imaging

#### Endometrial biopsy, cytology and histology

- Uterine biopsy of mares is common for determining the prognosis for conception
- Uterine biopsy is less commonly done in cattle since the placental sites are discreet and only comprise a small percentage of the endometrial surface

#### Semen evaluation

- Evaluation of the semen is commonly done pre-breeding or pre-purchase to help assure fertility of a potential sire.
- Semen is also evaluated every time that a semen ejaculate is collected for artificial insemination (AI) purposes. This semen exam includes:
  - Semen volume,
  - Motility (% of progressively motile sperm cells),
  - Concentration (number of cells per ml), this exam allows for the calculations that are needed to properly extend and divide the ejaculate into appropriate inseminating doses with adequate numbers of normal motile sperm cells to achieve the maximum possible conception rate,
  -
- Stallion semen is typically collected with an artificial vagina (AV)
- Bull semen can be collected with an AV or can be sampled using "Electro-Ejaculation"

#### Embryo evaluation

- Embryos can be collected at 6 to 7 days after ovulation by catheterizing the uterus and flushing it with a tissue culture solution. They are evaluated for fertilization, stage of development and general quality.
- Embryo collection protocols can be used as a diagnostic tool to evaluate fertilization and embryo development in a valuable female that is displaying signs of sub-fertility. Evidence of sub-fertility could include repeated return to estrus after breeding with a proven fertile sire or after artificial insemination (AI) using semen known to be fertile.
- Embryo collection is most frequently done for production purposes and the genetic improvement of the herd. Regardless of the purpose for the embryo collection procedure, every embryo collected is examined for the developmental stage. A single celled oocyte or embryo whether fertilized or not is referred to as a stage 1 structure, 2-4 cell embryo is a stage 2 embryo, an early 5 cell to 20 cell loose loose morula is a stage 3 embryo, a tight compacted morula is called stage 4, an early blastocyst is stage 5, a blastocyst is stage 6, an expanded blastocyst is stage 7, a hatched blastocyst is referred to as a stage 8 embryo. The quality (normality) of each embryo is also noted.

## Reproductive and Endocrine hormone assays

- BioPRYN is a pregnancy test for use in ruminants that tests for a pregnancy associated glycoprotein produced by the embryo and fetus known as "Pregnancy Specific Protein B" (PSPB). The BioPRYN tests require 2-3 ml of serum.
  - In beef & dairy cattle the PSPB test is accurate at 28 days post breeding.
  - The sheep and goats BioPryn test can be used at 30 days of pregnancy.
  - There is also a BioPRYN PSPB pregnancy test for elk, moose, deer, caribou, African antelope and other ruminant animals. This test is accurate at 40 days post-breeding
  - Idexx has a similar test for "Pregnancy Associated Glycoproteins" (PAG) for use with dairy and beef cattle. This test can be run on serum or milk samples.
- Progesterone (P4) assay,
  - Determine the competency of a CL in producing progesterone,
    1. P4 assays are done in mares to assess the ability of the mare to maintain pregnancy.
    2. P4 can be used to make a presumptive diagnosis of pregnancy in a ruminant at 21 days post breeding. P4 can be assayed in the blood or milk of cattle which is convenient. Testing for progesterone has been superseded by the readily available and cheaper BioPRYN test.
    3. Serial P4 assays can be used in dogs to detect the LH surge. P4 begins to increase very soon after the LH surge and prior to the initiation of ovulation. This is a method used to determine when breeding should commence. This is not effective in large animals though.
- Estradiol (E2) assays is used to evaluate a female that is not ovulating or has other fertility issues. The female's "pre-ovulatory" estrogen level is evaluated. Low E2 during estrus may interfere with the initiation of endocrine events leading to ovulation.
- LH level and LH surge detection is used to predict ovulation.
- Estrone sulphate –
  - pregnancy detection in swine and other species.
  - Estrone sulphate can also be used to identify cryptorchid stallions or "geldings" with remnants of testicular tissue.
- Urinary System
  - Rectal Exam and direct palpation (penis, urethra, bladder, kidneys)
  - Urinalysis
    - Routine UA
    - Stone and crystal analysis
  - Serum chemistry
  - Catheterization
  - Abdominocentesis (male foals, rupture of bladder at parturition)
  - Ultrasonography
- Dermatologic
  - Ectoparasites
    - Chigger – larval stage of [Trombicula alfreddugesi](#) in the US and *Trombicula autumnalis* in Eurasia. The adult chigger is a free living mite in the family Trombiculidae and class Arachnida. The extreme itching that results in self inflicted trauma is caused by digestive enzymes injected by the chigger larva.
    - Ticks –
    - Mange Mites –
      - Skin scraping, deep dermal scraping using a scalpel blade or sharp knife.
    - Sucking Lice –
      - Skin scraping, superficial epidermal and hair scraping using as in shaving with a straight edge razor or sharp knife

- Biting Lice –
- Blood sucking flies belonging to the order Diptera.
  - Horse Fly and Deer Fly - Large blood sucking flies that belong to the family [Tabanidae](#). They are carriers (vectors) for non-contagious viral diseases such as Equine Infectious Anemia virus
  - Biting midges, are small flies in the Family [Ceratopogonidae](#). *Culicoides* sp. and other small biting midges or “no see ems” can act as vectors for the viruses that cause Blue Tongue, Epizootic Hemorrhagic Disease in ruminants and Vesicular Stomatitis in ruminants and horses. They can act as vector for protozoan parasites, such as *Leishmania* spp. Also. These small midges can cause allergic reactions in horses (and likely any species) to the saliva and mouth secretions deposited in the puncture wound when feeding on mammals. In horses the most commonly affected areas are the concave surface of the ear pinna and the lateral sides of the neck.
  - [Phlebotominae](#) – Sand flies, another family of “no see ems”
- Mosquitoes are insects that are flies that constitute the family Culicidae.
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Ringworm

Skin tumors and warts

Biopsy

Microbiology

- Ophthalmologic System
  - Ophthalmoscope
  - Special ophthalmologic exams, slit lamp, etc
  - Auriculopalpebral nerve block
  - Flourescien staining of cornea
  - Microbiologic exam
  - Nasolacrimal catheterization & irrigation
  - Suture 3rd eyelid to upper lid for corneal ulcers
- Neurologic System
  - CSF Examination
  - Radiography
  - Neurologic response tests
- Hemolymphatic and Immunological Systems
  - Hematology
  - Clotting profile
  - Bone marrow biopsy
  - Serum chemistry
  - Lymph node biopsy, aspiration
  - Immune status tests
    - Combined immunodeficiency (CID) testing
    - Failure of passive transfer in foals and calves



## Equine Parasites

- Large strongyles

Most harmful internal parasite of horses

Primary species

- *S. vulgaris*
- *S. edentatus*
- *S. equinus*

Direct life cycle

- Eggs hatch and free living larval stages live on pasture
- Require moisture and moderate temperatures to develop
- Third stage infective larva are picked up by foraging animals

6-7 month pre-patent period (1 cycle per year)

Larvae in abdominal tissue, organs and vasculature

- Causes of "Verminous Arteritis"
- Anterior mesenteric artery and other arteries
- Weakened arteries – aneurysms
- Secondary embolisms

Adults in cecum and large colon

- Blood sucking
- Chronic damage to mucosa can cause ulcerations

Signs;

