

A Review on African Horse Sickness

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Abstract: African horse sickness is an infectious but non contagious arthropod born viral disease affecting all species of equidae. It is an OIE listed disease and has been classified as a notifiable disease worldwide and it is endemic to sub-Saharan, central and east Africa. It is caused by a virus of the Reoviridae family, genus Orbivirus which is transmitted by haematophagous midges of the genus Culicoides. The disease exclusively affects members of the equidae family under natural conditions. Environmental factors, including topography, influence the distribution of midges within their overall range and therefore the disease has a geographical distribution. Four clinical presentations of the African horse sickness have been described, each associated with a specific pathogenesis and mortality ranging between 95% (Pulmonary form) to 0% (fever form). Gross findings in acute cases include severe hydrothorax and pulmonary edema and moderate ascites. Diagnosis may be made on the basis of typical clinical signs and lesions in association with the seasonal prevalence of competent vectors. Apart from supportive therapy there is no treatment for this disease. The disease was a tremendous economic concern in southern Africa when horses were important for transportation and as draft animals. The principles of control in enzootic areas are vaccination and reduction of exposure to biting insects, whereas in non-enzootic areas the aim is to prevent introduction of the disease and eradication if it is introduced. There is no evidence that humans can become infected with any field strains of viscerotropic AHSV, either through contact with naturally or experimentally infected animals or by virus manipulation in laboratories.

Key words: African horse sickness • Culicoides • Orbivirus

INTRODUCTION

Ethiopia has the largest equine population in Africa and 8th in the world. She possesses 2.75 million horses, 5.02 million donkeys and 0.63 million mules [1]. They are an estimated 80% of the world equine population, 90% million equine, are found in the developing world, including 97% of mules, 96% of donkeys and 60% of horses and the majority of these will be used for work [2]. Equines play an important role in the transport of farm product, fodder, fire wood, agricultural inputs and construction and waste materials [3]. Many factors can contribute to the poor performance of equines, among which viral diseases characterized by high morbidity and mortality rates are to be the first one and African horse sickness is one of the viral diseases [4].

African horse sickness (AHS) is a disease caused by the African horse sickness virus. The disease affects horses and European donkeys most severely; mules are

somewhat less affected and African donkeys and zebra are refractory to the devastating consequences of infection [5]. This virus is non-contagious, vector born Orbivirus that is transmitted primarily by Culicoid midges [6]. The disease has both a seasonal (late summer/autumn) and a cyclical incidence with major epizootics in Southern Africa during warm-phase events [7]. Mortality due to AHS is related to the species of equidae affected and to the strain or serotype of the virus. At least two field vectors are involved: *Culicoides imicola* and *Culicoides bolitinos* [8].

Additionally, some carnivores such as dogs can become infected via ingestion of contaminated meat. However, there has been no documented cases of transmission AHSV (African horse sickness virus) in carnivorous in the wild and it is considered that they are a “dead-end-host”, rather than reservoir of infection [9]. Owing to the potential of this virus to cause wide spread death and debilitating disease in naïve equid populations,

it is listed as a notifiable equine disease by the World Organization for Animal Health (OIE), which makes outbreaks of the disease compulsorily notifiable to the OIE. Such occurrences can result in serious consequences for international trade of animals and animal products for the affected country [10]. Currently available vaccines are polyvalent or monovalent preparations containing attenuated strains of the virus [11]. It is currently predicted that a wide spread outbreak of this disease would have a devastating effect on the horse industry of any country affected [12]. Therefore, the objectives of this seminar paper are: to review the etiology, host and environmental risk factors of AHS, to review on the economic importance of the disease and to describe methods to prevent and control AHS.

African Horse Sickness: An African horse sickness is a highly fatal insect born viral disease of horses, mules and generally sub-clinical diseases in other equidae. It is caused by a virus of the Reoviridae family, of the genus Orbivirus. The virus is inactivated by heating at 50°C for 3 hours or 60 °C for 15 minutes, is stable at 4°C and survives 37 days at 37°C. It remains viable at PH of 6-12, but it is inactivated by acid and at 48 hours by 0.1% formalin or phenol and sodium hypochlorite [12]. The principal vector of AHSV worldwide is *Culicoides imicola*, which is a common species distributed throughout Africa, much of south East Asia and southern Europe [13].

