Review on the Pneumonic Pasteurellosis of Cattle

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Abstract: Pneumonic pasteurellosis is a common disease of respiratory system of cattle as a result of inflammation of pulmonary parenchyma which is usually accompanied by inflammation of bronchioles and often by pleurisy. This review was made to overviews pneumonic pasteurellosis which is caused by a gram-negative bactoria pathogen is called M. haemolytica (P.haemolytica biotype A) serotype 1. The disease occurs most commonly in young growing cattle. Stress is an intrinsic condition that was consistently reported to increase the susceptibility to various types of infectious disease. Pasteurellosis occurs worldwide but it is a particular problem in the tropics especially the hot, humid tropics where environmental stress is an important trigger mechanism of the disease complex. The global economic impact of the disease is very well recognized and more than one billion dollars are annually cost in beef cattle industry. A microbiology culture from the lower respiratory tract by tracheal swabs is the most important laboratory diagnosis. Broad spectrum antibiotics are used commonly. Prevention and control of Pneumonic Pasteurrollosis has centered on the predisposing factors in combination with vaccination and management where herds are at high risk. Chemoprophylactic measures are useful for preventing the outbreak of the disease. The disease has great impact on animals’ production. Emphasis should be taken on improved management system and providing prophylactic drugs during loading of animals in case of transportation.

Key words: Cattle · Pneumonic Pasteurellosis · Vaccination

INTRODUCTION

Ethiopia has diverse animal genetic resources and its relatively large livestock populations (Approximately 100 million) is well adapted to and distributed among diverse ecological condition and management system [1]. In Ethiopia, like many developing Countries, livestock play multiple roles. Despite the huge number of cattle and economic importance, the productivity is low due to the constraints of disease, nutrition, poor management and poor performance of the indigenous breeds. These constraints result in poor reproductive performance of these animals [2]. On the basis of statistics acquired from different sources, livestock provides 16% of the total GDP (equivalent to 30% of agricultural GDP) and generates 14% of the country’s foreign exchange earnings [3].

Disease constraints like respiratory diseases contribute to the great financial losses and the socio-economic development of poor farmers in the area. These diseases cause a huge mortality and morbidity [4]. Among these pneumonic pasturellosis is one of the most common respiratory diseases prevailing in most parts of the World including Ethiopia [5].

The disease in its typical clinical form, is highly infectious, often fatal and with very serious economic impact in animal industry. Mannheimia haemolytica biotype A serotype1 is the most common cause of pneumonia. Eleven serotypes have been demonstrated within M. haemolytica, Serotypes 6, 2, 9 and 11 and untypable serotypes have been found in lesions of Pneumonic Pasteurellosis [6].

Several respiratory viruses including PI-3 virus, BHV-1 and BRSV may predispose the bacterial incubation [7]. An acute fatal respiratory disease was also induced in cattle by previous infection BHV-1 challenged with M. haemolytica [8]. Clinical signs of respiratory distress usually develop within 10 to 14 days, in adult animals after being exposed to stress [9]. Infected animals appear extremely dull with reduced appetite, depression, bronchopneumonia, abnormal lung sound, coughing, mucoid to mucopurulent nasal discharge, high fever (40-41°C or 104-106°F) [10].

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It is well established that Pneumonic Pasteurellosis is responsible for largest cause of mortality in which the disease accounts for approximately 30% of the total cattle death worldwide and more than one billion dollars are annually lost in beef cattle industry [11] and in addition to the death losses, the cost of treatment is considerable. Risk factors such as animal risk factor, environmental, managemental risk and the pathogen risk factor are involved in the complexity of the disease, as well as virulence factors including endotoxin, fimbriae and leukotoxin are involved in the pathogenesis [12].

Generally, diagnosis relies on bacterial culture and specimen can be collected from the lower respiratory tract by tracheal swabs or bronchoalveolar lavage. Early recognition and treatment with antibiotics are essential for successful therapy [13]. Vaccination regimes for respiratory pathogens should be completed at least 3 weeks before transportation and vaccine M. haemolytica which incorporate modified leukotoxin and surface antigen may produce production [14].

