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Epidemiology and risk factors of contagious caprine pleuropneumonia in the Republic of Chad

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Abstract

Contagious caprine pleuropneumonia is a bacterial infection of goats. It is caused by a bacterium belonging to the Mycoplasmataceae family and the *Mycoplasma genus*. Causative agent of the disease is *Mycplasma capricolum subspecies capripneumoniae* (Mccp). This disease causes significant economic losses in Asia and Africa. Because of the very high morbidity and mortality and its socio-economic impact, contagious caprine pleuropneumonia is on the OIE list of notifiable diseases. This disease affects mainly goats and occasionally sheep, but also wild ruminants. Contagious caprine pleuropneumonia is characterized by cough, dyspnoea and very high mortality and morbidity, fibrinous pleuropneumonia, unilateral lung hepatization and accumulation of pleural fluid in the thoracic cavity. Animals are infected by inhalation of dropes expelled by sick animals. Direct contact is essential for infection to occur. The porosity of borders shared with other countries and the lack of financial resources allocated to the national animal disease surveillance system make it difficult to control cross-border livestock movements. This exposes the national herd to various infectious diseases, including contagious caprine pleuropneumonia. Cross-border movements linked to the international trade in animals, to transhumance, as well as to insecurity due to existing hotbeds of tension in African countries, lead to massive movements of herders and animals in search of pastures and water. All of this constitutes risk factors for the introduction and spread of viral and bacterial infections in the countries. The objective of this manuscript is to summarize the epidemiology and risk factors of contagious caprine pleuropneumonia in Chad based on bibliographical data.

Keywords: *Mycoplasmas*; Contagious Caprine Pleuropneumonia; Goats; Sheep; Epidemiology; Chad

1 Introduction

The rearing of small ruminants is one of the main income-generating activities for rural populations in African countries. The role of this breeding in the reduction of the deficit in proteins of animal origin is important [1]. Among Central African countries, The Republic of Chad is considered as excellent breeding country. It has nearly 94 million head of cattle of all species except poultry. Among these 94 million, there are 57 million or 60.6% of small ruminants [2]. Thanks to their high level of adaptation, their ease of maintenance, their adaptation to difficult conditions and their socio-cultural role, sheep and goats are raised in almost the entire national territory of Chad. However, several factors limit the development of this breeding, in particular contagious caprine pleuropneumonia (CCPP), which is one of the main priority diseases indicated on the list of diseases monitored by the Epidemiological Animal Disease Surveillance Network/system in Chad (REPIMAT) set up in 1995. [3]. In sub-Saharan Africa, where the deficit in protein of animal origin is remarkable, the breeding of small ruminants occupies an important place in the animal production system. It can be noted that everywhere in Africa, sheep and goats represent an important part of the national herd [4]. Therefore, they are important resources not only in terms of the economy of livestock products, but also for all of these countries.

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Small ruminants have an ability to produce meat, milk and other products, even under particularly difficult ecological conditions. This gives them a special importance in the lives of traditional breeders and peasants. Sheep and goats are prolific and hardy animals that adapt more easily than cattle to the difficult conditions encountered in the Sahelian zone. The breeding of these animals constitutes a significant nutritional contribution because their milk and meat provide an important part of the protein ration of the rural populations. They constitute an easily mobilized cash-flow for current expenses. Finally, they allow breeders to capitalize often used during an epizootic phenomenon decimating the cattle herd, namely rinderpest episode of 1983-1984 [5].

In The Republic of Chad, livestock is one of the main sources of income because it generates an annual cash-flow of more than 140 billion F/CFA, an added value of 210 billion F/CFA and contributes up to 35% of agricultural GDP [6]. It supports 40% of the rural population and employs 80% of the working population. Apart from the oil sector, it contributes between 30% and 50% of national exports [6]. This breeding is 80% dominated by mobility (transhumance/pastoralism). It is an extensive and mixed breeding (cattle, camels, sheep and goats). The transhumant livestock system favors the introduction and spread of infectious diseases, in particular contagious caprine pleuropneumonia (CCPP).

