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Prevalence and drug efficacy against secondary bacterial infections in FMD-affected cattle in Harinakunda

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ABSTRACT

This field study aimed to assess the effectiveness of various drugs in combating Foot and Mouth Disease (FMD) among cattle while detecting the disease outbreak strategy and complications of FMD prevailing in Harinakunda Upazila of Jhenaidah district. This study was conducted at different areas (8 unions and 1 Paurashava) under the Upazila Livestock Office (ULO) and Veterinary Hospital of Harinakunda, Jhenaidah from March 2022 to March 2023. A total of 1500 suspected cases were investigated and 53.33% (800) of cattle were recorded FMD. The cases were treated as Group 01 Cattle (n=140): {Pheniramine Maleate BP 22.75 mg and (Procaine Benzylpenicillin BP 15 lac IU + Benylpenicillin Sodium BP 5 lac IU + Streptomycin 2.5g)}, Group 02 (n=140): (Oxytetracycline HCl USP 100mg and Pheniramine Maleate BP 22.75 mg), Group 03 (n=140): (Sulphadimidine Sodium BP 0.333 gm and Pheniramine Maleate BP 22.75 mg), Group 04 (n=140): {(Procaine Penicillin BP 3000000 IU + Benzyl Penicillin Sodium BP 1000000 IU) and Pheniramine Maleate BP 22.75 mg), Group 05 (n=140): {(Amoxicillin 1g+ Calvulanic acid 200 mg) and Pheniramine Maleate BP 22.75 mg)}. Group 06 (n=100): Control (untreated). Research parameters were different drugs, seasons, geographical locations, animal sex, recovery rates, and consequences. Group A showed higher recovery rate (90%) recovery rate within 7 to 10 days followed by Group D (70-71%) within 10 days. Lowest recovery rate(50-55%) were observed in Group C in between 17 to 20 days. Group E (Pregnant animals) had an 80% improvement rate with 5% abortion.The FMD outbreak resulted in a devastating 90% mortality rate among calves. Milk production dropped by 40%, and 75-80% of cattle suffered hoof deformities. Additionally, 85% of susceptible animals from the local market spread FMD to surrounding area.

Introduction

Foot-and-mouth disease (FMD) is a profoundly contagious viral illness with significant economic ramifications and impacts cloven-hoofed animals (Alhaji et al., 2020; Tadesse et al., 2019). The virus responsible for FMD belongs to the Picornaviridae family, and there are seven serotypes: A, O, C, Asia 1, SAT 1, SAT 2, and SAT 3, and more than 65 subtypes (Bazid, 2023; Al-Rukibat, 2014). FMD is a major threat to animal health in Bangladesh, the primary means of FMD control in endemic areas are vaccines, which are widely utilized to restrict the transmission of infection (Kharatyan, 2023). Although in field conditions, a combined vaccine is administered and the antibody titers are compared with those generated by administering the two vaccines separately (Muenthaisong, 2021), the body immunity of animals FMD virus conferred by one strain does not offer protection against other strains (Abd-Ellatieff et al., 2023; Lee et al., 2017). Periodic emergence of new variant FMD viruses renders the existing vaccine ineffective (Mahapatra et al., 2018). It is incredibly challenging to develop vaccines tailored to each specific outbreak. Typically, the process of developing a new vaccine strain can take anywhere from 6 to 18 months (emergence-msd-animal-health.com). Even in vaccinated populations virus infection acquires the carrier stage and shedding the virus silently without clinical symptoms (Singh, 2019). Because of several distinct and highly contagious virus strains, every year farmers have to face economic losses (Rasmussen et al., 2023). Farmers encounter losses both directly (Changes in animal productivity and shifts in herd composition) and indirectly (Managing expenses and encountering limitations in market entry) (Mahapatra & Parida, 2018). Small-scale farmers often lack comprehensive knowledge about managing disease risks on their farms, particularly during outbreaks such as foot and mouth disease (FMD), they often resort to using traditional remedies that may not be effective for addressing the health issues of their livestock and the widespread use of inappropriate traditional treatments and antibiotics, often administered by

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undertrained people, poses significant challenges in animal healthcare and antimicrobial stewardship (Windsor, 2020). The disease impacts animals of all breeds and ages, and those that recover may experience a variety of complications that can significantly impact livestock productivity and disrupt both local and global trade of animals and animal-derived products (https://www.woah.org/en/disease/foot-and-mouth-disease/). There are multiple sources, epidemiology, and locations of FMD virus infection through trade and transmission (Zewdie et al., 2023 Chanchaidechachai et al., 2022). From experimental trials and observational analyses, it has been discerned that the viability of aerosolized Foot-and-mouth disease (FMD) is contingent upon specific weather conditions (Hagerman et al., 2018). When introduced into disease-free herds or regions, FMD has the potential to rapidly propagate, causing a surge in cases with significant morbidity rates (Grubman & Baxt, 2004).

