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Epidemiology, challenges and prospects for control of Newcastle disease in village poultry in Nigeria

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Newcastle disease is a viral and often fatal disease that has been reported to affect a wide range of avian hosts, irrespective of age and sex. It is reported to be a major constraint to the development, survival and productivity of village poultry. This paper is a review of the epidemiology of Newcastle disease in village poultry in Nigeria, with emphasis on the susceptibility of species, types and ages. Also examined are the challenges and prospects of Newcastle disease control in this village poultry sector in Nigeria. This was conducted for the purpose of formulating effective strategies for controlling the disease in the rural areas of Nigeria.

Keywords: ND; epidemiology; challenges; prospects; control; village poultry

Introduction

Until the recent upsurge of Avian Influenza, Newcastle disease (ND) has been a most important viral disease of poultry, especially in developing countries (Nawathe *et al*., 1975; Adu *et al*., 1986; Adene, 1990; Chabeuf, 1990; Spradbrow, 1993; Yongolo, 1996). It is a serious constraint to poultry raising and has a devastating effect on the productivity and survival of commercial and village poultry industry (Nawathe, 1988; Shamaki *et al*., 1989).

Village poultry accounts for about 90% of the total poultry population in Nigeria (Sonaiya *et al*., 1999). It provides an important source of high quality animal protein and income for rural dwellers (Jagne *et al*., 1991). Investment in the form of breeding, housing, feeding, labour and veterinary care is minimal, therefore egg production is low and mortality is high as a result of infection by contagious diseases and predators and other losses (*e.g.* drowning) of chicks (Sauer, 1991; Dipeolu *et al*., 1998).

In spite of the significant advances in poultry vaccination programmes and efficacy, outbreaks of infectious diseases, particularly ND are still being recorded in many areas in both vaccinated and non-vaccinated flocks (Giambrone and Closer, 1990). The losses

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attributable to morbidity are not known, but it has been estimated that over 250 million chicks, keets and ducklings in Africa die annually as a result of various infections (Sonaiya *et al*., 1999). Experience has shown that ND control in village poultry is possible, but requires efficient application of suitable vaccines and rigorous biosecurity, which are lacking in Nigeria (Nwanta *et al*., 2006).

The purpose of the paper was to review the epidemiology, challenges and prospects of ND control in village poultry in Nigeria and suggest strategies for the control of the disease in the country.

Epidemiology of ND in Nigeria

Previous studies have revealed that ND is an endemic disease in both village and commercial poultry, with frequent epidemic outbreaks being recorded in highly susceptible poultry flocks (Nawathe *et al*., 1975; Adu *et al*., 1986; Orajaka *et al*., 1999). Clinical and serological studies of ND in Nigeria have confirmed the particular susceptibility of village chickens (Hill *et al*., 1953; Hill and Davis, 1962; Abdu *et al*., 1985; Ezeokoli *et al*., 1985; Wosu and Okeke, 1989; Orajaka *et al*., 1999; Nwanta *et al*., 2006), pigeons (Ezeifeka *et al*., 1992), guinea fowls, ducks and turkeys (Majiyagbe and Nawathe, 1981; Gomwalk *et al*., 1985; Durojaiye and Adene, 1988; Echeonwu *et al*., 1993). However, village chickens appear more resistant to ND infection than exotic chickens (Oluyemi *et al*., 1979), while young domestic fowls and guinea fowls are more commonly affected than adults (Nwanta *et al*., 2006). Turkeys and pigeons may develop generalized disease, but clinical signs are rarely reported in geese and ducks (Nwanta *et al*., 2006).

ND is equally regarded as the most economically important disease that devastates village poultry in Nigeria (Abdu *et al*., 1985) as it causes the death of millions of birds (particularly young birds) and economic losses through the slaughter of sick birds (Nwanta *et al*., 2006). A morbidity rate of 80% has been recorded in chickens (Fatunmbi and Adene, 1979), in another report, an average mortality rate of 28% was recorded and the disease has been found to be responsible for 56% of all mortalities in the birds (Abdu *et al*., 1992). Mortality due to ND may range from 24-100% although in most outbreaks 45- 100% of the birds in a flock have been reported to have died of the disease (Abdu and Saidu, 1990).

