Abortions in Dairy Cows: New Insights and Economic Impact

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- **Take Home Messages**

  - Abortion is the most important condition that limits cow's ability to produce a calf and considerably erodes the profit.
  - Abortion is defined as fetal death and expulsion between 42 and 260 days of gestation.
  - The greatest risk of fetal loss is during the first trimester of gestation and then progressively decreases as gestation advances with a slight increase in the risk toward the last month of gestation.
  - The infectious causes include bacterial, mycotic, viral, and protozoal. The non-infectious causes include nutritional factors, chemicals, drugs, toxins, poisonous plants, and hormonal agents.
  - Many abortions go unnoticed or undiagnosed and we always suspect fertility problems when cows are found open rather than embryo/fetal loss.
  - Determining the cause of an abortion is not simple and attempts to arrive at a diagnosis are frequently frustrating and unproductive. Diagnostic efforts should be initiated any time more than 1% of the herd abort.
  - Under modern systems of dairy management cows continue to experience a seemingly high risk of abortion, despite intensive efforts toward immunization against infective agents.
  - Each midterm abortion costs the producer between $600 and $1000.
  - Good record keeping systems help to monitor the trends and occasionally assist in diagnosis or solution to the problem.
  - The only effective control in cases of infectious abortion is vaccination when available.
Definition

Abortion is defined as fetal death and expulsion between 42 (an estimated time of attachment) and 260 days (the age at which a fetus is capable of surviving outside the uterus) of gestation. The condition does not include fetal maceration and mummification.

Process of Abortion

Abortion results from premature initiation of parturition when normal relationships between fetus and dam fail. This results in the expulsion of a fetus that is incapable of independent life. Parturition is normally initiated via the fetal pituitary-adrenal axis. Effective fetal control of the pregnant uterus is lost after the fetus dies. Although many factors have been incriminated, the mechanism of abortion has never been explained. Whether abortion and normal parturition are mediated through the same pathways is unknown. Also unknown is whether the mechanism is the same for all types of infectious abortions. Abortion can occur any time during gestation, but most of them are observed during the second half. Most abortions that occur during the first trimester of pregnancy are unnoticed and the animal is treated clinically for infertility. The pathogenesis for abortion may be acute or chronic. In general, premonitory signs are usually lacking.

Incidence

Many abortions go unnoticed or undiagnosed and we always suspect fertility problems when cows are found open rather than embryo/fetal loss. The greatest risk of fetal loss is during the first trimester of gestation and then progressively decreases as gestation advances with a slight increase in the risk toward the last month of gestation (Thurmond, et al., 1990). The observed fetal loss is far less than the actual incidence. The cumulative incidence of fetal loss between 31 and 260 days of gestation is 10.8%. Of this only 20% of the fetal losses are detected by observation of an expelled fetus or fetal membranes and the proportion detected increases with increasing gestational age at time of fetal loss (Forar, et al., 1996). A most recent report (Kinsel, 1999) identified a lesser incidence of 2.9% abortion (3012 lactations out of 103,396) and a detection rate of 45.8% (1380 out of 3012). It is also believed that the abortion rate increases after 5 pregnancies or after 4 calvings and furthermore the risk is higher for a cow that already had an abortion.
Causes

Either infectious or non-infectious agents may cause abortion. The infectious causes include bacterial, mycotic, viral, and protozoal. Historically, it has been suggested that 50-65%, 20-25%, and 15-25% of infectious abortions were caused by bacterial, fungal, and viral causes respectively. Based on diagnostic samples submitted to a laboratory in western United States, 45% are attributable to bacterial causes, 31% to mycotic causes, and 15% to viral causes. The non-infectious causes include nutritional factors, chemicals, drugs, toxins, poisonous plants, and hormonal agents. In addition, epizootic bovine abortion is caused by an unknown agent in the foothills of California, Nevada, and Oregon, and may be in other parts of the western United States. Under modern systems of dairy management cows continue to experience a seemingly high risk of abortion, despite intensive efforts toward immunization against infective agents. It should be remembered that because of the endemic nature of abortion occurring in vaccinated cattle, factors other than the infectious agents might contribute to the risk of abortion.

