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Popular Article

Psittacosis and its Zoonotic Potential

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Introduction

Psittacosis is caused by *Chlamydophila psittaci (Chlamydia psittaci)*, it is a zoonotic bacterial pathogen with wide range of hosts, that includes birds, humans and other mammals. Psittacosis is derived from the Greek word 'psittakos' means parrot (first used in 19th century).

Chlamydia psittaci primarily affects birds – tamed (pet birds like parrots, finches), feral (pigeons), domesticated (poultry) and wild bird species. Chlamydial bacteria have been found in more than 70 species of wild birds, with the greatest chlamydial diversity identified in Europe (Stokes HS *et al*., 2021). In psittacine birds (parakeets, small and large parrots sp.), the infection can vary widely from asymptomatic carriers to severe systemic illness mainly affecting respiratory and gastrointestinal systems. In non-psittacine birds this infection is referred as ornithosis, affects poultry like turkey, geese and ducks, feral birds like pigeons and others. The incidence in ducks and turkeys are more common compared to chicken. There are several reports of the transmission of *Chlamydia psittaci* from ducks and turkeys to humans and even an outbreak of chlamydiosis was investigated in workers at a duck farm and processing plant during winter 1989 (Hinton DG *et al*., 1993). In humans upon get in contact with the infectious secretions, susceptible individuals develop flu-like symptoms and in some cases, atypical pneumonia.

Keywords: Psittacine birds, Chlamydia, Elementary bodies, Doxycycline.

Synonyms: Parrot fever, Avian chlamydiosis, Ornithosis.

Aetiology

Avian chlamydiosis can result from infection by *Chlamydia psittaci* or the recently recognized species *C. avium* and *C. gallinacea*. There may also be other avian associated Chlamydia, particularly in wild birds. For example, the candidate chlamydial species *C. ibidis* was detected in healthy, free-living African sacred ibises (*Threskiornis aethiopicus*) in western France, and potentially novel chlamydiae have been found in some raptors and seabirds (Spickler, Anna Rovid. 2017).

Characteristics of pathogen

Avian Chlamydia is a spherical intracellular pathogen that grows in the cytoplasmic vacuoles of host cells. It is usually difficult to gram stain but is considered as a gram negative bacteria. The species *Chlamydophila psittaci* has been renamed as *Chlamydia psittaci*. It has 2 alternating forms called elementary bodies (infectious but metabolically inert) and reticulate bodies (metabolically active), where former one is infectious. Each extracellular elementary body is surrounded by a conventional bacterial cytoplasmic membrane, a periplasmic space and an outer envelope containing lipopolysaccharide (P. J. Quinn *et al*., 2011).

According to Geens T *et al*., 2005; *C. psittaci* is classified into 6 serovars, designated A to F. Serovar A (endemic among psittacine birds and in humans), Serovar B (endemic among pigeons), and also been isolated from turkeys, and was the cause of abortion in a dairy herd. Serovar C (isolates obtained from a German, Bulgarian and Belgian duck, a white swan, and a Californian turkey and a partridge). Serovar D (mainly turkeys but also from a seagull, a budgerigar, and humans). Serovars C and D are known occupational hazards for poultry workers. Serovar E (isolated during an outbreak of human pneumonitis in the late 1920s and early 1930s).

There are ten known genotypes based on sequencing the major outer-membrane protein gene, ompA, of *C. psittaci*. Each genotype has overlapping host preferences and virulence characteristics (Wolff BJ *et al*., 2015). According to the study done by Sachse, K *et al*., 2023; there is a clade membership (four major clades within this species) correlates with typing schemes based on SNP types, ompA genotypes, multilocus sequence types as well as plasticity zone (PZ) structure and host preference.

Hosts

The organism primarily affects birds (reported in more 400 bird species), also *C. psittaci* has been found occasionally in various mammals including dogs, cats, horses, cattle, goats, sheep, water buffalo, pigs, muskrats, wild ungulates and some zoo species (Spickler, Anna Rovid. 2017). Occupational or accidental exposure can cause infection in humans. Data regarding host range of *C. avium* and *C. gallinacea* is scarce.

