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Review on Epidemiology, Control Measures and Economic Impacts of Contagious Bovine Pleuropneumonia (CBPP) and Its Status in Ethiopia

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Abstract: Contagious bovine pleuropneumonia (CBPP) is a disease of economic importance that is widely distributed in Sub-Saharan African and contributes significantly to cattle morbidity and mortality. This review was aimed to elucidate the epidemiology, control measures and economic impacts of CBPP. The disease is characterized by its ability to transmit through direct contact, long incubation period, possibility of early excretion of mycoplasmas (up to 20 days) before apparition of clinical sings during the course of the disease and after recovery in "lungers" up to two years. Closeness of contact, intensity of infection and the number of susceptible animals determine the rate of spread of the disease. The post mortem lesions of CBPP include thickening and inflammation of lung tissues. Diagnosis requires the isolation of the etiological agent. Treatment is recommended only in endemic areas because the organisms may not be eliminated and carriers may develop. CBPP has been causing significant economic losses on the agricultural sector and the national economy of Ethiopia. It accounts for a loss of over 8.96 million US dollars per year. Control of CBPP offers a number of challenges as a result many developing countries in Africa are still struggling with this disease.
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INTRODUCTION

Contagious bovine pleuropneumonia (CBPP) is an infectious and contagious respiratory disease, mainly of cattle, caused by *Mycoplasma mycoides* subsp. *mycoides* (Mmm) [1]. It is transmitted by direct or close contacts between infected cattle and susceptible animals, and remains an important constraint to cattle production in many sub-Saharan African countries [2]. It is a disease with very high economic importance, with the ability to compromise food security in endemic areas [3].

Contagious bovine pleuropneumonia (CBPP) causes threat to livestock and is a highly infectious disease that affects the respiratory tract of cattle and characterized by fever, anorexia, dyspnea, polypnea, cough, and nasal discharge [4]. All ages of cattle are susceptible, but young cattle develop joint swelling rather than lung infections. Many cattle show no disease signs despite being infected [5] and chronically infected animals might act as carriers and sources of infections [6].

Among the exacerbating risk factors of contagious bovine pleuropneumonia in Ethiopia are; lack of knowledge of the disease by farmers, vaccine shortage, poor diagnostic assays, management system, limitation of epidemiological information about the disease, concentration of livestock at watering points and grazing areas and difficulty to control of cattle movements are the principal things which have been cited by many literatures [7]. It is estimated that annual losses due to CBPP amount to 38.81 million US dollars in 12 endemically infected sub-Saharan African countries [3]. It also has a great economic importance to cattle keepers because of its high mortality rate, production loss, increased production cost due to cost of disease control, loss of weight and working ability,

delayed marketing, reduced fertility, loss due to quarantine, loss of cattle trade, and reduced investment in livestock production [8]. Regarding the Ethiopian situation, CBPP has been causing significant economic losses on the livestock sector and the national economy. It accounts for a loss of over 8.96 million US dollars per year [9].

Up to date studies conducted in Western part of Ethiopia [10], Northern Ethiopia [11], Southern Ethiopia [7], Southwest Ethiopia [12], and different regions of the country [13] showed that CBPP is posing a major threat to cattle production in many parts of the country, thereby causing considerable economic losses through morbidity and mortality and demanding for serious attention from the concerned body. In countries such as Ethiopia where CBPP was reported to be prevalent, the knowledge of the diseases and factors associated to such important disease is crucial. Therefore, the objectives of this paper are to review on the epidemiology, control measures and economic significance of Contagious Bovine Pleuropneumonia (CBPP).

CONTAGIOUS BOVINE PLEUROPNEUMONIA (CBPP)

Contagious bovine pleuropneumonia (CBPP) is an insidious pneumonic disease of cattle sometimes referred to as lung sickness [14, 15]. The disease has been known to occur in Europe since the 16 century but it gained a world-wide distribution only during the second half of the 19 century because of increased international trade in live cattle [16]. It was eradicated from many countries by the beginning of the 20th century through stamping out policies. However, the disease persists in many parts of Africa, with minor outbreaks occurring in the Middle East.

Causative Agent

Contagious bovine pleuropneumonia (CBPP) is caused by a bacterial agent Mycoplasma mycoides which belongs to the order *Mycoplasmatales* and class Mollicutes (soft skin). *Mycoplasmas* are unique in microbiology because of their extremely small size and their growth on complex but cell-free media.

Mycoplasma mycoides subspecies *mycoides is* the cause of CBPP in cattle [17, 18]. Large colony types occur almost exclusively in goats, rarely in sheep while SC types cause CBPP in cattle [17]. *M. mycoides* subspecies *mycoides* large colony (LC) type does not result in disease in cattle, but, causes septicemia, polyarthritis, mastitis, encephalitis conjunctivitis, hepatitis and occasionally pneumonia in sheep and goats [16].