- The majority of symptoms are a result of *S. spp.* adult infestation
- Mucosal damage results in:
  - Fluctuating fever
  - Leukocytosis
  - Colitis as a result of heavy adult infestation
- Blood consumption by adult parasites causes
  - Anemia
  - Hypoproteinemia
    - Can cause swelling of the legs and distended abdomen (ascites).
  - Depression
  - Inappetance
  - Unthriftiness
- Colic
  - Larval infestation can damage major arteries leading to colic in later life due to Verminous Arteritis:
    - Mesenteric arterial obstruction
    - Intestinal ischemia)

Decreasing incidence due to use and efficacy of most modern paste wormers

- Small strongyles

In the large colon and cecum:

Cyathostomes is the family name

Triodontophorus, Poteriostomun, Cyathostomum, and other species

Direct Life cycle

- Eggs hatch and free living larval stages live on pasture
- Require moisture and moderate temperatures to develop
- Third stage infective larva are picked up by foraging animals

2 or 3 month to 2 or more years pre-patent period

- Depending on length of time larva remain encysted in colon

## Signs

- Dark feces
- Anemia
- Anorexia
- Colitis
  - Diarrhea
  - Foul odor
  - Irritation from infective 3rd stage larval invasion
  - 4th stage larva encysted in the cecum and colon
  - Further damage from 4th stage larval emergence

Incidence of small strongyles seems to be increasing

- In spite of the widespread use of modern paste wormers
- Poor efficacy of most wormers, used at routine dose, on larval stages
- Loss of competition from Large Strongyles?

Treatment of encysted larva requires multi-day therapy with fenbendazole or other broad spectrum wormers

- **Ascarids**

*Parascaris equorum*

Large roundworms

Most common in young horses

Pathology:

- Parasite inhabits the small intestine (the most nutrient rich portion of the bowels)
- Heavy burden of adult worms results in loss of large amount of high quality small intestinal nutrients to the parasites. This result in a malnutrition state
- Parasites causes irritation of intestinal wall
- Dead worms being expelled after de-worming can cause obstruction of the small intestine at the ileo-cecal valve
  - Usually when infestation is severe in foals
  - May be best, if severe infestation is suspected, to use ½ dose of a moderately effective anthelmintic such as Ivermectin and then repeat treatment with a full dose 2 weeks later

Direct life cycle

- Embryonated eggs are infective
- Infection can be transmitted in a dry-lot or stall setting
- Larva migrate in liver and lungs of foals
- Larva enter the respiratory tree, are coughed up and then swallowed. They enter the small intestine and become adults

Signs

- Diarrhea
- Rough hair coat
- "Pot belly"
- Coughing from final stages of "Visceral Larval Migrants"
  - The larval migration can contribute to respiratory infections
  - "Summer Cough"

- **Pinworm**

- *Oxyuris equi*

In large and small colons

Signs

- Restlessness
- Irregular feeding
- Loss of condition
- Tail rubbing
- Dull hair coat

Adults feed on intestinal contents

Adults lay eggs outside of the rectum on the perineal area

- Egg bundles cause pruritis of the anus
- Like ascarids the eggs are infective
- Transmission can occur in a dry setting

Larvae feed on mucosa

- Threadworm
- *Strongyloides westeri*  
Inhabit the small intestine of young horses

Adult horses may carry somatic larva yet never develop a patent infection, due to immunity directed at the adult parasite

Young horses (under one year of age) carry the patent infection and are responsible for maintenance of the infestation in a herd

Pregnant mares at parturition may pass somatic larva through the milk to new-born suckling foals, thus passing on the infection

It is almost as if the mares act as an intermediate host for this parasite

Foals will rid themselves of the adult infestation by one year of age

Signs

- Loss of weight
- Diarrhea in suckling foals
- Cause irritation of intestinal mucosa
- Enteritis

Most modern anthelmintics, particularly ivermectin are effective in treating adult parasite infestations. Treatment of mares with ivermectin at parturition may be effective in preventing transmission to foals.

- Stomach worm
- *Habronema* spp. and *Draschia megastomas*  
Developing larva and adult parasites inhabit the stomach

*Habronema* larva may also infest skin lesions

Infested skin lesions are referred to as "Summer Sores"

Also called "Cutaneous Habronemiasis"

Indirect life cycle

- House flies and Stable Flies are the intermediate hosts
- Flies ingest the stomach worm eggs from feces
- Larval development occurs in the fly or in maggots
  - Flies deposit infective larva around the face
  - Larva migrate into the mouth and then to the stomach
  - Larva in the stomach develop into adults and re-establish patent infections
  - Flies may also deposit infective larva into abrasions or cuts
  - Larva in dermal lesions cause Summer Sores
  - Larva in a Summer Sore do not mature into adults
- Transmission can occur in dry-lots or stable settings

Signs

- GI
  - Gastritis and mucosal thickening are the result of *Habronema* activity in the stomach
  - Tumor like, granulomatous lesions, in the stomach wall, are the result of adult *Draschia* parasites activity. The adults live inside these lesions.
- Dermatologic
  - Granulomatous, non-healing skin ulcers

Treatment

- All modern anthelmintics are effective against GI infestation.

- Summer sores respond best to local debridement and topical organophosphate treatment.
  - Fly control is also important for control of stomach worm.
- Tapeworm
  - Anoplocephala spp.  
In small intestine and cecum  
Life cycle:
    - Typical tapeworm indirect life cycle, except for an insect intermediate host
    - A free living oribatid mite acts as the intermediate host
    - Mites containing infective larval cysts are consumed while grazing
    - Annual life cycle
 Signs
    - Unthriftiness
    - Acute obstructive colic
    - Causes obstruction and ulceration of ileocecal valve and enteritis
 Treatment
    - Best to treat in the spring so as not to infect pastures, retreat in the fall
    - Fenbendazole or pyrantel pamoate at 2x dose is effective
    - Niclosamide and praziquantel are also effective
      - Not approved for use in horses
      - Expensive
      - Narrow spectrum, might as well use a broad spectrum wormer
  - Bots - Larva of the Gasterophilus spp. Fly  
Life cycle
    - The fly lays eggs in the late summer
      - Attached to hair on legs – G. intestinalis
      - Attached to hair on jaw - G. nasalis
      - Hatch in response to warm moisture (licking)
      - Hatched larva migrate in gums and esophagus
    - Larva spend the winter in the stomach of horses
      - Larva erupt and attach to stomach mucosa
      - Larva release from gastric mucosa in late spring
    - Larva passed in feces to pupate on the ground and form adults
    - Adults are free ranging appear to cover large area
 Signs
    - Usually sub-clinical
    - Digestive upset
    - Oral irritation, periodontal ulcers
    - Cause inflammation, perforation of stomach
 Treatment
    - Tube or paste worming with boticide
      - Oral organophosphate boticides  
Trichlorfon  
Dichlorvos
      - Ivermectin
    - Best to treat after hard freeze kills adult flies
    - Removal of bot eggs from legs
      - Warm water wash
      - Curry combs
  - Equine Parasite Control Beyond Anthelmintics  
Manure management procedures
    - Don't spread manure on pastures where horses are grazing
    - Compost manure to kill parasite eggs

