D-5972
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REVIEW ARTICLE Agricultural Science Digest,

Contagious Bovine Pleuropneumonia: A Review

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10.18805/ag.D-5972

ABSTRACT

Contagious bovine pleuropneumonia (CBPP) is a bacterial disease, the causative agent of which is *Mycoplasma mycoides subsp. Mycoides*. The CBPP disease is one of important disease to be given attention because it is causing heavy mortality in bovines all over the world with African continent being hardly hit due to vagaries of bacteria. Air droplets is primary source of infection. Colonization in lower respiratory tract, *Mmm* invades arteries cause vasculitis. Many pathways of *Mmm* organism to cause destruction in host animal, presence of Gts ABC is one such mechanism. In CBPP we see pulmonary sequestra in chronic cases, severe fibrinous bronchopneumonia and pleural effusion during the acute to subacute phases. For confirmatory diagnosis, laboratory investigation and use of molecular techniques is recommended. Isolation of causative agent is also optimal method for diagnosis. The use of danofloxacin, tetracycline, flufenicol etc have been documented with varying degree of efficiency. Control over movement of bovine species, adequate space (where droplet spread is prevented) for each animal and vaccination are recommendatory steps. Though India has been declared CBPP free in 2007 we still need cautious approach and continue surveillance because north east of India seems very vulnerable to CBPP. Also, the fact that animal husbandry and agriculture drive economy of some of our most populous states it is all the more important that we give due consideration and focus on CBPP.

Key words: CBPP, Danofloxacin, Lung lesion score, *Mycoplasma mycoides* subsp. *Mycoides*.

Contagious bovine pleuropneumonia (CBPP) is an important infectious disease of respiratory system of cattle, caused by Mycoplasma mycoides subspecies mycoides (Ahsan *et al.*, 2019). The mycoplasmae are gram-negative mollicutes that fall between bacteria and viruses in terms of microbiology. They are made up of cells that are joined together by a plasma membrane and an indiscrete cell wall. These pathogens are extracellular; they can live as commensals or as pathogens on mucosal membranes. Gram-negative mollicutes, mycoplasmae are categorized as bacteria or viruses in microbiology. They are made up of cells with an indiscrete cell wall and a plasma membrane bond. Extracellular pathogens that are either commensals or pathogens have a preference for mucous membranes (Shaheen *et al.*, 2024).

Contagious bovine pleuropneumonia (CBPP), foot and mouth disease (FMD) and rinderpest, are three major cattle plagues in history. Cattle have been at risk from enzootic illnesses ever since they were domesticated. Nocard and Raux were the first to isolate the causative agent of CBPP (Prosperi and Pini 1991). The first unambiguous description of the disease may well be that of B de Haller in Switzerland in 1773. (Haller B 1773). Reported 1st in 1693 in Germany. CBPP-India- In India, particularly in Assam there were, 30 cattle deaths reported in 1932, were the first confirmed cases of CBPP. Illness that is locally referred to as “Brahmaputra Valley Disease.” However, the mycoplasma was not isolated or found because there were insufficient culture capabilities. (Shirlaw and Iver, 1946). Acute, subacute, clinically imperceptible, or chronic CBPP disease is defined by the development of extensive pathological alterations in the thoracic organs, particularly the lungs and pleura. Significant interlobular septal edema, widespread pneumonia and sero-fibrinous pleuritis are among the abnormalities (Chakravarthy, 2007).

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How to cite this article: Wagh, K. (2024). Contagious Bovine Pleuropneumonia: A Review. Agricultural Science Digest. 1-10. doi: 10.18805/ag.D-5972.

Submitted: 19-02-2024 **Accepted:** 07-09-2024 **Online:** 13-11-2024

Etiology

Mycoplasma mycoides subsp. mycoides small colony (MmmSC) is the cause of contagious bovine pleuropneumonia (CBPP) (Belinda *et al.*, 2018). The pleomorphic organisms, some of which are filterable, are easily maintained in special culture media and in the eggs of embryonated hens. The ‘Mycoplasma mycoides cluster’ comprises 6 important ruminant mycoplasmas, of which only 2 are known to cause disease in cattle: Mycoplasma bovine group 7 (Bg7), which can cause bovine mastitis and arthritis and two subspecies of Mycoplasma mycoides species. The other 4 are responsible for respiratory and other ailments in goats (Radostits *et al.,* 2007). Although Mmm requires certain medium to develop, it is not thought of as a sensitive mycoplasma. Although various reference laboratories use different media compositions, all of them should fundamentally include a basic medium, such as PPLO broth (pleuropneumonia-like organisms) or heart-infusion broth, 1-2.5% yeast extract, 10%-20% inactivated horse serum, 0.1% glucose, 1% tryptose and 0.0024% DNA (WOAH

Terrestrial Manual, 2021). Disinfectants, acidic and alkaline pHs, heat and a brief environmental survival period (up to 2 weeks) can all readily deactivate *Mmm*. Two (2) epidemio-geographically separate clusters of *Mmm* strains were identified in 1995: one (1) cluster included strains isolated from several European nations and the other cluster had strains from Australia and Africa (Vilei *et al.*, 2000). Epidemiological and clinical investigations revealed that CBPP outbreaks of European origin are less virulent when compared with those observed in Africa. (Alhaji *et al.*, 2020). Because mycoplasmas lack cell walls, they are vulnerable to the environment and resistant to antimicrobials that damage cell walls. Their mutation rates are higher than those for typical bacteria, establishing that they can quickly become resistant to antimicrobials such tylosin and oxytetracyclines (Ayling 2013) (Masiga and Read 1972). PCR tests have revealed that three primary lineages are distinct from Europe, Southern Africa and the remainder of Africa. (Belinda *et al.*, 2018).

March *et al.* (2000) assessed the doubling time of bacteria Mmm and concluded to obtain a more quantitative estimate of the growth rate of strain M375 (Africa, recent isolate), growth curves with GB were performed and the doubling times of various strains were measured. Strain M375 grew significantly more slowly than the other strains (P<0.01 with the exception of KH_3J (Africa, vaccine strain), for which P<0.05), with a mean doubling time of 346 min. For most other strains the doubling times were in the range of 168 to 229 min. The only exception was Gladysdale (Australia, challenge strain), with a mean doubling time of 101 min, significantly faster than the other strains (P<0.01).

