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Infectious Causes of Abortions and Stillbirths in Horse Breeding

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ABSTRACT

Horse breeding is a fundamental component of economic and social development in many countries. Maintaining high fertility rates and ensuring the birth of healthy foals is crucial for the sustainability of the equine industry. However, both infectious and non-infectious factors contribute significantly to reproductive losses, including miscarriages, stillbirths, and postpartum fetal deaths. Infectious agents such as bacteria, viruses, fungi, and parasites play a significant role, while non-infectious causes include stress, transportation, hormonal imbalances, and uterine torsion. Early and accurate diagnosis of these factors is critical for effective treatment and prevention. In this context, the implementation of comprehensive preventive strategies, such as routine vaccination (e.g., against equine herpesvirus), isolation of pregnant mares, regular veterinary checkups, ongoing monitoring, and appropriate nutritional management, is crucial. This review aims to inform breeders and veterinarians about the underlying causes of miscarriage, infertility, and foal deaths in horses and to emphasize the importance of preventive medicine in reducing these risks.

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INTRODUCTION

Following the process of domestication, the utilization of horses has undergone a series of changes over time. Initially employed as a food source during the paired periods, horses were subsequently raised for use in warfare and as part of the labour force during the following periods. The advent of mechanization and technological development has led to the current practice of breeding horses for recreational and sporting purposes. Horses possessing superior characteristics are selected as breeders, and these horses are subsequently utilized in flat running and obstacle jumping competitions (Paksoy and Ünal, 2019).

To achieve success in the field of equine breeding, it is essential to obtain foal that possess both high endurance and speed ability from mothers and fathers that demonstrate superior yield power. Achieving this objective is contingent upon factors such as an elevated fertility rate, uncomplicated pregnancy processes, and an augmentation in the number of healthy foals born. It is imperative to acknowledge the numerous infectious and non-infectious factors that can influence these processes. Infectious factors include bacteria, fungi, parasites and viruses, while non-infectious factors encompass transport, hormonal disorders, torsion and stress (Li et al., 2024).

This review examines the potential causes of litter failure and infertility problems in horses. It also aims to provide information to breeders and veterinarians for the solution of these problems with a holistic approach.

Pregnancy Process in Horses

Complications arising prior to and following parturition in equines have the potential to result in the termination of the pregnancy process or the failure of the foal to survive post-partum. It is therefore vital to be well-versed in the physiological and behavioural conditions of mares during pregnancy and parturition. The average gestation period in mares is 330-345 days. It is notable that births in mares tend to occur predominantly during nocturnal hours (Paksoy and Güngör, 2024). The birth process in horses is comprised of three distinct stages. In the first stage, the foal assumes the correct position within the uterus. During this period, the mare typically exhibits increased activity, often walking at a faster pace within the barn, and displays frequent defecation behaviour. It is during this stage that restless behaviour is observed, and labour is initiated. The second stage of labour is characterised by the rupture of the foetal membranes, the presence of water, and the eventual occurrence of birth. The final stage of labour is characterised by the continued contraction of the uterine muscles and the expulsion of the membranes (Smith, 2023). It is estimated that the incidence of difficult labour in mares is approximately 10%. As horses are seasonal polyestrous animals, it is imperative to adhere strictly to the vaccination schedule, and mating should be scheduled in accordance with the veterinarian's guidance. In mares where the optimal time for mating has been overlooked, there is a demonstrable decline in fertility, resulting in financial and moral losses in the context of horse breeding (MacMillan and Cockrem, 1986).

Infectious Agents Causing Abortions and Foal Mortality in Horses

The prevalence of equine abortions caused by infectious agents currently ranges from 18.7% to 53.1%. These infectious agents include bacteria, viruses, and pathogenic organisms such as fungi or parasites.

Bacteria

Bacterial infections have been identified as the primary cause of infectious abortions in mares. Moreover, it has been reported that such cases are more prevalent during the latter third of the gestation period. The most prevalent bacterial abortive and genital system agents observed in equines include.