Infectious causes of abortion:

Bacterial: Bacterial abortions result from brucellosis, leptospirosis, campylobacteriosis (vibriosis), listeriosis, haemophilus somnus complex, and ureaplasmosis. Bacteria like Salmonella, Actinomyces, Escherichia coli, Streptococcus, Staphylococcus, Bacillus, Pseudomonas, Proteus, Pasteurella, nocardia, and chlamydia species, as determined by the microbiological findings, can cause abortion. All these organisms and few others that are not listed have been isolated from sporadic cases of abortion. These are secondary to either a septicemia in the dam or ascending infection through the vagina and cervix or due to persistent endometritis.
Table 1: Ten most common bacterial agents encountered in bovine abortions

<table>
<thead>
<tr>
<th>AGENT</th>
<th>OCCURRENCE, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actinomyces pyogenes</td>
<td>4.22</td>
</tr>
<tr>
<td>Bacillus spp</td>
<td>3.58</td>
</tr>
<tr>
<td>Listeria</td>
<td>1.35</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>1.09</td>
</tr>
<tr>
<td>Leptospira interrogans</td>
<td>0.88</td>
</tr>
<tr>
<td>Pasteurella haemolytica</td>
<td>0.41</td>
</tr>
<tr>
<td>Streptococcus spp</td>
<td>0.30</td>
</tr>
<tr>
<td>Pasteurella multocida</td>
<td>0.29</td>
</tr>
<tr>
<td>Salmonella spp</td>
<td>0.29</td>
</tr>
<tr>
<td>Brucella abortus</td>
<td>0.27</td>
</tr>
</tbody>
</table>

(Adapted from Yaeger and Holler, 1997)

Brucellosis is caused by the organism *Brucella abortus*. Aborted fetus, uterine discharge, placenta, infected premises and milk are sources for the spread of infection, and abortion occurs from 6 to 9 months into gestation. It is possible to eradicate the condition, for example, Indiana is classified as a brucellosis free state. Leptospirosis is caused by *Leptospira pomona, hardjo, canicola, icterohemorrhagiae, and grippotyphosa*. Infected cows, wildlife, swine, and water and feed contaminated with urine are some of the sources of infection. Abortion occurs from 6 to 8 months of gestation. Camphylobacteriosis is caused by *Camphylobacter fetus*. Infected bulls and cows spread the infection and abortion occurs from 6 to 8 months of gestation. Not reported in states like Indiana but has been found in southern and western United States cattle. Listeriosis is caused by *Listeria monocytogenes*, and the organism is excreted in feces, urine and milk. The organism grows in silage with high pH. Abortion occurs mostly in the latter part of last trimester. Haemophilus somnus is responsible for the haemophilus somnus complex. The organism is cultured from individual abortions and also isolated from a few herd abortions. Infected cattle spread the infection possibly via the respiratory route. Based on experimental studies it can be concluded that the organism is capable of causing abortion in all stages of gestation. Ureaplasmosis is caused by *Ureaplasma diversum* and is spread via semen, vulvar discharges, and possibly by nasal secretions. Abortion can occur anytime but usually in the last trimester of gestation.

Mycotic: Fungal or mycotic infection of the placenta is one of the most common causes of sporadic bovine abortion. Anywhere from 20-35% of abortions have been attributed to fungal causes. Abortion occurs when fungal spores enter a pregnant cow’s blood stream (possibly through breaks in the lining of the upper digestive tract), settle at the junction of the maternal and fetal placentas, grow and attack the placental tissues. In general, fungal spores may be present in
cattle feed. However, some feeds such as improperly preserved silage and hay that has been wet, contain many more spores than others. *Aspergillus fumigatus* accounts for 60 to 80 percent of abortions that are caused by fungal organisms. The organism may cause abortion from 4 months to term. The period of highest incidence in the Northern Hemisphere is January through March. Other species of molds and yeasts have been associated with abortion. Any condition that reduces the cow’s resistance to infection increases the chances of mycotic abortion. Providing good health (via good management and nutrition) and not feeding moldy feeds can reduce the incidence. When possible, depending on the availability and demand decrease the period of confinement, decrease cow density, and improve ventilation.

**Viral:** Infectious bovine rhinotracheitis (IBRV) or bovine herpesvirus 1 (BHV-1) is a major cause of viral abortion. Although the development of effective vaccines appears to have reduced the incidence of IBRV induced abortions, it still remains the most frequently diagnosed viral cause of abortion in North American cattle. Infected cows or any animal with a positive titer may be carrying the virus and abortions occur from 4 months to term. Bovine viral diarrhea causes abortion usually in the early part of gestation (up to 4 months) and is spread by infected cattle housed or pastured together.

