ENDEMICITY OF NEWCASTLE DISEASE VIRUS IN VILLAGE INDIGENOUS CHICKENS AND THE ROLE OF CARRIER DUCKS

Dr. LUCY WANJIRU NJAGI (BVM, MSc, Nairobi)

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Department of Veterinary Pathology, Microbiology and Parasitology

Faculty of Veterinary Medicine

University of Nairobi, Kenya

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ABSTRACT

While the epidemiology of Newcastle disease (ND) in commercial poultry systems is very well documented, the ecology of this disease in indigenous birds, especially in tropical environments, is not adequately reported. This thesis covers work carried out to investigate the ecological and biological factors that are associated with NDV endemcity in local indigenous chickens in wet and dry areas. The results led to the development of the elements of an endemicity model. Three on-farm studies were done, namely: (1) Establishing factors associated with ND disease outbreaks in chickens for five different agro-ecological zones; (2) Establishing ND virus prevalence in chickens in these zones; and (3) Establishing the role of serum and egg-yolk antibodies as indicators of ND carrier status in chickens. The first study was carried out by interviewing 15 farmers from each zone using questionnaires. Samples were collected from chicken for viral isolation and serology from the respective farmer’s flocks for the second and third studies.

Controlled studies were then designed to investigate whether a stress model can explain the dynamics of Newcastle disease virus (NDV) ecology in the duck – chicken transmission interactions. Stress was simulated by injecting birds with dexamethazone to induce immunosuppression (IS). The study design comprised experiments 4 -7, namely: (4) Cross-transmission studies between infected ducks and sentinel chickens; (5) Studies establishing the types of pathological lesions in NDV carrier ducks, (6) Determination of NDV antigen localization in various tissues of experimental ducks; and (7) Determination of persistence of the virus in experimental ducks with various levels of NDV antibodies. Various groups of NDV - seronegative ducks, raised at the university premises, were
used in the four experiments. In experiment 4, five IS-infected, five non-IS-infected and five naïve ducks were each mixed with five naïve chickens. In experiment five, 38 IS-infected, 37 non-IS infected ducks were investigated for pathological lesions and compared with respective control ducks that were penned separately. In experiment six, 23 IS-infected ducks and 22 non-IS infected ducks were tested for the location of the viral antigen and compared with 10 naïve ducks that were separately penned. In Experiment seven, 94 ducks were divided into 3 groups according to antibody status [low antibody (32), medium antibody (32) and antibody free (30)]. Each duck group had four sub-groups namely IS-infected; IS-non-infected and two respective controls. Each experiment had 12 non – IS infected chickens as positive controls.

Data showed that ND outbreaks in chickens were significantly associated with: stress – inducing factors (p<0.05), i.e. confinement of birds, seasons, windy conditions and temperature changes. Other factors associated with ND outbreaks were: age of birds, restocking of farms with chickens and disposal methods of infected birds and fecal matter. Dust storms, cultural ceremonies and wild birds were not significantly associated with ND outbreaks (p>0.05). Prevalence of Newcastle disease virus was higher (17.8%) in the dry zone (Lower midland 5, LM 5) compared to the cool wet zone (Lower highland 1, LH 1) at 9.9%. Sero-prevalence was significantly highest (p<0.05) in adult birds (10%) while growers had 5.1% and chicks 2.9%. The geometric mean antibody titres were significantly higher in mature eggs than in sera of the same hens (p<0.05). The geometric mean antibody titres of mature egg yolk were significantly higher than those in ovules in LH 1, Upper midland 2 and Lower midland 3, but the reverse was the case in Upper
midland 3 and LM 5. Hens were seronegative and infected or seropositive with antibodies in eggs and ovules or seronegative but with antibodies in eggs and ovules. The hens with high antibody levels would be infected by NDV but not die, however when antibodies waned off they would be susceptible to infection. This completed one component of the endemicity model.

Ducks showed minimal to very mild clinical signs. They did not die but transmitted the virus to in – contact sentinel chickens, resulting in 100% chicken mortality. Ducks shed the virus for 15 days post infection. Chickens mixed with IS ducks showed more clinical signs than those mixed with non - IS ducks. The NDV was more readily transmitted from IS ducks to chickens than from non - IS ducks demonstrating the second component of the endemicity model. This model simulates the potential for disease transmission scenario in rural duck – chicken mixed flocks. This phenomenon has not been demonstrated before and is being reported here for the first time.

Air-sacculitis, necrotic foci on the spleen and congestion of the small intestines were dominant pathological lesions in challenged IS ducks. Congestion of the liver, lymphoid depletion in cecal tonsils and spleen and the focal infiltration of mononuclear cells in these organs were observed more in IS ducks than in non- IS ones. The lesions (except airsacculitis) in positive control chickens were extremely severe compared to those seen in ducks. Immuno-suppression therefore exacerbated lesions in ducks completing the third component of the model. On immunohistochemistry, viral nucleo-proteins were found mainly in the large mononuclear cells of cecal tonsils and tubular epithelial cells of
infected duck kidneys. This study demonstrated for the first time that NDV localized and possibly multiplied in cecal tonsils and kidneys of the carrier ducks, where it can be excreted into feces leading to periodic outbreaks of the disease in duck – chicken mixed rural flocks. This formed the fourth component of the model.

For the low-antibody and medium-antibody maintained ducks that were challenged with virulent NDV, the IS ducks manifested more clinical signs of ND than NIS ducks. The ducks that were NIS, with no pre –challenge antibody titers had a high increase in antibody levels compared to respective IS –challenged ducks. The IS ducks had a high concentration and persistent viral levels in their tissues than NIS ones, making them better carriers. The pre – challenge antibody levels therefore affect the immune response in NDV carrier ducks and form the fifth part of the endemicity model.

In conclusion, seronegative hens harbored NDV while seropositive hens did not. Kidneys and cecal tonsils seemed to sequester the virus in carrier ducks while immunosuppression increased the intensity and frequency of lesions, clinical signs and the persistence and quantity of virus released from IS carrier ducks to chickens. Thus, a five-component endemicity model can explain the ND carrier status in duck – chicken mixed flocks and in village indigenous multi-age chicken flocks and should be taken into account when ND control strategies are being developed.

Further studies should investigate the role of egg yolk and sera antibodies in carrier ducks in addition to carrying out a prospective cohort study with large sample size and long
period of follow up in order to understand the role of the risk factors that were raised in this study in the epidemiology of ND in village indigenous chickens in Kenya. Since there is frequent transportation of birds between the two agro-ecological zones studied, a phylogenetic analysis of the NDV isolates recovered to reveal whether there are differences among them is recommended.