Salmonella enterica subspecies *enterica* serovar abortus equi (*Salmonella abortus equi*), *Taylorella equigenitalis*, *Streptococcus equi* subsp. *zooepidemicus* (*Streptococcus zooepidemicus*), *Staphylococcus aureus, Escherichia coli, Klebsiella spp., Pseudomonas spp., Chlamydia abortus, Leptospira* and *Rhodococcus equi* (Yeni and Balevi, 2023; Yeni et al., 2024). *Streptococcus equi* subsp. *zooepidemicus* is the bacterium most frequently identified in cases of abortion. It is responsible for almost 28% of bacterial causes of abortion (Smith et al., 2003).

With the exception of *Leptospira* spp. and nocardioform infection, most bacterial placentitis in mares are the result of an ascending infection (Tibary and Pearson, 2015). This condition is characterised by early breast development, increased uteroplacental thickness at the level of the cervical star, and mucopurulent vaginal discharge. If left untreated, ascending placentitis can result in fetal death and expulsion (Leon et al., 2023). Bacterial placentitis generally leads to abortion during the sixth to ninth months of pregnancy (Laugier et al., 2011). Treatment of bacterial agents causing abortion includes tocolytic drugs to reduce increased uterine contractions, anti-inflammatory drugs to inhibit cytokine and prostaglandin production, and antimicrobial therapy to control bacterial growth. Antimicrobial therapy should be based on the results of antimicrobial susceptibility testing of bacteria isolated from vaginal discharge or cervical swabs (Tibary and Pearson, 2015).

Viruses

The most prevalent abortive agents reported worldwide are equine herpesvirus type 1 (EHV-1) and the rarer equine herpesvirus type 4 (EHV-4), in addition to equine arteritis virus (EAV), equine infectious anaemia virus and West Nile virus. (Laugier et al., 2011; Costa et al., 2022).

Members of the *Alphaherpesviridae* family, namely EHV-1 and EHV-4, have been associated with urinary tract infections and abortion in young horses. Although the lesions in abortions caused by EHV-1 and EHV-4 are similar, EHV-4 has been reported to cause abortions relatively more sporadically (Reed and Toribio, 2004). In cases of abortion caused by EHV-1 and EHV-4, the foetus exhibits signs of inflammation, including the presence of acidic and pleural fluid, as well as edematous and congested lungs. The liver is characterised by the presence of grey necrotic spots (Bryans et al., 1977; Ostlund, 1993). As indicated by studies conducted, the presence of EHV-1 has been documented in 15–26% of foetal losses (Laugier et al., 2011). EHV-1 can spread rapidly among horses and affect the entire population of pregnant mares (Damiani et al., 2014). A study conducted in Türkiye reported EHV-1 and EHV-4 seropositivity rates of 23.2% and 78%, respectively (Ataseven et al., 2010).

The equine arteritis virus (EAV), which belongs to the *Arteriviridae* family, has been demonstrated to be the causative agent of reproductive disorders and respiratory infections in equids (Timoney and McCollum, 1993). The pathophysiology of EAV-induced abortions in pregnant mares is characterised by panvasculitis, which results in oedema, bleeding and abortion (Del Piero, 2000). EAV infections have been observed to result in abortion in pregnant mares and have a deleterious effect on the genital system (Balasuriya, 2014; Damiani et al., 2014). In Türkiye, EAV seropositivity has been

reported as 6.5%-24.4% (Kırmızıgül et al., 2007; Gür et al., 2018). Equine infectious anemia (EIA) is a viral disease caused by the equine infectious anemia virus (EIAV), which belongs to the genus *Lentivirus*, family *Retroviridae* (Lupulovic et al., 2021). Infection is characterised by a persistent infection, which is typified by recurrent febrile episodes associated with viremia, fever, thrombocytopenia, and wasting symptoms (Lupulovic et al., 2021). Despite the global prevalence of the disease, numerous studies have demonstrated that enterprises within our nation are not affected by it (Akpınar et al., 2023). It has been reported that the virus can be transmitted to foals via vertical route and may cause abortions (Gregg and Polejaeva, 2009).