**Protozoal:**

Trichomoniasis: Caused by *Trichomonas fetus* and is spread by venereal transmission. The organism is responsible for early embryonic death, infertility, and rarely abortion.

Neosporosis: *Neospora caninum* is a recently recognized protozoan parasite of animals, which until 1988 was misidentified as *Toxoplasma gondii* (Dubey, 1999). It is probably not a new disease, but rather a newly recognized one. Neosporosis is a major cause of abortion in cattle in many countries including Canada and USA (Dubey and Lindsay, 1996; Pare et al., 1996). An important feature of the disease is that the parasite can be maintained in cattle as a chronic, apparently lifelong, infection which can be passed on to the fetus during pregnancy. Initially, the organism was isolated from a paralyzed dog tissue and was named as *Neospora caninum*. Subsequently, it was isolated in brain tissue of bovine fetuses from a herd with persistent abortion in New Mexico. The tissue reacted with antibodies against *Neospora caninum*. Similarly, using specific antibodies, *Neospora caninum* was recognized as the cause of abortion in California drylot dairies. Between 10 and 25% of aborted fetuses submitted to diagnostic laboratories around the world are found to be infected with *Neospora caninum*. Abortion attributable to *Neospora caninum* infections can be expected to be a continuing major cause of abortion in dairy herds with a history of neosporosis. It will be also attributed as a cause of abortion in dairy herds that have a history of sporadic abortions, but for which
Neospora caninum infections have not been previously identified as a cause of abortion.

**Time of abortion:** The greatest risk of fetal death is observed between 98 and 105 days of gestations and median age at fetal death ranged from 99.0 to 105.5 days. Seropositive cows have a risk of aborting 2 to 3 times greater than seronegative cows. In abortion storms it is greater (20 to 50 times) in seropositive cows. Research show that subsequent abortions can be expected in congenitally infected cows that have aborted previously. Since it has been observed that for cows with at least one previous abortion, the proportion of aborting (14.5%) was higher than that for cows without a previous abortion (12.14%).

**Life cycle:** The life cycle of this family of protozoan parasites has two hosts: a carnivorous predator is the definitive host and a prey species is the intermediate host. Transplacental spread (vertical transmission) occurs in up to 90% or pregnancies in infected dams, and this mode of transmission is believed to be important in maintaining infection in a herd (Wouda, et al., 1999). Recent epidemiological studies have suggested that the dog may be involved in the horizontal transmission of Neospora caninum. It is possible that the dog is the definitive host (Anderson, 1999) and may transmit the protozoa by contaminating feed with oocysts excreted in the feces. Presence of dogs and presence of seropositive cattle in control herds in a detailed study suggested the role of dogs in the spread of the condition. The cat is not a definitive host for neosporosis.

**Prevention:** Subsequent pregnancies in cows that abort a Neospora caninum infected fetus also are at risk of infection, suggesting that the immunity provided by an initial infection is inadequate to prevent repeat infection or that cows can be persistently infected with Neospora caninum. The key to prevention is to detect infected cows and prevent new infections. It is recommended to progressively cull seropositive cows as they maintain infection in the herd through vertical transmission and provide infectious material (aborted fetuses) to the definitive host. Heifers born to seropositive (presence of antibodies for Neospora caninum) cows can be eliminated from the herd. They can be retained if they test negative prior to their intake of colostrum or after 6 months. Only seronegative heifers are used as replacement stock. Drug treatment of patients with neosporosis is unlikely to eliminate the infection and may be impractical and expensive because of milk withdrawal time for lactating dairy cows. It is concluded that Neospora caninum infected calves should not be used as replacement stock to decrease the future risk of abortion in dairy herds. To prevent horizontal transmission from occurring, domestic and wild animals, particularly dogs, should not have access to cow feed. They also should not have access to potentially infectious material. There is no vaccine available for Neospora caninum. In embryo transfer situations only use seronegative recipients. All the hard work of scientists (parasitologists,
epidemiologists, theriogenologists, pathologists, immunologists, and molecular biologists) and industry cooperation has helped to find the causative organism of this costly and serious problem in the bovine industry. It is imperative that our focus is on control and prevention of this expensive abortion episode.

Noninfectious causes of abortion:

Nutritional: Starvation may result in placental insufficiency and abortion, however, it rarely occurs in a modern dairy practice. Vitamin A deficiency has been suggested to result in thickening and degeneration of placenta and abortion in late gestation. Iodine deficiency has also been suggested as a cause of abortion.