Subsistence is the primary objective of small ruminant keeping in Africa; meat and milk are consumed and surplus males are either sold to provide cash inflows or kept in the herds as broodstock [4].

Despite the economic importance of small ruminants, the major constraint identified to their production in Africa has been the appearance of infectious diseases, including contagious caprine pleuropneumonia, peste des petits ruminants, pasteurellosis, etc. [7; 8; 9; 10; 11].

It should be noted that respiratory pathologies are a major concern in the agropastoral system. Several infectious and non-infectious factors contribute to this. Regarding the infectious factors, we can cite viral and bacterial infections. According to Traoré [12], small ruminants could contribute more to being better breeders if they did not pay a heavy price for both infectious and non-infectious pathologies. The porosity of borders shared with other countries and the lack of financial resources allocated to the national animal disease surveillance system make it difficult to control cross-border livestock movements. This exposes the national herd to various infectious diseases such as contagious caprine pleuropneumonia and others. Cross-border movements linked to the international trade in animals, to transhumance, as well as to insecurity due to hotbeds of tension that exist in African countries, lead to massive movements of herders and animals in search of pastures and water points. All of this constitutes risk factors for the introduction and spread of viral and bacterial infections in these countries. Indeed, contagious caprine pleuropneumonia is a bacterial infection of goats. It causes significant economic losses in Africa and Asia. Based on bibliographic data, this manuscript summarizes the epidemiology and risk factors of contagious caprine pleuropneumonia in the Republic of Chad.

2 Epidemiology of the disease

Contagious caprine pleuropneumonia has so far only been found in goats, In these animals, the disease causes significant economic losses [13]. Because of the very high morbidity and mortality and its socio-economic impact, CCPP is on the OIE list of notifiable diseases [14].

2.1 Etiology

CCPP is caused by bacteria belonging to the class Mollicutes, order Mycoplasmatales, family Mycoplasmataceae and genus *Mycoplasma* [35; 34]. This genus has no wall [38; 45]. The causative agent of CCPP is *Mycplasma capricolum subspecies capripneumoniae* (Mccp), strain F_{38} [19]. *Mycoplasma capricolum* subspecies *capripneumoniae* (Mccp) is close to three other *Mycoplasmas* namely: *Mycoplasma mycoides* subspecies *mycoides* Large Colony, responsible for contagious pleuropneumonia in cattle, *Mycoplasma mycoides* subspecies *capri* and *Mycoplasma capricolum* subspecies *capricolum*, all responsible for the syndrome of *Contagious agalactia* of small ruminants [41].

2.2 Affected species

The disease mainly affects goats and occasionally sheep, but also wild ruminants [31]. In a game reserve in Qatar, the following species were recognized as infected with significant morbidity and mortality: wild goat (*Capra aegagru*), Abyssinian *ibex* (*Capra ibex nubian*), Laristan mouflon (*Ovis orientalis laristanica*), Gerenuk (*Litocranius waleri*). In mixed herds of goats and sheep, the latter may be infected, but clinical expression is often limited to goats and the sheep may simply act as a reservoir for the disease. CCPP usually affects goats. However, Litamoi et al. [44] isolated Mccp from sheep that were in contact with sick goats. This germ has also been isolated from wild animals in captivity [31] as well as from cows with mastitis [43].

2.3 Clinical manifestations

CCPP is characterized by cough, dyspnea and very high mortality and morbidity, *fibrinous pleuropneumonia*, unilateral lung hepatization and accumulation of pleural fluid in the thoracic cavity [26]. The incubation period of Mccp varies from 2 to 28 days with an average of 10 days [53]. The disease exists in 3 forms: Pperacute, acute and chronic forms.

