Advances in Biological Research 14 (3): 136-142, 2020
ISSN 1992-0067

DOI: 10.5829/idosi.abr.2020.136.142

Contagious Caprine Pleuropneumonia, A Review

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Abstract: The objective of the current review was to provide available information about the status and economic importance of contagious caprine Pleuropneumonia. Contagious Caprine Pleuropneumonia (CCPP) is a highly contagious infectious disease of goats that causes inflammation of the lungs and accumulation of fluid in the chest cavity. It is a serious OIE -list B disease affecting goats in the Middle East, north and east Africa and Asia. Typical cases of CCPP are characterized by extreme fever (40.5-41.5°C), high morbidity and mortality rates in susceptible herds affecting all ages and both sexes and abortions in pregnant goats. It is transmitted via the respiratory route (infective aerosol) and is spread by close contact between goats. CCPP was thought to be highly specific to goats and is not zoonotic. The diagnosis is hampered by the fastidiousness of the causative mycoplasma but molecular-based tests like PCR have greatly improved detection. Rapid latex agglutination tests that can be performed at the pen side are also available for antibody detection. Clinically affected animals respond to a range of antibiotics although it is unlikely that this results in the complete elimination of the mycoplasma. Vaccines consisting of saponized organisms are protective but the quality and efficacy may be variable.

Key words: Contagious Caprine Pleuropneumonia · Goat · *Mycoplasma capricolum*

INTRODUCTION

Goats have always been considered very useful animals. They are thought to have been the first animal to be domesticated for economic purposes [1]. There is a huge variation of size, color and hair type among breeds of goats. Goats are highly adaptable to a broad range of climatic and geographic conditions and are more widely distributed than any other mammalian livestock. They contribute to the economies of people in developing countries; like providing for their owners' meat, skins, hairs, horns, bones and manures [2]. Apart from economic values, they are relatively cheap to buy and increasing the number will reduce the probability of losing all animals at once in case of some disaster. Goats reproduce very fast in some cases regularly produce twins and sometimes triples. They can easily be sold in terms of urgent needs such as sickness, death, or payment of school fees [3, 4].

The goats' natural behavior of feeding in different vegetation, the ability to tolerate harsh environment, cheap to purchase, easy to handle make them preferable animals by many livestock producers all over the world, particularly by poor farmers. Despite all these advantages, little attention is given for this animal to improve their productivity in the world in general, in developing countries in particular [1, 4].

In Ethiopia, though, there are about 29 112 963 goats [5]; less attention is given to increase their output. The majority of the populations do exist in lowland under the pastoral production system, where the veterinary infrastructure is scarce. As a result, several goats are easily affected by rampant disease in the area. Among the major diseases which affect goats include external parasites, internal parasites, blue tongue, pest des Petites ruminants (PPR), brucellosis, contagious caprine Pleuropneumonia, etc. are the most common once [4, 6].

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Only a few studies have been carried out in Ethiopia, but these showed that CCPP is prevalent and causes considerable mortality in goats. For instance, between 2011 and 2015, 83 outbreaks affecting 23,950 goats were reported [7, 8].

Contagious Pleuropneumonia (CCPP) is the most important epidemic disease of small ruminants especially goats. It is characterized by severe fibrinous pleura pneumonia with morbidity 100% and mortality ranging from 60 to 100% in the susceptible flock [9]. CCPP is a very precise entity were its limits, its pathogencity in the lung, whereas the other mycoplasmas that affect goats belong to the syndrome "MAKePS" which stands for mastitis, arthritis, keratitis, pneumonia and septicemia [10]. The causal agents of classical CCPP classified as *Mycoplasma capricolum* subsp. *capripneumoniae* (MccP) [9, 11]. This organism is closely related to three other mycoplasmas: *M. mycoides* subsp. *mycoides*, *M. mycoides* subsp. *Capri* and *M. capricolum* subsp. *capricolum*. All three mycoplasmas may confuse the diagnosis of CCPP, because the disease caused by MccP and because they share several serological and biochemical characteristics with MccP [12].