- Prevent contamination of food and water with manure
  - Remove manure from stalls daily and strip all bedding frequently
  - Clean and disinfect stall floors, walls, feeders and waterers as needed.
- Other management procedures
- Avoid low wet pastures if possible
  - Use rotational grazing if possible
  - Harrow pastures
    - Immediately after grazing, while grass is shortest
    - Breaks up manure and exposes larva to sun shine
- Strategic Anthelmintic Use
    - Deworm all horses at the same time
    - Worm horses prior to moving them to a clean pasture
    - Separate older horses from weaned foals
    - Isolate all new horses
      - De-Worm immediately upon arrival
      - De-worm a second time with a larvacidal regimen 2 to 3 weeks after the first de-worming and before turn-out with the resident herd
      - Do not intermingle them with resident herd until all de-worming is complete

## INFECTIOUS DISEASES

### Viral Diseases (Respiratory and other viral diseases)

#### Influenza Virus Infections

- Equine Influenza
 

Caused by an influenza virus in the Orthomyxovirus family. It is thought that equine infl

Diagnosis:

  - Virus isolation
  - Paired serology (SN)

Transmission

  - Spread via inhalation of infectious virus
  - Spread on environmental surfaces
  - Young horses in crowded conditions are most susceptible

Pathogenesis:

  - Short incubation period--1-3 days
  - Respiratory inflammation
    - Erythema and edema in epithelium
    - Focal erosions of respiratory epithelium
  - Can lead to pneumonia, pericarditis and pleuritis

Signs:

  - High fever
  - Depression
  - Anorexia
  - Coughing

- Serous nasal discharge
- Swollen lymph nodes
- Weakness and stiffness
- Leukopenia and other sequela

Treatment is supportive in nature

- NSAID
- Prophylactic antibiotics

Prevention

- Routine immunization
  - Immune responses are weak and short
  - Start all foals at 3-6 mo of age
  - Initial series: 2 or 3 IM injections, 3-4 weeks apart
  - Booster according to risk; 2 – 4 times per year
- Management
  - Isolate new horses
  - Adequate ventilation
  - Good disinfection of equipment

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## • Bovine Parainfluenza 3 (PI 3)

Etiology

- Parainfluenza Virus-3
- Viral infection that is uncomplicated by bacterial infection is usually mild
- Morbidity up to 100%
- Low mortality (less than 5%)
  - Mortality associated with secondary bacterial pneumonia
  - A severe form of the disease can result in death
- Calves 3 to 10 months of age most susceptible

Pathogenesis

- Affects all levels of the respiratory tree
- Interstitial pneumonia with some emphysema
- Alveolar collapse (atelectasis)

Symptoms ##

- Usually mild to sub clinical infections
- Initiator to secondary bacterial infections, pneumonia, bronchopneumonia
- Cough
- Serous nasal and lacrimal discharge
- Lung consolidation
- Bronchiolitis

Diagnosis ##

- Immunoassay
- Fluorescent antibody
- Paired Serum

Treatment

- Supportive
- Broad spectrum antibiotics to prevent secondary infections
- NSAID (Banamine IV)

Prevention

- Vaccination
  - 1st vaccination at 2 to 3 months
  - Modified live vaccine is safe and effective
  - Intranasal vaccine available (combination with IBR)
- Isolation of new cattle
  - Especially from calves
  - Prevent overcrowding

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- Bovine Respiratory Syncytial Virus (BRSV)

Etiology ##

- A pneumovirus in the Influenza family

Pathogenesis

- Causes a characteristic interstitial pneumonia with pulmonary edema and emphysema
- Can be fatal due to dyspnea and hypoxia but is frequently a mild disease
- Becomes severe with secondary bacterial pneumonia

Symptoms ##

- Fever, Depression, Anorexia
- Cough
- Nasal discharge
- Dyspnea
- Emphysema
- Secondary bacterial pneumonia

Diagnosis ##

- Immunoassay
- Fluorescent antibody
- Virus isolation
- Paired Serology

Treatment

- Supportive
- Broad spectrum antibiotics to prevent secondary infections
- NSAID (Banamine IV)
- If BRSV is confirmed corticosteroid therapy may be of benefit

Prevention

- Vaccination
  - 1st vaccination at 2 to 3 months
  - Modified live vaccine is safe and effective
- Isolation of new cattle
  - Especially from calves
  - Prevent overcrowding

## Herpes virus Infection

- Equine Herpes Virus Infections
- Equine Herpes Virus-1 (EHV-1) Rhinopneumonitis respiratory disease,
- EHV-1 abortion
- EHV-1 neurologic disease (myeloencephalopathy), and
- EHV-4 Rhinopneumonitis respiratory disease

Etiology:

- A variable species of herpes virus that can affect all species of equines
- The two varieties that affect domestic horses are:
  - EHV 1 Equine Rhinopneumonitis, Herpes viral abortion, Herpes viral myeloencephalitis
  - EHV 4

Transmission

- Airborne
- Oral and respiratory contact

Pathogenesis:

- Highly contagious
  - Carrier animals exist
- Inhalation, ingestion of contaminated material
- EHV 1 causes:
  - Abortions
  - Upper respiratory infection

- Encephalomyelopathy
- High mortality in newborn
- EHV 4 causes:
  - Upper respiratory infections
  - Occasional abortions

#### Symptoms

- 2-10 day incubation
- Unapparent infection is common
- Young horses more likely to show signs
- Rhinitis, fever, conjunctivitis, coughing
- Short illness- 2-5 days
- Persistent cough
- Secondary pneumonia
- Abortion
- Outbreak of late term abortions
  - Can follow respiratory phase by up to 4 months
  - Foals can be stillborn or weak at birth
  - Severe respiratory distress and depression
  - Usually die within a few hours of birth
- Neurological signs
  - Ataxia
  - Spinal cord signs

#### Treatment

- Supportive care
- Antibiotics
- NSAID
- Fluids and other symptomatic treatments

#### Prevention

- Preventive immunization
  - No protection against neurological form of disease
  - Immune responses are weak and short (Killed Virus Vaccine)
  - Start all foals at 3-6 mo of age
  - Initial series: 3 IM injections, 3-4 weeks apart
  - Booster according to risk; 2 – 4 times per year
- Vaccinate pregnant mares at 5, 7, and 9 months of gestation
  - Use inactivated virus EHV-1 or combination vaccine
  - Pneumabort ® Ft. Dodge is vaccine of choice for mares
  - Assists in prevention of EHV-1 abortions

### • Infectious Bovine Rhinotracheitis (IBR)

#### Etiology

- Bovine Herpes Virus h-1
- Sometimes called "Red Nose"

#### Pathogenesis

- An Epitheliotropic virus
- Can infect many epithelial tissues
- Rapid incubation, 4-6 days
- Typical herpes like blisters, pustules and subsequent erosions on affected epithelium
- There can be few local lesions to extensive involvement of multiple locales
- Can cause several syndromes
  - Upper respiratory infections
  - Meningoencephalitis, occasionally in young calves
  - Abortion
  - Venereally transmitted disease
  - Infectious Pustular Vulvovaginitis (IPV)



## Infectious Pustular Balanoposthitis (IPB)

### Transmission

- Airborne
- Oral and respiratory contact
- Venereal

### Symptoms

- Respiratory disease
  - Oral, nasal, tracheal and bronchial pustules and erosions
  - Dyspnea and open mouth breathing
  - GI lesions can occur
  - Viral infection by itself is mild
    - Recovery in 4-5 days
    - Bacterial infection (pneumonia) is the main complicating factor
- Genital Infection; IPV and IPB
  - Infectious Pustular Vulvovaginitis (IPV)
    - Vestibular and Vaginal epithelium become infected
  - Infectious Pustular Balanoposthitis (IPB)
    - Glans penis and prepuccial epithelium become infected
  - 2-5 mm blisters, pustules and subsequent erosions on genital epithelium
  - 2 to 3 week duration
  - Transmissible during coitus
  - Virgin animals can acquire infection via oral (or respiratory) to genital transmission
  - If bacterial infection does not ensue, fertility is unaffected
- Abortion at any stage of gestation
  - Abortion occurs 20 to 90 days after any forms of the disease
  - Abortion can occur after vaccination of naïve, pregnant cows, w/ MLV

