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An Outbreak of Strangles in Arabian Horses in Saudi Arabia: Epidemiology, Clinical Signs and Treatment Outcomes

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ABSTRACT

This study was carried out to investigate an outbreak of strangles in horses at the Qassim Region, Central Saudi Arabia. From 29 horses included in this study, the disease was observed in 13, five of them were died: representing a morbidity rate of 44.8% and a mortality rate of 17.24%. The morbidity and mortality rates significantly (P≤0.05) differed among different age groups. In contrast, the case fatality rate was not significantly different among different ages. Gender has no significant effect on disease occurrence. Clinically, signs observed in infected horses were high fever, anorexia, soft non-productive cough, muco-purulent bilateral nasal discharge, enlargement and abscessation of submandibular lymph nodes. Metastatic infection, including abdominal abscessation, was observed in 5 of the infected cases where signs of acute abdominal pain were recorded. *Streptococcus equi* subspecies *equi* was the only organism isolated from the lesions. Significant increases in the total white blood cells and neutrophils were detected in the diseased horses compared to healthy ones. Penicillin therapy, surgical intervention of the ripened sub-mandibular abscesses, isolation of healthy horses away from infected ones and thorough disinfection of the contaminated environment were the control measures that were applied to manage this outbreak. Treatment was very effective in the typical form of the disease whereas it had no value in the bastard form. Finally, it can be concluded that strangles in horses in the Qassim Region represents a great risk due to the high case fatality rate, and therefore using a protective vaccine is essential.

Key words: Strangles, Epidemiology, *Streptococcus equi*, Control.

INTRODUCTION

Strangles is an acute and highly contagious bacterial disease affecting the respiratory system of equines, caused by *Streptococcus equi* subspecies *equi* (*S. equi*), a β-hemolytic, Lancefield's group C and mainly transmitted by direct contact with an infected horse or indirect contact with contaminated equipment (Lindah et al. 2011; Gharieb et al. 2019). The disease is endemic throughout the world causing considerable welfare and economic cost to the global horse industry (Robinson et al. 2018, 2020; Cohen et al. 2020). Equines can serve as carriers or reservoirs, therefore, are important for the maintenance of the bacteria between epizootics, making the control and prevention of the disease more difficult (Duran and Goehring 2021).

The disease has also been described in early veterinary science literature. It was first documented by Jordanus Ruffus in 1251. The name strangles is due to the enlarged lymph nodes that made affected horses suffocate by obstructed airways (Sweeney et al. 2005; Liu et al. 2019).

Clinically, strangles is characterized by inflammation of the upper respiratory tract and abscessation in the adjacent lymph nodes. The infection starts in the pharyngeal and nasal passage resulting in the occurrence of pharyngitis and rhinitis (Boyle et al. 2018). Spread of the infection to the internal organs results in abscessation in the kidneys, brain, liver, spleen, tendon sheaths and joints. Strangles affects horses of different ages, but horses less than 5 years are particularly affected. Inhalation of infected droplets is the main route of infection followed by ingestion of contaminated foods. Complication as purpura hemorrhagica may happen as a result of the development of sensitivity to streptococcal protein (Noormohamad et al. 1992; Boyle et al. 2018; Ikhuoso et al. 2020). The morbidity rate

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of the disease may reach up to 100%, while the case fatality rate may not exceed 10% due to dissemination of the pus to the internal organs (Chanter et al. 2000).

Many predisposing risk factors such as overcrowding, mixing horses from different sources, breeding season, exposure to bad weather, concomitant disease, nutritional deficiency, and parasitic infestations are associated with strangles outbreaks (Oikawa et al. 1995; Moraes et al. 2009). Strangles is a common disease in Saudi Arabia where there is no vaccine available at present. This study describes an outbreak of strangles in Qassim Region, with especial reference to epidemiology, clinical signs, hematology and control measures applied during this outbreak.

MATERIALS AND METHODS

Ethical Approval

Ethical approval for this study was obtained from Animal Ethical Committee, Deanship for Scientific Research, Qassim University, Saudi Arabia.

Animals

Based on clinical signs suggestive of strangles, this study was conducted to investigate and manage an outbreak occurred in a private horse stable consisted of 29 Arabian horses of different ages and sexes in the Qassim Region, Central Saudi Arabia in 2019. During this outbreak, the number of horses showing clinical signs of strangles was 13, 5 of them had died.

Epidemiological Investigation

Morbidity, mortality, and case fatality rates were estimated epidemiologically according to Martin et al. (1987). All horses in the infected stable were included in this study.