Clinical Signs and Pathogenesis

The pathogenesis of CBPP in susceptible animals is characterized by the development of thrombosis in the pulmonary vessels, which may occur prior to the establishment of pneumonic lesions. Pathologically, CBPP causes unilateral pulmonary necrosis, marked sero-sanguineous fluid accumulation in the interstitial and pleura, and sometimes sequestration [19].

CBPP is manifested in four forms: hyperacute, acute, subacute, and chronic forms. The hyperacute form is seen at the onset of the disease outbreaks, may affect up to 10% of the infected herd, and sudden death occurs often without other clinical signs. About 20% of the affected cattle are observed during the acute form, with the course usually running from 5 to 7 days, and characterized by fever, self-isolation from the herd, anorexia, and difficult breathing that is labored and painful. Other signs that may be observed include abdominal breathing and "grunting" during expiration. Affected cattle may develop a shallow, dry, and painful cough that is often observed during exercise. Affected animals may protest when pressure is applied between the ribs because of pain and could sometimes react violently [20].

Also, affected animals in acute form stand with nostrils dilated, mouth open, and panting for air, head, and neck extended, forelegs spread apart, frothy saliva accumulation in and around the mouth, and nasal discharge, sometimes streaked with blood. Furthermore, some affected animals may develop swellings of the throat and dewlap in this stage. About 40% to 50% of the affected cattle are most frequently seen in subacute form with characteristic signs resembling those in the acute form, though they could be less severe and with recurrent fever. Some cattle may directly go into the chronic stage, which is a natural evolution of both acute and subacute stages. The clinical manifestations gradually regress, though affected cattle may still manifest fever, anorexia, and loss of weight. Young calves often manifest swollen, hot, and painful limb joints that result in lameness [21]. They stand with head and neck extended and legs widely placed. Often the elbows are turned out. Inflammation of the membranes surrounding the lungs and fluid in the thorax cause pain in the chest resulting in abdominal and exaggerated breathing movements.

Epidemiology

Mycoplasma mycoides subspecies *mycoides* SC type, the causative agent of CBPP has two principal clusters; the European and Afro-Australian cluster according to the isolate of strains collected over

the last 50 years. Moreover, the African isolates are the one seen to surpass that of the European on the basis of degree of virulence [22].

Cattle movement is solely incriminated for maintenance and extension of the disease as there is no wild reservoir to make the transmission route complex [23].

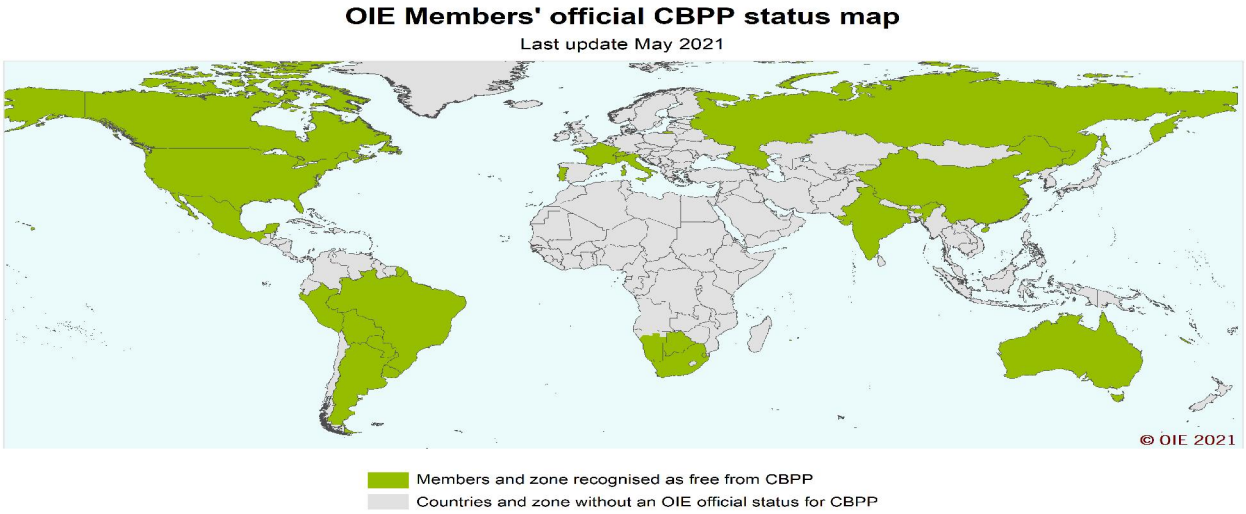

Figure 1: Map showing the OIE members' official CBPP status

Source: [24]

