British Journal of Poultry Sciences 8 (1): 10-16, 2019
ISSN 1995-901X

DOI: 10.5829/idosi.bjps.2019.10.16

Review on Salmonella Gallinarum-Pullorum

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Abstract: Pullorum disease is an egg transmitted disease of poultry, especially chickens and pullet and it infects the ova of turkeys and chicken. Salmonella Enteric serovar Gallinarum biovar Pullorum, it is Gram negative bacillus, non-motile, non-spore forming salmonella. The disease often characterized by enteritis, white diarrhea and high mortality in young birds' results asymptomatic career in adults. Diagnosis of Pullorum disease requires isolation and identification of *Salmonella* Pullorum (*S*. Pullorum). It is almost exclusively a disease of young chickens, while *Salmonella* Gallinarum (*S*. Gallinarum) is disease of old chicken and the agent can be recovered from almost abdominal organs, tissues and feces. *Aspergillus* or other molds may produce similar abscesses and lesions in the lungs, but the lesions are more discrete than fowl typhoid. Rarely *S.* Gallinarum may localize in the joint and tendon sheaths and be confused with other infections associated with synovitis. Septicemic disease may be confused with fowl typhoid; fowl cholera, *erysipelas,* acute *Staphylococcus* and acute *Colibacillosis* are considerd as a differential diagnosis. Poultry and poultry products (egg and meat) are major source of Salmonella in humans. There is no effective treatment to cure infected career, but addition of *furazolidone* to the mass at a level of 0.04% for 10 days or *cocoban* 20% (*Amprolium*) at a dose rate of 0.012% in drinking water has to be provided. Economic loss is very high, not only from loses due to mortality but also from other cost that may be involved, such as removal of dead animals, disinfection and preparation of poultry house during entrance of new flocks. Good bio-security is essential including all- in-all- out policy forms, eliminate infected breeders from the flock, Repeatedly blood test and the vaccines have been prepared for use against *S*. Pullorum and *S*. Gallinarum.

Key words: Fowl typhoid · Gallinarum · Pullorum · Septicemic

INTRODUCTION

Ethiopia owns 42, 915, 629 poultry, of which 95.37% is under rural holdings while the rest 4.63% is urban. About 98% of the total national poultry population consists of endogenous chickens and the remaining 2% consist of exotic breed [1]. Virtually all poultry under rural holding in this country is free ranging. The country needs to increase the number of its poultry and intensify its management in order to satisfy the protein need of its ever increasing human population estimated at 79, 086, 894 in 2007 [2]. However, poultry population in Ethiopia is not growing; it is even under a gradual decline and is highly constrained by a disease among other factor [3]. *Salmonella* Gallinarum (*S*. Gallinarum) and *Salmonella* Pullorum (*S*. Pullorum) are non-motile and highly host adapted pathogenic avian serotype responsible for typhoid and Pullorum disease respectively [4] are widely distributed throughout the world but they have been eradicated from the commercial poultry in many developed countries of Western Europe, the United State of America (USA), Canada, Australia and Japan. In the United State and United Kingdom the serovar is referred to as Pullorum [5] Chickens are the natural hosts for both *S.* Pullorum and *S.* Gallinarum [6].

Salmonella Pullorum is a disease of newly hatched chickens and dies between 2 and 7 days of age, if they have infection during hatching (infected eggs) and if they

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get infection after hatching, they show symptoms about 10 days post infection, up to the age of 3 weeks [7]. Usually it causes high mortality in young chicken and turkeys and occasionally in adult chickens [8]. Hirsh and Zee reported that the mortality from Pullorum disease as a result of horizontal transmission in non treated contact chickens was approximately 68%. Thus the embryo is already infected when the egg is hatched [9].

Fowl typhoid, caused by *Salmonella* Gallinarum is an acute septicemic or chronic disease of domesticated adult birds, mainly chicken. The disease is diagnosed by culturing the organism from liver or spleen [9].

Therefore the objective of this review is to show, the impact *Salmonella* Pullorum-Gallinarum on poultry industry, how it sustain, transmit and cause illness on poultry and reduce production and productivity.

Pullorum Disease (Bacillary White Diarrhea) and Gallinarum Disease (Fowl Typhoid): Pullorum disease is an egg transmitted disease of poultry, especially chickens and poults [10]. At this time the serovar is referred to as Gallinarum biota Pullorum (*S.* Pullorum) is known as Gallinarum in same part of the world and Pullorum in the others. In its acute form, Pullorum disease is almost exclusively a septicemic disease of young chickens [11].