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Epidemiology

Birds -

According to the review on global prevalence of chlamydial infections in birds by Peerapol Sukon *et al*., 2021; The cumulative evidence over time indicated that the prevalence of chlamydial infections in birds has been relatively consistent around 20 % since 2012. The global prevalence of chlamydial infections in birds was 19.5 % & no significant differences of the prevalence were observed among continents. The prevalence in birds ranged from 13.4 % in Passeriformes to 32.0 % in galliformes. The incubation period between exposure to *C. psittaci* and the appearance of clinical signs is 3 days to several weeks (J. L. Colville and D. L. Berryhill, 2007). Morbidity and mortality rates may be as high as 50–80% and 30%, respectively (H. Fan and M.A. Scidmore., 2019).

Humans -

According to W.H.O (2024), *C. psittaci* has been found in various mammalian species, including dogs, cats, horses, large and small ruminants, swine, and reptiles. However, birds, especially pet birds (psittacine birds, finches, canaries, and pigeons), are most frequently involved in causing human psittacosis. In humans, case reports are scarce due to under-diagnosed and under-reported. Individuals with exposure to pet shops, veterinary hospitals, bird exhibitions, and occupational exposure in the poultry industry are considered at the highest risk of contracting the disease (De Gier *et al*., 2018). Incubation period varies from one week to three weeks. Psittacosis was responsible for numerous outbreaks in the 1930s, characterised by significant human mortality and disruption to the global trade in parrots (Kathryn M. Weston *et al*., 2023).

Predisposition - There is no breed and age predisposition, but any species exposed to pathogen especially those under stress or affected by any other risk factor can become infected.

Genetics and Breed Predisposition - None specific, but in the pet birds, cockatiels are commonly diagnosed with the disease.

Risk Factors -

- Stress
- Adverse environmental conditions
- Inappropriate husbandry
- High reproductive activity
- Exposure to other birds
- Younger and older birds
- Immune suppressed individuals (Clinical Veterinary Advisor, 2013).

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Transmission

Transmission between birds occurs through:

1) Direct contact with infectious secretions from sick birds
2) Aerosol inhalation of dried, infected bird dropping and dust containing the organism.
3) Ingestion of contaminated feed and water.
4) Mechanical transmission via lice, flies and other vectors.
5) Fomite transmission
6) Vertical transmission

Disease transmission to humans occurs mainly through inhalation of airborne particles from respiratory secretions, dried faeces, or feather dust. Direct contact with birds is not required for infection to occur (W.H.O 2024). Birds are the original and typical host for *C. psittaci*, while mammals merely act as alternate hosts and any passages of avian strains through non-avian hosts are accompanied by loss of virulence. Apart from these considerations, the factors determining host preference and adaptation of chlamydiae are largely unclear (Michael R. Knittler *et al*., 2014).

Life cycle & Pathogenesis

Chlamydia primarily affects the epithelial cells and dust cells (macrophages) of respiratory system. After initial replication, the bacteria will disseminate to various organs, affecting epithelial cells and causing lesions. It was speculated that chlamydial cell contact is a two-step process, i.e. reversible binding followed by irreversible attachment (Carabeo and Hackstadt 2001). After entering a new host, elementary bodies invade cells through receptor mediated endocytosis. Inside the host cell endosome, they develop into reticulate bodies which replicate by binary fission. Some reticulate bodies then transform into elementary bodies. Eventually the host cell lyses releasing elementary, reticulate and intermediate forms. The elementary bodies go on to infect new cells. Following the initial replication, the bacteria tend to invade deeper tissues, allowing them to infect new cells and spread to new hosts.

Chlamydial replication may be delayed in the presence of gamma interferon or penicillin or when the availability of tryptophan or cysteine is limited, resulting in morphologically aberrant forms and persistent infection (P. J. Quinn *et al*., 2011). The inhibition of the phagosome-lysosome fusion and the further intracellular survival of chlamydiae are quite likely a multifactorial process where EBs, RBs and the host cell might be involved at different stages during the developmental cycle (C.E-Ochoa *et al*., 1998).