Epidemiology

Occurrence and prevalence

Plenty of domestic and wild ruminants have been shown to be susceptible to Mmm infection; however, only cattle (*Bos taurus*) and zebuine cattle (*Bos indicus*) have been shown to be significant in the CBPP epidemiology (Masiga *et al.*, 1996). Animals under 3 years old are also more susceptible and European breeds appear to be more susceptible than African types. In zoos, illnesses have been observed in water buffalo and bison, as well as yaks. Camels and wild cattle are resilient (Gladon *et al.*, 2006). Its range in Africa extends from the Atlantic to the Indian Ocean and from the Tropic of Cancer to the Tropic of Capricorn, all south of the Sahara. Recent reports of CBPP have come from Bangladesh, Myanmar and Assam in India. 49 (8.75%) of the 560 serum samples taken from cattle that were analyzed by (Ahsan *et al.,* 2019) tested positive for CBPP. Jhang (10.25%) had the highest prevalence, followed by Lahore (8.26%) and Kasur district (8.20%), although not substantially.

There have been documented sporadic outbreaks in the Middle East, most likely caused by the importation of livestock from Africa. In 1892, the CBPP was eliminated in the United States; in 1904, Zimbabwe; in 1924, South Africa; in 1972, Australia and in the 1980s, China. (Recognising Cbpp FAO, 2002). While some suggested the disease might have been present approximately the start of the 20th century, Rao conjectured that it might have existed in Assam as early as 1919 (Rao, 1969).

The Index case of CBPP was recorded in Golpara district of Assam in 1942. About 7.500 km^2 of cattle in Asom were afflicted by the CBPP infection, out of a total population of 1.25 million. It caused a significant percentage of the northeastern region's cow population to die, resulting in significant financial losses. Approximately 12,000 cattle perished between 1951 and 1978, posing a threat to the lives of all cattle in the northeastern states of the nation. (Singh and Rana, 2014). India was proclaimed to be temporarily free of the illness, with effect from October 2003. In accordance with OIE decision number 17 (Nicholas, 2023), the WOAH proclaimed India free of CBPP infection on May 26, 2007, seven years later.

Source of transmission

The primary means of transmission for contagious bovine pleuropneumonia is inhalation of aerosolized respiratory tract droplets from diseased animals; close and frequent contact is usually necessary. Additionally, the organism may be transmitted tran-splacentally and can be detected in the saliva, urine, foetal membranes, or uterine secretions of infected animals (Belinda *et al.*, 2018). CBPP is common in elderly animals may be caused by the likelihood that older animals may be exposed to infections for longer periods of time, a lower level of immunity as people age and the persistence of sequestrum in older animals relative to younger ones, which may benefit somewhat from maternal protection (Dar *et al.*, 2017; Geetha *et al.*, 2015).

The causative agent is present in liquid droplets in breath and urine. Although the CBPP organisms are killed rapidly in hot dry environments, airborne transmission appears possible over distances of up to 200 metres. (Recognizing CBPP FAO, 2002). Closely stabled or trucked animals are more likely to contract Mmm infection, the more than hundred metres transmission is seldom observed. (Marobela-Raborokgwe *et al.*, 2003). (Nicholas *et al.*, 2007) The organism was found in the semen and preputial washings of two young bulls that were intended for introduction into a breeding facility. The bulls were the offspring of frozen embryos transplanted into Portuguese cows. (Radostitis *et al.*, 2007).

Transplacental transmission has been suggested with the isolation of Mmm from the foetus of an infected dam Masiga *et al.*, (1975). Urine has been proposed as a potential method of transmission, particularly in temperate European countries where cattle are intensively raised in confined areas and multiple herds share a single stream (Grieco *et al.*, 2001). It has been documented that an infection can spread from the cow to the foetus (Gladon *et al.*, 2006).

Economic importance

Being the only bacterial illness included in the old world Organization for Animal Health (OIE) List "A" Diseases grouping that required urgent outbreak reporting. It is a disease of great economic significance that has the potential to jeopardize food security in endemic areas (Tambi *et al.*, 2006). In endemic African countries, the projected cost of CBPP due to mortality, decreased livestock production and disease management efforts is €44.8 million/year (€3.7 million per country) (FAO, 2002) (Muuka *et al.*, 2013).

Pathogenesis

For naturally infected animals, the incubation period might be anywhere from 3 weeks to 6 months. (WOAH Terrestrial Manual, 2021). Cattle that are infected with the organism experience substantial morbidity and death rates due to mycoplasmemia, which is caused by the invasion of the lungs and subsequent localization in the brain and kidneys, among other places. A crucial aspect of the disease's pathophysiology involves thrombosis in the pulmonary arteries, most likely occurring before pneumonic lesions manifest (Radostitis *et al.*, 2007). Teodoro *et al.* (2020) segmented the CBPP pathogenesis into consecutive, interconnected stages.

Adhesion to and Invasion of the Host's Cells and Tissues

Animals inhale droplets containing the CBPP etiological agent, which is the main way that illnesses spread. Consequently, the initial pathogenetic stage, which is essential for the host's successful colonization, is represented by Mmm adherence to the airway cells (Nicholas *et al.*, 2007) (Pilo *et al.*, 2007).

Mmm prefers to attach itself to the non-ciliated cells that line the alveoli and the bronchioles, which are the first areas to become infected (Teodoro *et al.*, 2018).

Pilo *et al.* (2007) explained and represented the virulence pathways of M. *mycoides subsp. mycoides* SC (Fig 1), as represented above, according to which there are main pathway or upper pathway is based on glycerol import and metabolism.

There is no concrete proof of the bypass mechanism that permits glycerol to diffuse through the glycerol facilitator factor (GlpF) and be phosphorylated by the glycerol kinase (GlpK). The key player in this virulence pathway is the membrane-located L-aglycerophosphate oxidase (GlpO) (Fig 2).

Variable surface antigen (Vmm) elude's the host's immune system. Mycoplasma species generate capsular polysaccharide and trigger the production of cytokines. Due to its superantigen-like characteristics, lipoprotein LppQ is extremely antigenic and appears to be involved in the development of inflammatory processes. African strains of Mmm are more likely to be virulent than European strains, as evidenced by their greater GtsABC efficiency and higher ROS production (Abdo *et al.*, 1998). It is well known that mycoplasmas cause phagocytic cells to produce reactive oxygen species (ROS), which may intensify tissue and cell damage (Fig 2) (Koppel *et al.*, 1984).

Inflammation and collateral damage

One of the most crucial and initial lines of defence against bacteria that invade the lower respiratory tract are alveolar macrophages. Alveolar macrophages produce a variety of chemical mediators that help regulate the inflammatory response in addition to their phagocytic and microbicidal actions (Grommes and Soehnlein, 2011).