The occurrence of CCPP in Ethiopia has been suspected since 1983. It was confirmed later in 1990 by isolation and identification of MccP [13, 14]. Since then the disease has become endemic in different regions of the country. Today there are repeated outbreaks found in different parts of the country from south to north and east to west with different frequency occurrences. In addition to this, the limited vaccine production, antibiotics shortage, high cost of treatment and scarce veterinary infrastructures aggravated the situation in the remotes part of the country, where more than 75% of the total goat population of the country is reared [14-17].

The farmers depend for their livelihood on goats due to their comparative advantage of short generation interval and high frequency of multiple births rather than other livestock [18]. Goats play a unique role in the livelihood of pastoral communities, especially for women, as they provide milk and dairy products and are a source of income for the family to cover school fees for children and other family expenses. However, their productivity is constrained by many infectious diseases among which contagious caprine Pleuropneumonia is causing major economic losses [6].

In general, the goat population and their important socio-economic role and health of goats, in particular, have received little attention so far [19]. Hence, paying attention to the disease and updating the available findings may contribute a significant role for farmers' livelihood. Therefore the objective of this paper is to collect the available written information about the status and economic importance of the contagious caprine Pleuropneumonia.

Literature Review on Contagious Caprine Pleuropneumonia: Contagious Caprine Pleuropneumonia CCPP is a contagious disease that affects goats. It is a classical disease of goat, which commonly confuse with other serious pneumonia of goat and sheep. Sheep may be affected In CCPP outbreaks affecting mixed goat and sheep herds. Mccp has also been isolated from healthy sheep and their role as a possible reservoir must be considered [20]. Subclinical cases were also reported in sheep and some wild ruminant species [21]. Recently CCPP was confirmed in wild ruminants kept in a wildlife preserve in Qatar. The disease affected wild goats (Capra aegagrus), Nubian Ibex (Capra ibex Nubian), Laristan mouflon (Ovis orientalize laristanica) and Gerenuk (Litocranius walleri) with significant morbidity and mortality in these species [22]. *Mycoplasma capricolum* subsp. *capripneumonia* is now recognized as the cause of this highly contagious lethal disease. It is one of the devastating diseases of susceptible goat population with 100% morbidity and 60 to 100% mortality rate [9, 10, 23].

Etiology: CCPP is caused by mycoplasma strain *M. capricolum* subsp. *capripneumonia* (MccP) [Formerly known as Mycoplasma sp. type F-38] or vaccinal strain [20, 24, 25]. For many years the causative agent of CCPP was considered to be mycoplasma mycoides Capri because this was the agent most commonly isolated from goats with CCPP. However, in 1976 MacOwan and Minette have developed special media and isolated a fastidious new Mccp CCPP outbreak in Kenya and demonstrated that it was a case of a highly contagious form of pneumonia resembling the original description of CCPP by Hutcheon [26] as cited by Nicholas [27].

Epidemiology

Source of Infection and Mode of Transmission: The disease readily transmitted by direct contact through inhalation of infective aerosols, through droplets released during coughing and a very short period of contact is sufficient, but the organism does not survive for long outside of the animal body; therefore, carrier or newly infected animals are the main sources of infection [10, 28]. In extensive husbandry practices, the communal grazing

areas and watering points are the major sites of disease transmission [29]. Outbreaks of the disease often occur after heavy rains and after cold spells. This is probably because recovered carrier animals start shedding the mycoplasma after the stress sudden climatic change [28]. Some animals became latent chronic carriers and thus play an important role in the transmission of the disease. Unlike in the case of CBPP, no sequestra have been described for CCPP. The exact location of mycoplasma in the latent carriers is not known [10].

Factors Associated with the Epidemiology of CCPP.

Host Range: Under natural condition CCPP infect goats. But some study indicates there are outbreaks of CCPP on sheep [30]. CCPP has been reported from various wild animals like wild sheep, wild goat, gazelle, Tibetan antelope, Arabian oryx and sand gazelles [22, 32, 33]. Though CCPP may affect other wild species, the susceptibility of these species to Mccp has not been worked out [34].

Husbandry Conditions: The disease is more serious under intensive husbandry systems. Overcrowding and confinement favor contact and hence the circulation of the agent. In extensive husbandry practices mixing of goats at watering, grazing areas, marketing sites and shelters play a great role in the spread of the infections [35].