Clinical Examination

All horses under study were subjected to complete clinical examination, including temperature, pulse and respiratory rates, and examination of the mucous membranes according to the method described by Rosenberger (1979).

Hematological Examination

Two blood samples were collected via jugular vein puncture from the infected horses (n=10) as well as from the apparently healthy ones (n=10) in tubes containing ethylene diamine tetra acetic acid (EDTA) as an anticoagulant. Counts of white blood cell (WBC), neutrophil, lymphocyte, monocyte, eosinophil, basophil, and erythrocyte (EC), packed cell volume (PCV), and hemoglobin (Hb) concentration were estimated using VetScan HM6, ABAXIS. These samples were taken before administration of any medications.

Postmortem Examination

During the postmortem examination, any gross abnormalities in the internal cavities and organs were recorded. Postmortem lesions were determined according to guidelines mentioned by FAO (2007).

Bacteriological Examination

Nasal swabs and pus samples were taken aseptically from infected horses and used for isolation of the causative agent. The samples were first enriched in brain heart infusion broth (HiMedia Laboratories, Mumbai, India) and then sub-cultured on 5% sheep blood agar (Oxoid, Ltd, Basingstoke, UK). Inoculated media were incubated aerobically at 37^{o}C for 48 hours (Forbes et al. 2007). Gram-stained smears were prepared directly from samples and from broth and solid cultures and examined for presence of gram-positive cocci in short or long chains. Colony characteristics and catalase test result were recorded (Quinn et al. 2007). Identification of the obtained colonies was confirmed by VITEK 2 GP card (bioMérieux, Marcy L'E`toile, France).

Control Measures

Control of the outbreak was done through several steps including treatment of infected animals using Flunixin meglumin (Finadyne, MSD Animal Health) and penicillin-streptomycin (Pen & Strep, NorBrook Co). Flunixin meglumin was administered by intravenous injection at a dose rate of 1mL per 45kg bodyweight (BW) (1.1mg flunixin/kg) once daily for up to 5 days according to clinical response. Penicillin-streptomycin was administered by deep intramuscular once daily for 7 consecutive days at doses of 1mL/25kg BW (8mg procaine penicillin and 10mg dihydro-streptomycin sulphate/kg BW). Surgical intervention was done for the ripened abscesses plus irrigation using iodine in a separate place away from the farm, in addition to hygienic disposal of pus. Disinfection of the farm and equipment was done in adjunct with animal treatment. In contact healthy horses were isolated in a separate stable and injected with penicillin-streptomycin for five days. Moreover, avoiding contact between healthy and infected horses and overcrowding at water sources were considered to prevent the spread of the disease (Sweeney et al. 2005; Firew and Pal 2015).

Statistical Analysis

The obtained data was analyzed by chi-square and t-tests using the SPSS for Windows (Version 15.0, USA) statistical software program, and probability (P-values) of less than 0.05 was considered significant.

RESULTS

Out of the examined 29 horses in this study, 13 horses showed typical signs of strangles representing a morbidity rate of 44.82%. Out of these 13 horses, 5 were died representing a mortality rate of 17.24% and case fatality rate of 38.46% (Table 1). The morbidity rate was higher in young horses less than 5 years than those over 5 years. The morbidity and mortality rates in young horses were 72.72% and 36.36% compared to 27.27% and 5.55% in animals over 5 years. On the contrary, the case fatality rate was higher in young horses (50%, 4/8) compared to adult ones (20%, 1/5). Concerning sex predisposition, out of the examined 24 female and 5 male horses, 12 female and 1 male horse manifested the disease representing an infection rate of 50 and 20%, respectively (Table 2).

Clinically, in this outbreak the infected horses showed two forms of the disease (typical and bastard). Signs observed were in the form of high fever, depression, anorexia, soft non-productive cough, muco-purulent bilateral nasal discharge, enlargement and abscessation of submandibular lymph nodes (Fig. 1). Blood examination

Table 1: Morbidity, mortality and case fatality rates during the strangles outbreak

Age	Total Examined	Diseased	Dead	Morbidity %	Mortality %	Case fatality rate (%)
Under 5 years	11	8	4	72.72*	36.36*	50.00
Over 5 years	18	5	1	27.77	5.55	20.00
Total	29	13	5	44.82	17.24	38.46

*Significant at P<0.05 in a column.