There are currently insufficient and contradictory data available regarding Mmm. In fact, following in vitro stimulation with Mmm or galactan, respectively, macrophages can create pro-inflammatory (TNF-a) or anti-inflammatory (interleukin [IL]-10) cytokines. (Jungi *et al.*, 1996; Tott´e *et al.*, 2015).

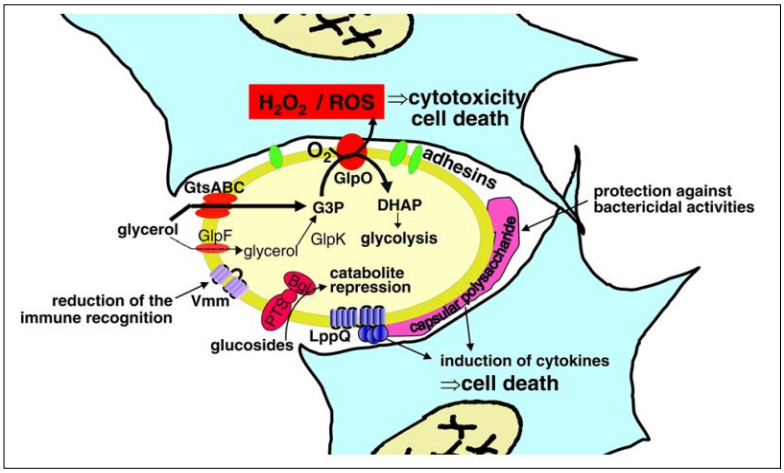


Fig 1: Pictographic representation of infectious pathways of *M. mycoides subsp. mycoides* SC (Pilo *et al.*, 2007).

Immune-Mediated Mechanisms in the Pathogenesis of CBPP

Lymphoid proliferation, often arranged as follicles (so-called “tertiary lymphoid follicles”), is among the main features of mycoplasma infections (Teodoro *et al.*, 2020).

Mycoplasmas have been found to cause mucosal infiltration of lymphocytes in a well-organized manner: B lymphocyte infiltration occurs and becomes dominant later, with the antigenic variation of mycoplasma lipoproteins likely inducing a long-term stimulation of the immune response; CD4+/ TCR helper T cells and CB8+/TCR cytotoxic T lymphocytes arrive at 2 to 3 weeks pi (Castro-Alonso *et al.*, (2009). Helper T cells significantly contribute to the synthesis of interferon-g (IFN-g), which is thought to be protective during CBPP (Dedieu *et al.*, (2006).

Clinical signs

There are four ways that CBPP might present itself: hyperacute, acute, subacute and chronic. Up to 10% of the infected herd may be affected by the hyperacute type, which manifests at the beginning of disease outbreaks and frequently results in abrupt death without other clinical symptoms. The acute type, which typically lasts five to seven days and is marked by fever, self-isolation from the herd, anorexia and painful, laborious breathing and dyspnea is noticed (Fig 3), affects about 20% of the affected cattle. Additional symptoms that could be seen include “grunting” on expiration and breathing from the abdomen. Cattle that are impacted may experience a harsh, dry and shallow cough, edema (Fig 4) which is frequently noticed when they exercise. When pressure is placed between the ribs, affected animals may cry out in agony and occasionally may respond violently (FAO, 2002).

Belinda *et al.* (2018) also concluded that for CBPP, the incubation time varies from a few weeks to many months. Depression, anorexia, pyrexia, dyspnea, tachypnea, nasal discharge, coughing and open-mouth breathing are examples of clinical symptoms. Adult animals that are affected may stand with their necks extended and their elbows bent, arthritis is also evident (Fig 5). Rales, friction rubs (Radostitis *et al.* 2007; Nehra *et al.*, 2018) and crepitant noises can all be detected by thoracic auscultation. The degree of lung involvement and fluid accumulation can also affect lung sounds, causing dull sounds to be auscultated upon percussion over more ventral parts of the thorax. After recovering from pneumonia, some animals may develop persistent shedding as asymptomatic carriers (Belinda *et al.,* 2018).

Necropsy finding and histopathology

The evaluation of ad hoc lung lesion scoring systems is desirable due to the distinct pathological characteristics of CBPP. A particular technique to score CBPP lesions in this regard created to evaluate the efficacy of vaccination against CBPP wherein, the scoring system had been developed where researcher allotted two points for acute or necrotic lesions; one point for healing process. Such scores were

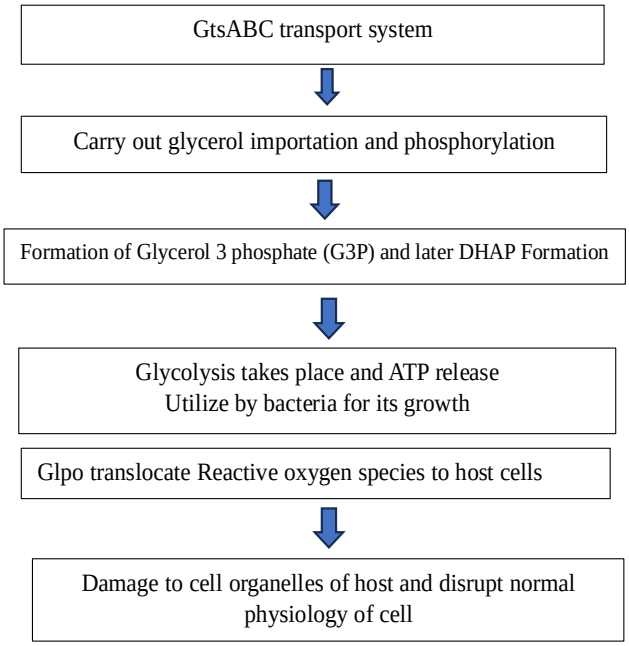


Fig 2: Flow chart-based representation of glycerol imports and metabolism of M. *mycoides subsp. mycoides* SC aiding in virulence. (Pilo *et al.*, 2007).

Fig 3: Dyspnea being exhibited by animal.

Fig 4: Intermandibular edema in Cbpp infected animal (Teodoro *et al.*, 2020).

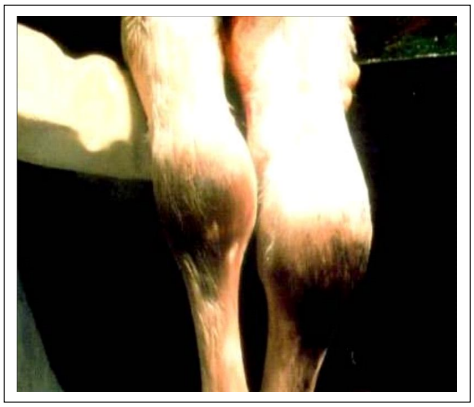


Fig 5: Bent elbows and symptomatic arthritis in Cbpp infected animal (Teodoro *et al.*, 2020).