The West Nile virus (WNV) is a positive-sense, single-stranded RNA enveloped virus that belongs to the genus *Flavivirus* in the family *Flaviviridae* (Castillo-Olivares and Wood, 2004). The symptoms of the disease are most commonly characterised by the presence of encephalitis, ataxia, limb weakness, lying down and muscle fasciculation (Angenvoort et al., 2013). Transplacental transmission of WNV poses a risk of foaling in pregnant mares with severe neurologic WNV disease (Venter et al., 2011). There is no specific drug that is effective against viral diseases. However, good hygiene and management practices, together with the symptomatic treatment of infected horses, may help to prevent the spread of viral infections. Vaccines play an important role in preventing these infections (Bresgen, 2011). Current recommendations for the treatment of recumbent horses include providing supportive and nutritional care, rehydration, and frequent evacuation of the bladder and rectum to prevent colic. Reducing central nervous system (CNS) inflammation is also recommended (Laugier et al., 2011; Pusterla et al., 2022).

Fungal and Parasitic Infections

Several fungal agents can affected to horses however only some agents well described. The most common fungal agents seen in horses are *Aspergillus* spp., *Mucor* spp., *Candida* spp., *Histoplasma capsulatum* and *Cryptococcus* spp. Has been reported *Coccidioidomycosis* and *Histoplasma capsulatum* can lead abortion in horses (Giles et al., 1993; Laugier et al., 2011; Cafarchia et al., 2013).

Certain protozoan diseases have been observed to result in infertility and death in equines. Protozoans such as *Theileria equi, Babesia caballi, Neospora* spp. and *Toxoplasma gondii* have been identified as causative agents of various clinical symptoms, including abortion, icterus, anaemia, fever, neurological symptoms, liver and kidney failure (Erol et al., 2022). The present study was conducted for the purpose of investigating the prevalence of certain protozoa. The study revealed the prevalence rates of the protozoa *B. caballi, T. equi, T. gondii*, and *Neospora* spp. in horses to be 12.12%, 34.84%, 9.09%, and 10.6%, respectively. Furthermore, the molecular prevalence of the viral agents was found to be 3.03% for equine influenza virus and 6.06% for equine herpesvirus 5. The presence of the equine viral arteritis virus and other herpesviruses (types 1, 2 and 4) could not be detected in any of the samples examined (Baydar et al., 2023). Treatment for fungal and parasitic infections should use specific antifungal and antiparasitic drugs. For this purpose (Cafarchia et al., 2013). As drugs used to treat fungal diseases are expensive and not always effective, determining susceptibility to antifungal drugs is important (Voelter-Ratson et al., 2014). The first step in preventing parasitic infections in horses should be to reduce the transmission of parasites between animals. Although typical prevention programmes for these parasites are based on the use of antiprotozoal drugs, this can also be achieved through non-chemical means, such as frequently collecting pasture droppings or feeding grazing animals parasite-catching fungi (Lewis et al., 1999; Proudman and Matthews, 2000; Love, 2003).

Non-Infectious Agents Causing Abortions and Foal Mortality in Horses

Reproductive failure is the most significant cause of financial and moral losses in the field of horse breeding. Termination of pregnancy prior to 10 months of gestation is categorized as abortion, a process that poses significant challenges for equine enterprises. The etiology of miscarriage can be categorized into non-infectious and infectious causes. Non-infectious causes include multiples, poisoning, management disorders, umbilical cord torsion, prolonged transport, trauma, hormonal disorders, inadequate care and feeding. Early diagnosis and treatment of the problem are of paramount importance in order to prevent pregnancy loss (Li et al., 2024).

In the field of equine breeding, twins have been identified as a significant contributing factor to foal mortality. Depending on the lack of nutrition, this may result in termination of pregnancy in the last months of pregnancy or failure of the born foal to survive. In the case of one twin foal diagnosed during an early ultrasound examination, termination of the pregnancy is recommended. It is imperative that virgin mares, mares with foals, mares fed with foods of high nutritional value, and mares with a history of twin births are closely monitored (Alamaary and Ali, 2020; Peere et al., 2024).

Embryonic losses have been observed to be more prevalent in aged mares than in younger ones. The underlying cause of this phenomenon is attributed to the fact that the oviduct's environment, which is conducive to embryonic development, is not as conducive to the development of older mares. While fertility remains relatively unaffected by age, pregnancy loss is susceptible to the impact of age (Roach et al., 2021).