The clinical signs and lesions result from selective increased of vascular permeability and are characterized by an impairment of the respiratory and circulatory system. The hosts in order of decreasing severity of AHS are horses, mules, donkeys and zebras. Horses and mules have the highest mortality; and African donkeys have subclinical infection [11]. There are nine serotypes of AHSV distributed worldwide which are differentiated by neutralization and plaque inhibition test [14, 15]. AHS is one of the most lethal of horse disease and has been allocated World Organization for Animal Health (OIE) list A status [16]).

Etiology: African horse sickness is caused by an Orbivirus, 55-70nm in diameter, of the family Reoviridae. A genus of double stranded RNA virus that has genome composed of 10 segments with the core RNA particles having characteristic ring shaped capsomers and that include the causative agent of AHS. There are nine immunologically distinct serotypes. The virus is inactivated at a PH of less than 6 or greater or equal to 12 or by formalin,

acetyl ethylene amine derivatives, or radiation [17]. This infection has a seasonal incidence, is a highly fatal, acute or sub-acute disease of equidae characterized by clinical signs due to respiratory and circulatory impairment [12]. AHS is associated with a viscerotropic Orbivirus of which nine antigenic strains (serotypes) are recognized. The stereotypic differences are due to variations in the capsid proteins, predominantly VP2 and to a lesser extent VP5 ([11].

Epidemiology

Geographic Distribution and Occurrence: AHS used to be confined to the African continent until World War II when serious outbreaks occurred in the Middle East. The disease comes in to existence again in 1959 when it spread to Iran and Pakistan [18]. The disease is endemic in tropical and sub-tropical areas of Africa South of the Sahara, occupying a broad band extending from Senegal in the west to Ethiopia and Somalia in the east and extending as far South as Southern Africa [12].

Affected Species and Host Range: The disease exclusively affects members of the equidae family under natural conditions. Horses are highly susceptible, mules and donkeys are less susceptible. Some authors have described clinical forms of in experimentally infected dogs. Rare human infections (with clinical signs of encephalitis and Chorioretinitis) which occurred in vaccine plant workers via inhalation of lyophilized vaccine virus have been reported [12]. AHS is well adapted to zebra, which is considered the natural host and also the main reservoir of the virus in Africa. AHSV host range comprises horses and other equines, elephants, camels, dogs and wild reservoirs. Horses, donkeys, their hybrids and zebras are the only species playing a significant role in the epidemiology of AHS [19].

Transmission and Source of Infection: AHS transmitted indirectly to equidae by the way of haematophagous arthropods. The principal vector of AHSV worldwide is *Culicoides imicola*, which is a common species distributed throughout Africa, much of South East Asia and Southern Europe [13]. Direct transmission has been described in dogs contaminated by the oral route after ingestion of infected meat [12]. Transmission of the virus to areas where it does not usually exist occurs both by movement of infected animals. Such as zebras and horses and by transportation of midges by wind. Mechanical transmission of the virus on contaminated surgical instruments and needles should be considered a possibility [11].

No experimental and or epidemiological data suggests a transovarian transmission mechanism [12]. The virus is present in all body fluids and tissues of affected animals from the onset of fever until recovery. It is moderately resistant to external environmental influences such as drying and heating and it can survive in putrid blood for two years. Although clinically affected equidae are the major source of virus during an outbreak the current view is that in enzootic areas there must be a silent, non – equine reservoir host which perpetuates the virus between seasons when no insects are present [18].

Risk Factors

Environmental Risk Factor: The incidence of the disease is often seasonal because of the seasonal variations in the number of Culicoides species present and possibly other weather related factors such as host (zebra) behavior. Local factors, including topography, influence the distribution of midges within their overall range and therefore the disease has a geographical distribution. The areas most affected are low lying and swampy [18].

