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Infectious bronchitis in poultry: A review

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Abstract
Infectious bronchitis (IB) is an extremely contagious viral disease of poultry caused by *Corona virus.* The disease was first described in 1930 in USA. The disease is prevalent globally with the incidence of infection approaching 100% in most locations. The virus replicates not only in the epithelium of respiratory tract, but also replicates in many other tissues causing respiratory, renal and urogenital disorders. Clinical signs of disease vary based on the age of birds, pathogenecity of the virus strain and existing level of immunity. Economic consequences to the poultry industry comprise growth retardation, decreased egg production, reduced internal and external egg quality, reduced hatchability and infertility. Since the disease continues to emerge with diversity it is much difficult to control infection as no specific treatment is available. Therefore, early diagnosis and concentrated efforts is necessary to reduce the impact of disease. This review gives insight on infectious bronchitis virus effect on poultry.

Keywords: *Corona virus*, infectious bronchitis, RNA virus, poultry

1. Introduction
The poultry farming in India was at its infancy during the 1960s which started as a small backyard venture. However, during the past three decades, poultry farming has developed into a vibrant, full-fledged organized commercial industry with the growth rate of 8-10% in egg production and 12-15% in meat production [24]. As a result, India occupies 3rd, 4th and 6th rank in egg, layer and broiler production, respectively in However; presently the poultry sector faces challenges in several fronts. Increase incidence of disease outbreaks, re-emergence of various pathogens with higher virulence from time to time, evolution of variant strains due to recombination and simultaneous infection with multiple virus type and use of live vaccines are the reasons for such challenges [14]. These diseases bring piles of economic loss in the form of inefficient feed conversion, decreased production, mortality, loss of market value and increase production cost etc [6].
It is an acute and highly contagious viral disease caused by Corona virus. The virus has 4 clusters, grouped into seven serotypes and the most important strains are Massachusetts, Connecticut, Arkansas, Gray, Holte and Florida along with numerous others, distributed round the globe [9].
'All-in /all-out' operations of rearing along with good biosafety measures forms the basis of prevention, whereas vaccination forms the backbone of IB control programme both live and inactivated conventional vaccines are available. However, vaccination is less successful because of continuous emergence of antigenic variance and less cross protection between the variance [21]. Since the disease continues to emerge with diversity it is much difficult to control infection as no specific treatment is available. Therefore, early diagnosis and concentrated efforts is necessary to reduce the impact of disease.

2. Etiology
The disease is caused by Infectious bronchitis virus belongs to order Nidovirales, family Coronaviridae, subfamily Coronavirinae, genus Gammacoronavirus and species Avian corona virus [19]. The corona virus has the largest genome, consisting of a 27.7kb. It is an envelope, non-segmented, positive-sense, single-stranded RNA virus and round to pleomorphic in shape. The virus is fairly labile (fragile), being easily destroyed by disinfectants, sunlight, heat (56ºC for 15 min) and other environmental factors [22].

3. Economic Importance

Infectious bronchitis is an economically important disease of poultry having worldwide distribution. Losses from production inefficiencies are more than mortality. In broilers IB leads to poor weight gain and loss of profit at slaughter. In layers, IB causes loss of egg quality and egg production may drop down to 10 to 50%. Nephropathogenic strains cause mortality up to 30% in susceptible flocks. In United Kingdom (U.K.), IBV is the biggest single cause of infectious disease related economic loss [14].

4. Transmission and Spread

Airborne Transmission- Is via aerosol and occurs readily between birds kept at a distance of over 1.5 m. Prevailing winds might also contribute to spread between farms that are separated by a distance of as much as 1,200 m [10].

The virus can survive for a considerable time in feces and is suspected to represent a continuing source of re-infection in the recovery phase of the disease.

Mechanical Transmission- Is via personnel, material and equipment, and plays a role in transmission of IBV between flocks or farms. Movement of live birds, either as one-day-old chicks or as adult birds, should be considered as a potential source for the introduction of IBV. Contaminated litter, footwear, clothing, utensils, equipment and personnel are all potential sources of virus for indirect transmission and have been implicated in IBV spread over large distances [17].

5. Pathogenesis

Infectious bronchitis virus has wide tissue tropism including respiratory, reproductive, urogenital and digestive system. [11] IBV initially infects the upper respiratory tract and attaches to glycoprotein receptors containing sialic acid, where it is restricted to the ciliated and mucus-secreting cells and replicates in nasal turbinate's, nose, trachea, lungs, air sacs and Harderian gland and lead to deciliation of epithelia of the nose and trachea, mucus accumulation and necrosis following which viraemia occurs the virus gets widely disseminated to other tissue through hematogenous route [15]. The virus also grows in many other epithelial cells, including in kidney, oviduct, testes, and many parts of the alimentary tract i.e. oesophagus, proventriculus, duodenum, jejunum, bursa of Fabricius, caecal tonsils, rectum and cloaca, many times with little pathobiological clinical effect. IBV infection of female chicks less than 2 wk of age can causes permanent damage of respiratory–urinary organs, digestive tracts and generative organ [5].