Hormonal disorders have been demonstrated to exert an influence on the process of pregnancy. The hormone progesterone, which is produced by the corpus luteum, is imperative for the continuation of pregnancy. Uterine cysts have been demonstrated to disrupt the functioning of the corpus luteum, thereby restricting progesterone production. The regular analysis of progesterone is therefore recommended to ensure the correct monitoring of the stages of pregnancy in mares. It is imperative to emphasize that close monitoring of hormone levels is paramount, particularly during the initial five months of pregnancy. Consequently, the analysis of progesterone, gonadotropin, and estrogen levels is imperative in the assessment of reproductive activities in mares (Hollinshead et al., 2022; Raghupathy and Szekeres-Bartho, 2022).

The pathological condition that occurs when the umbilical cord folds excessively is known as umbilical cord torsion. This condition can result in the obstruction of umbilical vessels, thereby impeding the infant's ability to feed. The length of the umbilical cord is influenced by several factors. The movements of the foetus and umbilical cord can be monitored by ultrasound examination (Li et al., 2024).

Mycotoxins, such as aflatoxins, are frequently identified as contaminants in animal foodstuffs. These mycotoxins have been demonstrated to induce reproductive and immune complications in equines. Diagnosis of mycotoxins is typically accomplished through the utilization of immunological analysis (Chiminelli et al., 2022; Xu et al., 2022).

Inadequate care and feeding, mechanical injuries, lack of veterinary care and poor farm management are among the factors that adversely affect pregnancy. Furthermore, foal deaths are frequently observed in horses subjected to extended travel. In mares exposed to stress factors, cortisol levels may increase and foal deaths may occur. To address these challenges, strategies have been developed to prevent foal losses and enhance reproductive performance in horse breeding. These

strategies involve the implementation of planned and programmed management procedures. The implementation of environmental modifications has been demonstrated to enhance equine welfare and to mitigate the occurrence of abortions. The implementation of a system in which a specialized veterinary surgeon oversees horse breeding can ensure the continuous monitoring of the mare, facilitating the early detection and rapid treatment of any issues that may arise (Li et al., 2024).

Testing and Diagnosis

Correct diagnosis of the underlying causes of abortions in horses facilitates treatment (Alamaary and Ali, 2020). In general, diagnostic tests for these disease agents include the following:

1. Sending the fetus and placenta to the diagnostic laboratory for examination
2. Physical examination
3. Blood and serological tests
4. Culture
5. Cytology and/or biopsy

Ways to Prevent Foal Deaths

There are many prevention and control methods to prevent pup mortality. In general, it is important to take these measures within the rules of preventive medicine. These should be determined as routine vaccination (equine herpes virus etc.), separation of pregnant mares from other horses and suspicious & sick horses (isolation), routine health checks, careful observation and developing a suitable diet under the guidance of an equine nutritionist (Ataseven et al., 2010; Bresgen, 2011).

CONCLUSION

Our study examines potential risk factors for pregnancy loss in horses and provides detailed guidance on prevention, diagnosis, treatment and management. The prevalence of equine abortions caused by infectious agents currently ranges from 18.7% to 53.1%. These infectious agents include bacteria, viruses, and pathogenic organisms such as fungi or parasites. Preventing infertility problems, primarily by adopting preventive medicine, is an essential component of managing litter loss. Strategies to prevent non-infectious and infectious pupping problems include appropriate nutritional recommendations, vaccination against infectious diseases and eradication methods. Adopting proper treatment and biosecurity strategies routinely will greatly facilitate the solution of problems.

Ethical Statement

This research article has not been published anywhere before.

Ethics Committee Approval

This study did not require ethics committee approval.

Author Contributions

Research Design (CRediT 1) Author 1 (%50) – Author 2 (%50)
Data Collection (CRediT 2) Author 1 (%00) – Author 2 (%50)
Research - Data analysis - Validation (CRediT 3-4-6-11) Author 1 (%25) – Author 2 (%25) – Author 3 (%25) – Author 4 (%25)
Writing the Article (CRediT 12-13) Author 1 (%25) – Author 2 (%25) – Author 3 (%25) – Author 4 (%25)
Revision and Improvement of the Text (CRediT 14) Author 1 (%25) – Author 2 (%25)

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Conflict of Interest

The authors declared that there is no conflict of interest.

Sustainable Development Goals (SDG)

3 Good Health and Well-Being

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