### Diagnosis

- Clinical signs primarily
- Virus Isolation (VI)
  - Tracheal wash, nasal swab or Necropsy material
- Virus Fluorescent Antibody (FA)
  - Identifies presence of virus in exudate or tissues
- Serology
  - Serum Neutralization (SN)
  - Kinetic Enzyme Linked Immuno-Sorbent Assay (K – ELISA)
  - Paired samples are required
  - Obtain samples 2 weeks apart
  - A rising titer is diagnostic of infection or recent vaccination

### Treatment

- Supportive
- Broad spectrum antibiotics to prevent secondary infections
- NSAID (Banamine IV)

### Prevention

- Vaccination
  - 1st vaccination at 2 to 3 months repeat in 2-3 weeks or prior to weaning
  - Modified live vaccine is safe and effective on calves
  - Do not use MLV vaccine on pregnant cows or on calves nursing pregnant cows
  - Intranasal vaccine available (combined with PI3, TSV-2, Pfizer (The intranasal vaccines contain temperature sensitive live viral strains that are safe to use on pregnant cows )
- Isolation of new cattle
  - Vaccinate new cattle upon arrival and repeat in 2-3 weeks
  - Do not co-mingle with other new arrivals
  - Prevent overcrowding

## Togaviridae Virus Infections (A group of RNA containing viruses)

- Equine Viral Arteritis
  - Etiology
    - Caused by arterivirus in the Togaviridae family
  - Pathogenesis:
    - Upper respiratory tract infection
    - Abortion
    - Arteritis
  - Transmission
    - Ingestion of contaminated material
    - Inhalation
    - Virus can survive in environment 10 days
    - Virus is shed in urine and semen
      - Infected stallions can be carriers for several years
      - Testicular and epididymis infection
      - Venereal transmission
    - Transplacental transmission
  - Symptoms
    - Incubation of 1-6 days
    - Fever
    - Vascular damage
    - Ocular
      - Lacrimation
      - Conjunctivitis
    - Pulmonary edema w/ pneumonic symptoms
    - Limb edema and abdominal edema (ascites)
    - Abortion
    - Course of disease is 3-8 days in surviving animals
  - Diagnosis
    - Paired Serology (Serum Neutralization)
    - Virus Isolation
  - Treatment
    - Supportive treatment
    - Antibiotics
    - Anti-inflammatory drugs
    - Diuretics; when peripheral edema or severe respiratory problems are present
  - Prevention
    - Vaccination
      - A modified live vaccine offers some protection
    - Test animals
      - Remove any stallion from service if he tests positive for the virus
  
- BVD (Bovine Viral Diarrhea)
  - Etiology
    - Pestivirus (family Togaviridae)
    - Related to hog cholera and border virus of sheep
    - Related to Equine Viral Arteritis
    - Several strains
    - Cytopathic and non-cytopathic variants within strains
    - BVD virus easily mutates into new variants

i.e. from non-cytopathic to a cytopathic variant

#### Pathogenesis

- Epitheliotropic
  - Affects several epithelial tissues
    - Respiratory tree
    - GI epithelium
    - Epidermis of mouth, pharynx, larynx
    - Skin of the nose, horns and feet corium
- Lesions can resemble Foot and Mouth Disease if severe
- Causes necrosis of mucosal lymphoid tissues
  - Peyer's patches in small intestines, ileum
  - Pharyngeal lymphoid tissue (Tonsillar tissue)
  - Immunosuppression, (Lymphoid depletion?)
- During the febrile, viremic stage of the disease many other tissues and the fetus of pregnant cows can become infected
- CNS tissue of fetuses is very vulnerable

#### Transmission

- Horizontal
  - Airborne – respiratory
  - Fecal contamination
  - Fomites
  - Animal – animal contact
  - Persistently Infected (PI) calves are responsible for maintenance of infection in a herd
    - and will shed virus into environment and infect herd mates
    - PI calves were infected as a fetus (vertically)
    - Act as a virus carrier for life

#### Transmission

##### Vertical

- Trans-placental
  - Fetal death, abortion (infection of fetus in 1st trimester)
  - Congenital abnormalities (infection of fetus in 1st trimester)
  - Congenital disease (infection of fetus in 3rd trimester)
  - Persistent infection (infection at 4 Mo. Gestation)

#### Symptoms and signs

- Respiratory distress
- Diarrhea
- Fever and depression
- Oral, pharyngeal & esophageal lesions, excessive salivation
- Nasal and tracheal lesions, bloody & purulent nasal discharge
- Bronchitis and Pneumonitis, coughing

#### Unique syndromes

- Mucosal disease is a severe, peracute, fatal form of BVD
  - Occurs when a non-immune or a non-immunocompetent animal acquires a cytopathic BVD virus.
  - Usually occurs in persistently infected calves
- Neurological disease in neonatal calves
  - Due to cerebellar dysgenesis or agenesis
- Congenital defects
  - Cerebellar agenesis or dysgenesis
  - Cranial, spinal and limb deformities
  - Ocular deformities
  - Alopecia
- Persistently infected (PI) carriers

- Occurs with transplacental transmission at 3 to 4 months gestation. This coincides with a period where the fetal immune system is developing it's "recognition of self"
- Fetus develops immunotolerance to any infecting BVD virus and if the virus is non-cytopathic the fetus may survive to term
- PI calves have no immunity (antibodies or cellular response) to the BVD strain it is infected with
- PI calves may be normal at birth
- PI calves usually are "poor doers", due to activity of the virus and immunosuppression
- PI calves may develop "Mucosal Disease" when infected by a cytopathic BVD virus
- BVD Vaccination of PI calves may precipitate Mucosal Disease
- Diagnosis of PI calves
  - 1) Identification of virus:
    - Positive Viral FA or
    - Immunohistochemistry of biopsy sample or
    - Virus isolation on blood, exudate or tissue sample
  - 2) Negative serological (SN) test.
    - No antibodies!
    - In spite of viral presence!