ND sero-prevalence studies conducted in village chickens in different parts of Nigeria have shown that the prevalence rates are variable: in Kaduna State, 73.0% (Ezeokoli *et al*., 1985), 74.3% (Nwanta, 2003), in Maiduguri, Borno State, 54.0% (Baba *et al*., 1998), in Plateau State, 41. 0% (Adu *et al*., 1986), Ibadan, Oyo State, 38% (Oyewola *et al*., 1996) and in southeast derived savannah zone of Nigeria, 63.0% (Orajaka *et al*., 1999). Velogenic viscerotropic Newcastle disease virus (VVND) strain has been commonly isolated in rural areas of Nigeria from parrot (Onunkwo and Momo, 1981), dead and healthy free–range chickens and guinea fowls (Echeonwu *et al*., 1993).

A total of 1,193 (74.3%) out of 1,605 unvaccinated village chickens that were bled and screened for ND antibody had detectable HI antibodies to NDV. Only 102 birds (6.4%) had an HI antibody titre of $\geq$4 log2 and were presumed protected leaving 93.6% of the sampled population at risk of suffering from ND (Nwanta, 2003). Chicken are infected by both inhalation and ingestion of virus through contaminated feeds and water. The introduction of ND virus is most likely to occur when infected live chickens or birds are introduced (Martin, 1992). Apart from ducks, doves, turkeys, geese, guinea fowls, ND virus has also been isolated from wild birds, which suggests that they also harbour and shed the virus, acting as source of infection for chicken (Lancaster, 1966; Onunkwo

and Momo, 1981 Alders and Spradbrow, 2001). It is also uncertain whether chickens can become long-term carriers of ND virus. ND vaccine has been reported to induce an immunity that prevents clinical disease but that does not necessarily prevent ND infection. This suggests that chickens vaccinated against ND can become infected by virulent ND virus without developing clinical signs (Ezema, 2002) and then spread the virus to other susceptible birds within the vicinity. Also infected birds shed the virus in their faeces which contaminate the environment. The virus can survive perhaps up to 3 months at temperatures of 20 –30^{O}C, and longer under cooler conditions. Aerosol transmission of the virus is only possible where there is concentration of infected chickens necessary to generate sufficiently dense aerosols for transmission (Martin, 1992; Huchzermeyer, 1993). Therefore, bird-to bird contact would seem to be the most important mode of transmission in tropical and subtropical production systems (Huchzermeyer, 1993).

By nature, village poultry flocks are small in number, scattered and multi-aged. During the day, as they are scavenging, the entire local population can be regarded as a single unit, and all the birds may be in direct or indirect contact with each other. At night, observations in Nigeria have shown that the birds congregate in smaller household groups either in houses, in the areas immediately surrounding dwellings or in trees within settlements (Nwanta *et al*., 2006). Close contact between infected and susceptible birds under these conditions has been reported to aid the spread of ND virus infection (Huchzermeyer, 1993).

The movement of live infected village birds is probably seen to be the main source of virus transmission (Nawathe, 1988; Ibrahim and Abdu, 1992). Village poultry are mobile and may pass through markets. Poultry in villages congregate, and the infected birds will spread the virus and disperse. Even chickens purchased for consumption are bought live and may mix for a while with the home flock. Experience has shown that outbreaks of ND may follow the introduction of newly-purchased chickens (Nwanta *et al*., 2006). Sick birds or suspected contacts are slaughtered for consumption or sold in the pretext of salvaging the birds by their owners (Nawathe, 1988; Ibrahim and Abdu, 1992). The sale of such infected birds aid the spread of infection (Nwanta *et al*., 2006).

In Nigeria, outbreaks of ND are observed to be seasonal and occur at certain periods of the year which in some cases may be attributed only to seasonal condition (Nawathe, 1988). Studies have shown that the outbreaks of October to December and January to April (dry season) coincide with the time of greatest movement of birds for sale during festivities of Eld-El-Fitre, Eid-El-Kabir, Christmas and Easter (Abdu *et al*., 1985; Nwanta *et al*., 2006). In Uganda, it has been suggested that outbreaks of ND during the dry season (October – December) coincide with the travels of unemployed agricultural workers who carry chicken as gifts when they visit relatives (Alders and Spradbrow, 2001). The VVND virus sweeps through villages and kills unprotected chickens and other susceptible birds at alarming rate of up to 100% between the months of January to April and October to December, coinciding with cold Harmattan windy periods of the year (Nwanta, 2003).

