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Review on Pneumonic Pasteurellosis

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Abstract: M*annheimia haemolytica* which is an opportunistic pathogen is considered as the predominant cause. Various combinations of risk factors such as: environmental stress, poor management and several infectious agents, such as virus, mycoplasma and other bacteria can serve as cofactors in the pathogenesis of pneumonic pasteurellosis.Various virulence factors allow *M. haemolytica* to colonize the lungs and establish infection. Transmission occurs by the inhalation of infected droplets coughed up or exhaled by infected animals. Diagnosis relies on gross necropsy findings, bacterial culture and clinical signs as well as stress exposure history. Broad-spectru antimicrobials are used commonly. Satisfactory economical control of the disease depends on the successful integration of management and perhaps the use of vaccines and antimicrobials prophylactically. Generally, pneumonic pasteurellosis is a highly multifactorial disease of a worldwide prevalence and distribution in cattle, sheep and goats.

Key words: Bronchopneumonia · Mannheimia Haemolytica · Pneumonic Pasteurellosis · Risk Factors

INTRODUCTION

The term pasteurellosis was broadly used to designate a number of infections in domestic animals caused by gram-negative non-motile facultative anaerobic rods or coccobacilli formerly grouped under the genus Pasteurella. For several decades, the genus Pasteurella was believed to be only one single genus with numerous species responsible for or associated with a wide range of systemic, pulmonary and septicaemic infections in various species of farm animals, particularly ruminants [1].

However, with more recent advancements in molecular biology involving DNA hybridization studies and 16S rRNA sequencing, most of the formerly recognized species were found to share a number of common features and became the subject of intensive revision and reclassification [2].

Pneumonic pasteurellosis is an entity within the bovine respiratory disease complex, characterized by severe bronchopneumonia and pleurisy. It is commonly associated with *M. haemolytica,* although *P. multocida* has also been isolated from the lungs of affected animals [3].

This review is pneumonic pasteurellosis considering its etiology, epidemiology, pathogenesis, associated risk factors and control and prevention management in cattle, sheep and goats.

Pneumonic Pasteurellosis: Respiratory tract infections are a common occurrence in various species of domestic and farm animals. However, pneumonic pasteurellosis, also known as respiratory mannheimiosis, or shipping fever pneumonia, is the most common disease with a wide prevalence in ruminant animals [1].

Etiology: Pneumonic pasteurellosis is caused by *P. haemolytica* biotype A serotypes. *P. haemolytica* falls into one of the two distinct biotypes based on its ability to ferment different sugars. Biotype A has the ability to ferment the sugar arabinose while biotype T has the ability to ferment trehalose and they differ with regard the reservoir, pathogenicity, antimicrobial susceptibility, cultural and serological traits and genetic relatedness. Type A is *P. haemolytica* and type T has been renamed *P. trehalosi*. Further classification is based on serotype. The serotype is defined by soluble or extractable capsular surface antigens using a passive haemagglutination procedure or rapid plate agglutination test. Sixteen serotypes are recognized currently and are designated by the numbers 1 through 16. Those serotypes numbered 3, 4, 10, 15, are all trehalose fermenters, biotype T [4].

Although pneumonic pasteurellosis, is caused by *P. haemolytica,* almost always of serotype A1 recent surveys have demonstrated the increasing importance of serotype A6 [5]. *Pasteurela multocida,* serotypes A and

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D tends to produce sporadic cases of the disease. In contrast to the disease in cattle, in sheep and goats, it is predominantly caused by serotype A2, although serotypes A1, 6, 7 and 9 are also involved, with other A serotypes more rarely [6].

Occurrence, Distribution and Host Range: Pneumonic pasteurellosis is a common disease of young growing cattle in Europe, UK and North America. However, it is a common disease of ruminants with worldwide distribution. Most ruminants are asymptomatic carriers of *M. haemolytica* and they frequently carry strains of *P. multocida* as well [7]. Pneumonic pasteurellosis caused by *M. haemolytica* is a common disease in ruminants that exposed to predisposing risk factors throughout the world. All ruminants are susceptible with more severity in young ones [8].

The outbreaks of mannheimiosis are generally noted at the beginning of the rainy season. However, the disease can occur throughout the year in the endemic areas. Since this disease has similarities with other respiratory diseases; it is critical to diagnose the disease right at the onset of an outbreak to prevent further transmission for safeguarding the health of livestock [9]. The seasonal prevalence varies regionally. In the northern hemisphere, outbreaks, as opposed to sporadic disease, are more prevalent in the late spring and early summer. In contrast, in New Zealand and Australia the disease is more prevalent in the late summer and fall, occurring in lambs associated with mustering or transport in hot weather [10].