Table 2: Prevalence of strangles in relation to sex in horses

Sex	Total camels examined	No. infected camels	Prevalence (%)
Females	24	12	50
Males	5	1	20
Total	29	13	44.2

Table 3: Hemograms in healthy and horses infected with strangles (mean ± SD)

Variable	Healthy horses (n=10)	Infected horses (n=10)
RBCs (10^6/µl)	9.28±1.22	8.94±1.13
Hb (g/dl)	13.71±2.12	13.54±1.53
PCV (%)	37.93±6.06	38.60±6.22
WBCs (10^3/µl)	7.92±2.66	11.07±3.53*
Neutrophils (10^3/µl)	5.55±2.15	8.29±2.95*
Lymphocytes (10^3/µl)	2.06±0.74	2.00±0.77
Monocytes (10^3/µl)	0.35±0.33	0.39±0.32
Eosinophils (10^3/µl)	0.17±0.10	0.18±0.10
Platelets (10^9/l)	255.20±109.06	268.40±183.63

RBC, red blood cells; WBC, white blood cells; Hb, hemoglobin concentration; PCV, packed cell volume. *Significant at P<0.05 in a row.

for infected animals revealed an increase in the white blood counts because of increase in the number of neutrophils (Table 3).

Metastatic infection including abdominal abscessation was observed in some of the infected cases. Two infected horses were died after severe colic for 12 hours. Necropsy findings revealed perforated mesenteric abscess that had led to severe peritonitis, peritoneal effusions, and intestinal adhesions. Postmortem lesions for one dead horse revealed perforated mesenteric abscess that had led to severe peritonitis, peritoneal effusions, and intestinal adhesions (Fig. 2).

Gram-stained smears revealed Gram-positive cocci arranged in short chains from the solid medium and long chains from the liquid medium and directly from the pus samples (Fig. 3a and b). On blood agar, beta-hemolytic small, circular, translucent, glistening, and mucoid colonies were observed, which were catalase-negative. Microscopic and colony characteristics were identical and consistent with *Streptococcus equi*. Isolates were confirmed by VITEK 2 as *Streptococcus equi* subspecies *equi*.

Results of the control measures that were applied to control this outbreak showed that the used treatment regimen was very effective in the typical form of the disease (8 cases were recovered) whereas it had no value in the bastard form (5 cases had died). Moreover, the applied control measures decreased the spread of the infection to other horses.

DISCUSSION

Strangles is considered as one of the most common bacterial disease in many countries. Epidemiologically, the disease is characterized by high morbidity and low mortality, resulting in great economic losses due to the expense of treatment, in addition to the restriction of horse movement (Islam et al. 2014; Boyle et al. 2018; Robinson et al. 2020; Duran and Goehring 2021). In the present outbreak, the morbidity rate among horses was 44.82%, mortality rate was 17.24% and the case fatality rate was 38.46%. Ford and Lokai (1980) recorded that the mortality rate of a typical form of strangles cannot exceed 2%, while it can reach 62% in case of the bastard form.

Strangles is a highly infectious upper respiratory disease affecting horses of all ages, but most commonly in horses less than five years of age, especially in weanling foals or yearlings (Khoo et al. 2011; Tartor et al. 2020). The morbidity and mortality rates in this outbreak were significantly higher (P≤0.05) in young horses less than 5 years than those over 5 years. The morbidity and mortality rates in young horses were 72.72 and 36.36% compared to 27.27 and 5.55% in horses over 5 years. On the contrary, the case fatality rate was not significantly higher in young horses compared to adult ones. Similar observations were recorded previously by Manzoor et al. (2008) and Khoo et al. (2011). This may be attributed to the previous exposure of the adults to infection compared to the highly susceptible young horses (Boyle et al. 2018; Duran and Goehring 2021). Taylor and Wilson (2006) and Ijaz et al. (2012) mentioned that the disease was typically affected horses of all ages, but yearlings were mostly showed severe clinical signs.

Concerning sex predisposition, the morbidity rate did not differ significantly between male and female horses. Similar observation was recorded by Al-Gharban (2017), who observed that the prevalence of strangles among female horses was not significantly higher compared to males. This may be because of exposure of the male and female to the same risk.

Both typical and bastard forms of strangles were observed in this outbreak. Signs observed in the typical form were in the form of fever, depression, anorexia, respiratory dysfunction, in addition to enlargement and abscessation of submandibular lymph nodes, while signs of severe colic and deaths were observed in case of bastard form. Similar observations were recorded previously by Noormohamad et al. (1992), Boyle et al. (2018) and Ikhuoso et al. (2020).