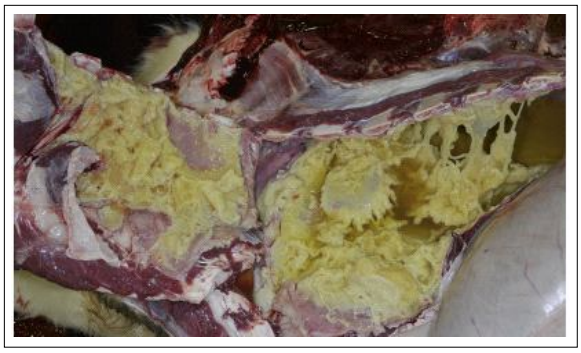


Fig 6: Straw-colored fluid in the hemi thoracic cavity and coalesce to create fibrinous clots (Belinda *et al.*, 2018).

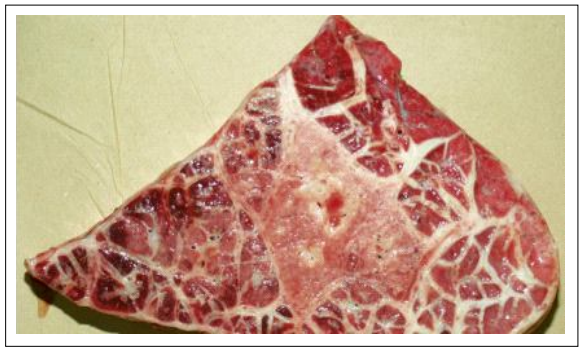


Fig 7: Lung lobules marbled appearance, consolidation with dilated interlobular septa. (Belinda *et al.*, 2018).

Fig 8: Cow mediastinal lymph node acute CBPP. Massive caudal mediastinal lymph node hypertrophy.

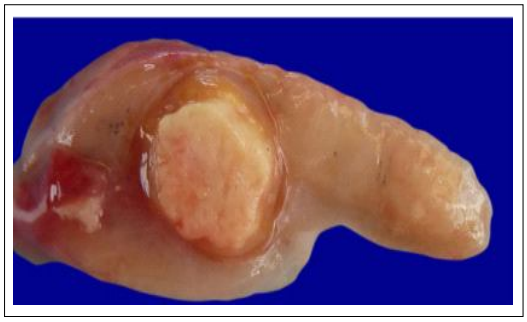
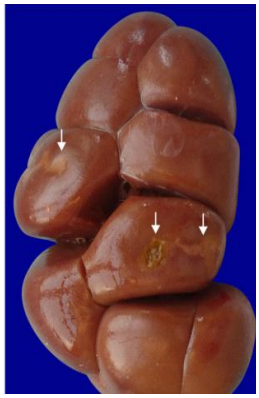


Fig 9: CBPP, mediastinal lymph node, cow. A small sequestrum is present.



Several infarcts (white arrows) are evident. Organization of the perivascular for CBPP, foci, also known as "organizing centers," located in the interlobular septa, are thought to be pathognomonic (Ferronha *et al.*, 1988).

Fig 10: CBPP, kidney, cow.

multiplied by a severity factor (1 to 3) according to the size of the lesions. Possible scores = 0, 1, 2, 4. and 6 (Turner, 1961).

Provvido *et al.* (2018) evaluated a novel lung score system for the CBPP, as there are number of lung affections, such as straw-coloured fluid accumulation and marbled appearance of lungs (Fig 6 and Fig 7) as well as lymph node affections such as hyperthrophy, lymphadenopathy as well as infarction (Fig 8, Fig 9 and Fig 10) is observed. Turner system only partially separates CBPP lesions; for instance, an animal with a big sequestrum (diameter greater than 20 cm) receives the highest possible score of 6 points, in the same manner as a patient with widespread, bilateral, acute-to-subacute pneumonia. To negate these lacunae created the current lung lesion score system, which is thought to be helpful in quantifying CBPP lesions.

Table 1: Samples to be collected for isolation of *Mycoplasma mycoides subsp. mycoides* (Mmm).

Sample for isolation	*In vitro*	Transport media
From live animals	Nasal swabs or nasal discharges, broncho-alveolar lavage or transtracheal washing and pleural fluid collected.	Using nasal swab samples, a transport medium (heart-infusion broth without peptone and glucose, 10% yeast extract, 20% heat-treated serum (horse or pig), 0.3% agar, 500 International Units [IU]/ml penicillin, 0.2 g/litre thallium acetate) should be used to preserve the mycoplasmas and stop the growth of cell-walled bacteria and fungi.
At necropsy	Lungs with lesions, pleural fluid ('lymph'), lymph nodes of the broncho-pulmonary tract and synovial fluid from those animals with arthritis. The lung samples should be collected from lesions at the interface between diseased and normal tissue.	

It compiles the scores that have been published previously by different writers. Method similar with the "consolidation lung lesion score," and is presently advised by the European Pharmacopeia for pleuropneumonia in pigs (Sibila *et al.*, 2014).

Diagnosis

For diagnosis, samples can be collected (Table 1) and diagnostic test based on patho, micro, molecular biology, or serology can be utilized to examine CBPP. Abattoir surveillance for CBPP, which involves lung examination.

Suspected animals can be isolated and below mentioned samples can be used for diagnosis of CBPP outbreak. In situations when blood is unavailable and mycoplasma culture from the lung is problematic, immunohistochemistry (IHC) is the preferred test (Fig 11, 12, 13) when a carcass with lung lesions suggestive of CBPP is reported to the diagnostic laboratory. Fresh or previously formalin-fixed and paraffin-wax-embedded samples are obtained from lung lymph nodes or lung tissue suspected of having macroscopic lesion (Noordhuizen *et al.*, 2001).

Tests using the polymerase chain reaction (PCR) have shown to be incredibly helpful in quickly identifying Mmm. (Bashiruddin *et al.*, 1999). In a fluid medium, a uniform cloudiness (Fig 14) that is characteristic of Mmm typically arises in three to five days and is sometimes accompanied by a delicate, silky filament known as a "comet/ fried egg form (Fig 15). While immunohistochemistry is merely a supplemental diagnostic tool for CBPP, it can be extremely helpful in chronic cases, instances where Mmm isolation may be hampered by suspected antibiotic treatment and particularly in renal tissues where Mmm isolation can be challenging. (Bashiruddin *et al.*, 1999).