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The persistent presence of the pathogen can trigger an immune response in the host. In asymptomatic infections, bacterial replication doesn't extent to deeper tissues. Intermittent bacterial shedding occurs in sub-clinical cases and is correlated with stress.

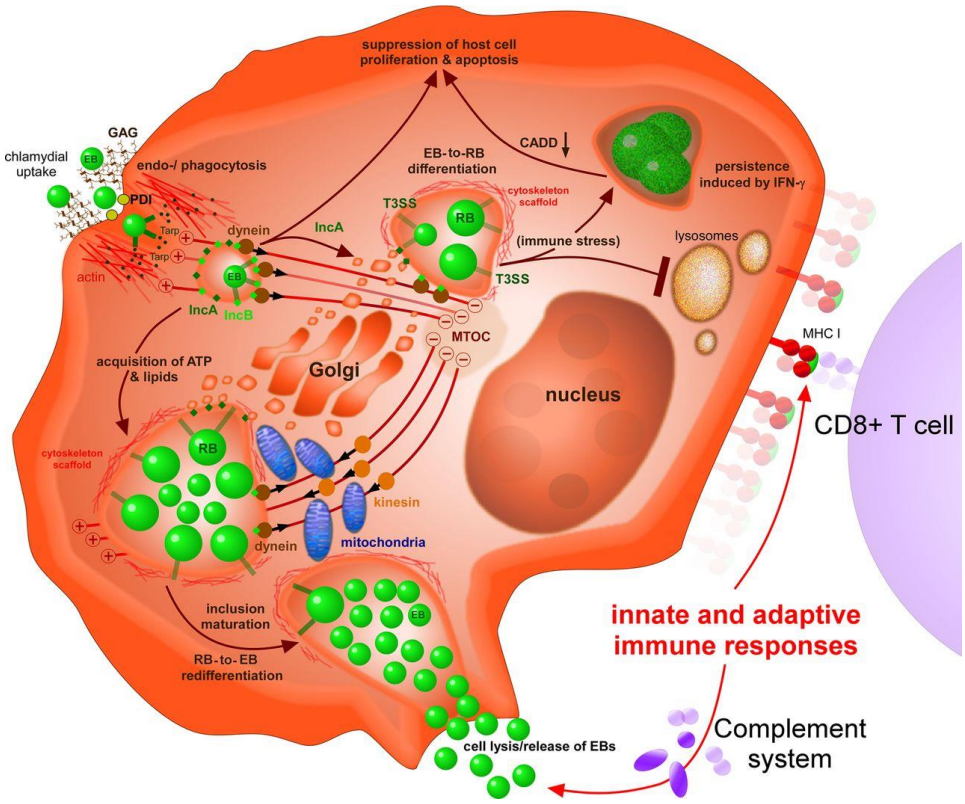

Figure 1: Developmental cycle of *C. psittaci*

Fig 1 Reference: Michael R. Knittler, Konrad Sachse, Chlamydia psittaci: update on an underestimated zoonotic agent, Pathogens and Disease, Volume 73, Issue 1, February 2015, Pages 1–15, https://doi.org/10.1093/femspd/ftu007.

***C. psittaci* and heat shock protein**: Early in the developmental cycle, bacterial heat shock proteins of the 60-, 70- and 110-kDa families are synthesized (C.E-Ochoa *et al*., 1998), because the heat shock proteins of *C. psittaci* and other species of Chlamydia possess conserved epitopes, antibodies can cross-react between them, thus making it difficult to differentiate between *C. psittaci*, *Chlamydia pneumoniae*, and *Chlamydia trachomatis* as the cause of infection (Shaoqiong Liu *et al*., 2023).