- In the peracute form, affected animals die between 1 and 3 days with minimal clinical signs [33].
- The acute form shows the following clinical signs: high fever (41-43°C), very high mortality and morbidity, anorexia, dyspnoea and abortion in pregnant females [23]. Lesions are strictly restricted to the lungs and pleura [20]. Breathing is accelerated and labored, often accompanied by rattling. The cough is frequent, violent and productive [21]. In the terminal stage, the animals are unable to move, remain upright with the forelimbs apart, the neck stiff and extended and sometimes saliva flows from the mouth.
- In the chronic form, the symptoms are similar to the acute form but with less expression [26]. The clinical signs last up to about 3 weeks, there is debilitation, chronic cough, discharge, fever and painful breathing [33].

2.4 Transmission

CCPP is transmitted directly between infected and healthy animals; transmission occurs by inhalation of contaminated aerosols [24]. The disease can therefore be disseminated by introducing a sick animal into the herd [23]. No indirect transmission has been reported so far because the causative agent is very fragile in the environment [25]. The disease can occur when animals are weakened or tired, especially after heavy rain, or when animals are transported over a long distance [23]. Some animals become latent chronic carriers, so they may play an important role in disease transmission [36].

2.5 Geographical distribution

Since its description in Algeria in1873, the disease was introduced into the colony of Cape Town (South Africa) with a shipment of Angora goats in 1881. It was then eradicated by a policy of slaughter associated with the vaccination of goats that had been in contact with the sick animals [22]. It is now an epizootic present in many countries in Africa and Asia, where it causes significant economic losses. The exact extent of its spread is difficult to assess because its diagnosis is difficult and it is often confused with other respiratory pathologies.

According to Manso-Silvan et al. [14], Nicholas and Churchward [53], CCPP is found in many countries in Africa, Europe, the Middle East and Asia. In Africa, Mccp has been isolated in Chad, Sudan, Uganda, Kenya, Tunisia, Ethiopia, Niger, Tanzania, Eritrea, United Arab Emirates and Mauritius (16; 22; 17 ; 29; 32; 38; 51] .

2.6 Diagnosis

2.6.1 Clinical diagnosis

The clinical diagnosis is based on the typical clinical signs observed. However, it is difficult to achieve due to the presence of multiple other *Mycoplasmas,* which can affect the same host and cause similar symptoms, there are no pathognonomic symptoms. In all cases, the high contagion with a high rate of mortality (80%) and morbidity calls for CCPP [18] as well as a high mortality associated with thoracic attack in goats [42]. In agreement with Nicholas et al. [20], CCPP would be strongly suspected if:

- The lesions are strictly restricted to the lungs and pleura and suggestive of pleuropneumonia;
- the contagion is strong, with a high rate of mortality and morbidity;
- there is no widening of the interlobular septum.

Since respiratory Mycoplasma infections have similar clinical features, post-mortem diagnosis can differentiate between CCPP and other infectious diseases. This is why surveillance of the disease at slaughterhouse level is essential. In all cases, laboratory diagnosis with the isolation of Mccp or positive serology must be used to confirm or invalidate the diagnosis.

2.6.2 Laboratory diagnosis

Laboratory diagnosis called definitive diagnosis requires the culture of the causal agent from samples of lung tissue and/or pleural fluid taken after the death of the animal. Laboratory diagnosis makes it possible to remove the ambiguity on the suspicion expressed in the field.

2.6.3 Samples

The sample to be taken consists of lung lesions, pleural fluid and mediastinal lymph nodes in a post-mortem situation. All these must be kept cold (+4°C) to preserve the viability of Mycoplasmas [21].

Observation under a darkfield microscope of exudates or tissue suspensions obtained from lesions or pleural fluid, Mccp exhibits a branching filamentous morphology. The other goat Mycoplasmas appear in the form of short filaments or *coccobacilli*.