Challenges of ND control in village poultry in Nigeria

There is a much literature documenting ND and its control in commercial (industrial) poultry production systems. Comparatively little information regarding ND control in village poultry has been reported, even though scientists are of the opinion that the disease is a major constraint to poultry development and productivity (Spradbrow, 1993). Basic characteristics of ND virus in commercial and village poultry are

similar; however, the difference in manifestations relate to the production systems and socio-economic status of the owners. Extensive methods of production are essentially adopted in the raising of village poultry in Nigeria (Nwanta *et al*., 2006). Village flocks, in most cases, are free range and are allowed to roam about in small numbers of 5-20 with limited husbandry and health care (Adu *et al*., 1986; Orajaka *et al*., 1999; Nwanta *et al*., 2006). In the free range system of management, village poultry species directly or indirectly contact ND from contaminated environment or infected birds that serve as reservoirs of virulent virus that may threatens the survival of commercial poultry-production (Bell and Moulaoudi, 1988). The spread of ND is also enhanced through the movement of birds, particularly when in contact with the infected poultry on retiring to shelters at night (Huchzermeyer, 1993).

Report on outbreaks of ND among village chickens in Nigeria showed that heavy losses are recorded annually as a consequence of the type of husbandry and management methods employed in their production (Majiyagbe and Nawathe, 1981; David-West, 1992; Echeonwu *et al*., 1993; Nwanta *et al*., 2006). Farmers in the village poultry business are discouraged by the losses caused by the circulating strains of VVND, commonly found causing up to 100% mortality in unprotected flocks (Echeonwu *et al*., 1993; Ezema, 2002). Most village poultry farmers are aware of the infectious nature of the ND and of the failure of any treatment measures (Nwanta *et al*., 2006). This discourages them from investing time and money in improving the standard of their poultry husbandry and health care (Nwanta *et al*., 2006). Sick or dead birds are slaughtered for consumption or sold for salvage. The sale of such infected birds aids in the spread of infection and militate against any control measures (Nwanta *et al*., 2006). Village poultry are owned and managed by women and children in Nigeria (Spradbrow, 1993; Gueye, 2000; Nwanta *et al*., 2006), while men have virtually drifted to cities to look for jobs. The women left with the responsibility of household work for both immediate and extended family members rarely have time to care for the welfare and health of their flocks (Nwanta *et al*., 2006).

Four general approaches have been suggested for the control of Newcastle disease: hygiene, vaccination, slaughter of infected flocks, and selection for resistance to the diseases or for a better immunological response (Bell, 1990). While hygienic measures are of limited use in the case of very small flocks that are free roaming, they become increasingly important as soon as semi- intensive farming is undertaken. In this situation all the measures applied to commercial farms such as cleaning and disinfections between flocks, isolation of farms, limited access to birds and personal hygiene become necessary. The slaughter of infected flocks and proper disposal has been reported as a measure which has been successfully adopted in regions that are essentially free of the disease, such as the United States (Bell, 1990). The measure is clearly not applicable in Africa, particularly in Nigeria where the disease is endemic.

Vaccination is an effective method of controlling ND in both commercial and village poultry, but is rarely given priority in rural communities of Nigeria where majority of poultry are kept (Nwanta *et al.*, 2006). The concern for these rural poultry owners is the cost of the conventional ND vaccines, which are supplied in 200 dose vials, compared to the small sizes of the village flocks of 5 – 20 per household. It is therefore difficult to assemble all the birds from different households for vaccination (Nwanta *et al.*, 2006). Furthermore, the cold-storage required of the conventional vaccines is a problem in the rural areas of Nigeria where electricity supply is hardly available. Consequently the practicing veterinarians have to carry vaccines in portable Coleman flasks.

In Morocco, conventional live ND vaccine such as Hitchner B was successfully applied by eye-drop method and it considerably reduced mortality rates of rural poultry (Bell, 1990). These live vaccines require refrigeration, and their use may not be advisable in

hotter climates with limited refrigeration or electricity facilities, as found in Nigeria. In Burkina Faso, inactivated ND vaccine was successfully used in village poultry vaccination (Verger, 1986). Its disadvantage is that it requires some training in application. Also both these inactivated and live vaccines applied by eye-drop method require handling of individual birds, which is a difficult task for village poultry that are free-range.

