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Newcastle Disease in Ethiopia: A Review Article

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Abstract

Ethiopia, with an estimated chicken population of above 56.9 million, has a long history of raising chicken in backyard production system. Newcastle disease is the first and the most prevalent infectious disease accounting prevalence rates of 80% and 43% in industrial poultry farms and local village chicken respectively and the disease remains endemic in Ethiopia. Newcastle disease is the most contagious and devastating viral diseases of poultry caused by a Paramyxovirus. Three strains of Newcastle disease virus have been recognized; namely the velogenic, mesogenic and lentogenic strains. The disease affects all species of birds and all age groups are susceptible to the disease. The main mode of transmission of the disease is through aerosol. Based on the strains and clinical signs observed, Newcastle disease has five forms, visrotropic velogenic, neurotropic velogenic, less pathogenic form, mild or in apparent respiratory infection and asymptomatic enteric form. Serological tests can be used to diagnose the disease and prevention and control of Newcastle diseases is achieved by vaccination. Four years (2012-2015) retrospective data analysis had figured out the occurrence of 86 outbreaks of NCD in seven national regional states of Ethiopia. Therefore, NCD is the most economically important disease that has inflicted high losses in both village chickens and commercially poultry farms. Hence, routine effective control measure against NCD infection particularly in village chickens should be employed and firm and conclusive information has to be given regarding the epidemiology of NCD in a nationwide approach.

Keywords: Newcastle Disease, Ethiopia

1. Introduction

Ethiopia, with an estimated chicken population of above 56.9 million (CSA, 2014/2015), has a long history of raising chicken in backyard production system. In general, the productivity of local chicken under this production system remained marginal compared with their large size due to the low inputs (feed, water and medicaments) and the poor genetic potential of local chicken. Thus, to increase the benefit out of chicken greater efforts have been made to make changes in the production systems. Bilateral to the traditional methods, the most commercialized poultry production is increasingly intensified in a large scale. In order to achieve this goal i.e. to improved poultry productivity in Ethiopia high producing exotic breeds of chicken have been imported from developed countries and Africans countries. Concurrent with the importation of exotic breeds of chicken, diseases of various natures have been introduced to Ethiopian. The rapid spread of infectious diseases among farms and emerging highly virulent strains of infectious agents make poultry production a risk business and further limited the development of the sector. Fast and

easy disseminating diseases like Newcastle disease(NCD), Mycoplasmosis, Fowl pox, Marek's disease and infectious bursa disease have been reported in Ethiopia (Alemargot,1987; Ashenafi,2000). Of these, Newcastle disease is the first and the most prevalent infectious disease accounting prevalence rates of 80% and 43% in industrial poultry farms and local village chicken, respectively(Alemargot,1987;Ashenafi,2000).Similarl y, one of the major outbreaks of NCD recorded in three major poultry enterprises(Dembi, Shola and Lemilem) in Ethiopia that accounted mortality rates of 14.9% in vaccinated flocks, has resulted in a serious economic losses (Nasser,1998).

Newcastle disease outbreaks associated with the velogenic strain is known to cause serious economic losses through mortality of chicken under experimental conditions (Nasser, 1998). Accordingly; control strategies have been designed and implemented to control NCD under commercial production system. However, very little attempts have been done to control the disease under the backyard production system. The probable reason for this may be related with the nature of the preparation of conventional vaccines (are live vaccine with large doses) and their delivery which are not suited to apply in situations where chicken are roaming freely, such as in the case of village chicken. Hence, NCD remains endemic in the Ethiopia chicken population and similarity chicken under backyard production system can serve as potential sources of infection to commercial farms. NCD, therefore, the continues to threaten commercial farms. This urges to make safe and effective vaccines and to design efficient vaccine delivery methods. Therefore, the objectives of this review article are:

- To review information regarding the status of NCD in the backyard and commercial production systems.
- To recommend feasible intervention strategies for the control of the disease in both the backyard and commercial poultry farms.
- To point out future research directions.

2. Review on newcastle disease

2.1 Definition and Etiology

Newcastle disease (NCD) is one of the most contagious and devastating viral diseases of poultry. Synonymously, it is also recognized as avian pnemoencephalitis, psedo-fowl pest, pseudo-poultry plague, avian pest an avian distemper.NCD is caused by a Paramyxovirus belonging to the Paramyxoviridae family together with morbilivirus and pneumovirus. On the basis of antegenic relatedness in haemagglutination inhibition(HI) tests, Paramyxovirus 1(PMV1) is divided in nine serotypes(PMV1,2,3...9). On the basis of intra-cerebral pathogenicity indices (ICPI), three strains of NCD virus have been recognized; namely the velogenic (very pathogenic), mesogenic (mildly pathogenic),and lentogenic(less pat hogenic)strains(OIE,2000).