Morbidity and Mortality: In cattle the morbidity due to pasteurellosis may reach 35%, the case fatality rate may range from 5-10% and the population mortality rate may vary from 0.75-1 %. The incidence of morbidity ranged from 0-69% with most reports between 15 % and 45 %. The population mortality rate ranged from 0-15% with most reports between 1 % and 5 % [3].

Risk Factors: Predisposing factors such as management and environment, in which proof circumstantial; and infectious agents including PI-3 in cattle and sheep, BH1 and BRSV in cattle, mycoplasma or bacteria that have been incriminated epidemiologically in association with outbreaks of pneumonic pasteurellosis converts healthy carrier cattle into cases of clinical disease [11].

Host Risk Factors: Young growing calves from 6 months to 2 years of age are more susceptible while nursing beef calves, yearlings and mature dairy and beef cows may also be affected, but less frequently. Young's are most susceptible during the first few months of life in small ruminants and ewes are most susceptible at lambing [9].

Environmental and Management Risk Factors: Environmental factors such as heat, cold stress, fluctuations in temperature, dust, humidity, etc, make animals susceptible to the disease. On the other hand managemental practice such as mixing of animals from different sources, weaning, shipping, crowding and handling, confinement in drafty or humid and poorly ventilated barns, exposure to inclement weather, fatigue and deprivation from feed and water are commonly followed by outbreaks of the disease in ruminants [12].

Pathogen Risk Factor: It is established that the ability of pathogenic bacteria to cause infection is greatly influenced by certain endogenous factors which can enhance the pathogenicity of the organism and facilitate rapid invasion and destruction of target tissues of the susceptible host. These factors; are generally designated as virulence factors and constitute parts of the surface components of the bacterial cell and cellular products. Virulence factors are, in fact, capable of promoting adhesion, colonization and proliferation of the organism within the animal tissues. In other words, virulence factors are actively involved in the conversion of the organism from commensal into pathogen [13].

Four main virulence factors have been identified in strains of *M. haemolytica*. These are fimbriae, capsule, endotoxin and leukotoxin [14].

Endotoxin is directly toxic to endothelial cells and capable of altering leukocyte functions and causing lysis of blood platelets [15].

Source of Infection and Mode of Transmission: *Pasteurella haemolytica and Pasteurella multocida,* are normal flora that is present in the upper respiratory tract [3]. They are highly susceptible to environmental influences and it is unlikely that mediate contagion is an important factor in the spread of the disease. However, *M. haemolytica* is also present on grass and in water in grazing areas and in the bedding of sheep pens; survival in these environments is prolonged in cooler, wet conditions. The incubation period may be from 3-5 days, but of the time it is 10-14 days depending on risk factors [16].

Transmission of Pasteurella is probably occurre by the inhalation of infected droplets coughed up or exhaled by infected animals, which may be clinical cases or recovered carrier animals [17].

Pathogenesis: The pathogenesis of pneumonic pasteurellosis remained a subject of considerable speculation and controversy due to the complex nature of the disease and the lack of consistency of the results obtained by the experimental approach. *Mannheimia haemolytica* cannot act alone as the causative pathogen of the disease in the absence of a well-defined predisposing factor [1].

Stress and/or viral infection would eventually impair the local pulmonary defense mechanisms by causing deleterious effects on the ciliated cells and mucous coating of the trachea, bronchi and bronchioles. The causative bacteria from the nasopharynx will then reach the ventral bronchi, bronchioles and alveoli by gravitational drainage along the tracheal floor and thereby become deeply introduced into the lung tissue. Endotoxins produced by rapid growth and multiplication of the bacteria in infected lobules will cause extensive intravascular thrombosis of pulmonary veins, capillaries and lymphatics. These vascular disturbances eventually result in focal ischaemic necrosis of the pulmonary parenchyma accompanied by severe inflammatory reaction dominated by fibrinous exudates [8].

Clinical Signs: Observable clinical signs of acute respiratory distress usually develop within 10 to 14 days in adult animals after being exposed to stress but a much earlier onset is more typical. Nevertheless, infected animals in severe cases may die as a result of toxemia even before the development of significant pulmonary lesions. In this case sudden death may be the first sign of acute outbreaks particularly in young animals [1].