The cyclical nature of seasons delineates pivotal environmental factors such as rainfall, temperature, and environmental determinants exerting significant influence on the epidemiology of FMD. Categorized into distinct periods, the seasons include the rainy season spanning from November to March, followed by the cold dry season extending from April to July, and concluding with the hot dry season from August to October (Guerrini et al., 2019; Nazari Ashani et al. 2023). After analyzing various risk factors, including age, sex, species of animal, seasons, flock/herd size, farming methods, outbreak location, and nomadic animal movement, it was discovered that they are significantly correlated ($p < 0.05$) with the seroprevalence of FMD (Ullah et al., 2023). The presentation and intensity of clinical symptoms can differ among individual animals. In cattle, vesicular lesions, characterized by blisters, ulcers, and sores, may manifest in various locations including the mouth, feet, muzzle or nostrils, and teats (Mohebbi et al., 2017; Islam et al., 2017). Primary clinical indicators included lameness, encompassing lesions on the feet, along with excessive salivation (Ismail et al., 2023). The administered treatment typically included sulphonamides or amoxicillin, supplemented by additional supportive medications, antiseptics like povidone-iodine (PVP-I) are crucial for infection control in diverse clinical environments (Tan, 2021). Given its viral nature, there isn't a specific curative medication for Foot-and-mouth disease. However, providing supportive care with antibiotics and applying antiseptic dressings to lesions can help prevent additional complications (Shaban et al., 2022). However, FMD vaccines currently available provide limited early protection as their effectiveness typically kicks in only after 7 days post-vaccination. As a result, during outbreaks of FMD, antiviral medications or additives are employed to swiftly halt the spread of the virus (Zhang et al., 2023). In Bangladesh traditional treatments for FMD, may not always be effective due to factors such as bacterial resistance or the presence of multiple pathogens, like, genes associated with antibiotic resistance in *E. coli*, obtained from secondary infections after a Foot-and-mouth disease outbreak in cattle (Algammal et al., 2020).

Considering the above facts the present study was conducted to find out the efficacy of combined drug treatment for FMD to prevent secondary bacterial infections

Materials and Methods

Study areas

The study was conducted at Harinakunda upazila of Jhenaidah district from March 2022 to March 2023. Eight unions (unit) and 1 Paurashava of under Upazila livestock office and Veterinary Hospital of Harinakunda Upazila of Jhenaidah district. FMD was recorded based on clinical signs, symptoms, and lesions of animal. Throughout the study period, a comprehensive examination of 1500 suspected cases was undertaken, revealing that 53.33% (800) of the cattle were diagnosed with FMD.

Data collection

Data on disease condition, age, sex, gender and treatment were collected during the study. Data was collected from diverse outlets, including the Upazila Livestock office and Veterinary Hospital in Harinakunda. Through interviews with cattle farmer in FMD-affected areas, a comprehensive understanding emerged regarding the current hurdles and past experiences. These conversations unveiled the profound impact of FMD outbreaks on local communities, offering insights into both immediate concerns and long-term consequences (Chowdhury et al., 2019).

During our field survey, we meticulously gathered epidemiological data including sample numbers, locations, villages, owner' names of the animals,

gender of the animals, age in months, month of the last FMD vaccination and treatment, along with the type of vaccine used, any remarks noting the current or previous presence of FMD clinical signs, including timeframe of occurrence, distance to pasture, categorized as less than or more than 10 kilometers. All gathered information, both from the field and laboratory, was diligently entered into an electronic spreadsheet for subsequent analysis.

Treatment

We administered different types of treatments in combination of different drugs for FMD infected cattle. Group 01 Cattle (n=140): {Pheniramine Maleate BP 22.75 mg and (Procaine Benzylpenicillin BP 15 lac IU + Benylpenicillin Sodium BP 5 lac IU + Streptomycin 2.5g)}, Group 02 (n=140): (Oxytetracycline HCl USP 100mg and Pheniramine Maleate BP 22.75 mg), Group 03 (n=140): (Sulphadimidine Sodium BP 0.333 gm and Pheniramine Maleate BP 22.75 mg), Group 04 (n=140): {(Procaine Penicillin BP 3000000 IU + Benzyl Penicillin Sodium BP 1000000 IU) and Pheniramine Maleate BP 22.75 mg), Group 05 (n=140): {(Amoxicillin 1g+ Calvulanic acid 200 mg) and Pheniramine Maleate BP 22.75 mg)}. Group 06 (n=100): Control (untreated). The doses and duration were followed according to the manufacturer instruction. In all groups, we used Povidone Iodine USP 10% and supportive care with (Vitamin C + Potassium Iodate + Glutamic acid).