Climate and Seasons: The occurrence and severity of CCPP vary seasonally. This is due to the effect of climatic conditions on the agent and the host. Raised environmental temperature and relative humidity predispose to respiratory diseases by favoring the survival and replication of the pathogen and rendering the host vulnerable to infection by lowering its resistance [10].

Immunological Status: In areas where CCPP already occurs, the severity of the disease may depend on different factors: such as; Immune status of the host: *i.e.* an animal that has survived a previous infection thought to be protected; secondly; Intercurrent infection: *i.e.* The occurrence of co-existing disease like viral infection (Orf, PPR), which may favor the development of CCPP, as immune status is compromised by concurrent infection and the third; Stress: *i.e.* Long-distance movement, the overcrowded flock could predispose to the host for infection. The lack of cell wall and endotoxins probably enables mycoplasmas to colonize the host without an aggressive immune response. The predilection of these organisms on mucosal surfaces must also limit the effectiveness of the humeral immunity. The majority of naturally infected goats with lesions have a detectable response but they appear to be no relationship between antibodies titer as measured by CFT and severity of lesions [10].

Clinical Signs: Clinical signs are restricted to the respiratory system and include; weakness, anorexia, cough, hyperpnoea and nasal discharge accompanied by fever (40.5°C-41.5°C) are often found. Exercise intolerance and eventually respiratory distress including open-mouth breathing and frothy salivation, develop. Septicemia from the disease without specific respiratory tract involvement has been described [29]. Affected animals normally have generalized signs such as depression, dullness, weakness and lethargy, pyrexia and weight loss and decreased production. They will also have respiratory signs including bilateral nasal discharge, dyspnoea, tachypnoea and coughing. Occasionally the only sign seen is sudden death. Typical pathological lesions are very suggestive of the disease - they are localized exclusively to the lung and pleura. Lungs are normally a port wine color and abundant pleural exudates and pleurisies and adhesions are common. The pleural exudates may have solidified forming a gelatinous covering. In later stages, severe lobar fibrinous Pleuropneumonia, profuse fluid accumulation in the pleural cavity, severe congestion of lungs and adhesion formation may occur [36].

Post Mortem Findings: The lesions are confined to the thorax. Typically, this contains an excess straw-colored fluid and there is acute fibrinous pneumonia with overlaying fibrinous pleurisy. Consolidation is sometimes confined to one lung [37]. The affected lung is enlarged, firm and edematous, varying in color from gray to red, these colors forming a mosaic. Evolving lesions are characterized by round foci of hepatization with a gray pinpoint center of necrotization and dark red hyperemic margins, which contrast markedly with the pink unaffected lung [38].

Diagnosis: The CCPP has often been considered difficult. This is because of the confusion that can arise from other mycoplasmosis of small ruminants. Symptoms and lesions are similar and isolation of MccP requires skilled technicians [38]. The clinical signs, epidemiology and necropsy findings are used to establish a diagnosis. The causative organism should be isolated and identified,

but isolation may be difficult and special media is required for culture [39, 40]. The organism has a branching, filamentous morphology in exudates, impression smears or tissue sections examined under the microscope. Other caprine mycoplasmas usually appear as short filamentous organisms or coccobacilli. Biochemical, immunological and molecular tests can be used for the identification of the culture [20].

Polymerase chain reaction PCR, which can be carried out directly on the pleural fluid or affected lung, has greatly facilitated the diagnosis of contagious caprine Pleuropneumonia [39, 40]. It is the preferred assay to identify M. capripneumonia cultures and to directly identify the organism in tissue samples. There are two specific PCR assays as well as a recently developed quantitative PCR assay. Recently polymerase chain reaction-based tests have been described and shown to be specific and sensitive and can be applied directly to clinical material, such as lung and pleural fluid [39-41].

Immunohistochemistry can identify *M. capripneumoniae* antigens in tissue samples, but it is not routinely used in diagnostic laboratories. At necropsy, samples from active lung lesions should be collected for culture and histopathology. These samples should be taken from the interface between consolidated and unconsolidated areas. Samples of pleural fluid, exudates from lung lesions and regional lymph nodes should also be collected. Tissue samples for virus isolation should be collected aseptically, placed in a transport medium, kept cold and shipped to the laboratory on ice packs. Samples should be frozen if they will not reach the laboratory within a few days; if necessary, samples can be stored at -20°C for months with little apparent loss of mycoplasmal viability. Paired serum samples should be collected 3-8 weeks apart [20].