Young calves less than two years old age needs more protection and supplement with ration in order to develop immunologically and to satisfy the required growth. But in developing countries including Ethiopia, these practices cannot be learned as much. The farmers in the country simply let their calves to the field, especially in the pastoral areas, since there is lack of education providing calves with potable clear water; feed and disinfected calf house is unexpected. So the young calves lack the ability to gain the required body weight, lack of performance poorly grows and contracted by different disease. This condition might cause high mortality in the susceptible young calves and financial losses to the cattle industry in the country. Therefore, the objectives of this seminar paper are:

- To overviews pneumonic pasteurellosis

**Definition of Pneumonic Pasteurellosis:** Pneumonic pasteurellosis is a common disease of respiratory system of cattle as a result of inflammation of pulmonary parenchyma which is usually accompanied by inflammation of bronchioles and often by pleurisy [15].

**Etiology:** Pasteurella is a major cause of severe “shipping fever” pneumonia when combined with stress and with and without viral agents. The major bacterial pathogen involved in pneumonic pasteurellosis of cattle is M. haemolytica (P. haemolytica biotype A) serotype 1 [16]. Eleven serotypes have been demonstrated within M. haemolytica, Serotypes 6, 2, 9 and 11 and untypable serotypes have been found in lesions of Pneumonic Pasteurellosis. P. trehalosi strains are commonly isolated causes and P. multocida biotype occasionally [17]. The bacteria is Gram-negative, non motile, non-spore forming, facultative anaerobic, small rods or coccobacilli [18]. P. multocida and M. haemolytica are similar with each other but unlike P. multocida, M. haemolytica does not ferment mannose [7].

**Geographic Distribution and Occurrence:** Pasteurellosis occurs worldwide but it is a particular problem in the tropics especially the hot, humid tropics where environmental stress is an important trigger mechanism of the disease complex [19]. It is a common disease of young growing cattle and common in America, the UK and North America. In Canada and the United states the disease occurs most commonly in beef calves after weaning in the fall of the year and is the most important disease in cattle that have been recently introduced into the feedlots [15]. The outbreaks of mannhheimiosis are generally noted at the beginning of the rainy season; however, the disease can occur throughout the year in the endemic areas [20].

**Animal Risk Factors:** The disease occurs most commonly in young growing cattle from 6 months to 2 years of age, but all age groups are susceptible. Calves those are non immune to M. haemolytica than calves that have serum neutralizing antibody to the organism and its cytotoxin. In western Canada auction market calves that originated from many different farm and remixed at the market are at high risk. However the distance that the calves were transported was not associated with fatal fibrinous pneumonia [21]. Although the disease occurs most commonly in young beef cattle soon after their introduction to feedlot, it is not uncommon on dairy herd, especially when recent have been made. Mature beef cows are also susceptible to Pneumonic Pasteurellosis if they are subjected to stress during the summer months or in the fall of the year. Usually associated with the movement of large groups to or from pasture during inclement weather herd outbreak of per acute pleuropneumonia due to M. haemolytica have been reported in adult dairy cattle [22].

**Environmental and Managemental Risk Factors:** Mixing of cattle from different source is an important risk factor, mixing of recently weaned beef calves from different source at auction market was associated with an increased risk of fatal fibrinopneumonia in calves moved
to feedlot in a western Canada, especially in November shortly after action sales had peaked and when feedlot was reaching capacity [21].

Stress is an intrinsic condition that was consistently reported to increase the susceptibility to various types of infectious disease. Stress can be induced artificially by administration of certain drugs and chemical compounds like dexamethasone [23]. Containment in dairy, humid and poorly ventilated barns, exposure to increment weathers, deprivation from feed and water are commonly followed by an outbreak of the disease in cattle. The reason for increased susceptibility to M. haemolytica infection in stressed animals was primarily attributed to the breakdown of innate pulmonary immune barriers by stressors [24].