Serological tests

Test results should be weighed as farm result and not interpreted on individual animal level because there will be lot of false positives or false negatives. Tests conducted on a single animal may be deceptive if the animal is in the chronic stage of the disease, when very few animals are seropositive, or if the animal is in the early stage of the

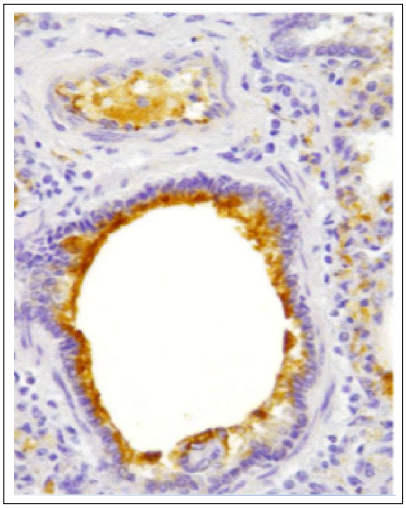


Fig 11: The bronchiolar epithelium exhibits immunolabeling (brown staining) with *Mycoplasma mycoides subsp. mycoides* (Mmm). (Teodoro *et al.*, 2020).

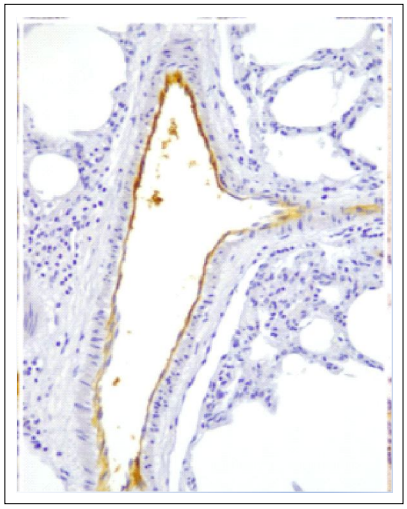


Fig 12: Within the endothelium of a blood vessel immunolabeling (brown staining) with Mycoplasma *mycoides subsp. mycoides* (Mmm). (Teodoro *et al.*, 2020).

disease, which can linger for several months before specific antibodies are generated. False-positive results can happen (2% of the time) and one major reason for this is serological cross-reactions with different mycoplasmas, especially those in the M. mycoides cluster. The most effective technique for identifying infection is still the complement fixation test (CFT) on serum. It is quick, straightforward to execute and outcomes are simple to understand. Although it is less sensitive for serum samples with extremely low antibody levels than ELISA testing, it is more selective than other tests. (Marobela-Raborokgwe *et al.*, 2003).

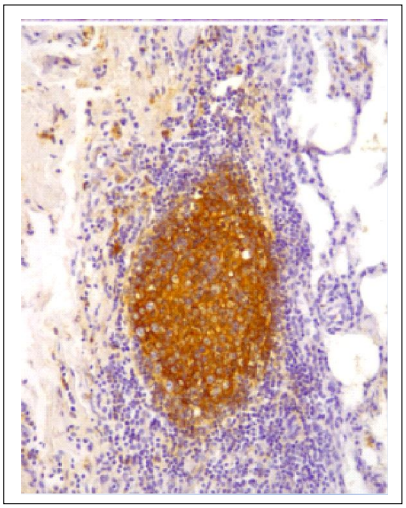


Fig 13: The tertiary lymphoid follicles immunolabeling (brown staining) with *Mycoplasma mycoides subsp. mycoide*s (Mmm). (Teodoro *et al.*, 2020).

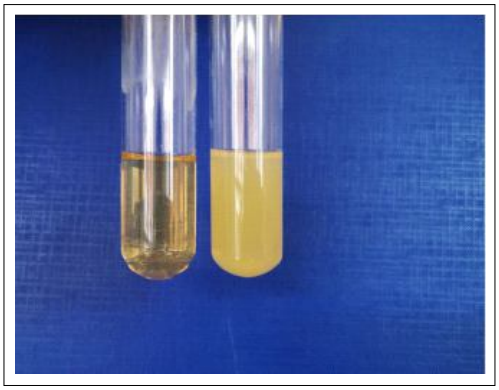


Fig 14: *Mmm* growth appears in the broth culture as a homogenous cloudiness (right tube), but no growth is apparent in the control broth (left tube).

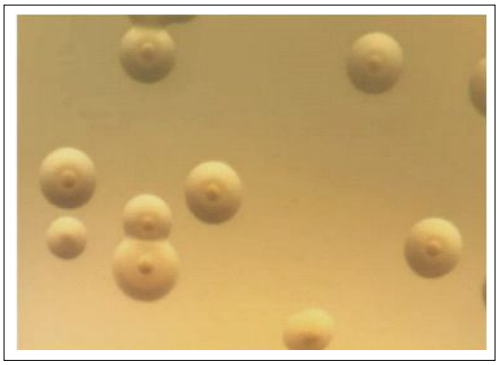


Fig 15: *Mmm* colonies: “fried egg” form.

Although the CF has a low sensitivity and might overlook animals that are critically ill or have persistent lesions, it is useful for identifying infected groups of animals at the herd level (Belinda *et.al*, 2018).

Differential diagnosis

Infectious causing consolidated pleuropneumonia, such as *Histophilus somni* and *Mannheimia haemolytica*, are possible differentials (Belinda *et al.*, 2018).

Acute and chronic respiratory conditions, including pneumonic pasteurellosis and Mycoplasma bovis infection are other differentials In acute cases, the diagnosis might be aided by the lungs’ marbled appearance, the pleural surfaces’ persistent involvement and the presence of vasculitis histopathologically (Teodoro *et al.*, 2020).

CBPP should also be differentiated from Haemorrhagic septicaemia (HS). Development of edematous swelling within 6-72 hrs is common finding in (HS). Pasteurella species can also be cultivated, which will aid in differential diagnosis.

East Coast fever, or theileriosis - Coughing, discharge from the nose and eyes, diarrhea and abomasal ulcers. But no lesions in the lungs.

Treatment

Mycoplasma don’t react well to antibiotic treatment was notion; in fact, use was discouraged because threat of carrier animal. Previously demonstrated in experiments that giving the antibiotic danofloxacin (Advocin; 2011) to calves affected by CBPP might dramatically lower the amount of mycoplasma that spreads to other cattle. Therefore, we used the antibiotic in accordance with the manufacturer’s guidelines to treat all clinically afflicted or seropositive herds in the Caprivi. Following treatment, there were no more overt instances and only three animal deaths in the first three months, marking an instantaneous decrease in the number of new cases (Hubschle *et al*., 2006b).