Hosts

Bovine, both *Bos taurus* and *Bos indicus*, are the main species that are susceptible to CBPP. Infections have also been reported from Asian buffalo (*Bubalus bubalis*), captive bison (*Bison bison*) and yak (*Poephagus grunnien*, formerly *Bos grunnien*). Sheep and goats can also be naturally infected, but with no clear associated pathology. Wild bovids and camels seem to be resistant and, so far, do not appear to be important in the transmission of CBPP [25]. The African water buffalo (*Syncerus caffer*) is refractory to CBPP. CBPP prevalence with respect to age was assessed and cattle over two years were found highly affected as compared to the younger animals with significant variation [26].

Incubation Period

Incubation period of the disease is usually 1-4 months, but can be longer. After experimental inoculation into the trachea, clinical signs may appear in 2-3 weeks [15].

Transmission

Contagious bovine pleuropneumonia is epidemiologically characterized by its ability to transmit through direct contact, long incubation period, possibility of early excretion of *mycoplasmas* (up to 20 days) before apparition of clinical sings during the course of the disease and after recovery in "lungers" up to two years [18, 22]. The organism is also present in saliva, urine, fetal membranes and uterine discharges [27]. Closeness of contact, intensity of infection and the number of susceptible animals determine the rate of spread of the disease. It is spread mainly by inhalation of droplets from infected coughing animals, especially if they are in the acute phase of the disease.

Outbreaks and Distribution

Contagious bovine pleuropneumonia was introduced in the Cape Province of South Africa in 1853 through cattle imports from the Netherlands. Following the first outbreak, CBPP quickly spread to neighboring countries and is now present in many parts of Africa.

Today, CBPP is present in Central, East, West and parts of Southern Africa but is absent in North Africa. After examination of the number of countries reporting the disease, a more accurate estimate of distribution was provided [28].

In 2015, CBPP was considered to be present in all sub- Saharan African countries. The Southern part of the continent is still considered to be free of the disease due to the physical barriers that prevent its spread, such as the Namibian veterinary cordon fence, but the Southern African Development Community (SADC) countries are clearly still at risk [19].

Diagnosis

Diagnosis of CBPP relies on clinical examinations, postmortem inspections, and laboratory analyses through culture and isolation procedures, and serological analyses. Protein and nucleic acid-based molecular techniques have also evolved and are more specific [29]. Contagious bovine pleuropneumonia is difficult to diagnose based on clinical signs alone as there can be many causes of severe pneumonia in cattle. But, we can diagnose CBPP based on a history of contact with infected animals, clinical findings, immunodiagnostic tests, necropsy findings and cultural examination. CBPP frequently results in disease in only one lung as compared with other types of pneumonia in which both lungs are affected. In a herd with signs of pneumonia in adults and polyarthritis in calves, CBPP should be considered. Post mortem lesions may be more useful in the diagnosis [27]. Confirmatory diagnosis is based on the isolation of *Mccp* from clinical samples of lung.

Treatment

Under practical field conditions, when the disease breaks out in a new area, treatment is not applicable and not recommended because of reasons of disease prevention. Treatment is recommended only in endemic areas because the organisms may not be eliminated and carriers may develop. Tylosin (10 mg/kg, IM, bid, for six injections) and danofloxacin 2.5% (2.5 mg/kg/day for 3 consecutive days) have been reported to be effective [30], but in practice farmers are treating their animals when they have no other alternative. Although the *Mycoplasmas* are susceptible to a number of antibiotics *invitro*, treatment failures are common [31]. Oxytetracyclines (OTC) are the antimicrobials most widely used in Africa to treat CBPP. In spite of widespread and probably sub-optimal use over a long period of time resistance has not been detected, but a number of other products have been investigated [32].

Control and Prevention

Four essential control approaches that include vaccination, treatment, movement control, and stamping-out through slaughter with compensation have been adopted towards mitigation of CBPP in Africa. Each of these mitigation measures reduces the occurrence of the effective reproductive number of *Mmm* in cattle populations [3]. Unfortunately, most of the CBPP affected countries in Africa do not apply all of these measures at the same time due to technical and logistic reasons. However, the AU-IBAR advocated a policy for control of the disease in Africa, which includes epidemiological data and information collection to identify foci of CBBP occurrence through active surveillance, regular annual mass vaccination of cattle herds two intervals in a year for at least 5 consecutive years with attainment of herd immunity, and effective movement control from and towards the infected foci [33]. Application of a mass vaccination campaign to vaccinate all herds in endemic areas two times in a year for 5 years implies close to 100% vaccination coverage and concurrent application of movement control will effectively mitigate the menance of the disease in Africa.