The velogenic strain causes the most devastating disease of poultry with mortality reaching up to 100% in unvaccinated flocks (Nasser,1998).

2.2. Distribution, host and transmission

NCD is reported from all poultry raising countries. The disease usually occurs in chicken although all bird species are probably susceptible to the infection and it may vary considerably from one avian species to another with any given viruses strain. All age groups are susceptible. Those people who came in close contact with NCD virus frequently develop temporarily localized eye infection (conjunctivitis) (Kaleta and Baldauf, 1988).

Transmission and spread of NCD virus occurs through virus containing excretions from infected birds. Aerosol transmission is the main mode of NCD infection. Furthermore, contaminated feed and water, footwear, clothing, equipment and the poultry environment itself are also incriminated. Consequently, the main modes of virus spread among different flocks are movements of live birds, movement of poultry products, contaminated poultry food or water and through non-avian hosts. Natural routes of infection (nasal, oral and ocular) appear to emphasis the respiratory nature of the disease (Alexander, 1988; Alexander, 2000).

2.3. Pathogenicity, clinical forms and lesions

The incubation period of NCD virus after natural exposure is on average 5-6 days. The pathogenicity of NCD virus strains varies greatly with the type of the avian species affected. Chicken are highly susceptible but turkeys ducks and geese may be infected and show few or no clinical signs even with strains that are lethal for chicken. In chicken the pathogenicity of

NCD virus is determined chiefly by the strain of the virus, although the ages of the chicken and environmental conditions all have an effect. Breed or genetic stock appears to have very little effect on the susceptibility of chicken to the disease (Beard and Hanson, 1984).

Based on the strains and clinical signs observed, NCD has five forms (Beard and Hanson, 1984).

Visrotropicvelogenic: Newcastle Disease is characterized by an acute lethal infection of chicken of all ages. Hemorrahagic lesions and signs of digestive tract disturbances are frequently present. It causes high mortality (50-100%) among adult birds.
Neurotropic velogenic: Newcastle Disease is characterized by an acute lethal infection of chicken of all ages. It produces respiratory and neurogenic signs and lesions.
Less pathogenicform: causes death only in young birds. The viruses causing this type of infection are the mesogenic patho-type and moderate respiratory disease has been registered.
Mild or in apparent respiratory infection: caused by viruses of lentogenicpathotype. It is also called Hitchner's form.
Asymptomatic enteric form: caused by lentogenic viruses, which produce chiefly gut infection with no obvious lesions or diseases.

2.4. Diagnosis, Control and Prevention

Serological tests such as haemagglutination inhibition (HI) and enzyme linked immunorbent assay (ELISA) tests can be used to diagnose NCD in non-vaccinated flocks (OIE, 1996).NCD virus can most easily be isolated from tissue samples or faecal or tracheal swabs from infected birds by inoculation of chicken egg embryos via allantonic cavity (Alexander, 1997).The strains of NCD virus ware differentiated according to the mean death time of chicken embryos after infection by determining the intra-cerebral phatogenicity index on day old chicks after intra-cerbral infection and by determining the intravenous phatogenicity index on sex weeks old chickens after intravenous infection (OIE,2000).

Generally, vaccination is the only means to reduce the occurrence of NCD in commercial poultry farms (Allan *et al.,* 1978.) Routine vaccinations were carried out with low virulent live vaccines and/or inactivated (killed) oil emulsion vaccines (administrated parentally as a final vaccine).The effectiveness of NCD vaccines in the control of the disease depends on the virulence of the field stains, the types and states of the vaccine, the immunological status of the birds and the methods of the vaccine application. NCD vaccine is usually given at 10 and 35 days of age and repeated every three months. The commonly used vaccines in Ethiopia are Hitchener's B1 (HB1) and La Sota, which are produced at the National Veterinary Institute (NVI), Debre Zeit .These vaccines are applied as mass application using spray/aerosol or via drinking water. Application of good biosecurity measures also help in the control of the disease (NVI, 1974). Biosecurity measures, such as cleaning and disinfection of bird-housing facilities and equipment are very important. New introductions or birds returning to the farm should be isolated for several weeks before being placed into the flock. A vaccine is available for birds and is routinely used in poultry flocks.