In a comparative study conducted by Muuka *et al.*, (2019) wherein, 2.5 mg/kg of tulathromycin, 6 mg/kg of a commercially available gamithromycin was compared with 24 mg/kg of a commercial oxytetracycline formulation. The study concluded that, tulathromycin protected 82%, gamithromycin 56% and oxytetracycline 80% of the animals in Kenya whereas in Zambia, tulathromycin protected 98%, gamithromycin 94% and oxytetracycline 80%.

The development of *Mmm* was effectively inhibited by oxytetracycline, danofloxacin and tulathromycin (Mitchell *et al.*, 2012).

In vitro study with five widely used antibiotics revealed that tilmicosin and danafloxacin were efficacious in both

mycoplasmastatic and mycoplasmacidal action (Ayling, 2013). A synthetic fluoroquinolone authorized for SC injection in cattle is danofloxacin mesylate (Advocin, 2011) efficient distribution and highly bioavailable. In cattle, danofloxacin has a 3-6 hours half-life and very little accumulation (Zeng *et al.*, 2011).

Broad spectrum antibiotic, targets bacteria's 50S ribosome is called flufenicol. Following I.M injection, the medication is only moderately bioavailable (79%) in cattle (Papich and Riviere, 2009; Plumb, 2016).

Control and prevention

Issues- Movement control, implementation of policies, dearth of pen-side diagnostic testing speed, ineffective vaccine, strained finances, Drought and civil unrest (Radostitis *et al.*, 2007).

Mmm has low environmental resistance; its survival is entirely dependent on the infection of animals that are susceptible, (OIE-WOAH 2018). defending the claim that the "CBPP walks on the feet of cattle." Given this, the following strategies are used to control the disease in CBPP-free areas: (1) prohibiting the import of cattle from infected nations; (2) enforcing border controls; (3) instituting quarantine; and (4) detecting outbreaks early and enforcing tight stamping-out procedures (FAO, 2002).

Serologic screening in disease-free areas and to eliminate any positive and in-contact animals. Immunization against CBPP is widely used and essential to control in endemic areas.

T1/44 and T1sr are the two strains against which vaccines CBPP have been produced. While T1sr is an avirulent strain, T1/44 is a moderate strain. Compared to T1/44, T1sr offers a shorter duration of immunity; nevertheless, T1/44 has the additional risk of causing postvaccinal responses, which may require antibiotic treatment after vaccination (Belinda *et al.*, 2018).

Vaccination campaigns must target all cattle within a specified geographic and epidemiological area in order to be effective. The vaccination must be given again, first at short intervals and then once a year for a number of years, or at least three to five years (FAO, 2002).

2 attenuated vaccines, T1/sr and T1/44, derived from the Tanzanian T1 strain, are advised by the OIE. T1/44 IS more effective after 44 passes on chicken embryos, although it only offers a brief immunological shield (less than a year). The "Willems' reaction" is an invasive edema that appears two to four weeks after injection. (Sheriff and Piercy, 1952; Revell, 1973; Rweyemamu *et al.*,1995; Mbulu *et al.*, 2004; Muuka *et al.*, 2014, OIE-WOAH, 2018). China was able to eradicate CBPP with the help of the attenuated strain Ben-1 (Xin *et al.*, 2012). More research on CBPP immunology and protective response as well as more effective, safer and less expensive vaccine formulations are required to potentially enable the distinction between infected and vaccinated animals (DIVA vaccines). (Dedieu-Engelmann, 2008). The development of vaccinations against the ISCOM protein component has shown promising early results. A significant surface antigen and pathogenicity factor of MmmSC is capsular polysaccharide (CPS), formerly called as galactan. Capsular polysaccharide conjugate vaccines against CBPP provide a protective immunological response in mice, suggesting that humoral immunity is not the primary mechanism of protection against MmmSC mycoplasmemia (Waite and March, 2002).

CONCLUSION

CBPP is an important bacterial infectious illness that primarily threatens the cattle industry and the financial well-being of pastoralists in Africa. India, especially the northeastern region, appears to be particularly vulnerable to CBPP. Among the drawbacks are the restricted diagnostic options for identifying CBPP in suspected cases and the challenging implementation of control strategies. After rinderpest, CBPP is the second most serious transboundary disease in Africa. Notable mortality and morbidity rates in CBPP. In addition to Sub-Saharan Africa, other countries with sizable bovine populations and husbandry practices are also susceptible to CBPP infection and suffer significant economic losses during epidemics. CBPP is crucial contagious disease, with posing threat to, africa's pastoralists' socioeconomic well-being as well as the livestock business. Limited diagnostic modalities to diagnose CBPP in suspected case is presented are also limited, difficult to implement control approaches. CBPP is 2nd most significant transboundary illness in Africa, after rinderpest. Significant of morbidity and mortality in CBPP. Beside Sub-Saharan Africa, countries in the world wherein there is huge amount of bovine population and husbandry practices, those nations as well, are vulnerable to CBPP infection and the economic losses which occurs after outbreaks are enormous.

Conflict of interest

The author declares that they have no conflicts of interest related to the research, authorship, or publication of this manuscript

REFERENCES

Abdo, El-M., Nicolet, J., Miserez, R., *et al.* (1998). Humoral and bronchial immune responses in cattle experimentally infected with Mycoplasma mycoides subsp mycoides small colony type. Vet. Microbiol. 59(2-3): 109-122.

Advocin (Danofloxacin Mesylate) (2011). Package Insert. New York: Pfizer Animal Health.

Ahsan, A., Asim, A., Raheela, A., Tahir, Y., Junaid, N., Alia, M., Muhammad, M.A. and Azeem, K.U. (2019). Seroprevalence of contagious bovine pleuropneumonia in cattle of Punjab, Pakistan and assessment of risk factors. Indian Journal of Animal Research. 55(1): 101-104. doi: 10.18805/ijar.B-1130.

Alhaji, N.B., Ankeli, P.I., Ikpa, L.T., Babalobi, O.O. (2020). Contagious Bovine Pleuropneumonia: Challenges and Prospects Regarding Diagnosis and Control Strategies in Africa. Vet. Med. (Auckl). 11: 71-85.

Ayling R. (2013). Contagious Bovine Pleuropneumonia. IOM Newslett. 37: 10-15.

Bashiruddin, J.B., De Santis P., Vacciana, A., *et al* (1999). Detection of Mycoplasma mycoides subspecies mycoides SC in clinical material by a rapid colorimetric PCR. Mol. Cell Probes. 13(1): 23-28.

Belinda, S., Thompson, Erin, L., Goodrich (2018). 16 - Miscellaneous Infectious Diseases. In: Rebhun's Diseases of Dairy Cattle [Editor(s): Simon F. Peek, Thomas J. Divers], (Third Edition), Elsevier, pp 737-78.