Results and Discussion

Current status of FMD in the study area

The study showed that farmers (n= 1000) from Harinakunda Upazila (8 unions and 1 Paurashava) of the Jhenaidah district brought their cattle affected by Foot and Mouth Disease (FMD) for treatment to the Upazila Veterinary Hospital. Vaccination against FMD had been administered only in cattle 5 to 6 months prior to the study, and no FMD cases were observed in vaccinated cattle. But due to the presence of local animal market (personal commuication) and cross contamination of non vaccinated animal from local market outbreaks happened easily and frequently all over the Upazila.

Prevalence of FMD

The prevalence of FMD varied union to union. Highest prevalence (26%) was observed in Chandpur union followed by Bhayna and Raghunathpur. Lowest prevalence (4%) was observed in Joradah (Table 1).

Table 1: Area-wise prevalence of FMD in Harinakunda Upazila, Jhenaidah, Bangladesh

Name of Unions	No of cattle	Prevalence
Paurashsava	64	08
Falshi	40	05
Taherhuda	48	06
Raghunathpur	152	19
Dowlotpur	40	5
Joradah	32	4
Bhayna	160	20
Chandpur	208	26
Kapashatia	56	07

Seasonal variation of Foot and Mouth disease (FMD)

The fluctuation in seasons appears to be the contributing factor behind the onset of foot and mouth disease in cattle. Table 2 demonstrates how seasonal factors impact the frequency of foot and mouth disease outbreaks in cattle.

Seasonal influences of Foot and Mouth disease in Cattle

Table 2: Seasonal effects of foot and mouth disease in cattle in Harinakunda Upazila, Jhenaidah, Bangladesh

Month	Cattle examined	Cattle infected	Percentage (%)
March, 2022	155	132	85.16
April, 2022	200	128	64.00
May, 2022	130	79	60.76
June, 2022	110	66	60.00
July, 2022	100	41	41.00
August, 2022	100	35	35.00
September, 2022	110	33	30.00
October, 2022	90	25	27.00
November, 2022	130	40	30.76
December, 2022	80	28	35.00
January, 2023	90	35	38.88
February, 2023	85	53	62.35
March, 2023	120	105	87.50
Total	1500	800	

The clinical prevalence of FMD was highest in the month of March (85.16-87.50 %) followed by April (64%) and May (60%). Lowest prevalence was observed in October (27%). The observation was higher than the other studies (Giasuddin et al., 2019; Mannan, et al., 2009). However different authors reported higher prevalence in different months might be due to changes in seasonal variation as a result of climate change.

Significant Clinical signs of Foot and Mouth disease

Among the clinical signs, common clinical manifestations were increased body temperature, profuse salivation, and development of vesicles on the oral mucosa, nostrils, interdigital spaces, and coronary bands of the feet (Table 3) (Figure 1). The observations are in accordance with the report of (Ismail et al., 2023).

Table 3: Clinical signs of foot and mouth disease-positive cattle in Harinakunda Upazila, Jhenaidah, Bangladesh

Clinical signs	Observed infected animal	Frequency (%)
Fever	100	100
Drooling Salivation	100	100
Stomatitis without lesion in interdigital space	100	25
Lesion only in interdigital space	100	15
Stomatitis with the lesion of interdigital space	100	60

Figure 1: Signs and Symptoms of FMD in Cattle in the field level of Harinakunda upazila

Prevalence of FMD in Cattle

Overall prevalence of FMD is 53.33%. Among the cattle only 27.62% calf were infected with FMD, whereas higher infection was observed in adult (72.37%). Infection was higher in female (65.45%) than male. Pregnant animal (53.56%) was more susceptible than non pregnant animal (Table 4).