According to Sweeney et al. (2005), the clinical signs of the bastard form of strangles differ according to the organ affected where aspiration of the purulent nasal discharges or hematogenous or lymphatic spread to the lung results in pneumonia, while abscessation of the mesentery, kidney, liver and spleen results in clinical signs of peritonitis and colic, while metastasis to the brain results in nervous manifestation.

Hematological findings for the healthy and strangles infected horses revealed significant increase in the white blood counts because of increase in the number of neutrophils in infected horses compared to healthy ones.

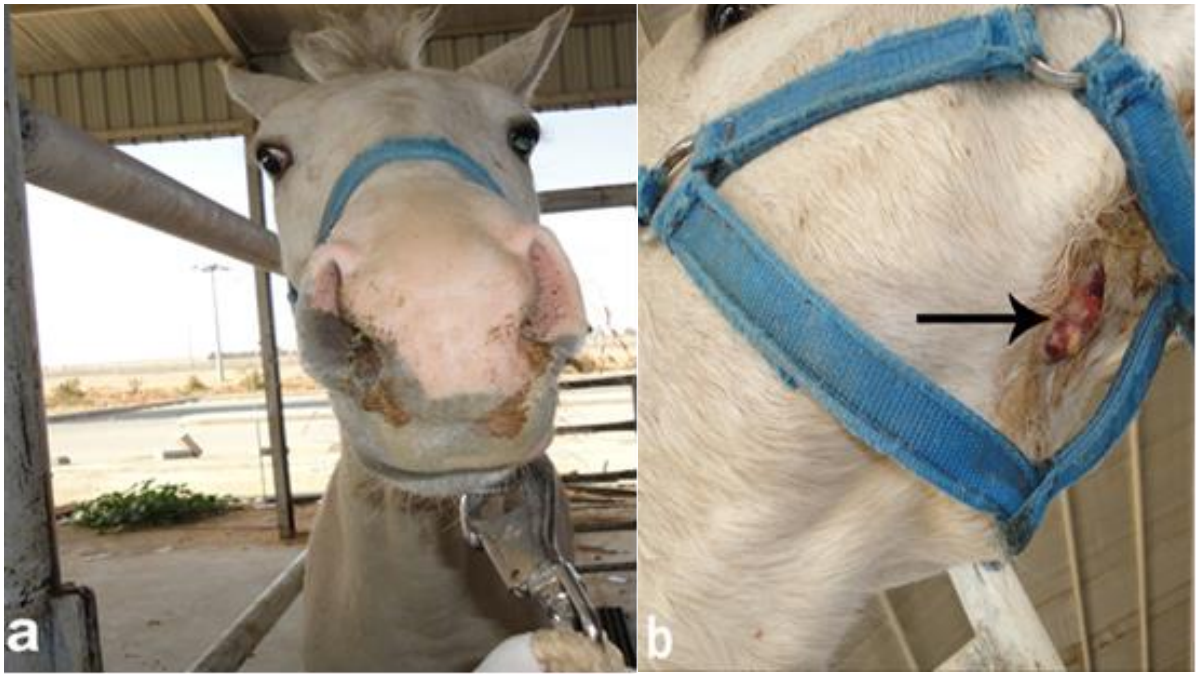

Fig. 1: Strangles-infected horse showing a) purulent nasal discharges and b) abscess in the submandibular lymph nodes.