The Nephropathogenic strain of virus replicates in all segments of tubules and ducts, but more frequently in the epithelial cells of the collecting ducts, collecting tubules, distal convoluted tubules and Henle's loops leads to kidney failure[10]. The virus commonly persists in the alimentary tract in young chickens[7] and in layers in the absence of clinical disease. Some Asian strains may cause lesions in the proventriculus. Infection of enteric tissues usually does not manifest itself clinically [7].

6. Clinical Signs

Clinical signs will vary based on the age of chicks, pathogenicity of the virus strain and existing level of immunity. The infection may be asymptomatic or may relate to their tissue tropism namely respiratory, reproductive and nephritic disorders. Besides, there may be general malaise and retarded growth [14].

(l) Respiratory Disorders

Respiratory disease is the most frequently observed syndrome in birds of all ages. Clinical signs seen are difficulty in breathing, tracheal rales, gasping, coughing and sneezing with or without nasal discharge and frothy exudates from eyes or wet eyes with facial swelling [11]. A generalized weakness is observed, accompanied by depression. The chicks are huddled under a heat source.

(ll) Reproductive Disorders

Infectious bronchitis virus infection at a young age and after maturity can both lead to reproductive problems in hens as two syndromes of disease. In adult chickens clinical signs may not be present or may take the form of a mild respiratory distress with coughing, sneezing and rales which can go unnoticed dullness when the flock is examined carefully [2].

(lll) Nephritic Disorders

The nephritic form of IB, usually affecting young growing birds (broiler) often with mild and transient respiratory signs followed by depression, ruffled feathers, hunched stance, reluctance to move, excessive water intake, wet dropping, rapid weight loss, diarrhea, wet litter and mortality. Death occurs four to five days after infection and ceases by day twelve after infection In the milder form, there may be little or no mortality whereas mortality as high as 30% in the severe form.[9]

In recent years, Nephropathogenic stains have become more common in laying flocks and cause an elevated mortality during the infection or long after as a results of kidney damage that progresses to urolithiasis otherwise flock appears healthy [9].

7. Gross Pathology

Lesions associated with IB include a mild to moderate inflammation of the respiratory tract. On necropsy infected chickens have serous, catarrhal, or caseous exudates in the trachea, nasal passages and sinuses is congested with excessive amounts of mucus, and where infection has been complicated with E.coli, airsacculitis, pericarditis and perihepatitis may also be observed [18]. Airsacs may be foamy during the acute infection, then become cloudy and contain yellow caseous exudates. Caseous plug may be found in the lower trachea (at the point of bifurcation) or bronchi of chicks that die. Small areas of pneumonia may also be seen around the large bronchi [18].

The lesions associated with the infection of pheasants by coronaviruses in the field are visceral urates deposition ("visceral gout") and urolithiasis with swollen pale kidneys [23].

8. Microscopic Pathology

In chickens with respiratory disease, the main histological lesions are found in the trachea. However, these lesions are not pathognomonic for IBV. The virus replicates in ciliated epithelial cells causing deciliation, edema, desquamation, hyperplasia and mononuclear cell infiltration of the sub mucosa [26]. Mucosa of trachea is odematous, loss of cilia, rounding and sloughing of epithelial cells and minor infiltration of heterophils and lymphocytes within 18 hrs of infection [1].

In the oviduct of mature hens resulted in decreased height and loss of cilia from epithelial cells, dilation of the tubular glands, infiltration by lymphocytes, other mononuclear cells,

plasma cells, and heterophils and edema, the epithelial cells especially the goblet cells become cuboidal and fibroplasias of the mucosa of all regions of the oviduct [20].

The kidney lesions of IB are principally those of an interstitial nephritis i.e. intertubular heamorrhages, necrosis of tubular epithelium with infiltration of lymphocytes and plasma cells. The virus causes granular degeneration, vacuolation and desquamation of the tubular epithelium, and massive infiltration of heterophils in the interstitium in acute stages of the disease. Cytopathic changes become apparent, initially in the tubular epithelium.[8]

Ultrastructural studies of infected kidney tissues revealed epithelial cells of the lower nephron and ducts to be the primary targets for IBV replication [10]. Infected epithelial cells containing virus particles were more abundantly found in the collecting ducts, collecting tubules, distal convoluted tubules, and Henle's loops than in the proximal convoluted tubules. Cytoplasmic changes in the infected epithelial cells were characterized by swelling of the mitochondria, dilation of Golgi vesicles, and an increase in the amount of rough endoplasmic reticulum (RER).