Castro-Alonso, A., Rodriguez, F., De la Fe C., *et al.* (2009). Correlating the immune response with the clinical-pathological course of persistent mastitis experimentally induced by Mycoplasma agalactiae in dairy goats. Res. Vet. Sci. 86(2): 274-280.

Chakravarthy, A (2007). A Textbook of Preventive Medicine (6th Edn). Kalyani Publishers. pp. 547-551.

Dar, A., Singh, S., Mondal, B., Palod, J. and Kumar, A., Singh, V., Sharma, R. and Khadda, B, (2017). Effect of probiotic, prebiotic and synbiotic on faecal microbial count and cell-mediated immunity in crossbred calves. Indian Journal of Animal Research. 52. doi: 10.18805/ijar.B-3383.

Dedieu, L., Balcer-Rodrigues, V., Cisse, O., *et al.* (2006). Characterization of the lymph node immune response following Mycoplasma mycoides subsp mycoides SC infection in cattle. Vet. Res. 37(4): 579-591.

Dedieu-Engelmann, L. (2008). Contagious bovine pleuropneumonia: A rationale for the development of a mucosal sub-unit vaccine. Comp Immunol. Microbiol. Infect. Dis. 31(2-3): 227-238.

FAO, (2002). Recognizing contagious bovine pleuropneumonia. Food and Agriculture Organization of the United Nations. Animal Health Manual No. 13. Rome, Italy.

Ferronha, M.H., Nunes Petisca, J.L., Sousa Ferreira, H., Machado M., Regalla, J. (1988). Localizacão de antigenios Mycoplasma mycoides subspecies mycoides nas lesoes do pulmao de bovinos com peripneumonia. Repositorio de Trabalhos do Laboratorio Nacional de Investigacao Veterinaria. Numero Especial, pp 25-36.

Geetha, R., Sathian, C., Prasad, V. and Gleeja, V. (2015). Efficacy of purified antimicrobial peptides from lactic acid bacteria against bovine mastitis pathogens. Asian J. Dairy Food Res. 34(4): 259-264. doi: 10.18805/ajdfr.v34i4.6874.

Gladon, J.M., Spickler, A.R., August, K., Roth, J., Edwards, K.T. (2006). Contagious Bovine pleuropneumonia (CBPP). Centre for Food Security and Public Health Lowa State University.

Grieco, V., Boldini, M., Luini, M., Finazzi, M., Mandelli, G., Scanziani. E. (2001). Pathological, Immunohistochemical and Bacteriological Findings in Kidneys of Cattle with Contagious Bovine Pleuropneumonia (CBPP). Journal of Comparative Pathology. 124 (2-3): 95-101. ISSN 0021-9975, https://doi.org/10.1053/jcpa.2000.0433.

Grommes, J. and Soehnlein, O. (2011). Contribution of neutrophils to acute lung injury. Mol. Med. 17(3-4): 293-307.

Haller B. (1773). Me´moire sur la contagion parmi le be´tail, mis au jour pour l'instruction du public. Berne. 32 p.)

Hubschle, O., Ayling, R. D., Godinho, K., Lukhele, O., tjipura-zaire, G., Rowan T. and Nicholas, R.A.J. (2006b). Danofloxacin (AdvocinTM) reduces the spread of contagious bovine pleuropneumonia to healthy in-contact cattle. Research in Veterinary Science. 81: 304-309.

Jungi, T.W., Krampe, M., Sileghem, M., *et al.* (1996). Differential and strain-specific triggering of bovine alveolar macrophage effector functions by mycoplasmas. Microb Pathog. 21(6): 487-498.

Koppel, P., Peterhans, E., Bertoni, G., *et al.* (1984). Induction of chemiluminescence during interaction of tumoricidal effector cell populations and tumor cells is dependent on the presence of mycoplasma. J Immunol. 132(4): 2021-2029.

March, J.B., Clark, J., Brodlie, M. (2000). Characterization of strains of *Mycoplasma mycoides* subsp. mycoides small colony type isolated from recent outbreaks of contagious bovine pleuropneumonia in Botswana and Tanzania: Evidence for a new biotype. J. Clin. Microbiol. 38(4): 1419-1425.

Marobela-Raborokgwe, C., Nicholas, R., Ayling, R., *et al.* (2003). Comparison of complement fixation test, immunoblotting, indirect ELISA and competitive ELISA for detecting antibodies to Mycoplasma mycoides subspecies mycoides small colony (SC) in naturally infected cattle from the 1995 outbreak in Botswana. Onderstepoort J. Vet. Res. 70(1): 21-27.

Masiga, W. N., Domenech, J., Windsor, R.S. (1996). Manifestation and epidemiology of contagious bovine pleuropneumonia in Africa. Rev. Sci. Tech. 15(4): 1283-1308.

Masiga, W.N. and Read, W.C.S. (1972). Comparative susceptibility of *Bos indicus* and *Bos taurus* to contagious bovine pleuropneumonia and the efficacy of the T1 broth culture vaccine. Vet. Rec. 90(18): 499–502.

Masiga, W.N., Roberts, D.H., Kakoma, I., Rurangirwa, F.R. (1975). Passive immunity to contagious bovine pleuropneumonia. Res. Vet. Sci. 19: 330-332. doi:10.1016/S0034-5288(18)33511-2.

Mbulu R.S., Tjipura-Zaire G., Lelli R., Frey J., Pilo P., Vilei E.M., *et al.*, (2004). Contagious bovine pleuropneumonia (CBPP) caused by vaccine strain T1/44 of *Mycoplasma mycoides* subsp. *mycoides* SC. Vet. Microbiol. 98: 229-234.

Mitchell, J. D., McKellar, Q.A., McKeever, D.J. (2012). Pharmacodynamics of antimicrobials against Mycoplasma mycoides mycoides small colony, the causative agent of contagious bovine pleuropneumonia. PLoS One. 7: 8.

Muuka, G., Otina, B., Wesonga, H., Bowa, B., Gicheru, N., Stuke, K., Poole, E.J, Salt, J., Colston, A. (2019). Evaluation of new generation macrolides for the treatment and metaphylaxis of contagious bovine pleuropneumonia (CBPP) in cattle experimentally infected with Mycoplasma mycoides subspecies mycoides. BMC Vet. Res. 15(1): 451.

Muuka, G., Songolo, N., Kabilika, S., *et al.* (2013). Challenges of controlling contagious bovine pleuropneumonia in sub-Saharan Africa: A Zambian perspective. Trop. Anim. Health Prod. 45(1): 9-15.