Clinical signs

Psittacine birds: Clinical presentation varies widely (acute or chronic). Some infected birds remain as asymptomatic carriers and shed the bacteria, while others may exhibit mild flu-like symptoms. In general, affected birds may show ruffled appearance, dullness, dyspnoea, hyporexia to anorexia, diarrhoea (yellow to greenish urates and loose droppings), periorbital swelling, general weakness,

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ocular and nasal discharge. Other early signs include sinusitis, unilateral conjunctivitis. During an acute infection, egg production may be reduced. In addition, weight loss, reduced body temperatures, dehydration, and loss of appetite may also be present (H. Fan and M.A. Scidmore., 2019). Some birds develop neurological signs such as tremors, torticollis, opisthotonus, paresis.

Non pscitacine birds: the clinical signs are usually similar to those seen in psittacine birds. While individual species variation may occur, the signs are generally non-specific. Ducks can develop trembling or gait abnormalities. Ocular affection is common in pigeons. Turkeys (mildly to severe), with signs like conjunctivitis, nonspecific signs of illness, respiratory signs and diarrhoea. Clinical cases are rarely reported in chickens. Diarrhoea and severe respiratory signs were prominent during an outbreak in peacocks, and sudden death (sometimes preceded by weight loss) occurred in some rheas and raptors (Spickler, Anna Rovid. 2017).

Humans: In some cases, only flu-like symptoms are present, but most infected humans have pyrexia, myalgia, chills, dyspnoea, cough and sometimes emesis. In some cases, pneumonia and septicaemia may develop. In left untreated or in severe cases affected individual may die. In short, complications of infection with *C. psittaci* include acute respiratory distress syndrome, respiratory failure, as well as endocarditis, myocarditis, sepsis, DIC, meningoencephalitis, hepatitis, and pancreatitis; rarely, the patient may present with a fulminant disease course characterized by multi-organ failure (Chu J *et al*., 2025).

Other mammals: infections are rare. Atypical hosts such as livestock, predominantly exhibit respiratory signs when infected. Cases of abortion or the birth to weak offspring have been reported in horses and cattle. Lisa D Sprague *et al*., 2009, reported *Chlamydophila psittaci* infection in four bitches with recurrent keratoconjunctivitis, severe respiratory distress and reduced litter size (up to 50% stillborn or non-viable puppies) in a small dog-breeding facility in Germany and fatal *Chlamydia psittaci* infection in cats is reported by Sanderson H *et al*., 2020. Chlamydiosis can occur in hosts such as small ruminants, pigs, wild mammals and reptiles, but reports are very scarce.

Post-mortem lesions: In birds, non specific, may include nasal adenitis, pulmonary congestion, fibrinous pneumonia, fibrinous air-sacculitis, splenomegaly, mottled or discoloured spleen and hepatomegaly with multifocal hepatic necrosis. Fibrinous perihepatitis, pericarditis, peritonitis and vascular congestion, as well as enteritis and conjunctivitis, may also be seen (Spickler, Anna Rovid. 2017).

Diagnosis - A Tentative diagnosis is based on history and clinical signs, but laboratory analysis is essential for confirmation. Samples include droppings as well as ocular, tracheal and cloacal swabs from live birds and various tissue samples from deceased birds.

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A) Isolation: Cell cultures are used for Isolation of pathogen, the most commonly used cell cultures for *C. psittaci* from pet birds are McCoy and mouse L cells. The sensitivity and specificity of cell culture equals or surpasses embryonating chicken eggs and mice, and results can be obtained in less than 7 days (Pearson JE *et al*., 1989).

B) Staining: Suitable chemical staining procedures include the modified Ziehl Neelsen, Giemsa, modified Machiavello and Castaneda methods. Methylene blue – stained smears can be examined by dark – field microscopy (P. J. Quinn *et al*., 2011).

C) Molecular Testing: A single testing method may not be adequate because of the diversity of reactions with immunoglobulins from the various avian species. Therefore, the use of a combination of antibody- and antigen-detection methods for the diagnosis of chlamydiosis is recommended, particularly when only one bird is tested (C.D.C, 1998).

D) PCR: Cps-indel84-PCR (84 bp indel in a gene of unknown function that is unique to *C. psittaci*) is a sensitive and specific method for detection of *C. psittaci* in animal and human samples. The method has potential for being a powerful tool for future investigations on the epidemiology of C. psittaci infections and the zoonotic potential of this bacterium (Øystein Angen *et al*., 2021).