Animal Risk Factor: Natural infection occurs in equidae, the most severe disease occurring in horses, with mules, donkeys and zebras showing lesser degrees of susceptibility in that order. After natural infection or vaccination immunity to that strain, but not to heterologous strains, is solid [11].

Mortality and Morbidity: AHS types 1-8 are considered to be highly pathogenic for horses and infection results in high mortality (90-95%). The type 9 AHS virus appears to be less pathogenic and infection may result in lower mortality (70%). Mortality in mules may reach 50% while in donkeys it is around 10% [20]. AHS takes on four different clinical forms in infected equids: sub clinical (horse sickness fever), sub-acute or cardiac, acute respiratory or pulmonary and mixed. Morbidity and mortality are dependent on the species of animal, previous immunity acquired and the form of the disease [16]. (Table 1; Table 2). Horses are more susceptible to the severe (pulmonary and mixed) forms of disease than other equids. Likewise, horses experience higher rates of mortality (50-95%) than mules (about 50%), European and Asian donkeys (5-10%), or African donkeys and zebras (near 0%) [21]. (Table 1).

AHS takes on four different clinical forms in infected equids. The sub acute or cardiac form exhibits mortality rates of 50% and higher, the mixed form has mortality rates at 70-80% or higher and the pulmonary form is almost

Table 1: Mortality / morbidity based on species

Species	Mortality
Horses	50-95%
Mules	50%
European and Asian donkeys	5-10%
African donkeys zebras	Rare

Source: AHCF [21]

Table 2: Mortality/ morbidity based on form disease

Pulmonary form	Up to 95%
Cardiac form	50% or more
Mixed form	70-80%
Horse sickness fever	typically recover

Source: Vannierkerk *et al* [16]

Table 1: Incubation period of the four disease form of AHS

Disease form	Incubation period
Per acute (pulmonary)	3-5 days
Sub-acute (edematous or cardiac)	7-14days
Acute (mixed) form	5-7 days
Horse sickness fever	5-14 days

Source: OIE [4]

always fatal. Horse sickness fever is rarely, if ever, fatal. This form is often the result of infection with less virulent strains of AHSV or the existence of previous immunity [16] (Table 2).

Pathogenesis: Despite the distinct differences in the clinical severity of AHS infection in different equidae, the typical pattern of pathogenesis is similar [22]. Zebras are the natural host and reservoir; transmission is via biting arthropods and midges (Culicoides species) are the most important vector. Infection results in damages to the circulatory and respiratory systems resulting in serious effusion and hemorrhage in various organs and tissues. Horses is bitten by an infected midge>initial viral replication in regional lymph nodes >primary viremia > infection of target organs (endothelial cells and mononuclear cells of the lung, spleen, and lymphoid tissue) secondary viremia > virally induced endothelial cell damage and activation of infected macrophages with subsequent cytokine production (IL-1, TNFa) > increased vascular permeability > edema. Distinct serotypes demonstrate individual tropisms for pulmonary and cardiac endothelial cells and account for the four frequently overlapping clinical forms of AHS: pulmonary form, cardiac form, cardio pulmonary (mixed) form, horse sickness fever (mild) form [23].

Clinical Sign and Incubation Period: In experimental infections, the incubation period can range from 2 to 21 days. In natural infections, the incubation period appears to be approximately 5-7 days (Table 3) [4].



Fig. 1: Frothy nasal discharge. Source: Lefevre *et al.* [12].

Four clinical forms of the disease occur, an acute or pulmonary form, a cardiac or sub-acute form, a mixed form and a mild form known as 'horse sickness fever.' An intermittent fever of 40 - 41°C is characteristics of all forms [11].

Pulmonary or per Acute Form: Pulmonary or per acute form is per acute and may develop so rapidly that an animal can be die without previous indication of illness. Usually there will be marked depression and fever (39-41°C) followed by the onset of respiratory distress and severe dyspnea. Coughing spasms may occur, the head and neck are extended and severe sweating develops [11].

