Combating chlamydiosis

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Chlamydophila psittaci is a zoonotic, intracellular bacterium, found in a wide range of birds, and is the causative agent of psittacosis, or avian chlamydiosis (AC). AC, as well as having significant zoonotic potential, causes high mortality in domestic birds, and there is no effective commercial vaccine. The group of Zhou et al. has generated recombinant adenovirus vaccines, which exhibit significant potential for the prophylactic treatment of poultry. Reduction of AC will affect not only the disease and associated mortality, but should also reduce the incidence of the carrier state, and should improve breeding performance in birds.

Design and successful vaccine implementation also has the potential to improve human health, by decreasing zoonotic risk and should also reduce the risk of emergence of antibiotic resistant strains.

Combating Chlamydiosis

Chlamydophila psittaci is a zoonotic, intracellular bacterium, found in a wide range of birds, including companion, domestic and wild birds.¹ *C. psittaci* is the causative agent of psittacosis, also known as ornithosis, parrot fever, or avian chlamydiosis (AC).² Several serovars of *C. psittaci* have been identified, using monoclonal antibodies, these correspond to 7 genotypes, seven of which (A-F, and E/B) are endemic to domestic poultry and other birds.^{3,4}

AC, as well as having significant zoonotic potential,⁵ causes high mortality in domestic birds e.g., chickens, and is therefore of major concern to the poultry industry, causing significant economic losses in the US, Europe and China (Fig. 1).⁶

While many elegant studies (involving nested PCR/EIA,⁷ Real-time PCR^{7,8} and recombinant ELISA⁷) have contributed to the improved detection and classification of *C. psittaci*, there is, as yet, no effective commercial vaccine. It has been established that the major outer membrane protein (MOMP) is the most important protective antigen against chlamydiosis.¹ Studies have reported some success using purified MOMP^{9,10} recombinant MOMP expressed by *E. coli*^{9,10} and subunit fractions^{10,11} as well as MOMP-based DNA vaccines.¹¹ However, production costs associated with these approaches are high, and there still remains a need for a cheap, safe and effective vaccine.

The group of Zhou et al. first addressed the problem of developing a *C. psittaci* vaccine in their 2007 study.¹² In this study, they used human adenovirus serotype 5 to express the major outer membrane protein (MOMP), encoded by the outer membrane protein 1 (*omp1*). The recombinant virus replicated well in vitro, MOMP was expressed in HEK293 cells, and the rAd-MOMP was used to inject specific pathogen free (SPF) chicks. Specific antibody responses were detected, as were cell mediated immune responses, following vaccination and subsequent challenge. Thus, the authors proposed that rAd-MOMP had significant potential as a candidate vaccine for preventing avian chlamydiosis.

The same group of researchers has now expanded the above study. They prepared several batches of recombinant adenovirus vaccines, inoculated these into chicks and carried out potency tests, demonstrating vaccine efficacy and safety tests, showing that the vaccines were safe. They also tested feces samples from vaccinated chickens, using PCR, over a 6 month

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Figure 1. Benefits of an Avian Chlamydial Vaccine.

period. These were negative for recombinant adenovirus, which is important as regards addressing concerns regarding live virus vectors.¹³ Protective tests also demonstrated reasonable protection following pathogen challenge 6 months post-vaccination. Furthermore, the vaccine was found to be effective following 12 months storage at -20°C . The proposed vaccine clearly exhibits significant potential for the prophylactic treatment of poultry. Reduction of AC will affect not only the disease, anorexia and associated mortality, but should also reduce the incidence of the carrier state and exacerbations due to interactions with other pathogens. An effective vaccine should also improve breeding performance in birds.

Design and successful implementation also has the potential to improve human health. *Cp. psittaci* infects humans in a number of ways—inhalation of organisms contained in urine, dried feces, respiratory

secretions following dispersal in droplets, mouth to beak contact, bites, handling feathers and tissue of infected birds, and is thus a significant public health risk.^{1,2,14,15} There are numerous ways of acquiring infections—not only from psittacine pets, but also from everyday activities, such as mowing lawns, gardening, etc.^{14,15} Human infections vary from inapparent to severe systemic disease, with interstitial pneumonia and occasionally encephalitis.^{14,15} Individuals at risk include bird breeders, pregnant women, workers at quarantine stations, poultry farmers, abattoir workers, veterinarians and assistants, pet shop workers, as well as employees of and visitors to zoos, wildlife parks, petting zoos, circuses.^{1,14,15} An effective vaccine would decrease zoonotic risk and also reduce the risk of emergence of antibiotic resistant strains.