#### Diagnosis

- Clinical signs
- Virus Isolation
  - Esophageal swab
  - Nasal swab
  - Blood (EDTA or heparin tube)
  - Fecal sample
  - Necropsy material, fetus
- Virus Fluorescent Antibody (FA)
  - Identifies presence of virus in exudate or tissues
- Serology
  - Serum Neutralization (SN)
  - Paired samples are required (as with IBR)
  - Obtain samples 2 weeks apart
    - A rising titer is diagnostic of infection or recent vaccination

#### Treatment

- Supportive
  - IV & oral electrolytes when severe GI symptoms occur
- Broad spectrum antibiotics to prevent secondary infections
- NSAID (Banamine IV)

#### Prevention

- Vaccination
  - 1st vaccination at 2 to 3 months repeat in 2-3 weeks or prior to weaning
  - Modified live vaccine is safe and effective on calves
  - Do not use MLV vaccine on pregnant cows or on calves nursing pregnant cows
  - Annual vaccination prior to breeding with MLV vaccine to eliminate PI calves
- Isolation of new cattle
  - Vaccinate new cattle upon arrival and repeat in 2-3 weeks
  - Do not co-mingle with other new arrivals
  - Prevent overcrowding
- Test for BVD and cull all persistently infected cattle
  - Skin biopsy (ear notch) is a good, general-purpose test to identify animals that have the virus present. (most will be PI)
  - Further testing can be done, if desired, to confirm PI status

## Ulcerative diseases

Could be confused with BVD, IBR

Differential diagnosis for oral ulcers

- BVD
- IBR
- Bluetongue (orbivirus)
- Vesicular Stomatitis (rhabdovirus)
- Foot and Mouth (enterovirus), exotic, not in US.
- Swine Vesicular Disease (enterovirus), exotic not in US
- Rinderpest (myxovirus), exotic not in US
- Papular Stomatitis
- Others

## Bacterial Pneumonia

- Strangles (equine distemper)

Etiology

- Caused by *Streptococcus equi*

Transmission

- Highly contagious bacterial disease
- Young horses more susceptible
- Inhalation or ingestion of contaminated material
- Horses can shed the bacteria for up to 4 weeks after getting the disease
- Organism can last for long periods in environment

Pathogenesis

- Pharyngitis and laryngitis result from the initial acute infection
- Incubation of 4-8 days
- The bacteria invades the lymph nodes causing inflammation and then abscessation
  - Submaxillary, Mandibular nodes inflammation and abscessation causes unsightly draining lesions and act as massive source for *S. equi* organisms
  - Retropharyngeal node abscessation can cause obstruction of the air way (strangles)
  - Secondary guttural pouch empyema
  - Spread to other organs ("bastard strangles")

Symptoms

- Anorexia and depression
- Fever
- Purulent nasal discharge-copious
- Cough
- Abscessation of lymph nodes in throat area
- Purpura hemorrhagica – rare

Diagnosis

- Clinical symptoms
- Culture from abscess drainage

Treatment

- Isolate
- Antibiotics,
  - Controversial, thought to predispose to bastard strangles
  - Appears to be best approach to serious illness
- Drainage of abscesses
- Supportive care
- Disinfect environment

Prevention

- Routine immunization with killed whole cell bacterin
  - 3 IM injections at 3-4 week intervals

- Begin vaccinations at 2 months
  - Biannual vaccination of yearlings
  - Annual booster 2-4 weeks prior to foaling for mares
  - Annual or biannual boosters for other horses as needed
  - Reactions at injection site are common
  - Vaccination with avirulent live bacterial culture, intranasal
    - Pinnacle IN ® Ft. Dodge
    - 2 doses at 3-4 week intervals
      - Begin vaccinations after weaning is probable the best approach
      - ?? No recommendation from Ft. Dodge
    - Annual booster
    - Do not use in pregnant mares
    - Use caution in handling live bacterial cultures – local infection
  - Isolate infected animals
- **Pasteurella pneumonia**
- Etiology
- Gram negative ovoid bacilli
  - Pasteurella hemolytica is the most common bacterial species that affects cattle in the “Bovine Respiratory Disease” (BRD) complex
  - Pasteurella hemolytica
    - “Shipping Fever” pneumonia
    - Pleuritis
    - Hemorrhagic septicemia
    - Weanling and feedlot cattle
  - Pasteurella multocida
    - Respiratory infection
    - Common wound contaminant
    - Opportunistic bacteria
    - Dairy cattle
    - Young suckling calves
    - Hogs
    - Sheep
- Pathogenesis
- Pasteurella are frequently normal pharyngeal inhabitants
  - Viral infection and stress will predispose an animal to Pasteurella infection
  - Early pharyngitis, laryngitis
  - Bronchopneumonia and pleuritis develops as organisms reach the bronchioles and alveoli
  - Hemorrhagic septicemia result from Pasteurella septicemia and endotoxemia
- Symptoms
- Fever
  - Cough
  - Muco-purulent nasal and ocular discharge
  - Dyspnea as pneumonia advances
- Treatment
- This pneumonia can be hard to treat with high losses - if not treated early
  - Several antibiotics are available and effective for use in BRD complex
  - NSAID
  - Fluids and other supportive therapy
  - In the face of an outbreak or in high risk situations
    - It may be efficacious to treat all cattle in the herd with an effective antibiotic.
    - Prevent symptoms in animals incubating disease.
    - This type of procedure is called “Metaphylaxis”.
- Prevention

- Several vaccines available
- Typically 2 injections, 3 to 4 weeks apart, prior to or at weaning
- 
- Haemophilus somnus
  - Etiology
    - Gram negative ovoid bacilli
  - Pathogenesis
    - "Haemophilus Septicemia of Cattle"
    - Pneumonia and pleuritis
      - Difficult to differentiate from pasteurilla clinically
    - TEME (Thrombo Embolic Meningo Encephalitis)
      - From septicemic seeding of the CNS
    - Septic synovitis and arthritis
    - Vaginal / uterine infection may affect reproduction
  - Transmission
    - Direct
    - Aerial transmission from inapparent carriers
  - Symptoms
    - Fever
    - Depression
    - Signs of septicemia
    - Respiratory symptoms
      - Cough
      - Muco-purulent nasal and ocular discharge
      - Dyspnea
        - From pneumonia
        - From Pleuritis
    - TEME
      - Depression, ataxia, weakness and recumbency
      - Other asymmetrical neurological signs
  - Treatment
    - Several antibiotics are available and effective for use in BRD complex
    - NSAID
    - Fluids and other supportive therapy
  - Prevention
    - Vaccine is available
    - Typically 2 injections, 3 to 4 weeks apart, prior to or at weaning

#### Arboviruses Infections (arthropod borne viruses)

- Equine Encephalomyelitis
  - Etiology
    - 3 species of Alphavirus in the family Togaviridae
    - Western Equine Encephalomyelitis, (WEE)
    - Eastern Equine Encephalomyelitis, (EEE)
    - Venezuelan Equine Encephalomyelitis, (VEE)
      - Severe epizootic occurred in Texas in 1971
      - VEE prevention is important in southern US
  - Transmission
    - Birds are Primary hosts or Reservoirs for encephalomyelitis viruses
    - Horses and humans are secondary (dead end) hosts
    - Spread via mosquito (disease vector)
      - From birds to other birds
      - From birds to horses, humans (primary to secondary host)

- From infected horses to other horses (rare)
- Incidence is highest when the mosquito population is the highest

#### Pathogenesis and clinical signs

- The virus does not always penetrate the nervous system
- Infection may be inapparent
- Viremia may be accompanied by fever and other mild symptoms
- Mortality: WEE = 20-50%  
                   EEE = 40-90%  
                   VEE = 40-90%

#### Symptoms

- If the virus penetrates the nervous system; signs would include:
  - High fever
  - Depression
  - Hypersensitivity to stimuli
  - Incoordination and ataxia
  - Poor prehension of food
  - Compulsive behavior, head pressing, maniacal walking
  - Blindness
  - Seizures
  - Paralysis

#### Diagnosis:

- CF and SN tests
- ELISA
- Virus isolation, post-mortem

#### Treatment: Supportive care

#### Prevention; Immunization

- Killed multivalent vaccine
- EEE and WEE are most commonly included in vaccine products
- Initial immunization:
  - Two IM injections 3 to 4 weeks apart
  - Start foals from vaccinated mares at 3-4 mo. of age
  - Start foals from unvaccinated mares at 2-3 mos. of age
- Booster immunizations
  - Administer in the spring, prior to the 'vector season'
  - Two boosters per year in areas with year round mosquitoes
- In the Southern US: Florida, Texas use VEE vaccine also
  - Prevent re-introduction of VEE from Mexico & S.A.