2.5. Current status of NCD disease in Ethiopia

2.5.1.History, prevalence and significance

NCD is the major constraint of poultry production in Ethiopia. One of the local names of the disease is ‘Fengle’. The first documented evidence of NCD in Ethiopia dates back to 1971(NVI,1974).The virus strains involved in those early outbreaks were the velogenic ones and caused up to 80% mortality. It is not known how the virus was introduced but it might have been introduced through the port. Since then, in subsequent years the disease was dissimilated and reported from different agro-climatic areas. Those early the outbreaks had occurred in Addis Ababa, Alemya and Debre Ziet. Despite the routine vaccinations with HB1 and Lasota strains at least nine outbreaks of NCD have been reported in three big poultry farms (Dembi, Shola and Lemlem) between 1983-1995 (Nasser, 1998).

The major outbreaks of NCD recorded in the year between 1983-1995 in three major poultry development enterprises in Ethiopia accounted mortality rates of 14.9% in vaccinated flocks. In the same year’s concurrent disease and nutritional problems aggravated mortality rates due to NCD infection. In 1995, NCD outbreaks killed almost 50% of the local or village chicken in the surrounding areas of Debre Zeit, Nazreth and Addis Ababa (Nasser, 1998).Strain characterization performed on field isolates of NCD virus from outbreaks showed the widely distributed nature of the velogenic strain in Ethiopia. Moreover, Almargot (1987) has indicated

that NCD was the first and most prevalent disease accounting prevalence up to 80% in industrial poultry farms. Similarly, the study of Ashenafi (2000) has indicated a seroprevalence rate of 43.7% in local chicken from the highlands of Ethiopia.

Dessie (1996) has shown the seasonal patterns of NCD where serious losses have been observed at the beginning of the rainy seasons. No seasonality of NCD has been documented with the rainy seasons (Nasser, 1998; Ashenafi, 2000). According to Minda *et al.*, 2016 seroprevalence of NCD in Sinana district (33.04%) is higher when compared to Agarfa (20.13%) district. The prevalence in each kebele ranges from 15.63% to 40%; the highest prevalence of 40% was found at Horaboka, but insignificantly associated with Newcastle disease (ND) seropositivity.

The prevalence of households with at least one seropositive chicken was higher during the dry season (27.4%) than during the wet season (17.4%). Viral genome was detected in 14.2% of households during the wet season using a fusion (F) gene assay and in 23.5 % of households during the dry season using a polymerase (L) gene assay that targets both class I and class II viruses. At the markets sampled overall bird level prevalence was 4.9% for period 1 (F gene assay), and 38.2% and 27.6% for periods 2 and 3, respectively (L gene assay) (Hassen *et al.*, 2012).

Serkalem *et al*., (2005) reported that sero-prevalence rates of 28.57%, 29.69%, and 38.33% NCD in the high, mid-range, and low altitudes, respectively. This study has shown that NCD is one of the major infectious diseases threatening the survival and productivity of traditionally managed local chickens in central Ethiopia (Serkalem *et al.*, 2005). Desalegn (2015) reported a sero-prevalence of 28.6% (149/521) NCD in East Showa zone of Oromia regional State. From the total of 242 clinically diseased chicken 61.6% (149) were positive for NCD.

Furthermost, four years (2012-2015) retrospective data analysis had figured out the occurrence of 86 outbreaks of NCD in seven national regional states of the country (Amhara, South nation and nationalities (SNN), Oromiya, Tigray, Addis Ababa, Gambella and Benshangul-Gumz) (Table 1).These reports were based on clinical signs and mortality rates and reports were also from every corner of the countries. Of these outbreaks 70.5% of the out breaks were reported from the Oromiya national regional state. Moreover, over 50.52 % of the outbreaks occurred during the five months of the years; February to June but the remaining outbreaks appeared randomly in the rest of the months of the Year (Table 2) (Ministry of Agriculture, 2018).

Table 1: Four years 2012 to 2015) NCD outbreak reports from seven national regional states of Ethiopia

Region	Number of outbreaks	Number of cases	Number of deaths	Population at risk
Amhara	54	3461	1540	178038
South Nation and Nationalities	32	2258	1263	465876
Oromiya	286	14602	5084	1885704
Tigray	17	7267	6179	218733
Addis Ababa	1	20	19	400
Gambella	1	18	8	506
Benshangul-Gumz	14	359	3324	54173

Source: Ministry of Agriculture and Livestock Resources (2018)

Table 2: Four years (2012 to 2015) monthly NCD outbreak reports from seven national regional states of Ethiopia.