Chemicals, drugs, and toxins: High concentration of nitrates in plants/weeds can cause abortion from 3 to 9 months of gestation. Pine needles and locoweeds can cause abortion depending on the stage and the amount consumed (Kirkbride, 1991). Ergot can cause placental necrosis, fetal death and abortion. Warfarin and coumarin can also cause abortion. Mycotoxins from the fungal agents are suspected to cause abortion. Bacterial endotoxin is responsible for sporadic abortions. Among the hormonal agents, estrogen, glucocorticoids, and prostaglandin are important. They cause abortion depending on the dose and the stage of gestation they are used. Stress may also cause abortion.

Diagnosis:

Only 30% of abortions are currently being diagnosed. Although infectious agents have been incriminated in 20-30% of abortion cases submitted to diagnostic laboratories, their role may even less important if the presence of organisms does not necessarily indicate a causal association with abortion. The causes of most abortions in dairy cows remain obscure, even though endemic rates may reach or exceed 10%. Other evidence suggesting dubious role for certain infectious agents in abortion is that vaccination and diagnostic efforts have had marginal success in solving endemic abortion problems. Constraints to diagnosis arise in interpreting the results of tests because most abortions are not detected for several weeks or months, by which time appropriate tissues may be unobtainable. Moreover, tissues submitted are usually from fetuses large enough to be noticed by dairy personnel. This potential under-representation of young fetuses by diagnostic follow-up presents a biased view of causes of abortion – the putative causes relating to whatever was found in tissues from older fetuses.

Determining the cause of bovine abortions presents many difficulties. This is evident from the diagnostic success rate of 30 to 40% attained by most
diagnostic laboratories around the world and rarely it reaches 50%. One reason for the low diagnostic success rate is that abortion is frequently the result of an event that occurred weeks or months earlier, and the cause of the event, if it was ever present is the conceptus, is often undetectable by the time of abortion. Other factors also contribute to diagnostic difficulties (Kirkbride, 1982):

- The fetus is often retained in utero for hours to days after death, resulting in autolysis that hides lesions.
- The fetal membranes, which are commonly affected first and most consistently, are frequently unavailable for examination.
- Toxic and genetic factors that may cause fetal death or abortion are not discernible in the specimens available for examination.
- Many causes of bovine abortion are unknown, or there are no effective routine diagnostic procedures for identifying them. Busy diagnostic laboratories must rely on well-established, routine procedures for their daily accessions, otherwise, each case becomes a research project rather than a diagnostic assignment. Most laboratories have neither the time nor the resources to study cases in other than routine fashion’ and even if they could, diagnostic results would usually be delayed, making them more of academic than of practical interest.

There is a selection bias in submissions of aborted fetuses to a diagnostic laboratory. Earlier abortions are not recorded and small fetuses are not submitted (Thurmond and Picanso, 1990). Also in certain cases scavengers consume smaller fetuses and larger fetuses are spared. Historically, low diagnostic success rates for first trimester abortions may have discouraged submissions.

It is important that the appropriate specimens are properly handled, preserved, and submitted to the laboratory without delay. As the collection-to-laboratory time increases, chances for diagnosis decreases (Dennis, 1991).
Specimens Required for Diagnosing Infectious Bovine Abortion

Best specimen is aborted fetus and its placenta. If not practical, perform a necropsy and submit the following:

<table>
<thead>
<tr>
<th>Frozen or refrigerated</th>
<th>10% buffered neutral formalin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abomasal contents (1-3 ml)</td>
<td>Lung</td>
</tr>
<tr>
<td>Lung</td>
<td>Kidney</td>
</tr>
<tr>
<td>Kidney (1/4 to ½)</td>
<td>Intestine</td>
</tr>
<tr>
<td>Spleen (for viral isolation)</td>
<td>Any other organs with lesions</td>
</tr>
<tr>
<td>Infected cotyledons 1 or 2</td>
<td>Infected Cotyledons 2 or 3</td>
</tr>
<tr>
<td>Serum or peritoneal fluid</td>
<td></td>
</tr>
<tr>
<td>Dam’s serum</td>
<td></td>
</tr>
<tr>
<td>Vaginal discharge</td>
<td></td>
</tr>
<tr>
<td>Decomposed fetus</td>
<td></td>
</tr>
<tr>
<td>(brain contents collected aseptically)</td>
<td></td>
</tr>
</tbody>
</table>

(Adapted from Dennis, 1980)

Interpretation of Results:

Interpreting diagnostic results presents some problems. Although organisms of relatively low virulence can cause abortion, such organisms are frequently may be present in fetal or fetal placental tissues as in utero infections, but they do not actually cause abortion. Determining the significance of their presence in relation to the abortion may be impossible at times. Concurrent infections are commonly recognized as causes of disease, but they have seldom been reported as causes of abortion. The agent isolated from an aborted fetus and identified as the cause of the abortion may be only one of two or more agents involved.