There may be periods of recumbency and, terminally, quantities of frothy fluid may be discharged from the nostrils. Anorexia is not a feature. The prognosis for horses suffering from this form of AHS is extremely serious and mortality rates commonly exceed 95% [12].

Cardiac or Sub-Acute Form: This can be more protracted and somewhat milder than the pulmonary form. Fever lasts for 3-6 days and, as the temperature falls, characteristic edema appears, involving the supra orbital fossae and eye lids, sometimes with accompanying congestion and hemorrhage in the conjunctiva. Sub cutaneous edema may also track down the neck toward the chest. Mortality rate for such cases may be as high as 50%, death occurs within 4-8 days of onset of fever [24].

Mixed Form: It is evident as an initial sub-acute cardiac form that suddenly develops acute pulmonary signs. This is not common in field out breaks [11]. This form is the most frequently observed presentation in horses [19].

Horse Sickness Fever: The mildest form of the disease is characterized by a 10 day incubation period, with high temperature (40.5°C for 1 to 3 days) but 100%

recovery [25]. The disease occurs in horses with some immunity or infection by serotypes of low virulence. This is the only form of the disease that occurs in zebras [11].

Diagnosis

Laboratory Diagnosis: Infectious virus, virus nucleic acid, viral antigens or specific anti bodies [19]. African horse sickness virus may be isolated from spleen, lungs, heart or from the blood of a viraemic animal (blood collected in EDTA stored at 4°C.) [12]. Serological diagnosis of the acute disease may be difficult because many horses die before they produce a detectable antibody response. In horses that survive for at least 10 day, AGID, IFA, VN and ELISA tests are all effective in detecting antibody to the virus [11]. The gold standard for the identification of AHS serotypes present in suspicious samples is virus neutralization. With this technique, serotype specific antibodies are detected [19].

Differential Diagnosis: The clinical signs of AHS, particularly when not fully developed, may be confused, with other infections, notably equine encephalosis and equine viral arteritis. In countries where piroplasmiasis occurs, the early stage of this disease, before blood parasites can be demonstrated and anemia develops, may be confused with AHS. The necropsy lesions of AHS can be confused with those found in cases purpura hemorrhagica. In the latter condition the hemorrhages and edema seem to be more severe and widely distributed than AHS and usually involve the limbs and lower abdomen. The highly sporadic occurrence of purpura also aids in differentiation [26].

Post Mortem Finding: Gross findings in acute cases include severe hydrothorax and pulmonary edema and moderate ascites. The liver is acutely congested and there is edema of the bowel wall [18]. It is possible to find 3-5 liter of fluid in the chest cavity [27]. In cases of cardiac horse sickness there is marked hydro pericardium, endocardial hemorrhage, myocardial degeneration and anasarca, especially of the supra orbital fossa [18]. At necropsy, the lungs are distended and heavy and frothy fluid may fill the trachea, bronchi and bronchioles. This frothy exudate may ooze from the nostrils [24].

Treatment: No treatment has been shown to have any effect on the course of the disease but careful nursing and asymptomatic treatments are not without value [28].

Prevention and Control

Endemic Areas: Vaccination: vaccination may be considered once the diagnosis has been confirmed. A killed vaccine has been produced against serotype 4 but is no longer available no killed or sub unit vaccines are currently manufactured commercially [4]. Onderstepoort biological products (OBP) African horse sickness vaccines currently used in southern Africa are supplied in two polyvalent vials containing AHSV types 1, 3 and 4 and 2, 6, 7 and 8, respectively. African horse sickness virus 5 is currently not included, because of reports of severe reactions and deaths in some vaccinated animals. African horse sickness virus 9 is not included because type 6 strongly cross-protective and type 9 is rarely present in southern Africa and is considered of low virulence [12]. Vector control: includes the use of repellents and insecticides, the elimination of insect breeding areas and housing of animals in insect proof buildings at dawn and at dusk when insect activity is maximum [29].

