FINAL REPORT
Adenovirus outbreak in WA
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Introduction
The recent outbreak of adenovirus infection in Perth Western Australia is of great concern for all Australian pigeon fanciers due to its rapid spread, high level of mortality and no potential for future protection from vaccination. This report presents a blue print for future outbreaks, which are likely to reach the Eastern states of Australia at some time.

Outbreak Narrative
Sickness and death appeared within 48 hours of race birds returning from the first race of the 2016 season. They had been exposed in the race transporter to the virus from lofts that had experienced the disease a week or so earlier.
The origin of infection appears to be linked to deaths in pigeons from lofts that shared a tossing trailor some 2 to 3 weeks prior to the first race which was not reported to the PRF committee.

Pigeon Racing Federation of WA (PRF) executives acted immediately to diagnose the exact cause of this disease outbreak by sending body specimens for analysis to veterinary pathologists at the Western Australian Department of Agriculture who quickly eliminated as its cause Avian Influenza, Newcastle Disease Paramyxovirus and other serious viral infections of danger to humans and the poultry industry.

Pathologists in Western Australia and Sydney also microscopically examined body organs. WA pathologists examined birds that had died from the disease whilst Sydney pathologists examined birds that were euthanatized after exhibiting typical symptoms of the disease. The combined results of these microscopic investigations presented a view of the disease, which formed the basis of the following disease control strategy.

Within three days of the first death a strategic plan had been implemented by PRF to control the disease, which included standard biosecurity measures of disease containment and the start of Sulfa-Trimethoprim antibiotic therapy for race and stock birds of all in-contact and affected pigeon lofts.

Diagnosis of the Disease
Department of Primary Industry WA pathology results revealed viral inclusion bodies suggestive of pigeon adenovirus infection whilst Sydney results showed no such inclusions but severe necrotizing hepatitis (liver cell destruction and death) and inclusion bodies consistent with pigeon circovirus and pigeon herpes 1 infections. Possible causes of necrotizing hepatitis include toxic or ischemic diseases, or infectious agents such as pigeon adenovirus (PiAV), fowl adenovirus (FAV), pigeons circovirus (PCV) and pigeon herpes virus 1 (PHV1). PHV1 and PCV have been previously recorded in Europe as being associated with pigeon adenovirus infections. These diseases were also present in birds that died first during the WA adenovirus outbreak.

Direct toxin exposure was dismissed and eliminated any possible failings within the pigeon transporter. A tentative diagnosis of pigeon adenovirus infection (PiAV) was made given the random nature of hepatic necrosis (liver cell death) and presence of intra-nuclear inclusion bodies. There are two forms of adenovirus recognised in pigeons referred to as Type 1 (PiAV1) and Type 2 (PiAV2) adenovirus infection.

Liver lesions in submitted birds were consistent with adenoviral hepatitis. Review of current scientific literature[1, 2, 3] confirms the symptoms and WA pathologic findings are consistent with Type 2 "necrotizing hepatitis" pigeon adenovirus infection (PiAV2) whilst Sydney pathology suggested "classic adenovirus" (PiAV1) signs of severe intestinal as well as massive liver damage and concurrent infections with PVC and PHV1. From these findings it was concluded both pigeon adenovirus disease (PiAV1 and PiAV2) entities were occurring concurrently in the WA outbreak.

Adenoviral diseases of poultry are found worldwide but PiAV1 and PiAV2 have not previously been experienced in Australia.

Avian adenoviruses are categorized into 3 serogroups, and multiple serotypes within each group. [1] To date, 7 different serotypes of group 1 FAV have been identified in pigeons, and in addition to these FAV serotyoes, specific PiAV strains have been found. [1] The PiAV serotype of the WA outbreak is unknown.

Pigeon strain-specific adenovirus tests are not available in Australia but diagnosis can be made according to typical symptoms and microscopic organ changes seen in birds that have died from the disease. Similar control measures and treatment plans are followed for PiAV1 and PiAV2.

Information about Pigeon Adenovirus Diseases - PiAV1 and PiAV2

Adenovirus infections are usually not highly pathogenic in most animals and usually regarded as secondary disease induced by one or many other inciting factors. A few adenoviruses, such as PiAV1 and PiAV2 are considered exceptions, as they are highly and primarily pathogenic.

Pigeon adenoviruses are responsible for two distinct clinical entities (PiAV1 and PiAV2), both causing serious harm to pigeon lofts.

In the WA outbreak both clinical syndromes of pigeon adenovirus infection were noted: Type 1 pigeon adenovirus disease (PiAV1) or "Classic adenovirus" and Type 2 pigeon adenovirus disease (PiAV2) or "Necrotizing hepatitis". Both these forms have not been previously recorded in Australia.