Pathogen Risk Factors: The frequency of isolation of Mannheimia species from the nasal passage of normal healthy unstressed calves is low but increased as animals are moved to auction market and then feedlot. The virulence factors of pasteurella species include fimbriae, polysaccharides, endotoxin and leucotoxins have been identified [12]. Respiratory viruses were reported to impair the phagocytic function of pulmonary alveolar macrophage. An acute fatal respiratory disease was also induced in cattle by previous infection with Bovine herpes virus-1 challenged with M. haemolytica. M. haemolytica serotype A1 and A2 can survive for long period at time at least 156 days in bovine and tracheobronchial washings [10].

Morbidity and Mortality: Morbidity and mortality are affected by a number of factors and their interaction. Age, endemicity of the region, previous exposure and immunity are important factors. The high susceptibility of young animals has been established in several studies in Sri Lanka. Morbidity may reach 35%, the case fatality rate may range from 5-10% and population mortality rate may vary from 0.75-1%. However, these morbidity and mortality may not be reliable because of wide variations in the method used to calculate disease incidence and prevalence. More recently in Britain, morbidity rates of 73-100% with mortality of 0-8% of those affected and average mortality of 4% have been reported [25].

Method of Transmission: Transmission of pasteurellas probably occur by inhalation of infected droplet, coughed up or exhaled from infected animals which may be clinical case or recovered carriers in which the infection persist in the upper respiratory tract. Mannheimia haemolytica is carried in the nasopharynx and tonsils of apparently health animals where, interestingly, serotyping is most commonly isolated from cattle [26]. Pasteurella multocida and Mannheimia haemolytica are highly susceptible to environment at influence and it is unlikely that mediated contagion is an important factor in the spread of the disease. When conditions are optimal, particularly when cattle are closely confined in inadequately ventilated trains or held for long periods in holding pens and feedlots, the disease may spread very quickly and affect high proportion of the herd within 48 hours. Animal at pasture able to move freely and the rate of spread may be slower [27].

Pathogenesis and Virulence Factors: Remaining in the URT of unstressed cattle, M. haemolytica 1: A causes no disease in the animal. Under times of stress in the form of transportation, crowding, irregular feeding or watering, abrupt climate change, exposure to viral agents, or combination of the above, M. haemolytica1: A proliferates in the URT [28]. Stress also disrupts M. haemolytica1: A localization and allows the bacterium to colonize other parts of the respiratory tract. Conditions such as stress or cell damage and inflammation are ideal for M. haemolytica1: A colonization and proliferation in the upper respiratory tract (URT). Stressed cattle shed large numbers of M. haemolytica1: A, which can be isolated during and immediately after shipment. Increased colonization and proliferation of M. haemolytica1: A in the URT allows the organism to be inhaled into the lung [28].

Researchers Have Shown That M. Haemolytica1: A can be isolated from droplet nuclei in tracheal air [29]. In the lower respiratory tract (LRT), M. haemolytica1: A would be easily cleared and no lung damage would occur under normal conditions [30]. However, chronic exposure to the lung allows M. haemolytica1: A to overcome clearance mechanisms and to initiate pneumonia. Intranasal and intratracheal inoculation of M. haemolytica1: A, as well as transthoracic inoculation of M. haemolytica1: A directly into the lung has been shown to produce pneumonic lung lesions [28].

Stress and viral infection would eventually impair the local pulmonary defense mechanism by causing deleterious effect on ciliating cells and mucous coating of the trachea, bronchi and bronchioles. The causative bacteria from the nasopharynx will then reach the central bronchi, bronchioles and alveoli by gravitation at drainage along the tracheal floor and there by become deeply introduced into the lung tissue. Toxin produced by
rapid growth and multiplication of the bacteria result in vascular disturbance and inflammatory reaction dominated by fibrinous exudates [31].