Months	Number of outbreaks	Number of cases	Number of deaths	Population at risk
January	28	2042	562	141169
February	33	7788	3126	282707
March	38	9307	5109	544954
April	46	1855	725	423153
May	39	3686	2776	229131
June	37	3558	1546	290902
July	29	2285	1398	71860
August	26	1385	521	56828
September	28	1185	578	202423
October	24	844	206	58827
November	27	1095	675	78763
December	27	536	183	125044

Source: Ministry of Agriculture and Livestock Resources (2018).

2.5.2. Risk factors associated with Newcastle outbreaks

Although, comprehensive data are lacking concerning the risk factors that predispose birds to NCD ranges of factors have been mentioned. Villagers by recognizing early signs of NCD or by notifying outbreaks in the neighboring household they can depopulated their stocks either by random sales of infected or clinically sick birds. Therefore, local open markets can be a potential common resource of NCD infection. Similarly the correlation of NCD outbreaks may be related with the selling /buying of chickens to celebrate socially and ritually functional cultural and social events in Ethiopia. On top of the villagers also carry chickens as gifts to heir kinfolk. These practices are frequently practiced in many regions of Ethiopia (Personal observation).

In previous outbreaks, villagization had contributed to the highest prevalence of the disease probably because of close contact among flocks of different households. In rural Ethiopia, where many flocks have communal scavenging environment different age groups and chickens of different health status can intermingle with each other. Although, chickens are the most important host for NCD other avian species may be a potential source of infection as well.Therefore, thismaintains the cycle of velogenic virus to remain endemic among the flocks (Dessie, 1996; Dessie and Jobre, 2004).

In commercial poultry farms the main source and dissemination of infectious virions might be due to lack of proper sanitary or quarantine measures. On top of this wild birds could also remain a potential source of infection. The risk factors incriminated for the outbreaks in the three major commercial farms in the year between 1983-1995 were related with poor bio security measures or insufficient sanitary and quarantine measures nutritional problems and concurrent infections. All of these factors might have contributed to the introduction spread and persistence of the diseases in the farms.The presence of multiple age groups in the farms minimal distances and lack of physical separation between different units could be suggested as the factors responsible for the outbreaks. Poor disposal of dead bird's absence of all in -all -out system on the farms and maintaining different types of chickens in the same farm also created favorable conditions for the outbreaks (Nasser, 1998).

Lack of strict control of movement of people and use of the same objects in and between infected farms favored the dissemination of the disease among the farms. Visits by attendants and farm managers without changing clothes or boots between houses disseminated the disease to all functional houses. Another factor of equally important in the spread was free movement of pets and wild bird between infected and non-infected premises. Infections with alfatoxicosis, salmonellosis, coccidiosis, mycoplasmosis and nutritional deficiencies that are prevalent in the farms could inhibit vaccine response and render the birds more susceptible to NCD infections (Nasser, 1998).

With the considerations of low genetic potential of indigenous local breeds, there is trend of importing high producing exotic day old chicks and fertilized eggs from Africa and Europe. In the last four years (2012-2015) 430,735 fertilized eggs and 1,151,219 day old chickens were imported from 2012 to2015 by private sector to improved breeding. This might be considered as risk factors of introducing diseases of various natures and there subsequent dissemination in poultry flocks. Parallel to this, there is a practice of distributing improved chickens to the farmers in rural and peri-urban areas though the extension and package systems. These chickens could transmit the virus to those birds managed by the farmers and to other avian species (Ministry of Agriculture and Livestock Resources, 2018).

Table 3: Four years (2012 to 2015) imported Chickens and fertilized eggs.

No	Commodity imported	Quantity
1	Day old chickens	1151219
2	Fertilized Eggs	430735

Source: Ministry of Agriculture and Livestock Resources (2018).

2.5.3. Control of Newcastle disease in Ethiopia

Of the many intervention strategies to control poultry diseases, vaccination is the most and highly practical and cost effective method that ensures successful poultry production via maintaining poultry health at high level (Al-Garib *et al.*,2003).With this notion, the National Veterinary Institute (NVI) since its inception has been well organized in the production of many for livestock diseases, including vaccines for NCD using specified pathogens free chicken eggs (NVI,1974).Strategies towards an efficient control of NCD were practiced by vaccination and hence attenuated and inactivated oil emulsion vaccines have been produced from the lentogenic strain of NCD virus (HB1 and Lasota) (NVI, 2000).