Serology has not been widely applied to identify the cause of outbreaks of Pleuropneumonia in goats and Sheep, due to the occurrence of false-positive results and that acute cases caused by Mccp rarely show positive titers before death. Such tests are best used on a herd basis rather than for diagnosis in individual animals. Serological tests for antibody detection are complement fixation, passive hemagglutination and ELISA; the latex agglutination test (LAT) can be carried out in the field directly on whole blood as well as serum samples in the laboratory. Serologic cross-reactions may occur with other members of the *Mycoplasma mycoides* cluster. The disease should be differentiated from diseases like pasteurolosis, peste des Petite's ruminants and other mycoplasmal pneumonic conditions [20, 42, 43].

Treatment: Treating diseased animals with broad-spectrum antibiotics (mainly tetracycline or antibiotics belonging to the macrolide group, such as tylosin and spiramycin) are effective although early-stage gives the good result [20, 28]. Goats usually kept by smallholders can be treated because of their small size, but it is difficult to eradicate based on treatment in large flock sizes. The recommendations of the manufacturer must be followed carefully, especially the dosage and the duration of the treatment, even though symptoms might disappear rapidly [44].

Control and Prevention: Disease control can be achieved if there is strict control of animal movement and a prohibition of the importation of live animals from infected regions (countries) because contagious caprine Pleuropneumonia is most likely to enter a country in infected animals. It is uncertain whether long-term subclinical carriers exist; however, some outbreaks in endemic areas have occurred when healthy goats were introduced into flocks. Outbreaks can be eradicated with quarantines, movement controls, the slaughter of infected and exposed animals and cleaning and disinfection of the premises. In endemic areas, care should be taken when introducing new animals into the flock. Flock testing, slaughter and on-site quarantine may help control the spread of disease [20, 38].

Vaccines help prevent disease in some countries [20]. An inactivated vaccine with saponin, which is used as an adjuvant, protects goats for approximately a year has been produced in Kenya [38]. In the former Soviet Union and China, aluminum-hydroxide formalin vaccines have been applied [44]. The current CCPP vaccine which is available commercially contains inactivated Mccp suspended in saponin, has a shelf life of at least 14 months and provides protection for over 1 year [20, 45].

Economic Loss Associated with CCPP: Contagious caprine Pleuropneumonia is one of the most fatal and contagious diseases of goats. It causes major economic losses in Africa, Asia and in the Middle East [46-48]. Economic losses are both by morbidity, mortality and decline or loss of production performance in addition to costs involved in the prevention, control and treatment [49, 50]. Morbidity and mortality can be as high as 100% especially in exotic breeds [48, 51]. In naive and native herds, 100% morbidity and 80% mortality have been noted. It is estimated that the total yearly cost of CCPP is about US$507 million in endemic areas thus involving major economic losses. The loss of production

performance is severe. The disease causes huge economic losses to traditional farmers which are directly dependent on traditional farming [49, 52]. A loss of around 30% in Pashmina yield in CCPP affected goats and a benefit-cost ratio of 0.79 in untreated animals against 8.76 in treated animals has been reported in India [49].

CONCLUSION AND RECOMMENDATIONS

Contagious caprine Pleuropneumonia (CCPP) is a serious disease of goats, occasionally sheep and wild ruminants, caused by *Mycoplasma capricolum* subspecies *capripneumoniae* (Mccp). It is found to be the most economically important disease in the Middle East, north and east Africa and Asia but has no zoonotic impact. The disease causes high morbidity and mortality rates on the flock. Therefore, control measures including routine vaccination and movement control measures should be implemented. Strengthening of veterinary infrastructures at the grass-root level is necessary to provide immediate service during outbreaks in the remotest part of the country, where market access for drug purchase and private veterinary service is scarce. Attention must be given for sheep as it could be a source of infection for *mycoplasma capricolum subsp. capripneumonia* and *Mycoplasma mycoides subsp.* small *mycoides* colony. Thus CCPP control program should include the control in sheep too.

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