#### • West Nile Virus

##### Etiology

- A Flaviridae
- An emerging disease in the US
- First discovered in US in August 1999 on Long Island, New York
  - 29 cases in horses
  - Numerous cases in birds
  - Human fatalities have occurred
  - 59 cases in 2000
  - Has spread rapidly since '99
  - Florida to the south in 2001
  - Michigan to the west in 2001
  - Hundreds of cases

##### Pathogenesis

- Similar to EEE or WEE
- Clinical sign evident in less than 50% of infected horses
- Approx. 40% mortality in horses showing clinical signs

##### Symptoms



- Indistinguishable from EEE or WEE
- Vaccine has been developed
- Fort Dodge is manufacturer of the first vaccine
  - Efficacy is less than 100%

- Equine Infectious Anemia
- Swamp Fever (chronic form of the disease)

#### Etiology

- Caused by a Lentivirus
- RNA virus
- Related to immuno-deficiency viruses HIV, FIV
- As with immuno-deficiency viruses, EIA infection persists for life
- Persistently infected animals are a source of infection

#### Transmission

- Transmitted via blood from infected, viremic horses
- Horseflies and deerflies are main vectors
- Mosquitoes could also transmit virus
- Virus survives less than 4 hours in fly mouthparts
- Contaminated needles and instruments
- Vertical transmission
  - Transplacentally
  - Colostrum, milk??

#### Pathogenesis

- Virus primarily infects mononuclear cells
- Replication only in mononuclear cells
- Replication primarily in tissue macrophages (a mononuclear cell)
- Does not infect lymphocytes thus no immuno-suppression
- Strong but only partially effective immune response
  - Cellular immunity responsible for suppression of viremia
  - Ineffective humoral antibodies are part of pathogenesis
    - Antibody coated virus is still infective
    - Antibody-virus complex attaches to or infects many cell types
    - Antibodies help cause viral infection of non-mononuclear cells
    - Antibody-virus complex coated cells susceptible to immune (compliment) mediated lysis
    - RBCs, thrombocytes and renal glomerulus cells destroyed
    - Results in anemia, hemorrhage glomerulonephritis, etc.
- Virus mutates often
  - New strains are responsible for intermittent recurring viremia

#### Signs

- Mostly inapparent
- Acute infection and recurrent viremia
  - Fever
  - Depression
  - Anorexia
  - Mild anemia
  - Thrombocytopenia
- Chronic infection (Swamp Fever)
  - Anemia
  - Thrombocytopenia and hemorrhages
  - Hypoalbuminemia and edema
  - Fever
  - Weight loss
- Abortion if viremia occurs during pregnancy
- Mild glomerulonephritis may occur even in inapparent infection

#### Diagnosis and control

- EIA is a USDA and state DA reportable disease
- AGID test, "Coggins Test", specific for EIA core antigen
  - Only USDA approved labs can perform official EIA test
  - Test required for interstate movement, sale and equestrian events
  - Required by most insurance companies
- EIA positive horses
  - Must be destroyed or:
    - If not euthanized they must be quarantined for life
    - Quarantine stipulates removal by at least 200 yards from all other equines
    - EIA positive horses cannot be moved except to slaughter or an USDA approved research center
    - EIA positive horses must be branded with an A and other ID numbers on the neck
- No vaccine available due to large number of antigenic variants and continued mutation

### Other Bacterial Diseases

- Tetanus:
  - Cause: Clostridium tetani
    - Gram +
    - Spore forming
    - Anaerobic
    - It is usually introduced through wounds.
  - Clinical signs
    - Lameness
    - Stiffness
    - Inability to eat
    - Tetanic convulsions
  - Treatment, (difficult)
    - Antitoxin; neutralize toxin
    - Antibiotics (penicillin), eliminate organism
    - Diazepam, control neurologic symptoms
    - Supportive care
  - Prevention
    - Pre-exposure - immunization with tetanus toxoid
      - Two initial injections 4-8 weeks apart
      - Annual booster.
    - Post-exposure
      - Vaccinated animals:
        - Booster with tetanus toxoid
      - Unvaccinated animals:
        - Antitoxin 1500-3000 I.U. subcutaneously
        - Commence tetanus toxoid series
- Brucellosis
  - Hosts
    - Domestic animals
    - Wild animals
    - Humans
  - Etiology
    - Gram negative bacteria
    - Brucella abortus - cattle
    - Br. suis - swine

- Br. melitensis - goats
- Br. canis - dogs
- Br. ovis - sheep
- All species infectious for all domestic animal
- Man is susceptible to all

#### Resistance

- Heat
  - Destroyed by 60o C for 10 minutes
  - Pasteurization
  - Sunlight, < 1 day
- Survives days to months in the environment

#### Transmission

- Spread may be vertical or horizontal
- Bacteria is present in most body fluids
  - Very heavy load of bacteria in uterine fluids at abortion
    - Vaginal shedding several days before parturition or abortion, continues for one mo.
  - Milk from infected animals
  - Semen
- Ingestion of
  - Un-pasteurized milk
    - Calves
    - Humans
- Direct contact with infectious material via:
  - Conjunctiva (droplets from tail, membranes or vaginal discharge)
  - Abraded skin
  - Respiratory tract
  - Reproductive tract (venereal transmission – sheep)
- Public Health Aspects
  - Human susceptible to all brucella species
  - Disease in humans is called "Undulant fever"
  - Occupational disease (Veterinarians, packing house workers and others animal workers)
  - Vaccine (strain 19 or RB51) can cause human disease
  - Disease in humans treated with tetracycline and streptomycin

#### Pathogenesis

- Following penetration – localizes in organs and adjacent lymph nodes
  - Mammary gland
  - Reproductive tract of females and males
  - Horse - ligamentum nuchae and navicular bursa
  - Fetus infected as early as 5th week of gestation
- Intracellular infection
  - Very difficult to treat w/ antibiotics
- Incubation period in cattle is 3 -12 weeks
- Orchitis – ram, bull and boar
  - Bulls play minor role in spread
- Mastitis
- Weak calves or pigs
- Arthritis – discospondylitis
- Horse
  - Fistula of withers
  - Poll evil
- Not an important cause of infertility in the bull
- Calves nursing infected cows get a transient infection.
- Females most susceptible during pregnancy
- Abortion,

- 2-3 mo after contact
- Any state of gestation
- Retained placenta
- Lowered conception – temporary sterility

#### Diagnosis

- Clinical
  - All aborting cattle should be tested
  - Rams, boars and bulls with orchitis should also be tested
- Brucella milk ring test (dairy cattle)
  - Hematoxylin stained antigen added to tube of milk
  - Incubate 37o for 30 - 60 min.
  - Blue milk with white cream layer = negative test
  - White milk with blue cream layer = positive test
  - Not effective in low fat milk, colostrum
  - Can not test non-lactating animals
  - 3 negative tests per year to maintain negative herd status
- Tube, Card and Rapid plate agglutination tests
  - serum diluted two-fold for plate or card test
  - Tube test uses serial dilutions
- Mercaptoethanol test
  - Mercaptoethanol inactivates IgM but leaves IgG
- Rivanol test - precipitation plate agglutination test
- Rivanol precipitates IGM in serum
- Buffered antigen, Card test
- RB51 Vaccinates can be differentiated from naturally infected animals
- No serological test to differentiate strain 19 vaccination and wild strain infections