After the onset of respiratory disturbances, infected animals appear extremely dull with reduced appetite and remarkable depression. They soon develop high fever (40-41°C), anorexia and rapid shallow respiration accompanied with profuse muco-purulent nasal and ocular discharges. In addition generalized weakness, lack of growth or weight gain, sudden death, poor condition, unthriftiness, lethargic/listless, abnormal lung or pleural sounds, dull areas on percussion of chest/thorax, open mouth breathing, rough hair coat, standing on end etc, are typical clinical signs appearing in this disorder [6].

In acute outbreaks, the clinical course of the disease is relatively short (2-3 days) terminating in death or recovery in either treated or non-treated animals. However, a number of sick animals that survive the acute phase may become chronically infected. The clinical course of the acute disease in sheep and goats is very much similar to that observed in cattle ending in death within 12 to 24 hours in severe cases or recovery within a few days [18].

Postmortem Lesions: The gross lesions in the affected lungs of cattle were generally described as a prototype of fibrinous (lobar) bronchopneumonia with prominent fibrinous pleurisy and pleural effusions. The inflammatory process is well dominated by fibrinous exudation in the pulmonary alveoli accompanied by interstitial edema and congestion, imparting a marbled appearance of the cut surface of the affected parts of the lung tissue. Lesions are always bilateral with cranio-ventral distribution, usually below a horizontal line through the tracheal bifurcation [1].

Diagnosis: Generally, neither serologic testing nor direct bacterial detection is performed and diagnosis relies on gross necropsy findings and bacterial culture in addition to a history of exposure to stress factors, season and sudden onset of respiratory disease [3]. Because the bacteria involved are normal inhabitants of the upper respiratory tract, the specificity of culture can be increased by collecting ante mortem specimens from the lower respiratory tract by tracheal swab, trans-tracheal wash, or bronchoalveolar lavage. Lung specimens can be collected for culture at necropsy [19].

Differential Diagnosis: As a general guideline the common pneumonia of cattle may be divided into bronchial, interstitial and hematogenous. Bronchial pneumonia includes pneumonic pasteurellosis and other less common bacterial pneumonias characterized by toxemia and shallow respiration and a good response to early treatment. Interstitial pneumonia includes viral and parasitic pneumonia and acute interstitial pneumonia is characterized by marked respiratory distress and a slow response or no response to treatment. In viral pneumonia, the animals may die acutely in a few days or recover over a period of several days. The hematogenous pneumonias are associated with venacaval thrombosis and pulmonary aneurysm and are characterized by acute respiratory distress and hemoptysis and no response to treatment [9].

Contagious bovine pleuropneumonia resembles pneumonic pasteurellosis but occurs in plague form; there is severe, painful, toxemic pleuropneumonia and the case fatality rate is high. Less common causes acute pneumonia in calves and young cattle include infection with Klebsiella pneumonia, Streptococcus spp. and Fusobacterium necrophorum, all of which are characterized by bronchopneumonia indistinguishable clinically from pneumonic pasteurellosis [18].

Table 1: Common antimicrobials drugs and their dosage schedule

Antimicrobial Individual treatment	Dosage and route of administration
Oxytetracycline	10 mg/kg BW, IV or IM daily for 3 day; can also use long-acting at 20 mg/kg
Florfenicol (analog of thiamphenicol)	20 mg/kg BW, IM; repeat in 48 hour
Trimethoprim-sulfadoxine (40mg trimethoprim/200 mg sulfadoxine/ml)	3-5 ml/45 kg BW, IV or IM daily for 3 days
Penicillin	20 000-3 0 000 IU/kg BW IM or SC daily for 3 days
Sulfamethazine (sustained-release bolus)	250 mg/kg BW per72 hour; severely affected cattle need to be treated parenterally initially with a rapidly acting sulfonamide because of rumen stasis due to toxemia
Tilmicosin	10 mg/kg BW SC and repeat 72 hour later if necessary
Enrofloxacin	2.5 mg/kg BW IM daily 3-5 day; or single dose of 7.5-1 2.5 mg/kg
Mass medication (feed and water)	
Sulfamethazine	100 mg/kg BW in drinking water daily for 5-7 day
Oxytetracycline	3-5 mg/kg BW in feed for 7 day
Mass medication (individual)	
Long-acting oxytetracycline	20 mg/kg BW, IM to all in-contact animals
Tilmicosin	10 mg/kg BW SC on arrival and/or 72 hour after arrival

Source: [8]

Prevention and Control: About 85-90% of affected animals recover within 24 hours if treated with antimicrobials. Commonly used broad-spectrum antimicrobials and their dosage schedule with their route of administration are listed in Table 1. One treatment is usually adequate and most economical for most cases but severely affected animals or those that relapse require treatment daily, or even two to three times daily, depending upon the drug used, for up to 3-5 days. Affected animals must be isolated and treated early in the course of the disease [19].