Type 1 Adenovirus disease was first identified in 1984 as a distinct pigeon disease entity in Belgium. This classic type adenovirus is a major disease in Europe nowadays seen as a seasonal problem thought to occur in young birds under stress from a multitude of issues whilst they are preparing for their first

races. From October 1992 a new adenovirus-related disease entity in pigeons called Type 2 Adenovirus was observed in Europe.

Pigeon adenovirus infections are highly contagious spreading through cross contamination in the common baskets by droppings, drinking water and air. PiAV1 is only observed in pigeons less than a year old. In contrast PiAV2 may occur at any time throughout the year and affects pigeons of all ages.

Type 1 Adenovirus (PiAV1) Symptoms noted with WA Outbreak

Classic symptoms of PiAv1 were noted in returning race birds and subsequently in exposed birds in the loft. Late bred birds were most affected by the disease. Vomiting was the first sign of infection, which started to appear 48-72 hours after the birds returned from the race. Vomiting continued for 36 hours and was followed by dark green slimy diarrhea that continued for 2-4 days. During this time birds were fluffed up and severely depressed.

The disease spreads quickly through the loft with 100% of birds becoming infected within 2 days of its introduction. Clinical signs usually disappear within one week in most pigeons as the adenovirus is quickly eliminated by a healthy immune system. The disease may become prolonged as a result of secondary E. coli infections especially in overcrowded flocks and those suffering other disease problems.

Antibiotic treatment was initiated to manage secondary toxic E.coli infections that are often responsible for death of pigeons with this form of the disease. Antibiotics are often but not always recommended in Europe where the disease has been established for more than 20 years. Some European veterinarians recommend an approach that stimulates recovery by natural immunity. Veterinary diagnosis should be sought regarding an exact treatment plan because PiAV1 infections resemble PMV, salmonellosis and hexamitiasis infections.

Antibiotics were recommended during the WA outbreak to reduce mortality from secondary infections related to PiAv1. Sulfa-trimethoprim was administered in the drinking water for 7 days and measures to boost immunity and limit stress were instigated. A different approach may be taken in future outbreaks.

Most PiAv1 infected pigeons recovered within a week. Mortality rate in most lofts was about 1-10% with most deaths occurring in late-bred youngsters. Some lofts recorded 40% mortality. Droppings and vitality returned within a week. However some birds had continuing diarrhea. The virus and secondary infections may have permanently damaged the liver and intestines of these birds.

Type 2 Adenovirus (PiAV2) Symptoms noted with WA Outbreak

PiAV2 can infect pigeons of any age. The symptoms of PiAV2 differ from that of young birds with PiAV1.

Pigeons suffering from PiAV2 in the WA outbreak died suddenly with no apparent signs of illness. This form of adenovirus moves more slowly than PiAV1 and may take up to 6 weeks to pass through the loft. Therefore new deaths may be experienced over a period of 6 weeks. Measures that boost immunity and limit stress especially regarding cold wet weather and overcrowding are recommended to help limit deaths in stock lofts. Mortality in affected WA stock lofts has been limited to 10-20% but one loft experienced 50% losses. In Europe PiAV2 has been reported to occur during the breeding season.

Anecdotal evidence suggests well-managed lofts and females are less likely to be affected by PiAV2 whilst scientific research suggests there is no correlation between the occurrence of the disease and the pigeons' physiological condition, sex and presence of stressing factors.

Treatment Plan

The current WA outbreak involves both PiAV1 and PiAV2 infections.

Pigeon adenovirus infections may inflict rapid and severe damage to the intestine causing massive loss of proteins and electrolytes, which causes mass multiplication of normal intestinal bacteria (E.coli) to reach toxic levels that cause vomiting, green slimy but sometimes yellow watery droppings, and death within a day or so as the secondary infections overflow into the liver and other internal organs. Other complicating infections such as Streptococcus, Staphylococcus and Hexamita may also need concurrent treatment as these may also be involved with pigeon adenovirus infection.

PRF has implemented a treatment plan that applies to all infected pigeons irrespective of whether PiAV1 or PiAV2 is involved. The aim of the plan is to protect unaffected stock and race birds from the harmful effects of secondary E.coli infections, to support a rapid and complete recovery of exposed and sick birds capable of being cured and to identify and cull those with irreversible liver and intestinal damage. Unfortunately there is no cure for the sudden death associated with PiAV2 and some stock birds will be lost.

PiAV1 usually passes within 3 weeks whilst PiAV2 may persist for 6 weeks.

