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| **Bovine Abortion****General comments** * A certain number of abortions are expected to occur within a year. A single isolated case may not warrant a full investigation. However, in the face of continued losses or an abortion storm investigation is indicated.
* A thorough, objective history should be taken along with a good clinical exam. Laboratory investigation requires good material and a good history to have a reasonable chance at arriving at a diagnosis. The average success rate of arriving at a diagnosis for an abortion is approx. 25%. To increase the chances of arriving at a diagnosis, submit several fetuses and placentas. Paired serum samples, from multiple animals, may be indicated if certain diseases are suspected.
* Numerous obstacles to diagnosis exist (see Kirkbride, Comp. Cont. Ed, 1982 4:S341 for further reading). Abortion is often the result of events occurring weeks to months previously and the cause, if it was ever present in the fetus, is often undetectable by the time of the abortion. The fetus is often retained in utero for hours to days after death, resulting in autolysis which hides lesions. Fetal membranes are often unavailable. Toxic and genetic factors are not always discernible in available specimens. Many causes are unknown and no diagnostic procedures are available.
* When an abortion occurs, in many cases the farmer finds the dead fetus but may not know which cow it came from. To narrow down the possibilities, it is helpful to know approximately how old the fetus is. To estimate the age of a dead fetus refer to gestation estimates based on size of the fetus.
* In other cases, it would be helpful to be able to estimate how long a fetus has been dead (for example when correcting a dystocia and delivering a dead calf).
* Estimation of the length of time a fetus has been dead in utero: 12 h - cloudy cornea; 24 h - kidneys soft and pulpy, abomasal contents cloudy, mucoid, and flocculent; 36-96 h - subcutis gelatinous and reddish or blood tinged; liver soft and friable; abomasal contents reddish.

**Terminology:** * Abortion - expulsion of dead conceptus or a living one incapable of independent life;
* Premature delivery - preterm birth of immature viable fetus;
* Stillbirth - dead fetus expelled at term.

**Non-infectious abortion:*** **Genetic** : most genetic causes of abortion are "Beyond routine diagnostic capabilities". The majority occur before pregnancy is diagnosed, therefore go undetected (See "Repeat Breeder" section). Numerous congenital defects have been reported, some of which result in abortion.
* **Nutrition** : Nutrition is seldom a cause of abortion but does result in dystocia and the birth of weak calves. Vitamin A deficiency of long duration will result in abortion in a small number of animals, weak calves, and increased incidence of retained placentas.
* **Iodine deficiency** and **selenium deficiency** have been proposed to cause abortion.
* **Environmental** : High maternal body temperature results in profound fetal hypotension, hypoxia and acidosis, but is usually due to maternal illness rather than environmental temperatures. Stress is often blamed for abortion but difficult to prove and has not been documented as a cause. Keep in mind however, that abortion or parturition can be induced with exogenous corticosteroids. Inflammatory conditions can result in abortion if they are associated with sufficient PGF release.
* **Physical** : Trauma is an unlikely cause of abortin, especially in mid to late gestation. Trauma due to palpation of the amniotic vesicle or fetal membranes in early gestation can result in pregnancy loss if overly rough. Rupture of the amniotic vesicle or trauma to the large vessels leading to the fetal heart can result in death of the conceptus. Remember that the fetal heart sac is outside of the body until the 6th week in the bovine.

**Toxins:** * **Nitrate** : Reports of abortion due to nitrates exist in the literature from the late 1950's. In general, a causative effect is questionable, with proof lacking. Feeding a high level of NO3 failed to cause abortion in one study, however, theoretically nitrates could affect the fetus by reducing oxygen availability. It has been suggested that nitrates in conjunction with certain plants may play a role in some abortions.
* **Sodium iodide (i.v.):** Its use during pregnancy has been avoided because of the threat of abortion. However, this has not been proven experimentally.
* **Corticosteroids** can cause unwanted pregnancy loss, usually through inadvertent administration to pregnant cows.