9. Diagnosis

The basis of diagnosis depends upon the clinical signs and history is suggestive of IB but not is diagnostic. Confirmation of disease can make by demonstration of virus, or detection of specific antibodies in sera [14].

9.1 Demonstration of Virus

9.1.1 Isolation of virus in embryonated eggs

The characteristic effects caused by IBV in chicken embryonated eggs are the most classic signs for the diagnosis, and have successfully been used since the beginning of the studies on IB. In this test, 9 to 10 day-old chicken embryonated eggs are inoculated in the allantoidal cavity with 0.1 to 0.2 ml of a field sample (tracheal or cloacal swabs, macerated organs or enteric content etc.). Morphological changes include embryo dwarfism, curling, hemorrhages, and death can be odserved from 3-6days. Maximum IBV titer is reached 1 to 2 days post-inoculation [28].

9.1.2 Cultivation of virus in trachea rings

This technique uses trachea rings of SPF embryos at 19 to 20 days of incubation. At 24, 48, 72 and 96 hours after inoculation, the tracheal rings are observed in inverted optical microscope, evaluating the ciliary motility, which should decrease due to replication of IBV [16].

9.1.3 Detection of viral nucleic acid

IBV detection based on the evidencing of specific viral RNA presence by the technique of reverse transcriptase reaction followed by the polymerase chain reaction (RT-PCR) has increased in the last years, because of its accuracy for diagnosis and classification of types. Its low implementation and execution costs have allowed a large number of public and private laboratories to use routinely. Immuno-histochemestry or in situ hybridization and Fluorescent Antibody technique is also a good test for antigen detection [29].

9.2 Detection of Antibody (Serological Tests)

A number of tests have been including as Virus neutralization (VN), agar gel immunodiffusion (AGID), Haemagglutination inhibiting (HI) and Enzyme-Linked Immunosorbent Assay (ELISA). Each test has advantages and disadvantages in terms of practicality, specificity, sensitivity and cost [4].

9.2.1 Enzyme-linked immunosorbent assay

The ELISA technique is a sensitive serological method and gives earlier reactions and higher antibody titers than other tests[25]. Commercial kits for ELISAs are available these are based on several different strategies for the detection of IBV antibodies. The ELISA is widely used to identify IBV-infected flocks (broilers) based on high antibody titers [25].

9.2.2 Agar gel immuno-diffusion

AGID can be used in diagnosis but test lacks sensitivity and is liable to yield inconsistent results as the presence and duration of precipitating antibodies may vary with individual birds [12].

9.2.3 Haemagglutination inhibition test (HI)

A standard protocol for a HI test for IBV has been described [3]. Haemagglutination-inhibiting antibodies are induced primarily against S1 spike protein. HI test usually detects first antibodies between 1 and 2 weeks after infection [27].

9.3 Differential Diagnosis

Infectious bronchitis may resemble other acute respiratory diseases such as Newcastle disease (ND), infectious laryngotracheitis, low pathogenicity avian influenza, and infectious coryza [9] and can be differentiated as:-

1. Newcastle disease caused by velogenic viscerotropic or neurotropic strains of paramyxovirus type 1 produces much higher mortality than IB. Lentogenic ND infections with pneumotropic strains.
2. Low pathogenic strains of avian influenza produce mild to moderate respiratory disease with low mortality and thus, may resemble IB.
3. Laryngotracheitis tends to spread more slowly in a flock, but respiratory signs may be more severe than with IB.
4. Production declines and shell quality problems in flocks infected with the egg drop syndrome (EDS) adenovirus are similar to those seen with IB, except that internal egg quality is not affected in the case of EDS.

10. Prevention and Control

Prevention and control measures mainly include follow up of strict biosecurity, good hygiene and sanitation practices, along with judicious vaccination programme.

- A one –age system (all-in /all out) of rearing, cleaning and disinfection between batches will reduce the level of infection.
- Good management practices comprise of strict isolation/quarantine, repopulation with disease free day old chicks and adapting appropriate cleaning, disinfection and hygienic measures in the poultry farm.
- Disinfectants can be very helpful for preventing virus infections in a farm[13].

11. Conclusion

Avian infectious bronchitis still poses a great challenge for the chicken industry worldwide causing high morbidity (80%) and low mortality (20%). The economic losses are incurred upon by reduced egg production as well as worsen egg quality, presence of silent layers, infertility and delay in growth and increase in the susceptibility to secondary. As a virus that goes through continuous changes, a large number of regional and global variants have been identified. A part from

this, it is essential to better understandings of pathological changes induced by present and new variants of IB virus which can be differentiates with other poultry diseases are also helpful to reduce the losses caused by IBV infection in field condition.

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