A brief introduction to chlamydial infections in animals and humans

Chlamydiae are widely distributed throughout the world, causing various forms of disease in animals and humans. Several species, particularly *Chlamydophila (Cp.) psittaci* and *Cp. abortus*, are known to be transmissible from animals to humans, causing significant zoonotic infections. The unique biphasic lifestyle of these obligate intracellular bacteria, which includes an infective extracellular and a parasitic intracellular phase, renders the respective diseases difficult to control. This is compounded by the specialist growth conditions for the organisms and the lack of a genetic based system for the transformation of chlamydiae, both of which have hampered research on these pathogens. To escape the host immune response these bacteria are capable of transforming into persistent stages of development characterised by a distinct antigenic profile.

**Chlamydioses in poultry and other avian species**

The most important animal chlamydiosis of zoonotic character is psittacosis, a systemic disease in psittacine birds of acute, protracted, chronic or subclinical manifestation. It is a notifiable disease in Belgium, Germany, Switzerland, the UK and other countries. In Italy, cases of transmission to humans are notifiable. The analogous infection in domestic and wild fowl is often called ornithosis. The economic damage in connection with outbreaks in poultry flocks can be considerable. Although the causative agent, *Cp. psittaci*, is known to be very wide spread in many avian species, not all carrier birds actually show symptoms of disease. Present knowledge about factors contributing to the development of clinical disease, including virulence factors of field strains, is rather limited.

**Chlamydioses in sheep and goats**

Another zoonotic disease, enzootic abortion of ewes or ovine enzootic abortion (OEA) caused by *Chlamydophila abortus* (formerly the ovine subtype of *Chlamydia psittaci*) has become recognised as a major cause of loss in sheep (and goats) in Europe, North America and Africa. It is the most common infectious cause of lamb loss in several countries of Western, Central and Northern Europe, e.g. accounting for around 50% of all diagnosed abortions in the UK. Economic costs to the farming industry resulting from the disease are considerable and amount to an estimated £15 million (€25 million) per annum in the UK alone. OEA is a notifiable disease in Ireland, where its incidence has increased dramatically in recent years. In the UK, cases of transmissions to humans are notifiable. Although it is well known that enzootic abortion in goats is quite similar to OEA with regard to severity and zoonotic potential, its present spread and economic importance for Europe cannot be assessed for lack of epidemiological data.

**Chlamydioses in cattle, pigs, cats, horses, and reptiles**

Over the last few years, endometritis and hypofertility in dairy cattle have sometimes been attributed to chlamydial infections, with clinical manifestations often recurrent in spite of treatment. In a regional survey in Germany, *Cp. pecorum/Cp. abortus* were detected at a rate of up to 100% in affected herds. Economic losses as a consequence of a drop in milk production and milk quality, as well as abortions and reduced fertility rates were estimated to be 40,000 Euros per year at an average farm of 60 dairy cows and 20 heifers. Investigations carried out in Italy have shown that the chlamydial organisms involved in these outbreaks belong to the so called "non-invasive" strains classified as *Cp. pecorum*. The same agent was also detected in cases of encephalomyelitis in water buffaloes used for milk production.

Chlamydioses in pigs are associated with three different species, i.e. *Chlamydia (C.) suis* (formerly *C. trachomatis*), *Cp. pecorum* and *Cp. psittaci/Cp. abortus*. A widely held view is that chlamydiae may act in concert with other agents in multifactorial infectious diseases,
such as abortions in sows, polyarthritis in piglets, diarrhoea in pigs and genital disorders in boars.

According to veterinary practitioners, clinical manifestations of conjunctivitis in cats are often suggestive of chlamydial infections caused by \textit{Cp. felis}. Based on an investigation of 462 cats with upper respiratory infections, Sykes et al. observed a prevalence of this agent of 14.3%. Since laboratory diagnosis is seldom conducted the few published data are not representative of the real epidemiological situation.

Occasional evidence of \textit{Cp. psittaci}/\textit{Cp. abortus} detected from aborted horse fetuses and \textit{Cp. pneumoniae} associated with respiratory disorders indicates a role of these species in various equine diseases. Although the former appears to be a commensal germ in many instances, the importance of chlamydial infection in horses is probably underestimated.

In the last few years, several strains of \textit{Cp. pneumoniae} were isolated from reptiles, some of which are kept as pet animals. It is still unclear whether they form a separate serovar, but it seems certain that the agent represents a pathogen.

Additionally, some recently discovered new members of the order \textit{Chlamydiales} need to be assessed for their zoonotic potential, for instance the bovine pathogen \textit{Waddlia chondrophila}.

\textbf{Chlamydiae as causative agents of zoonoses}

The zoonotic potential of chlamydiae is illustrated in Fig. 1. Avian strains of \textit{Chlamydophila psittaci} are pathogenic to humans, the symptoms being mainly non-specific and influenza-like, but severe pneumonia, endocarditis and encephalitis are not uncommon. In Germany, the annual number of notified human cases of \textit{psittacosis} in the last five years was between 15 and 86 with several deaths. A study in the United States revealed that, while the average prevalence may be at a few percent, up to 30\% of households having purchased pet birds from infected flocks were affected by clinical psittacosis or were serologically positive. The general situation in Europe is believed to be comparable, but comprehensive data are completely absent. It is perceived that, due to insufficient diagnostic testing, the disease is underdiagnosed and underestimated.

The main group of persons facing an elevated risk of infection includes those having frequent contact with domestic and companion birds at work or in their spare time. Infections of abattoir workers in connection with the slaughtering of ducks, turkeys or geese, as well as cases among bird breeders are regularly reported in several European countries. As a consequence of the increasing habit of keeping parrots, parakeets, budgerigars, etc. as pet birds many more persons are at risk. Feral pigeons are quite commonly found infected in many urban habitats, which also raises serious questions as to the hazards to human health.

In connection with \textit{ovine enzootic abortion}, transmissions to humans have been repeatedly reported. This serious and potentially life-threatening zoonosis affects pregnant women after contact with lambing ewes and leads to severe febrile illness in pregnancy. With OEA present in Ireland, Britain and other European countries, increased surveillance and improved reporting of human abortions associated with ovine contact are required, even more so as human cases are generally less thoroughly investigated in terms of bacteriology than abortions in animals. It is also necessary to investigate whether outbreaks of chlamydiosis in cattle pose a risk to animal handlers and other contact persons.

A general question that needs to be addressed is the identification of virulence factors of \textit{Cp. psittaci} and \textit{Cp. abortus}. The fact that i) only a certain proportion of persons actually develop symptoms of chlamydiosis after contact with infected birds or small ruminants, and that ii) certain geographical areas seem to be more affected than others (e.g. OEA in Britain and Ireland) cannot be explained on the basis of phenotypic or genotypic criteria at present.

The increasing number of reports on the occurrence of the human pathogen \textit{Cp. pneumoniae} in reptiles and horses raises the question of a potential hazard to human health, particularly among zoo employees and visitors, as well as people keeping such animals.
Fig. 1 Zoonotic potential of chlamydial pathogens

Cp. psittaci
Cp. abortus
Cp. pneumoniae
Cp. pecorum
C. suis
Cp. felis

→ proven zoonotic transmission
↔ zoonotic dimension yet to be clarified