The development of poultry health programmes requires reliable data on the epidemiology of diseases, which is lacking in village chicken production systems (Pandey, 1993). Disease surveillance is further limited by poor infrastructure and communication as well as inadequate diagnostic facilities. These limitations have resulted in the underreporting of disease outbreaks, as observed for ND in the United Republic of Tanzania (Yongolo, 1996). James (1997) cautioned that the animal health status of countries given by the FAO/OIE/WHO Animal Health Year book is based on a passive reporting system and it should be highlighted that lack of reporting does not necessarily mean the disease is absent. In the same context, the recent OIE report on ND presence showed that only two countries in Africa (South Africa and Swaziland) reported the presence of the disease.

The system of animal disease surveillance and reporting in Nigeria is still inefficient. ND outbreak status and sero-evaluation have not been ascertained fully. Non-payment of compensation by the government to rural poultry farmers for losses encountered in ND outbreak demoralizes farmers and discourages them from reporting outbreaks. This makes epidemiological trace-back and enforcement of control measures very difficult. The Pan African Programme for the Control of Epizootics (PACE) in Nigeria has rarely paid attention and given priority to the epidemiology and control of ND in village poultry and wild birds.

Prospects of Newcastle disease control in village poultry in Nigeria

Rural poultry production is a well known business and it is an important economic activity for rural dwellers in Nigeria. Poultry are kept purposely for meat and egg production and are sold to earn extra income. Unfortunately, ND however is a major hindrance to realization of the full potential of rural poultry in Nigeria. Knowledge and understanding of the prevailing strains of ND virus infecting the village poultry population and the prevalence of the infection as well as the factors responsible for the maintenance of the virus in circulation in Nigeria is crucial for the formulation of appropriate policies and strategies for ND control. The control of ND in village poultry in Nigeria will not only boost productivity of the sector, but will also guarantee supply of animal protein to human populace. Rural dwellers are usually very poor, and in some cases cannot afford to own cattle, but can afford to keep at least 5-10 chickens or other poultry. Disease control in village poultry sector would be the best way to uplift the economic status of the communities engaged in the business of poultry keeping. Meat and egg from village poultry can be used as affordable source of protein as Nigerians' consumption is still below FAO recommended standard (Ikeme, 1990).

The advent of the heat-resistant ND vaccines, V4 (Copland, 1987; Spradbrow, 1990; Ibrahim and Abdu, 1992) and I-2 (Tu *et al*., 1995) offers village poultry keepers the opportunity and hope of still being in business. The V4 vaccine technology, though not yet adopted by village poultry owners in Nigeria for the protection of their flocks, has been tested with good results (Baba *et al*., 1998; Nwanta *et al*., 2005). The National Veterinary Research Institute (NVRI) in Vom, Nigeria, started producing V4 vaccine and trials in the field have given good results (Usman, 2002). Cost-benefit analysis following

the use of the V4 in village chicken in Kaduna State, Nigeria showed that it was highly beneficial to adopt this technology in protecting our village poultry flocks than leaving them unvaccinated/unprotected (Nwanta *et al*., 2005).

The live V4 vaccine has been successfully used to control ND in village chicken flocks in Malawi (Saglid and Haresnape, 1987). A relatively heat-resistant derivative of the V4 vaccine applied to feed has been used successfully in South –East Asia (Copland, 1987). This vaccine does not only require individual bird application but can spread at least to some extent between birds through shedding of the virus from vaccinated to non-vaccinated ones by contact (Bell, 1990; Spradbrow, 1993; Alders *et al.*, 1994). The V4 vaccine is relatively thermostable, especially in the freeze dried form (Young, 1992). It retains its activity for 12 weeks at a temperature of 28^{o}C in freeze-dried form (Ideris *et al.*, 1987) necessary for the cold chain to extend to the village. Because the V4 vaccine is avirulent, it is possible to vaccinate all ages of birds with the one vaccine without causing any respiratory distress in young birds (Spradbrow, 1993).

Reports of the use of thermostable vaccines have yielded encouraging results in many countries of South East Asia (Spradbrow, 1993), Zambia (Alders *et al.*, 1994), Cameroon (Bell *et al.*, 1995), Tanzania (Spradbrow and Foster, 1997), Ghana (Amakye-Aim *et al.*, 1998), and South-Africa (Alders and Spradbrow, 2001). The FAO recommends this vaccine for the control of ND in village chicken in tropical and developing countries as means of improving the food security of rural communities (FAO, 1997). Good veterinary services, proper extension services delivery and availability of suitable grains are reported as important considerations for successful oral vaccination of village chicken (Alders and Spradbrow, 2001). The low recovery rate of the virus in some grains such as maize is a consequence of either binding or inactivation (Jayawardane *et al.*, 1990; Rajiswar and Masillamany, 1991). This has been found to seriously affect the development of immunity in the vaccinated birds (Alders and Spradbrow, 2001).