**Toxic plants:** * **Pine needle abortion:** Pine needles from the Ponderosa Pine ( Pinus ponderosa) contains an anti-estrogenic compound. Ingestion of the needles results in abortion during the last trimester. Cows develop an addiction in favor of the pine needles over good feed. A high protein diet increases the risk of abortion. Abortion is characterized by a hemorrhagic condition of the placenta and fetus. Incomplete dilation of the cervix, retained placenta and metritis are common. Prevention requires physically isolating the cows from the pine needles to decrease losses. Pine needles are dangerous whether fresh, dry, fallen, on the tree, etc. The pine needles do not cause abortion in sheep but may increase the rate of dead lambs at parturition.
* **Oxytropis** and **Astragalis sp**. cause abortion. The toxic principle is an indolizidine alkaloid, causing abortion if cows ingest large amounts or fetal abnormalities with lesser amounts.
* **Verratrum californicum** - It is associated with the cyclops condition in sheep.
* Moldy sweet clover causes abortion, the causative agent is dicoumarol.
* Other plants for example, perennial broomweed and Locoweed are known to cause abortion.

**Infectious abortion*** **Infectious Bovine Rhinotracheitis** ( IBR ) The causative agent is bovine herpesvirus 1. The virus can remain viable for years when frozen. It causes a variety of clinical syndromes, such as necrotic rhinitis or "red nose" (covered in other courses), conjunctivitis, CNS infection, neonatal infection and coital vesicular exanthema. Coital vesicular exanthema is commonly called infectious pustular vulvovaginitis (IPV) in the cow and infectious pustular balanoposthitis (IPB) in the bull. The disease may be mild and unnoticed or may be very painful as evidenced by tail swishing, raised tail, frequent urination and an edematous hyperemic vulva. The mucosa will be covered with small pustules which coalesce to form white necrotic plaques that leave ulcers (on vulva or on penis/prepuce). Mucopurulent exudate may be seen. Lesions heal in 10-14 d. Genital forms of IBR are spread in secretions of reproductive organs. Latent infections are common. The virus may persist for years (trigeminal ganglia) in the animal. It can be reactivated by a corticosteroid injection resulting in active shedding. It ahs been suggested that stress can stimulate endogenous corticosteroid release and similarly result in active shedding. Abortion can occur after inapparent infection or after respiratory disease, conjunctivitis, IPV. Abortion usually occurs during the last trimester. The time from infection to abortion is variable. Occasionally the fetus is carried to term and dies shortly after delivery. Usually, however, the fetus is autolyzed (unlike in the mare). Diagnostic lesions are focal necrosis and intranuclear inclusions in the liver and adrenals. There are no characteristic gross lesions. Paired maternal sera are of little value because of the ubiquitous nature of the virus, widespread vaccination and most importantly because of the time lapse between maternal infection and abortion. Prevention is best accomplished with a good vaccination program. Caution must be exercised with Modified Live Vaccines because they can result in abortion and temporary necrotic oophoritis (especially of the CL). In general, killed vaccines are safe to use in pregnant cows. It is best to follow the manufacturer's directions. Heifers should be vaccinated after 5 months of age. Vaccinate heifers at least 1 month before breeding. Double sheathing the AI pipette has been suggested to reduce the risk of transferring virus from the vagina/vulva into the uterus. Mycoplasmas/Ureaplasmas:
* **M. bovis**; generally associated with infertility (see previous discussion).
* **M. bovigenitalium** occasionally causes abortion.
* **Ureaplasma** sp. also ocasionally causes abortion, usually in the last trimester. Placentitis and fetal pneumonitis are common.
* **Salmonella** (usually S. dublin, ocasionally other serovars) may cause abortion.