However, these conventional NCD vaccines that were effective in commercial poultry farms were found to have little use in local/villages chickens. The probable explanation may be due to small flock sizes, scattered presence of chickens mixing up of multi-aged groups and poor management in the village system. In addition to these the vaccines were heated labile (requires cold chain from their production upto their administration to individual chickens) relatively expensive and produced in large dose units suitable for large commercial flocks. Therefore, this remains an obstacle to design nationwide preventive strategiesagainst the disease (Spradbrow *et al.,* 1997).

To control NCD in village chickens whereby each household owns chickens in scattered fashions, thermostable vaccines applied as feed baits seemed the most appropriate methods for introducing heat stable NCD vaccine to village chickens and are currently under production and its effect under field circumstance is similarly under experimental situation. This vaccine was prepared from NDV-V4 strain and was in practice in Australia and other countries and results were found to be encouraging (Spradbrow *et al.,* 1997). It was demonstrated that vaccination with NDV-V4 induces mucosal immunity constituting of specific IgA antibodies. The same vaccine had conferred substantial protection in broilers. This experience was adopted by the NVI and themostable vaccines were prepared from both NDV-V4 and NDV-I2 strains and is currently under experimental conditions and provided affluent results (NVI, 1995; Nasser *et al.,* 1998).

Nasser (1998) did various experiments on the efficacy vaccines and came up with the observation that the chickens vaccinated with the thermostable NDVI2 vaccine via the ocular and drinking water routes or orally with parboiled barely as vaccine carrier were substantially protected against challenge with virulent NCD. The results were found to be comparable with conventional HB1 and Lasota when applied via the drinking water or ocular route. Although some proportion of birds vaccinated with thermostable vaccine had low HI titers, however, they were found to be resistant to challenge with the velogenic strains. These may be due to the effect of local or cell mediated immunity they could play roles in the protection of vaccinated chickens against veleogenic NCD virus challenges. However, the efficacy is not tested at field levels. According to the information obtained from National Veterinary Institute (NVI), currently the institute produces four types of NCD

vaccines (HB1, Lasota, NDV-I2 thermostable and inactivated oil emulsion Newcastle. The first two vaccines (HB1 and lasota) are produced in vials of 500 doses. The costs of the vaccines are 0.5, 0.5 and 0.30 birr per dose, respectively. Moreover, the thermostable vaccine may be popular in the future to control NCD in village chickens as the preparation and handling is convenient than the conventional live vaccines (NVI, 2004).

Two large scales and one small scale private poultry farms located in Debre Zeit were interviewed pertaining to the use of vaccines to control NCD in their respective farms. Accordingly, it was noted that in the two large scale commercial poultry farms, vaccination was done by NCD vaccine imported from the Netherland whereas the small scales poultry farm vaccinated their chickens with vaccines from National Veterinary Institute (NVI).The two large scale farms use both the live (HB1) and inactivated forms of the NCD vaccines for vaccination of breeder flocks and commercial layers whereas all the three farms use the live (HB1) vaccine for broilers. In addition, the small scale farm very recently started to use the thermostable vaccine (NDV-I2) produced by the NVI.

3. Conclusion and Recommendations

In Ethiopia, NCD is the most economically important disease that has inflicted high losses in both village chickens and commercially poultry farms. The velogenic strains were responsible for most of the losses.The intention to improve the wealth of the poultry industry and that of individual farmers through the provision of improved breeds of chickens should follow vaccination strategies as integrating components. This is because, the reality that village chickens account for the highest population of poultry and having critical economic and social values, little or no efforts have been made so far towards the control of many diseases. Control of NCD in commercial poultry farms is done by the way of vaccines; however, conventional vaccines and conventional ways of vaccine delivery methods make NCD vaccination inaccessible to village chickens. Appling thermostable NCD vaccines orally via vaccine treated feed appears to be an attractive alternative over the conventional application methods in situations where poultry are roaming freely most of the time, such as in the case of village chickens. To date in Ethiopia, no routine effective control measure against NCD infection particularly in village chickens has been employed. Therefore, the existence of the disease in the village chickens could remain as potential source of infection to commercial farms and henceforth, the disease remains endemic to the country. Based on the above conclusion the following recommendations are forwarded:

- Chicken should be vaccinated regularly.
- The possible role of other avian species in maintaining NCD infection should be investigated through serology.
- Routine effective control measure against NCD infection particularly in village chickens should be employed.
- Firm and conclusive information has to be given regarding the epidemiology of NCD in a nationwide approach.

Conflict of Interests

❖ The authors declare that there is no conflict of interests regarding the publication of this paper

Authors' contributions

❖ Zerihun was involved in developing the idea. Zerihun and Temesgen were involved write up of the manuscript. Both authors approved the submitted version of the manuscript.

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