Four main virulence factors have been identified in strain of \textit{M.haemolytica} and \textit{P.trehalosi}. Fimbriae are small appendage, present in the surface of many gram-negative bacteria which enhance adherence to and colonization of the target epithelium of the susceptible animals. Two types of fimbriae have been detected in serotype 1 of \textit{M. haemolytica} [32]. Both of them are capable of enhancing mucosal attachment of the organism and colonization of lower respiratory tract epithelium of cattle. Successful colonization will thus enable considerable increase in the number of bacteria needed in the lung tissue beyond the level that normal lung capacity could efficiently resolve [33]. Similar to all other gram-negative bacteria the cell wall of \textit{M.haemolytica} contains Lipd Polysaccharide. This endotoxin is one of the most virulence factors involved in the pathogenesis of Pneumonic Pasteuriosis. It has been shown that serotypes 2 and 8 of \textit{M.haemolytica} possess rough LPS while the other 14 serotypes have characteristic smooth LPS [34]. Experimental evidence indicated that \textit{M.haemolytica} endotoxin is directly toxic to endothelial cells and capable of altering leukocyte functions and causing lysis of blood platelets [35].

Leukotoxin is heat-labile protein, a pore-forming cytolysin that affects ruminant leukocytes and platelets and also considered as a main virulence factor for \textit{M. haemolytica} [36]. The most susceptible cells are bovine macrophages, neutrophils and lymphocytes. At low concentration, leukotoxin impairs phagocytosis and lymphocyte proliferation while at higher concentration it has cytotoxic effect resulting in cell death due to lysis. The polysaccharide capsule of the organism inhibits complement mediated serum killing as well as phagocytosis and intracellular killing of the organism. The capsules also enhance neutrophil-directed migration and adhesion of the organism to alveolar epithelium. The interactions of these virulence factors contribute to the pathogenesis of the disease [37].

**Clinical Signs:** An observable clinical signs of respiratory distress usually develop within 10 to 14 days in adult mammals after being exposed to stress. 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 out breaks, particularly in young calves [38]. The incubation period of the disease ranges from 3 to 5 days, however, acute onset is not uncommon. 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 or 104-106°F). Anorexia and rapid shallow respiration accompanied by mucopurulent nasal discharge. Later on productive cough which is accentuated by physical effort or movement usually develop in most of the infected animals [39]. In acute outbreak, the clinical course of the disease is relatively short (2-3 days) terminating in death or recovery in either treatment or non-treated animals. However, number of sick animals that survive the acute phase may become chronically infected animals. Marked dyspnea with an inspiratory grunt may be observed in very advanced stages of disease [40].

**Post Mortem Examinations:** There is marked pulmonary consolidation, usually involving at least the antero-ventral part of the lungs. The lung is firm and the cut surface usually reveals an irregular, variegated pattern of red, white and gray tissue due to hemorrhage and necrosis. Occasionally sequestrate of necrotic lung tissue are found. \textit{P.multicoda} cause fibrino-purulent bronchopneumonia without the multifocal coagulation hemolytic necrosis that characteristics of fibrinous lobar pneumonia associated with \textit{M.haemolytica}. The post mortem findings of lung consolidation and pleurisy are present. The basic post mortem lesions are acute fibrin hemorrhagic pneumonia with pleurisy adhesion [41].

**Diagnosis:** Diagnosis is depending on the history of age, recent movement, weaning or housing, isolation and identification of the causative agent is important [27].