* **Haemophilus somnus**: occasionally causes abortion with retained placenta at 7-9 months of gestation. Listeriosis (Circling Disease, Silage Sickness) is caused by L. monocytogenes. The normal habitat of this bacteria is soil and the intestinal tract. Infection is usually by the fecal - oral route. Poor quality or poorly cured silage (pH>5.6) provides a favorable substrate for the organism. The majority of infections are asymptomatic. The organism has a predilection to localize in the intestinal tract, placenta and medulla oblongata. Uterine contents quickly become infected. Sporadic abortion is observed at any stage of gestation but usually in the last trimester. When abortion occurs near term, the calf may be stillborn, born alive and die shortly after birth or survive. There are typically no premonitory signs of abortion. In cases of abortion, no clinical signs are observed in the dam. Usually the dam recovers spontaneously. Fetuses are slightly to markedly autolyzed. The fetus has excess clear to blood tinged fluid in its serous cavities. Small necrotic foci are found in the liver, lungs and spleen. A Gram stain of abomasal contents may reveal the organisms. Diagnosis is made by isolation and identification of the organism, fluorescent antibody techniques or direct stained smears. Control is accomplished by improving hygiene and avoiding feeding spoiled silage.
* **Mycotic** : Fungi are estimated to be the cause of 2 to 30% of all infectious abortions. Two-thirds of mycotic abortions are due to Aspergillus fumigatus. Other species of fungus implicated in bovine abortion include Mucor, Rhizopus, Absidia and Mortierella. The source of infection is usually external via the respiratory or GI route. Alternatively, it may be from genital / vaginal flora or contaminated semen. Abortions may occur anytime after the 3rd month of gestation but are most common in late pregnancy. Mycotic abortions tend to peak during the winter. Pathogenesis is usually the result of a generalized infection with blood borne dissemination and subsequent localization in the placenta resulting in placentitis, necrosis, and hemorrhage with separation of the chorion from the caruncle by exudate. There are usually on clinical signs in the dam and the fetus may be grossly normal as well. Some fetuses (2-25%) may have ringworm - like skin lesions in which fungal elements can be demonstrated (especially in the head and neck region). Fetal lesions include generalized lymphadenitis, dehydration and emaciation. Necrotizing hemorrhagic placentitis with retained placenta is common. Microscopic lesions include vasculitis, bronchopneumonia, and necrotizing epidermitis. Diagnosis is made by demonstration of fungi in association with significant lesions. Tissues to submit include placenta, especially cotyledons; kin lesions, lymph nodes, lung and stomach (with contents).
* **Chlamydia** : Chlamydia are obligate intracellular bacteria. They are susceptible to tetracylines. Abortions occur without clinical signs as early as 5 months of gestation but usually occur in the last trimester. Retained placentas are common. Abortions are usually sporadic. The route of infection is hypothesized to be via ingestion of tissues but may involve birds as carriers. Rebreeding problems are common after abortion. Placentitis is a consistent lesion, while fetal lesions vary considerably. Diagnosis requires laboratory confirmation. Intracytoplasmic inclusions are characteristic. Paired sera are helpful in suspected cases. No vaccine is available, therefore prevention centers on hygiene while prevention of further cases is usually based on tetracyclines in the feed.
* **Parvovirus** : Typically, no clinical signs are observed in the dam. Abortions are most common in the 1st half of gestation. The fetus and placentas are edematous and the cotyledons necrotic. Diagnosis is by hemagglutination inhibition test.
* **Epizootic Bovine Abortion** commonly known as Foothill Abortion is a vector transmitted disease. The etiologic agent is unknown. The vector is the argasid tick, *Ornithodoros coriaceus*. Last trimester abortions are seen. The disease occurs annually in certain areas of California. Abortions are characterized by a sudden onset with high fetal mortality. The disease is confined to 1st calf heifers (females in their first pregnancy). There are no clinical signs in the dam. The fetus is delivered in a fresh state. Hemorrhages are observed on the ventral surface of the tongue. Straw colored peritoneal and pleural effusions are common. The subcutaneous tissues are often edematous. The liver is swollen and nodular, the spleen enlarged, and the lymph nodes enlarged and edematous. Prevention is accomplished by exposing yearlings and open 2 year-olds to summertime brush areas where the tick lives, and breeding in the fall.