Apart from the use of live V4 vaccine, successful controlled experimental trials with a recombinant vaccine for the control of ND in chicken have been reported (Bell, 1990). The recombinant vaccine virus appears to be stable and heat-resistant, and could easily be applied in the same way as the V4 vaccine in Asia for village poultry (Bell, 1990). This vaccine has been shown to be highly immunogenic and could spread easily by contact between vaccinated and non-vaccinated birds in similar manner to the thermostable V4 or I-2 (Fenner *et al*., 1988). Most importantly, with the recombinant vaccine, serological monitoring for the presence of wild-type virus is possible at the time of vaccination (Bell, 1990). The reason being that the vaccine only induces anti-bodies against the F protein and not against the HN protein. The presence of anti-HN antibodies would be uniquely indicative of infection by wild types virus. These antibodies are detected by the haemagglutination-inhibition (HI) test, which does not detect anti-F antibodies. Anti-F antibodies can be analysed by ELISA in order to assess the efficacy of the vaccination (Bell, 1990).

Discussion and conclusion

For effective control of ND in village poultry through vaccination in Nigeria, sustainability of the programme has to be considered. In the past, many vaccination initiatives have rarely continued after the end of the project which initiated them. This is mainly because such projects concentrated on technical issues, and paid little attention to social, cultural, administrative and economic issues. These include community

participation, gender sensitive extension activities, facilitation by government policies, training of staff and farmers, cost recovery, and establishing a distribution and marketing network for any increased production as a result of the successful implementation of the project.

It is well known that resource poor rural people are the least to take risks and, as a result, only adopt new technologies if they are sure of an adequate return on their investment in terms of time and money. The policy of compulsory vaccination of rural poultry flocks against ND in rural areas of Nigeria will be successful only if the vaccine is offered free of charge when used for the first time, and if the results show success at the initial stages of vaccination trials. Farmers may then be convinced of its benefits and become willing to pay and adopt the new technology. Even when free, experience shows that extension campaigns will be required to assure farmers that the vaccine is safe and inform them on how and when the vaccine should be administered. Once they are convinced of the benefits of ND vaccination, farmers will, in most cases, place a higher value on the vaccine if they are required to pay for it (Nwanta *et al*., 2006). Payment will thus ensure the sustainability of ND control programme. Consequently, attention must be given to creating awareness in farmers with regard to the need for prevention of ND by vaccination and ensuring that vaccine in use is efficacious, safe, appropriate to local conditions, available and affordable.

In Africa, a number of countries have introduced the V4 vaccine on a trial basis. The major concern has been the identification of appropriate food carriers to introduce the vaccine for easy application in village poultry that are on free range. Virucidal activity of some grains that reduce the effectiveness of the vaccine have been reported by Rehmani, *et al.* (1995). Laboratory virus trials in Zimbabwe demonstrated good recovery in pearl millet, sunflower, finger millet and sorghum. In Nigeria, where such gains are available for poultry feed, support research is required to determine the appropriate food carriers for the application of the vaccine. Fosta *et al.*, (1999) in their trials with the V4 thermostable ND vaccine in village chickens under village condition showed that eight of the 11 chickens (72.7%) survived laboratory challenge when eye-drop and drinking water groups were used for vaccination of the chickens. In the same trials, only three out of eleven chickens (27.3%) in the food vaccine group resisted challenge, whereas none of the ten control chickens survived the challenge. In Nigeria, Nwanta *et al.*, (2006) reported 100% protection with V4 via eye-drop and drinking water and 62.5% protection via ground maize when challenged. This showed that protection against challenge was better in birds vaccinated with V4 in both eye-drop and drinking water routes than in feed/food. Information on the introduction of the vaccine and usage could be transmitted to village poultry farmers through radio and announcement in churches, mosques and markets.

For the success of the ND control programme in village poultry, it is recommended that simple evaluation and monitoring systems must also be put in place. Secondly, epidemiological surveillance on prevalence and mode of transmission of common diseases of village poultry is recommended. Veterinary personnel should take advantage of the improved transport facilities and effective communication system in rural areas to collect appropriate specimens from village poultry for sending to suitably equipped diagnostic laboratories in the cities. This will overcome the disease diagnostic problem and under reporting in rural areas. The result of the diagnosis should be transmitted to appropriate agency responsible for disease control.

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