**Clinical Findings:** The spectrum of clinical finding depends in part on weather the disease is occurring in groups of young cattle in large commercial feedlot, in small farm feedlot or in individual animals such as lactating dairy cows in which illness is more early recognized by drop in milk production and feed intake. In the feedlot situation, affected animals must be identified primarily by visual observation followed by closer physical examination. However, close physical examination such as auscultation of the lungs have not been routinely used in feedlot, because of the time required to examine individual animals and the perceived accuracy of the examination in making clinical diagnosis [38].
The respiratory rate increased from 30 per minute up to 70 per minute as the percentage of lung consolidation increased from 10% to 50%. The typical case of pneumoniae Pasteurellosis reveals a fever (40-41°C or 104-106°F). In early stages there are loud breathing sounds audible over the anterior and ventral part of the lung. Clinically when viewed from a distance, affected cattle are depressed and up on auscultation, rapid shallow respiration with loudness of breath sounds, nasal and ocular discharge are present [10].

**Laboratory Diagnosis:** Microbiology cultures from the lower respiratory tract by tracheal swabs, transtracheal wash, or bronchoalveolar lavage are the most important laboratory diagnosis. Impression smears show bipolar staining organism with methylene blue. Examination or nasal swab sample from clinical case before treatment often yield bacteriological sample for pasteurella in which *M. haemolytica* biotype A serotype 1 is most common isolate obtained from cattle with Pneumonic Pasteuriosis. *M. haemolytica* or *P. multocida* may be isolated from nasal swabs in live animals [25]. Serology and mere isolation of *P. multocida* from nasal swabs is of little value without being able to predict pathogenicity. The application of the polymerase chain reaction (PCR) to detect and differentiate toxin producing and nontoxin producing *P. multocida* may prove to be a useful technique for control of both pneumoniae pasteurellosis and atrophic rhinitis [42].

**Differential Diagnosis:** Conditions that may be mistaken for pneumoniae pasteurellosis include; Contagious Bovine pleuropneumonia, Infectious Bovine Rhinotrachitis, Verminous pneumonia caused by Dictyocaulus viviparous and viral interstitial pneumonia and sporadic conditions, such as lung abscesses and aspiration pneumonia. The finding of a fibrinous or fibrino-bronchopneumonia on necropsy is highly suggestive of pneumoniae pasteurellosis, although *Haemophilus somnus*, also a member of the family pasteurelleae, can cause fibrinous lesions [43].

**Treatment:** Treatment should begin early. Most cattle will show some improvement within one to three days of initiating treatment. Broad spectrum antibiotics are used commonly. Antibiotics most commonly used are oxytetracycline at rate 20mg/kg BW, IM, long acting and 10mg/kg daily for 3 days short acting; Tilmicosin at rate 10mg/kg BW, SC and repeat 72hr later if necessary; florfenicol (Analog of thiamphenicol) 20mg/kg BW, IM repeat 48 hr and mass medication with sultmethazine 100mg/kg BW in drinking water for 5-7 days. Tilmicosin is effective in reducing the population of *M. haemolytica* that colonizing the nasal cavities of calves with respiratory disease [44]. Studies in Canada showed that oxytetracycline was usually the antimicrobial drug of first choice for treating case of shipping fever [45]. Florfenical given on arrival reduce the incidence of respiratory diseases and reduce the colonization of nasopharynx by *M. haemolytica* [46]. If pulmonary abscessation has occurred, it is difficult to achieve resolution with antimicrobials and culling of animal should be considered. NSAIDS have been shown to be a beneficial ancillary therapy in treating bacterial pneumonia [47].

**Prevention and Control:** Prevention and control of Pneumonic Pasteuriosis has centered on the predisposing factors in combination with vaccination and management where herds are at high risk [7].

**Management Strategies:** Because of common occurrence of the disease at the time of shipment from the range to the feedlot, much attention has been given to reduce the incidence of disease at this time. The calves should be transported from the farm of origin directly to the fattening unit. The transport distance should be as short as possible and the animal should be handled in calm and considerate manners at all stages of transport. The calves could weaned and introduced to fattening diet at least two weeks before leaving farm [28].