Treatment with oxytetracycline, potentiated sulphonamides, penicillin, trimethoprim-sulfadoxine and ampicillin is usually effective. Tilmicosin, a semisynthetic macrolide antimicrobial, is highly effective. It is also effective in reducing the population of *M. haemolytica* colonizing the nasal cavities with respiratory disease as well as for prophylactic use before transportation or during the first several days after arrival. Difloxacin and enrofloxacin are equally effective and danofloxacin is rapidly distributed to the lungs and high tissue concentrations are achieved in the pneumonic lung, including areas of consolidation [11].

Prevention of pneumonic pasteurellosis has been based on improving preconditioning methods, herd management practices and the use of prophylactic vaccination. Preconditioning is directed at decreasing stress, increasing the plane of nutrition and improving weight gain, feed efficiency and disease resistance. Stress factors must be kept to a minimum. Procedures such as castration, dehorning, branding and anthelmintic therapy should be carried out several weeks before young animals are transported [15].

Pasteurella vaccines have been developed based on the virulence factors, including leukotoxin, lipopolysaccharide with endotoxic activity, capsular polysaccharide and iron-regulated outer membrane proteins. Each of the vaccines produced may provide some protection against experimental and naturally occurring disease but none provides a high degree of protection. Several outer membrane proteins of *P. multocida* type A: 3, which occasionally cause severe bronchopneumonia in cattle, may be important for immunity to the organism [4].

Under ideal conditions, feedlot animals should be vaccinated twice at a 14-day interval with the *M. haemolytica* bacterial extract and genetically attenuated leukotoxin vaccine, with the second dose at least 14 days before arrival in the feedlot. The breeding herd and pregnant dairy cattle are vaccinated at 4 and 7 weeks prepartum to boost specific colostral antibody levels with the *M. haemolytica* bacterial extract and genetically attenuated leukotoxin vaccine. Nursing beef calves and dairy calves are vaccinated at 3-4 months of age, twice, at 14-day intervals. Since viral infections were associated with *M. haemolytica,* colonization in the lung, many viral vaccines such as PI-3, IBRV, BH1 and BVDV have been developed. However animals vaccinated with viral vaccines were still susceptible to *M. haemolytica* [20].

CONCLUSION AND RECOMMENDATIONS

Generally pneumonic pasteurellosis is a highly complex multifactorial disease of cattle, sheep and goats distributed worldwide. The disease primarily results from the interaction of stress, immunity and *M. haemolytica* which is commensally resident in the respiratory tract of susceptible animals. The major factors leading to stress and compromised immunity are naturally created by adverse environmental conditions and co-infection with certain respiratory viruses, mycoplasma or some other types of bacteria. Various virulence factors possessed by *M. haemolytica* promote lung colonization and evasion of

host immune response to establish the infection and development of acute bronchopneumonia with toxemia. Young animals are more susceptible than adults and they develop more severe infection in which sudden death may occur with or without any previous warning clinical signs. Diagnosis relies on gross necropsy findings and bacterial culture, in addition with a history of exposure to stress factors, season and of sudden onset of respiratory disease. Satisfactory economical control and prevention of the disease depend on the successful integration of management and perhaps the use of vaccines and antimicrobials prophylactically.

Based on the above conclusion the followings recommendations are forwarded:

- Implementation of better management practices like preconditioning of animals: castration, dehorning, branding and anthelmintic therapy should be carried out several weeks before young animals are transported.
- Identifying and isolating of sick animals and treating with proper drug as early as possible.
- Chemoprophylaxis and vaccination of herd and/or flocks.