The use of antimicrobials for control of CBPP in affected cattle herds in endemic areas is theoretically prohibited due to the lack of antimicrobial efficacy against the disease clinically. However, antimicrobials are still widely used by herders and professionals in the field in Africa. Though antimicrobials usage may greatly reduce transmission of *Mmm* to healthy ones, adequate mitigation against the disease can be achieved through concurrent application of antimicrobial treatment with vaccination [34]. Nevertheless, the use of marbofloxacin and spiramycin groups has been fruitful in the treatment of contagious caprine pleuropneumonia (CCPP), a similar disease in sheep and goats, as they produced a higher (70%) curative rate than the oxytetracycline group (40%) and a lower fatality rate (30%) than the oxytetracycline group (60%) [35]. His treatment regimen can be used for CBPP mitigation in endemic herds.

Control of CBPP by movement control and stamping-out could not be effectively adopted in many countries in Africa because the measures are too costly and logistically difficult, while many of them are faced with limited financial resources. Vaccination and treatment are still the better alternatives and possibilities for CBPP control in Africa. CBPP was eradicated through stamping-out and strict animal movement control in the US, Japan, and Western Europe, [21] but not successfully practiced in most African countries. It is important to note that stamping-out was successfully applied to control the disease in Botswana [36]. Unfortunately, stamping-out may not be practicable in most of the CBPP endemic countries in sub-Saharan Africa because of its capital intensive nature, and vaccination remains the most effective control strategy. Nevertheless, vaccination can only be successful and effective if it is repeated at regular short intervals of 6 months for 2 years, and annual coverage for 3–5 years consecutively [37, 38].

ECONOMIC IMPACTS OF CBPP

In the affected countries, enormous losses are experienced each year from the death of animals and the loss of production during convalescence. The highly fatal nature of the disease, the ease of spread and the difficulty of detecting carrier also mean that close restriction must be placed on the movement of animals from enzootic areas. The economic impact of

CBPP is enormous resulting in heavy losses in cattle populations [30].

STATUS OF CBPP IN ETHIOPIA

Even though there is a paucity of research conducted on CBPP in Ethiopia, the disease is widespread and considered as one of the most important cattle diseases and impediments to livestock development in the country [39, 40]. Studies undertaken on CBPP so far revealed the existence of the disease in different parts of the country with prevalence that range from 0.4% (from bull at finishing phase for export in East Shewa zone that brought from Borena pastoral area) [41] to 96% in Western Gojjam [42].

Recent studies conducted in Western Ethiopia [43], Northwest Ethiopia [44], Southern Ethiopia and different regions of the country [13] revealed that CBPP is posing a major threat to cattle in many parts of the country thereby causing considerable economic losses through morbidity and mortality and warranting for serious attention. The cattle population at risk of CBPP and livestock production systems in CBPP endemic and epidemic zones of Ethiopia is estimated to be a total of 13,325,700 heads of cattle. All of them are considered to be at risk of CBPP, of which 5,510,700 are in endemic zones and 7,815,000 are in epidemic zones [45].

CONCLUSION AND RECOMMENDATIONS

Contagious bovine pleuropneumonia presently poses a series of challenges to livestock industry and socio-economic welfare of pastoralists in sub-Saharan Africa. These challenges cover not only the epidemiological features but also several important methodological gaps that concern the diagnostic tools and control strategies. It was identified as the second most important transboundary disease in Africa next to render pest which needs a major focus. CBPP is a disease that causes high morbidity and mortality to cattle. The major risk factors those responsible for the occurrence of the disease are host factors, pathogen factors and the type of husbandry or management system. The financial implications of these losses are of great significance to both cattle owners and to the nation. Moreover, CBPP has potential to be spread in to new areas that have been considered previously as free areas. CBPP constitutes a major disease problem, posing a significant economic loss in the live stock sector and halts exchange of foreign currency from international trades. However nature of the disease makes the control and prevention difficult and responsible for the increased prevalence from time to time in the country. Based on these facts, the following recommendations were forwarded:

- Controlling and limitation of CBPP via animal movement control and vaccination, additionally, avoiding of re-introduction, close or frequent contact of cattle from neighboring countries or herds suspected of CBPP
- Endorsing of intensive serosurveillance in different agro-ecological zones and Abattoir surveillance for CBPP lesions
- Frequent training of veterinary personnel about diagnostic techniques and awareness creation among the society about the nature of CBPP without whom participation controlling process shouldn't be undertaken at ease.
- Producing marketing standards for livestock and livestock products for small holder farmers which do have paramount importance for generation of income to support livelihood of individual thereby increase participation of small holders in the disease controlling process.
- Improvement of the public and private veterinary service delivery has a major impact in mitigating the risk imposed by CBPP.

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