Apart from the isolation of Mccp, laboratory diagnosis is also carried out by the following tests:

- PCR can be applied directly to tissues such as lung and pleural fluid [18; 25; 26]
- the polyacrylamide gel electrophoresis test makes it possible to highlight the Mccp proteins present in exudates and pleural fluid.
- immunoperoxidase test.

To these tests are added the serological tests, which are:

- Immuno inhibition test;
- Hemagglutination reaction;
- Complement fixation reaction;
- Immunodiffusion reaction in gel medium;
- Immunofluorescence test;
- Competition ELISA test.

2.6.4 Differential diagnosis

The differential diagnosis of CCPP in the field seems difficult because of the susceptibility of goats to several species of *Mycoplasmas* whose clinical signs are similar. Nevertheless, CCPP can be suspected when the lesions are restricted to the airway and only affect one lung [22]. It must therefore be differentiated from pathologies such as Peste des Petits Ruminants, which affect both sheep and goats; Pasteurellosis, which differs in the distribution of large lung lesions, and *Contagious Agalactia* Syndrome, where breast involvement is more pronounced [26].

2.7 Treatment and prophylaxis

According to El Hassan et al. [40], tylosin, streptomycin and oxytetracycline showed positive effects in the treatment of goats against CCPP. But beware, treating animals with broad-spectrum antibiotics does not free them from the germ.

Medical prophylaxis consists of vaccinating the herd. For this purpose there are inactivated and attenuated vaccines.

- The inactivated (killed) vaccine contains a suspension of inactivated Mccp in saponin. The latter confers immunity for about 12 months [30].
- The freeze-dried attenuated vaccine based on Mccp confers 100% protection against mortality and 95% protection against clinical signs caused by this agent [15].

Apart from medical prophylaxis, there is also sanitary prophylaxis, which consists in applying the classic sanitary measures (segregated sick animals and their treatment with antibiotics or slaughtered), but which seem very insufficient and impossible in the context of traditional breeding where animals are often on move (transhumance), herds are scattered and animal owners are often uneducated in animal health.

2.8 Disease risk factors

Ignorance of the disease and because of its absence on the territory, its potential chronic forms due to the use of antibiotics and the presence of pathogenic agents in asymptomatic alternative hosts are all factors that could promote its spread at low noise Gaurivaud et al. [29]. Several factors can favor the outbreak of CCPP in a herd or in a country or even an entire region. We can cite between:

- Climatic factors (bad weather), cold and large temperature difference between day and night;

- Introduction of a sick animal into the herd, this animal will excrete the *mycoplasmas* by coughing and throwing and by inhalation the healthy animals become infected by the air route;
- Breeding system and the habitat (the animals are kept in the open air and therefore exposed to bad weather;
- Transhumance (movement of animals over a long distance),
- Trade in live animals (export and import);
- Livestock markets where animals come from all walks of life;
- The return of animals to the house due to poor sales;
- Water points where there is a significant concentration of animals;
- Stress caused by transport: these are trade animals.

3 Conclusion

Contagious caprine pleuropneumonia is a contagious disease that mainly affects goats and occasionally sheep. It is caused by a germ called *mycoplasma subspecies mycoplasma capripneumoniae* (Mccp- strain F_{38}).

Mccp is often associated with respiratory pathologies with multiple etiology where other pathogens such as viruses, bacteria and parasites are involved.

Contagious caprine pleuropneumonia is widespread in Africa and Asia where it causes very significant economic losses.

Like other *mycoplasmas*, Mccp is resistant to certain antibiotics and sulfonamides. On the other hand, it is sensitive to oxytetracycline (*terramycin*), *tylosin* and *spiramycin*, if they are used at conventional doses. However, it is not recommended to treat animals with antibiotics.

The outbreak of contagious caprine pleuropneumonia is most often favored by climate change (bad weather), the breeding system and the introduction of a sick animal into a healthy herd.

Compliance with ethical standards

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Disclosure of conflict of interest

Author declares that there is no conflict of interest.

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