The paper by Zhou et al. goes some way towards achieving this aim.

References

- Harkinezhad T, Geens T, Vanrompay D. *Chlamydia psittaci* infections in birds: A review with emphasis on zoonotic consequences. *Vet Micro* 2009; 135:68-77.
- Vanrompay D, Ducatelle R, Haesebrouck F. *Chlamydia psittaci* infections: a review with emphasis on avian chlamydiosis. *Vet Micro* 1995; 45:93-119.
- Everett KD, Bush RM, Andersen AA. Amended description of the order Chlamydiales, proposal of Parachlamydiaceae fam. nov. and Simkaniaceae fam. nov., each containing one monotypic genus, revised taxonomy of the family Chlamydiaceae, including a new genus and five new species, and standards for the identification of organisms. *Int J Syst Bacteriol* 1999; 49:415-40.
- Geens T, Desplanques A, Van Loock M, Bonner BM, Kaleta EF, Magnino S, et al. Sequencing of the *Chlamydia psittaci* *ompA* gene reveals a new genotype, E/B, and the need for a rapid discriminatory genotyping method. *J Clin Micro* 2005; 43:2456-61.
- Laroucau K, de Barbeyrac B, Vorimore F, Clerc M, Bertin C, Harkinezhad T, et al. Chlamydial infections duck plants associated with human cases of psittacosis in France. *Vet Micro* 2009; 135:82-9.
- Andersen AA. Comparison of pharyngeal, fecal and cloacal samples for the isolation of *Chlamydia psittaci* from experimentally infected cockatiels and turkeys. *J Vet Diagn Invest* 1996; 8:448-50.
- Sachse K, Vretou E, Livingstone M, Borel N, Pospischil A, Longbottom D. Recent developments in the laboratory diagnosis of chlamydial infections (Review) *Vet Micro* 2009; 135:2-21.
- Van Loock M, Verminnen K, Messmer TO, Volckaert G, Goddeeris BM, Vanrompay D. Use of a nested PCR-enzyme immunoassay with an internal control to detect *Chlamydia psittaci* in turkeys. *BMC Infect Dis* 2005; 5:76.
- Herring AJ, Jones GE, Dunbar SM, Nettleton PF, Fitzgerald TA, Andersen IE, et al. Recombinant vaccines against *Chlamydia psittaci*—an overview of results using bacterial expression and a new approach using a plant virus 'overcoat' system. In: Stephens RS, Byrne GI, Christoffersen G, Clarke IN, Grayston JT, Rank RG, et al. (Eds). *Proceedings of the Ninth International Symposium on Human Chlamydial Infection, International Chlamydia Symposium*. San Francisco CA 1998; 434-7.
- Sandbulte J, TerWee J, Wigington K, Sabara M. Evaluation of *Chlamydia psittaci* subfraction and subunit preparations for their protective capacities. *Vet Micro* 1996; 48:269-82.
- Vanrompay D, Cox E, Volckaert G, Goddeeris B. Turkeys are protected from infection with *Chlamydia psittaci* by plasmid DNA vaccination against the major outer membrane protein. *Clin Exp Immunol* 1999; 118:49-55.
- Zhou J, Qiu C, Cao X, Lin G. Construction and immunogenicity of recombinant adenovirus expressing the major outer membrane protein (MOMP) of *Chlamydia psittaci* in chicks. *Vaccine* 2007; 25:6367-72.
- O'Shea H. Viral Pathogens as Therapeutic Delivery Vehicles. 2008 in *Patho-Biotechnology* Eds: Roy Sleator and Colin Hill ISBN: 978-1-58706-304-6.
- Longbottom D, Coulter LJ. Animal chlamydioses and zoonotic implications. *J Comp Pathol* 2003; 128:217-44.
- Longbottom D, Livingstone M. Vaccination against chlamydial infections of man and animals. *Vet J* 2006; 171:200-3.