REFERENCES

1. Mohamed, R.A. and E.B. Abdelsalam, 2008. A review on pneumonic pasteurellosis (respiratory mannheimiosis) with emphasis on pathogenesis, virulence mechanisms and predisposing factors, University of Khartoum, Sudan. Bulgarian Journal of Veterinary Medicine, 11(3): 139-160.
2. Angen, O., R. Mutters, D.A. Caugant, J.E. Olsen and M. Bisgaard, 1999. Taxonomic relationships of the [Pasteurella] huurnolytica complex as evaluated by DNA-DNA hybridizations and 16S rRNA sequencing with proposal of Mannheimia haemolytica gen, nov., comh. nov., Mannheimia granulomatis comb, nov., Mannheimia glucosida sp. nov., Mannheimia ruminalis sp, nov. and Mannheimia varigena sp. nov. International Journal of Systematic Bacteriology, 49: 67-86.
3. Quinn, P.J., B.K. Markey, M.E. Carter, W.J. Donnelly and F.C. Leonard, 2002. Veterinary Microbiology and Microbial Disease, Blackwell Science, pp: 137-143.
4. Rogers, R.E., 2003. Effects of Pasteurella haemolytica on Pulmonary Vascular Adrenergic Mechanisms. PhD Dissertation, Virginia Polytechnic Institute and State University, Virginia, pp: 16-19.
5. Donachie, E., 2000. Bacteriology of bovine respiratory disease. Cattle Practice, 8: 5-7.
6. Frank, G.H., 1989. Pasteurellosis of cattle. In: Adlam, C. and Rutier, LM. (eds) Pasteurella and pasteurellosis. Academic Press, London, pp: 197-222.
7. Gilmour, N.J.L. and J.S. Gilmour, 1989. Pasteurellosis of sheep. In: Adlam, C. and Rutler, J.M. (Eds) Pasteurella and pasteurellosis. Academic Press, London, pp: 223-262.
8. Lopez, A., 2001. Respiratory system, thoracic cavity and pleura. In: Thomson's Special Veterinary Pathology, 3rd edn, Eds M. D. McGavin, W. W. Carlton & J. Zachary, Mosby-Year Book Inc, pp: 125-195.
9. Radostits, O.M., C.C. Gay, P.D. Constable and K.W. Hinchcliff, 2006. Veterinary Medicine: A Textbook of Diseases of Cattle, Sheep, Pigs, Goats and Horses, 10th edn, W.B. Saunders, pp: 934-949.
10. Karimkhani, H., T. Zahraie Salehi, M.H. Sadeghi Zali, M. Karimkhani and R. Lameyi, 2011. Isolation of Pasteurella multocida from cows and buffaloes in Urmia's slaughter house. Arch. Razi Inst., 66: 37-41.
11. Zecchinon, L., T. Fett and D. Desmecht, 2005. How Mannheimia haemolytica defeats host defense through a kiss of death mechanism. Veterinary Research, 36: 133-156.
12. Filion, L.G., P.J. Willson, H. Bielefeldt-Ohmann, L.A. Babiuk and R.G. Thomson, 1984. The possible role of stress in the induction of pneumonic pasteurellosis. Canadian Journal of Comp. Med., 48: 268-274.
13. Confer, A.W., R.J. Panciera, K.D. CIinkenbeard and D.M. Mosier, 1990. Molecular aspects of virulence of Pasteurella haemolyrica. Canadian Journal of Veterinar). Research, 54: 548-552.
14. Gonzales, C.T. and S.K. Maheswaran, 1993. The role of induced virulence factors produced by Pasteurella haemolytica in the pathogenesis of bovine pneumonic pasteurellosis: Review and hypothesis. British Veterinary Journal, 149: 183-193.
15. Breider, M.A., S. Kumar and R.E. Corstivel, 1990. Bovine pulmonary endothelial cell damage mediated by Pasteurella haemolytica pathogenic factors. Infection and Immunity, 58: 1671-1677.
16. Donachie, E., 2000. Bacteriology of bovine respiratory diseasc. Cattle Practice, 8: 5-7.
17. Biberstein, E.L. and D.C. Hirsh, 1999. Pasteurella. In: Veterinary Microbiology, Eds D. C. Hirsh & Y. C. Zee, Blackwell Science Inc., pp: 140-145.

18. Brogden, K.A., H.D. Lehmkuhl and R.C. Cutlip, 1998. Pasteurella haemolytica complicated respiratory infections in sheep and goats. Veterinary Research, 29: 233-254.
19. Aiello, E.S. and A. Mays, 1998. The Merck Veterinary Manual (8th Ed.). Merck and Co., Inc., White house, U.S.A, pp: 1070-1075.
20. Boudreaux, C.M., 2004. A novel strategy of controlling bovine pneumonic pasteurellosis: Transfecting the upper respiratory tract of cattle with a gene coding for the antimicrobial peptide cecropin B. M. Sc. Thesis, Louisiana State University, USA, pp: 1-18.