* **BVD**: The etiologic agent is a Pestivirus in the family Togaviridae. It is related to hog cholera in swine, border disease in sheep and equine arteritis virus (EAV). It is found worldwide. The virus can infect many species. The virus is shed in feces and nasopharyngeal secretions. It is transmitted by aerosol droplets and by the oral route from fecal contamination (which is the most probable route). Vector and mechanical transmission are also possible and vertical transmission is common. The majority of infections are unapparent, subclinical and lack clinical signs. When present, a variety of clinical signs may be observed and may be acute, chronic (cattle are considered "poor doers") or mild clinical. Clinical signs include immunosuppression (see Food Animal notes). Reproductive effects are variable. Associated with significant reproductive losses (fertilization failure, early embryonic death and abortion). Congenital malformations, especially of the CNS, may be seen as well. Determining factor of the outcome is the age of the fetus at the time of infection. Abortion is more likely if infection occurs in the early months of gestation. Fetal expulsion can occur close to the time of maternal infection or many months later. Congenital abnormalities may be observed. Affected fetuses may be aborted or carried to term. Most common congenital defects include cerebellar hypoplasia, ocular dysgenesis (microphthalmia, congenital cataracts), brachygnathia and musculoskeletal defects. Fetal mummification may be observed. Diagnosis is by virus isolation, identification of viral antigens by immunofluorescence or enzyme immunoassay. Demonstration of rising antibody titers are less useful in abortion cases. There is a relatively high incidence of BVD infection in fetuses so isolation of virus or demonstration of BVD antibodies in the serum from the fetus may not necessarily be diagnostic. BVD should not be considered the cause of abortion unless BVD lesions are present or cases of BVD have occurred in the herd. Prevention is accomplished by vaccination. Caution should be used with modified live vaccines as they can cause abortion. Killed vaccines are available. Annual booster vaccination is required with killed vaccines. Calves should be vaccinated after 6-8 months of age when maternal antibodies have passed. Persistent carriers may occur after fetal infection in utero before the immune system has matured. The virus is not recognized as foreign and is shed by that individual after birth. Because of the problem posed by persistent carriers, one form of control advocated by some is to vaccinate and then check titers. Any cattle not developing a titer should be culled, because they failed to recognize the vaccine as foreign and develop antibodies. These individuals are most likely persistent carriers.
* **Leptospirosis:** The etiologic agent is a spirochete, *Leptospira interrogans*, which has over 180 serovars in 19 serogroups. Each serovar is adapted to a particular reservoir host but can cause disease in any mammalian species (Table 28). The reservoir host has a high susceptibility to infection and endemic transmission. Pathogenicity in the reservoir host is relatively low, with a tendency to cause chronic rather than acute disease. However, insidious economic loss occurs through reproductive losses. Persistence in the kidneys and/or the genital tract may occur. In the reservoir host, the antibody response, as determined by the micro-agglutination titer (MAT) is low. In contrast, in an incidental host there is relatively low susceptibility with sporadic transmission. However, pathogenicity is high, characterized by acute, severe disease. There is a short kidney phase and a marked Ab response. Transmission can be direct, such as through urine splashing, placental and uterine discharges after an abortion, through the milk, transplacentally or venereally. Transmission can also be indirect, by environmental contamination of feed by urine of carrier animals. Survival of the leptospire is favored by moisture, moderately warm temperature and neutral to mild alkaline pH. The organisms may survive weeks to months under good conditions, yet only minutes if conditions are dry or <10oC or >34oC. Pathogenesis: Leptospires penetrate mucous membranes and water-softened skin. After a 4 to 10d incubation period, they disseminate to many organs in a leptospiremic phase lasting up to 7d. During this period, acute clinical disease may be seen. Antibody