E) Elementary-Body Agglutination (EBA) Test – EBA test detect IgM in serum (this indicates current infection).

F) DNA microarray – Sachse K *et al*., 2008; they concluded that the traditional genotyping system does not adequately reflect the extent of intra-species heterogeneity in ompA sequences of *C. psittaci*. The newly developed DNA microarray-based assay represents a promising diagnostic tool for tracing epidemiological chains, exploring the dissemination of genotypes and identifying non-typical representatives of *C. psittaci*.

G) Other tests: Histochemical and immunohistochemical testing (detection of lipopolysaccharide and Major Outer Membrane Protein), ELISA, Latex agglutination, Direct Complement Fixation Test.

In humans, Laboratory tests like PCR (with various targets), serologic tests [complement binding reactions, ELISA's, immunofluorescence tests (Micro Immunofluorescence (MIF)] and immuno-peroxidase tests) and culture, in various combinations are performed (Nieuwenhuizen AA *et al*., 2018).

Treatment

The tetracycline group of antimicrobials is the treatment choice for infected birds, Oral preparations are more commonly used than injectable due to the unavailability of specific injectable preparations for birds in India.

Doxycycline: considered as drug of choice for psittacosis in both birds and humans. Usually duration of 45days was followed.

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According to C.D.C Compendium on *C. psittaci*., 1998, Dosage recommendations are for birds are as follows:

- 40–50 mg/kg body weight orally once a day for cockatiels, Senegal parrots, and blue-fronted and orange-winged Amazon parrots
- 25 mg/kg body weight by mouth once a day for African grey parrots, Goffin's cockatoos, blue and gold macaws, and green-winged macaws.
- 25–30 mg/kg body weight administered orally once a day is the recommended starting dosage for cockatoos and macaws.
- 25–50 mg/kg orally once a day is recommended for other psittacine species.

Other antimicrobials such as tetracycline, oxytetracycline, azithromycin can also be used. Mediated feeds (contains chlortetracycline) show good results, but their unavailability and the varied feed acceptance by birds limit their use.

Prevention and Control

1. Currently no vaccines are available
2. Strict quarantine and testing should be followed before importing or introducing new birds especially pscitacine species.
3. Sick birds should be isolated and given proper treatment, all other birds housed with the sick birds should be tested, and doxycycline should be administered if needed.
4. In poultry farms high biosecurity measures and all-in, all-out method should be implemented.
5. All the materials that have come into contact with the sick birds including bedding, feed, perches should be disposed of properly. Cages should be thoroughly disinfected.
6. Overcrowding of birds and mixing of different species should be avoided.
7. Cages should not rack one over the other.
8. Birds should be provided with high-quality water and feed.
9. Stress less rearing is essential.
10. Professionals such as Veterinarians, should always wear protective gear when handling birds and after handling, through handwashing and personal hygiene should be maintained.
11. Veterinarians should consider psittacosis in differential diagnosis when treating lethargic or weak birds for early detection.
12. Instead of sweeping droppings and dust from cages, using a vacuum is preferable to aerosol transmission.
13. As psittacosis is an occupation zoonosis, people who come in to contact with birds on daily or frequently, should be cautious and wear gloves, masks at a minimum. If flu-like symptoms are

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noticed, they should not be neglected – one should consult a doctor immediately and receive treatment if necessary.

Conclusion

Psittacosis in birds, though not very common, requires a thorough understanding of its disease dynamics due to its zoonotic potential. While psittacosis is a notifiable disease in few countries, implementing mandatory reporting and control measures globally is essential to effectively manage and reduce the incidence. Currently the impact of this pathogen is underestimated due to inadequate disease recording and reporting. To address this education for veterinarians, bird handlers, poultry workers along with awareness and proper surveillance should be implemented. A One health collaboration, early disease detection and availability of standardized diagnostic techniques are effective strategies against psittacosis.

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