Non Endemic Areas: If an outbreak of AHS in a country that has been free of it, much more stringent control measures must be taken which involve quarantine, slaughtering of viraemic animals, vaccination, stabling and controlling culicoides [30]. Appropriate control measures to prevent movement of animals at risk of being infected should be instituted and include complication of a vaccination protocol effective against all important serotype at least 42-60 days before introduction of the horse, positive identification of all horses by pass port documenting, vaccination status and veterinary certificate confirming health and issues no more than 48 hours before introduction [31].

Importance of the Disease

Economic Importance: The disease was tremendous economic concern in southern Africa when horses were important for transportation and as draft animals. The disease is currently an economic concern because of the costs associated with preventive measures in enzootic areas, monitoring for introduction of disease in neighboring unaffected areas and restrictions on importation of horses from countries in which the disease is enzootic. The high case fatality rate and morbidity of the disease in outbreaks is another source of loss [11]. Outbreaks of AHS on the Iberian peninsula have resulted in losses of hundreds to thousands of animals and the expenditure of public funds for programs of diagnosis and control. Additional losses have resulted from cancellation

of participation in international events such as equestrian competitions and activities that produce tourism revenue [32].

Public Health Importance: There is no evidence that humans can become infected with any field strains of viscerotropic AHSV, either through contact with naturally or experimentally infected animals or by virus manipulation in laboratories. However, a neurotropic vaccine strain, adapted to mice, can cause encephalitis and retinitis in humans following trans nasal infection has been described very rarely, AHS can be zoonotic. The first evidence of this came when laboratory workers, exposed to the virus during vaccine manufacture developed encephalitis, chorioretinitis and disseminated intra vascular coagulation [33, 34].

The Status of the Disease in Ethiopia: Ethiopia is facing serious and repeated outbreaks of AHS in different regions. The virus could have been introduced in to Ethiopian equines by wind-borne infected midges (Culicoides) from endemic regions of Africa. The vectors were known to be wind-driven and migrate, carrying the virus over 700 Km [29]. The virus neutralization test indicated that two serotypes of AHS were involved in the outbreak occurred in 2002-2003 in Southern Ethiopia (Awassa, Hossana, Wondogenet and Hagerselam), western Ethiopia (Jimma, Bedelle, Nekemte, Horroguduru and Chaliya) and central Ethiopia (Debrezeit, Meki, Zeway, Filtimo and Bekejo), serotypes 9 and 6 were isolated from blood, spleen and lymph nodes collected from 12 sick and died animals. The outbreak affected horses vaccinated with monovalent vaccines containing type 9 of AHSV (AHS vaccine, National veterinary Institute, Debrezeit, Ethiopia). It is well documented that in spite of its wide distribution, serotype 9 of AHSV has a lower virulence than other serotypes, killing few horses in enzootic areas [35]. The identification of serotype 6 represents the first report in Ethiopia. Of the nine serotypes identified, type 9 is predominantly found throughout the African continent and it is the only serotype previously identified in Ethiopia [36].

CONCLUSION

African horse sickness is a serious, often fatal insect-borne viral disease of equidae, endemic to Africa. It is spread by arthropod vectors (primarily Culicoides species-biting midges), with mortality in horses as high as 95%. As a consequence its severity in horses and its

proven capacity for sudden and rapid expansion, AHS is listed by the OIE as a notifiable disease. The disease is currently an economic concern because of the costs associated with preventive measures in enzootic areas, monitoring for introduction of disease in neighboring unaffected areas and restrictions on importation of horses from countries in which the disease is enzootic. The principle of control in enzootic areas are vaccination and reduction of exposure of horses to biting insects, where as in non-enzootic areas the aim is to prevent introduction of the disease and eradication if it is introduced and the establishment of a protection zone of at least 100 km radius around infected premises. Based on the above conclusion the following recommendations are forwarded: When the disease is confirmed there must be a total ban on the movement of equidae. Horse owners should be advised to stable their horses from early evening until morning when the Culicoides are most active and to spray horses and stables with appropriate insect repellents and insecticides. There is a need of deeper understanding of the epidemiology of African horse sickness by an integrated approach of serotyping and identification of the culicoides vectors as well as other potential vectors.

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