production, which is detectable about 6d after the leptospiremia begins, stops the bacteremia and allows the leptospires to persist only in tissues of poor antibody penetration, resulting in chronic infection. Leptospires can persist in the kidneys and be shed in the urine for several weeks in an incidental host, or 6 months or more in a maintenance host. Leptospires can also persist in the genital tract of a maintenance host. For example, hardjo in cattle - oviduct (3wks), uterus (3-5 mos.), testes, seminal vesicles, prostate. In cattle, the major serovars are hardjo and pomona (type kennewicki). Acute disease is most commonly manifested as mastitis in dairy cows. Chronic infection is manifested as abortion, stillbirth, and the birth of premature and weak infected calves. Retained fetal membranes are common after hardjo abortion. Abortion may be the only manifestation of infection or may be related to an episode of illness 6 (pomona) or 12 (hardjo) weeks earlier. Hardjo infection is associated with infertility (early embryonic death (EED)) and abortion (4 months to term), while pomona infection is associated with abortion during the last trimester. Signs in the aborted fetus are negligible. Focal tubular necrosis and interstitial nephritis may be seen. Autolysis of the fetus is common. Diagnosis: Darkfield microscopy and silver staining of tissues are insensitive methods. Immunofluorescence of urine or homogenates of fetal lung and kidney or of the placenta is a good technique. When obtaining specimens for submission, it is important to remember that leptospires die rapidly in tissues unless kept at 4oC. The presence of leptospires in urine from cows that have recently aborted does not distinguish these cows from renal carriers. Serologic diagnosis is by Microscopic Agglutination Titer (MAT). This technique is useful in the diagnosis of the incidental host, but is less useful for diagnosis of the maintenance host. Herd serologic response is more helpful. Testing of fetal fluids in abortions is useful. A titer >100 is significant (>10 in fetal fluids). Paired sera are of no use in chronic infection, but are useful in acute infection. To test the herd, sample 10 animals from each management or age group. Titers >300 for hardjo indicate active infection. For treatment of acute infection administer tetracycline. Control is achieved through hygiene and vaccination.

http://www.vetmed.lsu.edu/eiltslotus/theriogenology-5361/cows007.jpg* Limit transmission by carriers. Reduce contact with wildlife, control rodents, especially contamination of feed. Fence swampy ground. Vaccination is recommended. Immunity is short lived, therefore vaccinate twice a year in open herds. Vaccines vary in efficacy and vaccine failures may occur. The vaccine is inexpensive and safe to use iin pregnant cattle.
* **Neosporosis** : This was first identified as a cause of abortion in 1989. The etiologic agent is a protozoa of the genus *Neospora*. The species is unclear. The life cycle is unknown but is probably similar to *Toxoplasma gondii* (i.e. oral route of infection with transplacental infection of the fetus; carnivore sheds oocysts in feces; oocysts are ingested by cattle, sheep and goats; carnivore eats cattle, etc). Abortion occurs at 3 to 8 (usually 5 to 6) months of gestation. Gross lesions are non-specific and the fetus is usually autolyzed. There is usually no metritis or retained fetal membranes after abortion. Occasionally the calf is born alive with hindlimb weakness or paralysis, but this carries a poor prognosis. However, congenital infection is not necessarily detrimental to the calf's health. Congenital transmission consitutes a major mode of transmission. There is no known treatment for the disease. Prevention is accomplished by protecting the feed and water from fecal contamination and fecal contact. On necropsy, an\borted fetuses have multifocal, necrotic, non-suppurative encephalitis along with mononuclear myositis and myocarditis. An immunohistochemical stain is used to identify the organism in tissue sections. Ttissues not fixed in neutral buffered formalin may result in false negatives. An Indirect Fluorescent Antibody test (for N. caninum) is also used. This disease may be a leading cause of bovine abortion. The significance of iImmunity after abortion is unknown. Some cows abort repeatedly but it is unknown if it is due to a chronic latent infection or recovery and reinfection. Some cows give birth to affected calves in subsequent pregnancies.
