DISCONTOOLS

Avian coronaviruses (AvCoV)
Summary

Introduction

1. This note provides a brief summary of the Disease and Product analysis prepared by a DISCONTOOLS group of experts on avian coronaviruses. They reviewed the current knowledge on the disease, considered the existing disease control tools, identified current gaps in the availability and quality of the control tools and finally determined the research necessary to develop new or improved tools. Full details are available on the web site at http://www.discontools.eu/.

Disease profile

2. There are currently three main avian coronaviruses (AvCoVs) affecting the poultry industry: Infectious Bronchitis Virus (IBV), Turkey Coronavirus (TCoV) and Guinea-Fowl Coronavirus (GfCoV). AvCoVs are of the genera gamma-CoV and delta-CoV. Those in poultry are almost uniquely of the genus *Gammacoronavirus* and those of small wild birds of the genus *Deltacoronavirus.* IBVs have now been isolated in all parts of the world where chickens are farmed and exist as many different antigenic and genotypes. All have been isolated from chickens and most cause respiratory problems in this species. However, renal and genital diseases can also occur which can vary in severity according to the IBV strain involved. AvCoVs are highly infectious and can result in prolonged infections. TCoV and GfCov are only known to affect the enteric system, and together with a complex of enteric pathogens are involved in severe enteritis.

Risk

3. IBV is probably the second most damaging virus for the global poultry production after Avian Influenza. AvCoVs cause severe losses to the poultry industry despite, as in the case of IBV, the use of different vaccines and vaccine programmes. This may be due to their strong capacity for rapid evolution, which urges for up-to-date knowledge on circulating strains. AvCoVs are not zoonotic and, given their global endemicity, have limited impact on international trade.

Diagnostics

4. Diagnostic kits are only available for IBV. For IBV antibody detection, commercial ELISA kits are available worldwide. Hemagglutination antigens are available for some of the serotypes. Virus neutralisation tests are always in-house methods and availability is poor. Commercial reverse transcriptase (RT)-PCR kits (especially genotype specific tests) are available in many countries and also many in-house RT-PCR's are being used. Specific diagnostic kits are required for TCoV and GfCoV.

5. There are no properly validated guidelines for the interpretation of commercial ELISAs and the many RT-PCR tests. Differentiation between vaccine and field strains is hampered by the lack of validated markers for attenuation.

6. There is need for more knowledge on reliable genetic markers that could help the development of DIVA vaccines and for more knowledge on the molecular basis of attenuation of current vaccines. This would be aided through the acquisition of more full-length genome sequences of circulating AvCoVs. Development of pen-side tests would also be very useful, but only if they have DIVA capacity.

Vaccines

7. Vaccines are only available for IBV and not for other AvCoVs. A very high percentage of poultry flocks worldwide are vaccinated for IBV. Both live-attenuated vaccines (administered by spray or in drinking water) and inactivated vaccines (administered by injection) are available. Live attenuated vaccines have shown to be far more effective than inactivated vaccines. Inactivated vaccines are helpful to lengthen the interval of protection against damage of the genital tract in laying birds, but only after adequate live priming. DNA vaccines, sub-unit and peptide vaccines,

virus-like particles, vector-based vaccines and reverse genetic vaccines have also been developed as proof of concept, however, none have yet been commercialized.

8. The basis of cross-protection needs to be unravelled and is crucial for developing next-generation vaccines. There are many strains of IBV in circulation and new strains will emerge on a regular basis. A highly immunogenic, broadly protective IBV vaccine, manufactured through reverse genetics would provide a good basis for future vaccines while reducing selective pressure for viral genome evolution. The development of a cell culture system that is permissible to infection with enteric AvCoVs would greatly facilitate development of novel vaccines. In addition, there is need to investigate if using multiple live IBV vaccines is contributing to the continual genetic evolution of IBV in the field and what level of protection would be needed to lower this risk.

Pharmaceuticals

9. No antivirals are currently available and would only be useful when they are inexpensive, applicable via drinking water, feed or spraying and have a very short withdrawal period. As AvCoVs evolve rapidly, it could be expected that antiviral treatment may induce drug-resistance easily.

Knowledge

10. CoVs are enveloped, which makes them susceptible to disinfectants. Therefore, cleaning, disinfection and biosecurity should be a high priority for controlling infections, especially for GfCoV and TCoV, for which vaccination support is not yet available.

11. IBVs have been isolated in all parts of the world and exist as many different antigenic genotypes. Most cause respiratory problems, but renal and genital disease can also occur. We need to understand the molecular basis of tissue tropism as well as the large variability in severity of disease. In comparison with IBV, there are very few TCoV and GfCoV isolates available for characterization.

12. While chicken, turkeys and guinea fowl are the natural reservoir for IBV, TCoV and GfCoV, respectively, IBV-like AvCoVs have been detected in other domestic and wild bird species. Interspecies transmission needs to be further investigated.

Conclusions

13. AvCoVs continue to cause severe losses to the poultry industry despite (in the case of IBV) the use of different vaccines and vaccine programmes over the last 70 years. AvCoVs seem to have a strong capacity for rapid evolution and this is arguably why they continue to cause problems. Fundamental epidemiological and experimental studies unravelling how and why AvCoVs, especially IBV, can create such diversity are lacking. Studies are required that focus on genomic evolution, its dynamics and the driving factors involved (environmental, physical etc) so that improved control measures can be implemented. The development of more specific and sensitive molecular and serological laboratory tests would greatly support such studies.