**Vaccination:** Pasteurella vaccines and respiratory viral vaccines have been used extensively in an attempt to control Pneumonic Pasteuriosis in cattle. However, their efficacy appeared to be low and literature review suggest that at present there is little evidence to show efficacy of such vaccines under feedlot conditions. Vaccination regimes for respiratory pathogens should be completed at least 3 weeks before transportation and vaccine for *M. haemolytica* incorporate modified leukotoxin and surface antigen induce production [14]. The experimental lung challenge of calves with formalin killed *P. multocida* does not provide subsequent protection to challenge with live *P. multocida* [47].

Single vaccination of *M. haemolytica* bacterin toxoid given to calves on arrival in the feedlot reduced overall mortality. Vaccination of calves after arrival in the feedlot with genetically attenuated leukotoxin *M. haemolytica* combined with its extracts reduced morbidity due to bovine respiratory disease. Several outer membrane
protein of \textit{P.\textit{multocida}} type A3, which occasionally causes severe bronchopneumonia in cattle, may be important for immunity for organism \[48\]. Vaccination of colostrum- deprived calves at 2 and 4 weeks 0f age with \textit{M.haemolytica}, a culture supernatant vaccine resulted in high titer of IgA antibody to capsular polysaccharides within one week of vaccination \[49\].

\textbf{Chemoprophylaxis:} Chemoprophylactic measures for preventing Pneumonic Pasteurlosis are useful for preventing the outbreak of the disease, especially when disease provoking stress is consciously put up with. Application of long acting oxitetracycline before shipping animals over a long distance will protect the animals effectively against shipping fever. The antibiotic chemoprophylaxis of pasteurlosis is the only way to stop the infection immediately during a sudden outbreak and prevents its spreading to other animals or herd. In such cases, the chemoprophylaxis replaces the application of hyperimmune serum which used to be applied \[19\].

\textbf{Economic Importance:} It is well established that Pneumonic Pasteurlosis is responsible for the largest cause of mortality in feedlot animals in which the disease accounts for appropriately 30\% of the total cattle death worldwide. The global economic impact of the disease is very well recognized and more than one billion dollars are annually cost in beef cattle industry. In addition to the death losses, the cost of treatment is considerable. It is also a disease of great importance in North America and Britain were it has caused great loss since before 1990s \[11\].

\textbf{Status of Pneumonic Pasteurlosis in Cattle in Ethiopia:} In a study under taken in calves with clinical signs of respiratory disease in the same area \textit{M.haemolytica} and \textit{P.multocida} isolates were obtained from nasal and transtracheal swabs \[50\]. \textit{M.haemolytica} serotype A\textsubscript{1} and A\textsubscript{2} are the most common in the country. However, no study has been done to know the prevalence and the actual organisms involved in Pneumonic Pasteurlosis of cattle but few studies have been done concerning Ovine Pneumonic Pasteurlosis in Central, North, Eastern and South Eastern high lands of the country \[51, 52\].

\textbf{CONCLUSION AND RECOMMENDATIONS}

Pneumonic Pasteurlosis is a highly complex multifactorial disease of a worldwide prevalence and distribution in cattle. The disease primarily results from interaction of stress, immunity and the causative bacteria (\textit{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 and climatic conditions and also by previous or co-infection with certain respiratory viruses, mycoplasma or some other types of bacteria. The disease is mostly transmitted by inhalation from infected droplets. Also the disease has typical clinical form, highly infectious, often fatal and economically important. It is a major cause of morbidity and mortality, accounting for 30\% of total cattle death globally. Diagnosis is depending on the history of age, recent movement, weaning or housing, isolation and identification of the causative agent is important. Effective control is based on management, vaccination and chemoprophylaxis. Based on the above conclusion, the following recommendations are forwarded:

- Infected animals should be isolated and treated early.
- Avoid overcrowding of cattle at the time of transportation.
- Emphasis should be taken on improved management system.
- Providing prophylactic drugs during loading of animals in case of transportation.
- Vaccination of animals at least 3 weeks before transportation.
- Further investigation has to be conducted on the status of pneumonic pasteurlosis in cattle.

\textbf{REFERENCES}


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