* **Brucellosis** : The species affecting food animals are: *Brucella abortus* Y cattle, elk, bison; *B. melitensis* Y goats and sheep; *B. suis* Y swine and reindeer. Transmission is by the oral route (*B. Abortus and B. melitensis*); oral and genital route *(B. suis* in swine); and oral route (*B. suis* in reindeer). Infection begins when the organism breaches the mucosal epithelium and makes its way to the local lymph node. This is followed by a bacteremia of variable duration. The incubation period can be as short as two weeks to as long as one or two years. The organism resides in the distal lymph nodes, spleen, bone marrow, joints, CNS, mammary gland, testicle, epididymis, seminal vesicles, prostate, and pregnant uterus. Clinical symptoms include abortion or birth of near-term weak offspring in cattle, acute to subacute mastitis in goats and sheep, chronic mastitis in cattle, orchitis and epididymitis in males. The social characteristics of cattle, herd females helping with the clean up following a birth, is an important epidemiological factor to remember when considering that primary exposure follows abortions, because the placenta and reproductive tract discharges are rich sources of the organism.

http://www.vetmed.lsu.edu/eiltslotus/theriogenology-5361/cows008.jpg* Susceptibility varies with 18-20% of the population being very resistant. There is an age and sex related susceptibility with males less susceptible than females and sexually immature females less susceptible than mature females. Pregnant females are the most susceptible. Most infected cows abort only once. Brucellosis is generally considered a first calf heifer disease in a chronically infected herd. Vertical transmission is rare and results in latently infected heifers. The organisms may be frequently shed in milk resulting human infection (undulant fever). Various diagnostic methods may be employed. The most common are serological tests, either on farm, at the market, or at slaughter. In a dairy herd, a milk ring test is performed every 3 months on a milk sample from the bulk tank. If results are positive, the milk is retested by heat inactivation. If results are still positive the area regulatory veterinarian is contacted. They can get a second milk sample and retest. If results are positive, then the entire herd is tested by serological means. As an option, they may decide to just test the entire herd without rechecking the milk. Individual animals are tested using a Buffered Acidified Plate Antigen (BAPA) or card test. Sometimes a rivanol test is used. The final test is a Complement Fixation Test. At market, a card test is performed, followed by a CITE if positive. If both testa are positive the animal is considered a reactor. If the card test is positive and the CITE negative, the owner can either take the animal home and retest it later (which is the preferred option) or brand the animal with an "S" (suspect). The disease may also be diagnosed on the basis of a diagnostic laboratory abortion screen, culture or pathology. Brucellosis has zoonotic potential causing Malta fever, undulant fever, or spring fever. It is shed in the milk (therefore raw, or unpasteurized, milk is prohibited in most states), but meat from infected animals is safe. Symptoms are highly variable. Because of its zoonotic potential, regulatory aspects have been instituted. Limited movement of animals from infected herds and from states with infected herds is allowed. Vaccination programs are regulated, stating which vaccines are allowed and the time frame during which they may be used. Brucellosis vaccination alone will not eliminate the disease. Only live vaccines are used. To be effective, vaccination must mimic a natural infection and the bacteria must remain alive in the host's tissues for at least 7 days. Immunity is due to cell mediated immunity. Remember that antibodies are not protective in ruminants and swine. Living vaccines that are or have been recently available include Rev 1 for *B. melitensis*, and Strain 2 for *B. suis*. Strain 19 was used in the past for *B. abortus* but has been replaced with Strain RB51. One problem with the live vaccines (especially Strain 19) is that they may cause post vaccine titers which interfere with diagnostic tests. This problem is greatly reduced with Strain RB51. RB51 may be effective in all animals including wildlife. The live vaccines may infect animals resulting in abortions and arthritis. They cannot be used in males because they can cause reproductive tract infections and sterility. The vaccines are infectious to man.
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