#### Test animal identification

- Cattle markets (sale barns, packing plants)
  - Backtag - Market Cattle Testing program
  - Identification tag applied on all potentially test eligible cattle (6 mo. old for non-vaccinates, two yrs old or older for vaccinates) before co-mingling with other cattle at market.
  - Tag should be applied on cattle marketed through dealers, stockyards, order buyers or direct to packer
  - Tag identifies animal so it can be traced to original owner
  - ID remains with animal through slaughter inspection and blood collection
  - All slaughtered cattle are blood tested for brucella
- On farm cattle
  - Steel clip ear tag for all tested cattle

#### Brucella control programs

- Veterinarians must be accredited by USDA & State DA
- Certified free herd
  - Test entire herd at least once per year
  - New additions should be tested and should come from a certified free herd or area
  - All new additions should be isolated 30 days and retested
- Herd eradication
  - Test all animals
  - Reactors are slaughtered
  - Clean and disinfect premises
  - Retest at specified interval, 60 days, until no further reactors
  - Then follow procedure for a certified free herd

#### Treatment - None practical

- Reactors
  - Branded on left Jaw, B
  - Reactor tag in left ear

- Permit required to move to slaughter

#### Immunization

- Strain 19 vaccine- NO LONGER USED
  - RB51 Vaccine used as of October 1997
  - Vaccine causes no infertility in female
  - Vaccine organism is pathogenic for humans
  - Bulls should not be vaccinated
    - Residual titer
    - Infertility – orchitis
  - Eligible Animals
    - Only heifer calves
      - between 4 and 12 months of age (beef)
      - between 4 and 10 months of age (dairy)
      - Best time is 4 to 6 months of age
      - Some states have stricter requirements
- Adult vaccination for brucellosis is conducted by state or federal officials only

#### Vaccinate identification

- with a tattoo, either 3V1 (strain 19) or RV1 (RB51) in right ear, (R = RB51, V = Vaccination shield, 1 = year of vaccination)
- R replaces the quarter for RB51 vaccine, for strain 19 the quarter of the year is used as first digit in the tattoo
- Orange steel clip tag with a unique ID number placed in the right ear, i.e. 84 VPI 1234 (84 = Colorado, VPI = identifies veterinarian 1234 = sequence #)

#### • Tuberculosis

##### Etiology

- Mycobacterium tuberculosis
- Acid-fast organism
- Types
  - Mammalian
    - var. bovis
    - var. hominus
  - Avian
    - Mycobacterium avium
    - M. avium var. paratuberculosis causes Johnes disease in cattle and granulomatous enteritis in other species (horses)

##### Bacterial Resistance

- Lives in soil for 4 years
- Destroyed by pasteurization
- Disinfectants
  - Cresylic disinfectants
  - Sodium orthophenylphenate

##### Transmission

- Humans
  - Close contact
  - Poor sanitation
  - Un-pasteurized dairy products
- Bovine
  - Primarily inhalation
  - Contaminated feed and water
  - Close housing
  - Contact with infected herd
  - Consumption of milk from infected cow
- Swine

- Primarily orally
- Contaminated food and water
- Uncooked garbage
- Avian - all species susceptible
  - contact with infected birds
  - offal - infected birds
  - contaminated yards and equipment

#### Symptoms

- Main lesion is a caseous abscess
- Swine
  - Primarily lymph node involvement of pharyngeal, cervical and mesentary nodes
  - Primarily digestive tract involvement indicates oral transmission
- Cattle
  - Emaciated with GI disease
  - Respiratory system (pulmonary)
  - Many inapparent infections in infected herds

#### Prophylaxis

##### USDA Eradication program

- Caudal Fold PPD tuberculin skin test, used for routine testing of cattle
- Comparative Cervical Test, retest of all suspects on the caudal fold TB test, clarify cross reaction of mammalian and avian strains to the PPD caudal fold TB test
- All Grade A dairy herds must be accredited free (complete herd test every 2 or 3 years)
- Pasteurization of milk prevents transmission from infected cows to humans
- All slaughter cattle are examined for lesions
- Cattle moving interstate from non-accredited areas are tested
- Neither treatment or immunization are practical for livestock

##### Public Health Aspects

- Humans subject to disease
- Incidence has decreased following eradication programs for cattle

- Leptospirosis

Cause: *L. pomona* & about 100 other serotypes

Shed in urine; contaminating water supply

Wildlife act as reservoirs

Low mortality in cattle

##### Symptoms

- Abortion of infected fetus is the main symptom
- Anemia
- Decreased milk production
- Respiratory distress due to anemia
- Nephritis
- Encephalitis in sheep and goats

##### Treatment

- Streptomycin or tetracycline

##### Prevention

- Multivalent bacterins
- Environmental controls of livestock water sources

- Clostridial diseases

##### Blackleg

- Myositis caused by *Cl. chauvoei*

##### Malignant Edema;

- Gaseous and edematous necrosis of muscle and connective tissues
- *Cl. septicum* is the classical etiologic organism

- Other Clostridial organisms cause identical disease
- Blacks Disease and Bacillary Hemoglobinuria
- Necrotic infarcts in the liver, associated with Fasciola (liver flukes)
  - Caused by *Cl. novyi* and *Cl. hemolyticum*
  - Clostridial toxins cause vascular damage and hemolysis
- Treatment is difficult, frequently unrewarding
- Penicillin
  - With myositis due to *Cl. chauvoei* or *Cl. septicum* the infected tissue must be incised and debrided, to establish drainage and expose the area to oxygen
- Prevention is very effective with multivalent clostridial bacterins

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Bovine and food animal issues

Pneumonia and Stress in Livestock

Stress – predisposes animals to disease

- Weaning
- Shipping long distances
- Taking away from familiar environment
- Crowding - feedlot
- Change of feed
- Change of people
- Rough handling techniques
- Dusty conditions
- Wet and cold conditions
- Immunosuppression
- Stress
- BVD (Bovine Viral Diarrhea)
- Bovine Respiratory Disease Complex – BRD complex
- IBR,
- BVD,
- PI3,
- BRSV,
- Pasteurella spp. and
- Haemophilus somnus
- Mycoplasma bovis

Hematological disease caused by *Mycoplasma*. spp. (Hemoplasmas) of Veterinary Importance

Species: Hemoplasma

- Dogs: 1. *Mycoplasma haemocanis* (formerly *Haemobartonella canis*)  
2. "Candidatus *Mycoplasma haematoparvum*"

- Cats: 1. *Mycoplasma haemofelis* (formerly *Haemobartonella felis*)  
(Causes Feline Infectious Anemia)  
2. "Candidatus *Mycoplasma haemominutum*"  
3. "Candidatus *Mycoplasma turicensis*"

- Pigs: 1. *Mycoplasma suis* (formerly *Eperythrozoon suis*)  
2. *Mycoplasma parvum* (formerly *Eperythrozoon parvum*)

- Cattle: 1. *Mycoplasma wenyonii* (formerly *Eperythrozoon wenyonii*)

Sheep and goats: *Mycoplasma ovis* (formerly *Eperythrozoon ovis*)

Llamas and alpacas: "Candidatus *Mycoplasma haemolamae*"

## Food Animal Issues

### Animal Identification

Permanent identification; of all animals is essential even in small herds. This allows the owner to track an animal's pedigree, production data, genetic statistics, breeding data and veterinary medical tracking of sick animals and many other data items. One of the more important reasons to permanently identify all food animals is to prevent a food animal, or milk from a dairy animal that has been treated with an antibiotic, a vaccine or other therapeutic drug from prematurely entering the human food market with a violative drug or vaccine residue. After an animal has been treated with a pharmaceutical or vaccine, no food animal can enter the human food chain prior to the expiration of the prescribed withdrawal period for the specific treatment. Without adequate permanent identification it is impossible on modern farms and ranches easily track treated animals. If a mistake is made regarding the identity a treated animal a violative drug residue may be found and the client may be severely fined or even lose the privilege to of selling meat and milk in the market.