Recommended Treatment Protocol

During the first week of an outbreak expect multiple deaths, vomiting and green slimy watery droppings. After 7 days the number of deaths and symptoms should start reduce. Droppings and bird vitality then return to normal pre-infection appearances.

1. Scrape clean and flame or liquid disinfect loft daily.
2. Remove dead birds for incineration and sick birds to isolation for intensive treatment.
3. Keep birds inside the loft for at least 2 days after deaths have ceased.
4. Do not loft fly until birds are wing flapping on loft floor and eager to resume flight training. .

5. Start to medicate all birds in drinking water with antibiotics (SulfaTrimethoprim) for 5-10 days even when signs of adenovirus have not appeared if your birds have been exposed to the disease in any way. This treatment should save many young birds and accelerate recovery as it controls the secondary E. coli infections that accompany pigeon adenovirus infection. Antibiotic treatment continues for at least 5 days after which time it can be halted when there is no longer any vomiting and droppings have returned to normal for at least 3 days.
6. Penicillin antibiotics and anti-canker treatments may be recommended under the advice of a veterinarian for lofts that fail to fully recover within 2 weeks. Enrofloxacin (e.g. Baytril or Enrotril) should be excluded from this treatment plan unless advised differently by an attending veterinarian.
7. A well-balanced light food mix should be supplemented with protein (e.g. Turbobooster), B-vitamins (e.g. E-powder) and mineral electrolytes (e.g. Bloomford - Fvite) to overcome the deficiencies created by the intestinal E. coli infections. Remove mineral and shell grits from loft as these will be over-engorged by recovering birds and cause potentially fatal gizzard impaction and sour crop problems.
8. An immune stimulating programme should be introduced for 4 weeks at the conclusion of the antibiotic treatment. This may include probiotics, bowel cleansers and herbal remedies.
9. The disease should pass through the pigeon loft within 3 weeks after which time loft training can commence. At this time a light purge with Epsom salts (1 teaspoon per 8 litres of drinking water) should aid flying vigour. This remedy is also used to expose birds that have not fully recovered from the sickness and may suffer the potentially incurable harmful effects of intestinal or liver damage. Weakened birds may become fluffed up and have watery droppings. It may be necessary to cull these birds.
10. It is suggested that some pigeon lofts may become susceptible to illness associated with E.coli, streptococcus, staphylococcus, Hexamitiasis and the common respiratory diseases as a result of this outbreak. The same health programmes used before the outbreak are used to manage these diseases.
11. Changes to this treatment protocol may be made as more is known about the progress of this disease within the Australian context.

Recommended Treatment Protocol For Birds Failing to Fully Recover

Most birds will recover from adenovirus infection even without the aid of antibiotics. Antibiotics however will help many birds recover from the effects of secondary infection. Some birds will not respond to the antibiotic treatment and die whilst others will continue to show watery droppings and other un-wellness signs. There are several possible treatment options to follow for these birds that fail to respond the initial course of antibiotics. Our recommendation is to continue antibiotic treatment for another week under the advice of an attending veterinarian. This may include combination antibiotics to treat infections other than toxic E.coli. Birds that fail to respond to these additional treatments within 2 weeks are best culled as the likelihood of their full recovery is low and the

infections they harbor are a threat to the continuing health the rest of the race team.

Thoughts About 2016 Race Season

It is proposed that racing may resume in 3-6 weeks after consultation with PRF membership, as infected birds should be protected from repeat adenovirus infection. Those pigeons with permanent or persisting liver damage may never achieve race form in the future. It is possible that sudden deaths from PiAV2 may continue to occur up to 6 weeks after the initial outbreak.

Future of Adenovirus

There is little doubt that both forms of pigeon adenovirus infections (PiAV1 and PiAV2) will recur in future years and most likely in young birds at the same time each year. Because young late bred pigeons are at most risk of disease it is proposed if PRF members agree that the first 6 weeks of 2017 racing be restricted to old birds and young birds that have completed their moult to a level of at least 8 full main flight feathers on each wing. This approach may reduce the likelihood of another similar massive outbreak by allowing young birds to develop some level of immunity before they enter races over the following years.

Protection of Eastern States from Adenovirus

National bodies for racing pigeons and show pigeons are approaching government departments to ban movement of pigeons from WA to eastern states for at least 6 months.

References:
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2. Vereecken M, de Herdt P. Adenovirus infections in pigeons: A review. Avian Pathol. 1998;27(4):333-338.
3. Himmel L et al. Necrotizing Hepatitis in a Domestic Pigeon. Vet Pathol. Online First Jan 23 2014.