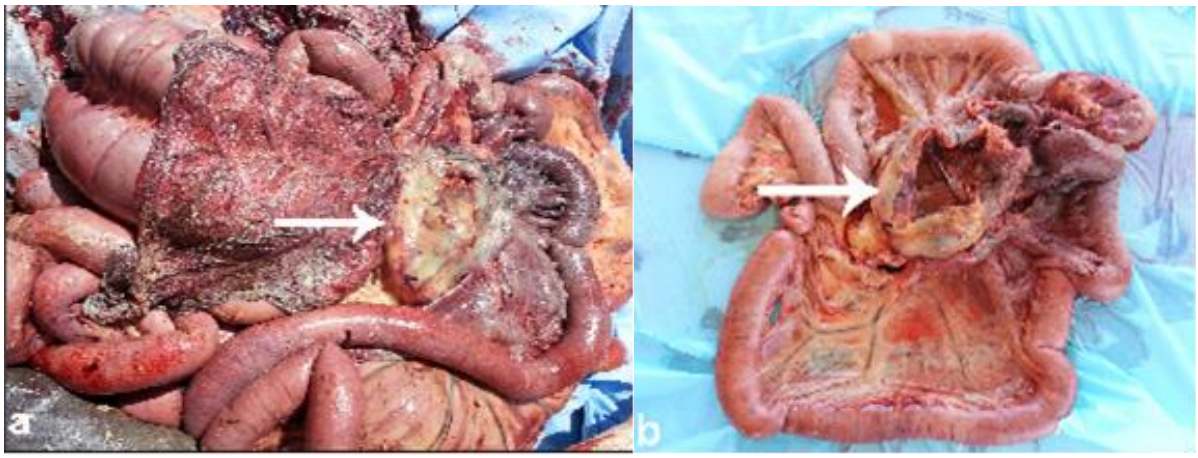

Fig. 2: Post-mortem finding in a horse with bastard form of strangles showing a) perforated mesenteric abscess and b) close-up view of the abscess.

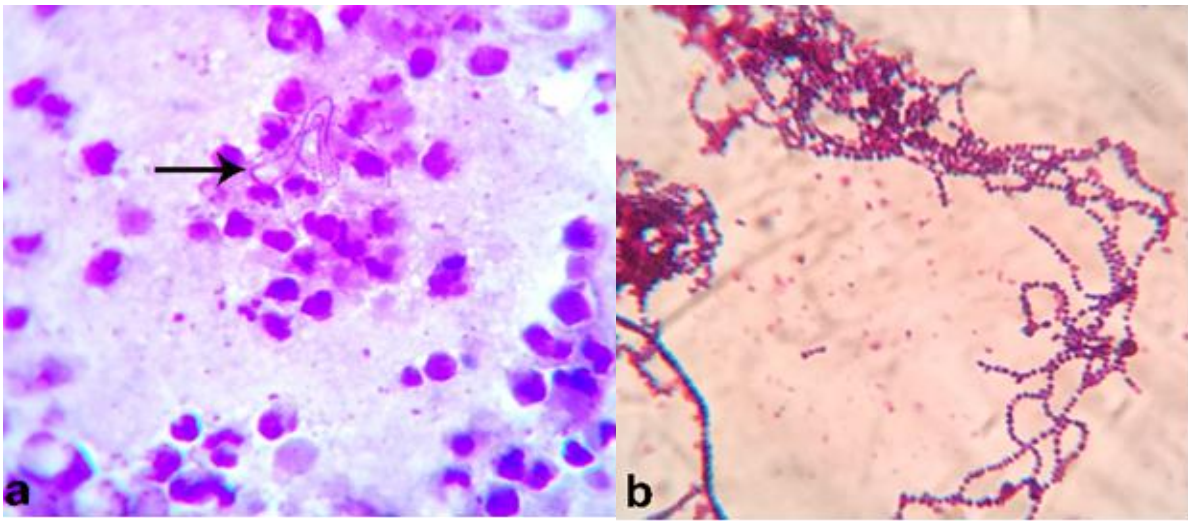

Fig. 3: Gram-stained smears showing Gram-positive cocci arranged in long chains (a) made directly from a pus sample, and (b) after enrichment in brain heart infusion broth medium.

Similar findings were recorded previously by Timoney (1993) and Ijaz et al. (2011), who observed leukocytosis and a high-segmented neutrophil count in strangles infected equines.

After the occurrence of strangles outbreaks, *Streptococcus equi* persisted in clinically normal silent carriers for months to years (Pringle et al. 2019). So, treatment of infected horses must be done effectively to avoid development of these carriers. During this outbreak infected animals were treated using penicillin-streptomycin. Treatment was effective in the typical form of the disease whereas it had no value in the bastard form. Similar observation was recorded previously by Noormohamad et al. (1992), who reported that all strangles infected horses were responded effectively to the treatment with intramuscular injection of penicillin-streptomycin. Also, Manzoor et al. (2008) found that all of S*treptococcus equi* strains isolated from cases of strangles showed maximum sensitivity to penicillin and cefotoxime.

Other precautions were applied to minimize disease spread or environmental contamination in the form of hygienic disposal of the discharged pus, disinfection of the farm and equipment, avoiding contact between healthy and infected horses by isolation of healthy ones in a separate stable and preventing overcrowding at common water sources (Sweeney et al. 2005; Firew and Pal 2015; Duran and Goehring 2021). These control measures were found effective in decreasing the spread of the infection to other horses.

Conclusion

It is concluded that, strangles in horses in the Qassim Region, Saudi Arabia represents a great risk that can threat horse industry due to the high case fatality rate and therefore using a protective vaccine is essential in this region.

Authors' Contribution

All authors contributed equally to this work.

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