Some of the standard method of animal Identification used in the United States and elsewhere include:

#### Ear Tags:

- There are many different types of ear tags
- Standard plastic ear tags, sometimes referred to as a bangle tag can be pre-numbered or they can be marked with an indelible marking pen with a within-herd ID number.
- USDA approved 15 digit, ADT tag (Animal Disease Traceability) ID tags (these are a bangle tags) or RFID (Radio Frequency ID) button ear tags can also be used. These tags use a 15 digit numeric ID # that identifies the country (the US is 840) and a unique number identifies the individual animal. The # looks like: 840 003 123 456 789. Whether the 15 digit tag is a bangle tag or a RFID button tag, the livestock owner cannot purchase and use these tags unless the ranch or farm premise is registered with the USDA and the state department of agriculture. In summary the national animal identification system (NAIS) and ADT rely on premise ID as well individual animal ID for traceability to work. These tags will be required for all animal sales of animal 18 months of age or over, starting in March, 2013.
- Obsolete RFID tags (Radio Frequency ID tags) with the first three digits of '982' and '985' are currently being accepted as official ID for sale animals; however, the USDA will not accept these tags in the future. Producers are asked to discontinue use of these tags as soon as possible.
- USDA 9 alphanumeric digit bright metal clip tag, usually used when an animal is tested for a disease by an accredited veterinarian. These tags are also used on dairy cattle for 'Dairy Herd Improvement Association' identification of dairy cattle, Similar 8 digit tags, which are a bit smaller are usef on sheep, goats, wild ruminants and swine.
- USDA brucellosis calfhoo vaccination tags are also 9 alphanumeric digit, orange clip tags. It is only legal to use these tags to identify Brucella abortus vaccinated heifers.

Tattoos are a permanent ID that are applied to the skin on the concave surface of the ear. They can be a good animal ID but require restraint of the animal in order to be read. A Tattoo can be hard to read due to fading or poor tattooing technique. A tattoo is often considered to be a good emergency, last resort, form of identification for a registered animal that has lost its ear tag.



Freeze branding an animal with the herd brand and individual animal ID can be an easy to read, permanent ID. A tattoo and a freeze brand can be used interchangeably for an animal that has lost its eartag.

#### Beef Quality Assurance Program

- Purpose
  - Supply only quality beef
  - Improve consumer perception of beef's safety
  - Elimination of drug residues
- Good records of all treated animals
  - Record of treatment is the responsibility of the owner and the person administering the treatment
  - Compliance with label or prescription dosage
  - Proper route of administration (SQ, IM)
  - Compliance with pre-slaughter drug withdrawal times
  - Veterinarian must order prolonged withdrawal time if label directions have not been followed exactly
- Prevention of muscle damage through proper drug administration
  - Cleanliness - use sterile techniques
  - Proper restraint
  - Proper injection procedures
  - Proper implant placement
  - Use appropriate size needle for route of administration
  - Use sharp needles
  - Try not to inject when animals are wet
  - Proper restraint assures proper administration
  - Proper injection procedures
    - Oral administration is preferable to injections if possible. Always use a balling gun of the proper size to administer oral pills or boluses to food animals. Unfortunately, there are only a few drugs available for food animals that are approved for oral administration. A few examples are:
      - Sulfamethazine boluses (also available as an IV solution)
      - Sulfadimethoxine boluses (also available as an IV solution)
      - Magnesium hydroxide - Antacid boluses
      - Corid brand of amprolium to treat coccidiosis, usually administered as a solution with a dosing syringe.
      - Anti-diarrhea agents and nutritional supplements
    - Intravenous – is the next most preferable method of drug administration. It has the advantage in food animals of not creating a tissue depot of drug or carrier vehicle. Some drugs, such as injectable sulfonamides and sodium iodide, must only be given IV to prevent tissue damage. Oxytetracycline is sometimes mixed with saline or dextrose solution to be administered IV as a dilute solution to prevent tissue damage or venous damage from the concentrated, undiluted solution. For other drugs, such as flunixin meglumine, an NSAID, commonly used in cattle, IV is the only approved route of administration. Other drugs, such as penicillin-G suspension or tilmicosin (a macrolide antibiotic) can be fatal if administered IV. Always follow label or circular directions when administering pharmaceuticals to food animals.
      - The IV route minimizes the risk of muscle damage
      - 14 to 18 ga. 1½ to 2 inch
    - Subcutaneous – is the preferred injection method for beef cattle
      - On neck, behind the shoulder or at base of the ear
      - Avoiding muscle reduces potential trim at slaughter
      - Tent the skin
      - 16 to 18 gauge ¾ inch needle
      - "B" bevel needles may be preferable to the "A" bevel
    - Intramuscular

- Neck musculature is preferred site for beef cattle
  - It is less valuable cuts of beef
- Avoid semitendinosus and semimembranosus muscles
- Avoid gluteus muscles or any other primal meat areas.
- Remember, even dairy cows will eventually be used for beef
- 16 to 18 gauge 1 to 1½ inch needle
- Anabolic implants - Proper placement
  - Subcutaneous on convex surface of ear, using only the proper implanter, which has been designed for the specific implant being used

#### Extra Label Drug Use

- AMDUCA - FDA's "Animal Medical Drug Use Clarification Act"
- See hand out
- Extra label drug use

A valid patient - client - veterinarian relationship exists

A diagnosis is made by a veterinarian

It must be determined that:

- There are no approved drugs specifically labeled to treat the condition diagnosed
- The approved label dosage is ineffective
- The condition to be treated is a life or performance threatening medical emergency

No illegal drugs may be used (illegal for use in cattle), for example:

- Chloramphenicol
- Diethyl Stilbestrol

Withdrawal times

- A significantly extended period of time is assigned for the drug withdrawal, in order to assure that there is no chance of a violative meat or milk drug residue.
- The veterinarian is the only one who can determine the withdrawal time for extra label use of a drug.
- Veterinarian will refer to research reports, and information in an online database to help determine the withdrawal time for extralabel drug use. The 'Food Animal Residue Avoidance Databank' (FARAD) is a congressionally-mandated risk-management program that is supported by the United States Department of Agriculture (USDA). FARAD's primary mission is to prevent or mitigate illegal or harmful residues of drugs, pesticides, biotoxins and other chemical agents that may contaminate foods of animal origin. <http://www.farad.org/>

Only a veterinarian can order extra label drug use

The attending veterinarian assumes responsibility

The client has agreed to follow all instructions

The veterinarian is available for follow up

The client must keep written compliance records