Results of serology should always be interpreted with care. A positive result from a single sample of material serum indicates only that the dam has been exposed to the particular antigen. The antigen might have caused the abortion or the animal’s exposure to the antigen might have occurred earlier. However, two-to four-fold increases in titer in a second sample 10-14 days after abortion is significant. Paired serum samples are usually more meaningful if collected from other cows in the herd (10 cows or 10% of the herd). Findings of serology should be carefully correlated with herd history, changes in aborted fetuses and placentas, and results of laboratory tests.

Finally, evidence of selection bias in laboratory submissions suggests caution in extrapolating diagnostic laboratory results to causes of disease in the general population. There may be causes of abortion that will be missed because all
the aborted younger fetuses are not submitted to the laboratory. Although the diagnosis of a cause of abortion is limited and laboratory results are discouraging, it behooves us to submit any aborted fetuses to the laboratory, provided it meets all the conditions of submission. All abortions should be treated as herd problem and the diagnostic work is important in each one of them.

- **Prevention:**

There is no practical treatment for controlling an abortion outbreak. As most abortifacient pathogens are spread by ingestion, animals that have aborted or are suspected to abort should be isolated until vaginal discharges have ceased. The only effective control in cases of infectious abortion is vaccination when available. Good record keeping systems help to monitor the trends and occasionally assist in diagnosis or solution to the problem.

- **Economic Impact:**

It is ideal to have every pregnant cow go to term and have a healthy calf. However, some losses due to abortion are expected and the maximum loss of 3% is acceptable. The economic impact of abortions depends on direct costs and value of fetuses lost. Indirect costs include those associated with establishing the diagnosis, re-breeding cows that aborted, possible loss of milk yield, and replacement costs if cows that aborted are culled. The questions to ask after an abortion are as follows: How likely are abortions to repeat? How do aborted cows perform following the abortion? Should I keep a cow that aborts? What is the cost of an abortion?

Aborted cows are at 3.2 times higher risk of being culled; however, only 1 out of 6 are recorded as ‘culled for abortion’. Aborted cows if not culled have 5 times more likely to abort subsequently than cows that never aborted. If one calculates the conception to conception interval, it is 173 days on an average. On average it takes 72 days for a cow to conceive after an abortion, however, there is a gestation age effect. As gestational age increased, time to rebreed increased. In the first trimester abortion it took 54 days to rebreed and 85 days in the second semester abortion and 116 days in the third semester abortion. The basis of cost estimation is to determine the number of days open plus the gestational days at the time of abortion. It can range from 150 to 225 days or more for a herd. Cost of open day estimate can be used to obtain the loss and inclusion of veterinary intervention and medication can provide the total loss due to abortion.
There are no conclusive data regarding economic losses to the cattle industry caused by neosporosis anywhere in the world. The best available figures are that 20 to 30% of all abortions in California are caused by infection with Neospora caninum. It has been estimated that economic losses in California directly related to Neospora caninum are approximately $35 million each year and this is based on 40,000 abortions caused by this organism. The dairy population (reproductive age) is 1.2 million and 5 to 15% of pregnancies are aborted. Each midterm abortion costs the producer between $600 and $1000. The other losses include the reduced production of milk by seropositive cows. They produce 1 kg less than their seronegative herdmates. It is also possible that cows were culled 6 months sooner than were seronegative cows.

**Conclusions**

In the event of an abortion (either sporadic or an abortion storm), it is but natural that each person involved in the farm level dairy operations would like to know the cause, risk for other animals, and to control the abortion from spreading to other animals. Finally and most importantly from the financial aspect, we always would like to know a way to prevent the condition. Abortions do occur despite the implementation of remedial measures. Instances like introduction of new animals into the herd with unknown history, introductions of new personnel into the farm are some of the issues that can create problems and wipe out the profit due to abortion storms. It is important that every effort is made to diagnose the cause of an abortion knowing fully well that diagnosis is not possible in each case. Finally, one has to be cognizance of the fact that a few abortions are likely to happen even in a well-managed dairy.

**References:**