Muuka, G.M., Chikampa, W., Mundia, C., *et al.* (2014). Recent observations on site reactions in cattle to vaccination against contagious bovine pleuropneumonia (CBPP) using T1/44 vaccine in Zambia. Trop. Anim. Health Prod. 46(2): 481-483.

Nehra, V., Shunthwal, J. and Rath, A. (2018). Aetio-pathological studies of digestive and respiratory affections in cattle calves. Indian J. Anim. Res. 52(11): 1628-1634. doi: 10.18805/ijar.B-3419.

Nicholas, R., Ayling, R., McAuliffe, L. (2007). Contagious bovine pleuropneumonia. In: Mycoplasma Diseases of Ruminants. [Nicholas R., Ayling R., McAuliffe L., (eds)]. Oxfordshire, England: Centre for Agriculture and Bioscience International: pp 69-97.

Nicholas, R.A.J. (2023). Contagious Bovine Pleuropneumonia: A Passage to India. Animals: An open access journal from MDPI. 13(13): 2151. https://doi.org/10.3390/ani13132151.

Noordhuizen, J., Nicholas, J., Pini, A., Regella, J. and Martel, J. (2001). Diagnostic Tests for Contagious Bovine Pleuropneumonia. In: Report of Scientific Committee on Animal Health and Animal Welfare. pp: 1-93.

OIE-World Organization for Animal Health. (2018). Manual of Diagnostic Tests and Vaccines for Terrestrial Animals. Paris, France (1097–1112).

Papich, M.G., Riviere, J.E. (2009). Chloramphenicol and derivatives macrolides, Lincosamides and miscellaneous antimicrobials. In: Veterinary Pharmacology and Therapeutics. [Riviere JE, Papich MG, (eds)]. Ames, IA: Wiley Blackwell. pp 945-982.

Pilo, P., Frey, J., Vilei, E.M. (2007). Molecular mechanisms of pathogenicity of Mycoplasma mycoides subsp mycoides SC. Vet J. p174.

Plumb, D.C. (2016). Veterinary Drug Handbook. 8th ed. Ames, IA: State Press.

Prosperi, S., Pini, A. (1991). Pleuropolmonite contagiosa del bovino (PPCB). Teramo, Italy: Veterinaria Italiana, collana di monografie.

Provvido, A., Di Teodoro, G., Muuka, G., Marruchella, G., Scacchia, M. (2018). Lung lesion score system in cattle: Proposal for contagious bovine pleuropneumonia. Trop. Anim. Health Prod. 50(1): 223-228.

Radostits, O.M., Gay, C.C, Hinchcliff, K.W. and Constable, P.D. (2007). A textbook of the diseases of cattle, horses, sheep, pigs and goats (10th Edn).

Rao, C.K. (1969). Contagious bovine pleuropneumonia in India. Bull. Off. Int. Epizoot. 71: 1309-1312.

Revell, S.G. (1973). Local reactions following CBPP vaccination in Zambia. Trop Anim Health Prod 5(4): 246-252.

Rweyemamu, M.H., Liamoi, J., Palya, V., *et al.* (1995). Contagious bovine pleuropneumonia (CBPP) vaccine: the needs for improvement. Rev. Sci. Tech. 14(3): 593-601.

Shaheen, M., Bashir, S., Hassan, N., Akhoon, Z.A., Muhee, A. (2024). Caprine Respiratory Mycoplasmosis (Contagious Caprine Pleuropneumonia CCPP)- A global perspective of the disease, epidemiology, diagnosis, chemotherapy and immunization: A review. Indian Journal of Animal Research. 58(5): 709-715. DOI:10.18805/IJAR.B-4425

Sheriff, D., Piercy, S.E. (1952). Experiments with an avianised strain of the organism of contagious bovine pleuropneumonia. Vet. Rec. 64: 615-621.

Shirlaw, J.F., Iver, P.R.K. (1946). Studies on contagious bovine pleuropneumonia in Assam. Indian J. Vet. Sci. Anim. Husb. 16: 191-208.

Sibila, M., Aragón, V., Fraile, L., Segalés, J. (2014). Comparison of four lung scoring systems for the assessment of the pathological outcomes derived from *Actinobacillus pleuropneumonia*e experimental infections, BMC Veterinary Research. 10: 165.

Singh, V.P., Rana, R. (2014). Contagious bovine pleuropneumonia infection and eradication. Indian Farming. 64: 15-18.

Tambi, N.E., Maina, W.O., Ndi, C. (2006). An estimation of the economic impact of contagious bovine pleuropneumonia in Africa. Rev Sci Tech. 25(3): 999-1012. doi:10.20506/rst.25.3.1710

Teodoro, G., Marruchella, G., Di Provvido, A., *et al.* (2018). Respiratory explants as a model to investigate early events of contagious bovine pleuropneumonia infection. Vet. Res. 49(1).

Teodoro, G., Marruchella,, Di Provvido, A., D'Angelo, A.R., Orsini, G., Di Giuseppe, P., Sacchini, F., Scacchia, M. (2020). Contagious bovine pleuropneumonia: A comprehensive overview. Vet. Pathol. 57(4): 476-489.

Tott´e, P., Puech, C., Rodrigues, V., *et al.* (2015). Free exopolysaccharide from *Mycoplasma mycoides* subsp mycoides possesses anti-inflammatory properties. Vet. Res. 46: 122.

Turner, A.W. (1961). Preventive tail-tip inoculation of calves against bovine contagious pleuropneumonia. Australian Veterinary Journal. 37(7): 259-264.

Vilei, E.M., Abdo, E.M., Nicolet, J., Botelho, A., Gonçalves, R., Frey, J. (2000). Genomic and antigenic differences between the European and African/Australian clusters of *Mycoplasma mycoides* subsp. mycoides SC. Microbiol.146: 477-486.

Waite, E.R. and March, J.E. (2002). J. Comp. Path. 126: 171.

WOAH Terrestrial Manual. (2021). CHAPTER 3 . 4 . 8. CONTAGIOUS BOVINE PLEUROPNEUMONIA (INFECTION WITH MYCOPLASMA MYCOIDES SUB SP. MYCOIDES)

Xin, J., Li, Y., Nicholas, R.A., *et al.* (2012). A history of the prevalence and control of contagious bovine pleuropneumonia in China. Vet J. 191(2): 166-170.

Zeng, Z., Deng, G., Shen, X., *et al.* (2011). Plasma and tissue pharmacokinetics of danofloxacin in healthy and in experimentally infected chickens with Pasteurella multocida. J. Vet. Pharmacol. Ther. 34: 101-104.