Table 4: Prevalence of FMD according to age, sex and pregnancy

Factors	Category	Infected animals	Percentage (%)
Age	Calf (less than 2 years)	221	27.62
	Adult (over 2 years)	579	72.37
Sex	Male	200	34.54
	Female	379	65.45
Pregnancy	Pregnant	203	53.56
	Non-Pregnant	176	46.43

So, it could be concluded that the rural farming system, adult, female and the pregnant cattle were more susceptible to FMD in pre-monsoon season

Therapeutic efficacy of different drugs

The therapeutic efficacy of Group =1 (Procaine Benzylpenicillin BP 15 lac IU + Benzylpenicillin Sodium BP 5 lac IU + Streptomycin 2.5g) showed a better result than other groups (Table 5). While foot and mouth disease (FMD) may not result in high mortality rates, its global repercussions are profound, primarily due to its widespread impact on animal populations. This impact can be delineated into two primary components. Direct losses- these stem from reduced agricultural output and alterations in herd composition caused by FMD. Indirect Losses -these arise from various factors related to FMD control efforts and market access limitations (Table 5).

Therapeutic efficacy of different drugs

It was observed that the treatment with either Pheniramine Maleate BP 22.75 mg or (Procaine Benzylpenicillin BP 15 lac IU + Benzylpenicillin Sodium BP 5 lac IU + Streptomycin 2.5g) at the recommended dose (Table 5) provided highest recovery (90%) of FMD. The recovery rate was 85% in pregnant animal when the FMD cases were treated with either Pheniramine Maleate BP 22.75 mg or Amoxicillin 1g+ Calvulanic acid 200 mg at the suggested dose (Table 5).

Table 5: Efficacy of different drugs on FMD infected Cattle in Harinakunda Upazila, Jhenaidah

Groups	Prescribed drugs	Doses and duration	Recovered Percentage (%)
Group A	Pheniramine Maleate BP 22.75 mg	1ml/10 kg body weight per day for 3 to 5 days IM. Injection repeated depending on severity.	90
	Procaine Benzylpenicillin BP 15 lac IU + Benzylpenicillin Sodium BP 5 lac IU + Streptomycin 2.5g	10ml/100 kg body weight IM for 3 to 5 days.	
Group B	Pheniramine Maleate BP 22.75 mg	1ml/10 kg body weight per day for 3 to 5 days IM. Injection is repeated depending on severity.	72
	Oxytetracycline HCl USP 100mg	1 ml/10-20 kg body weight IM for 3 to 5 days.	
Group C	Pheniramine Maleate BP 22.75 mg	1ml/10 kg body weight per day for 3 to 5 days IM. Injection is repeated depending on severity.	50-55
	Sulphadimidine Sodium BP 0.333 gm	15-30 ml/50 kg body weight and Maintenance dose half of the initial dose for 3 days. 1st IV following IM for 3 to 5 days.	
Group D	Pheniramine Maleate BP 22.75 mg	1ml/10 kg body weight per day for 3 to 5 days IM. Injection repeated depending on severity.	70
	Procaine Penicillin BP 3000000 IU + Benzyl Penicillin Sodium BP 1000000 IU	10 ml/100 kg body weight IM for 2 to 3 days.	
Group E	Pheniramine Maleate BP 22.75 mg	1ml/10 kg body weight per day for 3 to 5 days IM. Injection repeated depending on severity.	85 (For Pregnant animals)
	Amoxicillin 1g+ Calvulanic acid 200 mg	1 ml/28 kg body weight IM for 3 to 5 days.	
For all Groups	Povidone Iodine USP 10%	Use as per requirement in all infected animals.	Antiseptic solution

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Consequences of FMD in Harinakunda Upazila

Milk Production

Table 8: Reduced milk production after recovery of foot and mouth disease (FMD) in cattle

Before FMD	After FMD recovery
20 litre	12 litre
6 litre	1.5 litre
4 litre	0.5 litre

Other cost

Infected animals often have reduced weight gain and meat quality thus reduces meat production in study area. The cost of treating infected animals and implementing control measures can be substantial. Around 65% of recovered animals suffer from hoof deformities, which can lead to chronic pain and mobility issues.

Conclusions

With timely and appropriate measures, Foot and Mouth Disease (FMD) can be prevented and managed. However, different serotypes may not be prevented by a single vaccine. In such cases, a combination treatment using Procaine Benzylpenicillin BP 1.5 million IU, Benzylpenicillin Sodium BP 0.5 million IU, and Streptomycin 2.5g, along with Pheniramine Maleate BP 22.75 mg, has shown satisfactory results. For pregnant animals, a combination of Amoxicillin 1g, Clavulanic Acid 200 mg, and Pheniramine Maleate BP 22.75 mg has proven effective. Despite treatment, affected animals often experience decreased milk production and approximately 65% of them develop hoof deformities after recovery.

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