Salmonella Pullorum infects the ova of turkeys and chicken. Thus the embryo is already infected when the egg is hatched. The hatchery environment is contaminated following hatching of an infected egg, leading to infection of other chickens and pullet [9]. The disease often characterized by white diarrhea and high mortality in young birds and by asymptomatic in adult carriers [10].

Fowl typhoid is an acute septicemia or chronic disease of domestic adult birds, mainly chickens that caused by *Salmonella* Gallinarum [9]. Infection is rare in many countries including the USA and Canada, but it is a major problem in others. Although *S.* Gallinarum is egg-transmitted and produce lesion in chickens and poults similar to those produced by *S.* Pullorum, it has much greater tendency to spread among growing or mature flock [8] also transmitted by ingestion and causing high mortality [12].

Etiology: The disease is caused by *S. Pullorum* isolated by Rettger in 1900 [7] caused by *Salmonella* enteric serovar Gallinarum biovar pullorum [11]. It is a Gram negative bacillus adapted to poultry [10]. This is a non-motile, non-spore forming salmonella which when isolated from acute case in MacConkey agar plates, produce small translucent colonies which are fairly characteristic [13] and Several antigenic strains exist and it readily grow on artificial media as small, direct dew-drop like colonies and does not ferment lactose [14]. It has no flagella or H antigens and its somatic structure is 1, 9, 12 and it is listed in group D of the Kauffman white classification scheme [15].

The causative agent of fowl typhoid belongs to the genus *Salmonella* with the family *Enterobacteriaceae* [16]. The disease caused by *Salmonella* Gallinarum biovar Gallinarum, a Gram negative, non-motile bacteria and has somatic structure 0, 1, 9 and 12 [7].

The causal organism, now classified as *S.* Gallinarum, is closely related antigenically to *S.* Pullorum. The two organisms being serologically indistinguishable, although they can be differentiated by certain cultural characteristics, such as reaction in carbohydrate media [14]. Thus classified in-group D of the Kauffman white scheme, it ferment glucose, Mannitol, maltose and Dulcitol, but does not ferment lactose, sucrose and salicin [15].

Epidemiology: *Salmonella* Pullorum is spread primarily through occasional infected egg laid by infected carrier hen [10]. A high percentage of chicken which survive an outbreak become carriers, the organisms becoming localized usually in the ovary and that a percentage of egg laid by such carriers are infected and produce the disease in the progeny [14].

The epidemiology of fowl typhoid is similar to that of Pullorum disease; relatively speaking transmission of infection through egg shell contamination may be of same what greater importance than with Pullorum. Most outbreaks occur in domestic fowl but particularly in the USA serious out breaks have been reported in turkeys. Although all age of poultry are susceptible, most outbreaks occur in growing birds, particularly pullet from three month to point of laying [14]. The disease occurred sporadically mainly up on laying hens implying its association with stress factors, such as transportation, feed and water shortage. The recurrent attack of fowl typhoid highly affected the egg productivity of chickens [17].

Transmission: The disease occurs worldwide and the incidence is increasing with the intensification of livestock production. Transmission is chiefly by direct egg transmission, but it also occurs by direct or indirect contact [8]. *S.* Pullorum is disease of newly hatched chickens, transmitted within the egg from carrier hen

and usually causing death in incubator or brooder [7]. An infected chick transmits the disease to susceptible one through feed and water and from hen to chick by vertical transmission. Also, there is rapid lateral spread from chick to chick in hatcheries and raring units [18]. Viable chicks do hatch from such infected eggs and becomes a source of infection. Fluff from such chicks is likely to be heavily contaminated through the incubator or brooder [15].

Salmonella Gallinarum has a much greater tendency to spread among growing or mature flocks [8]. The infection transmitted through the egg to the progeny on hatching and during brooding is also a source of infection to susceptible birds in contact with them [14] and passed out by infected birds in the dropping and lateral spread is by ingestion of contaminated feed and water [15]. It is also transmitted during sexing, from contaminated incubators, chick boxes, brooder and attendants hands and cloth [14]. Red mite may be involved in the transmission of the disease and persistence in poultry house [11]. Fleas can also help in the spread of the disease [7]. Rat, dogs, foxes and wild birds may carry pars of infected carcasses from flock to flock under this condition and infected carcass may also contaminate ponds and steams. Recovered birds frequently remain carrier for long periods and it is axiomatic that the movement of such birds could readily be a means by which the disease spreads [15].

Pathogenesis: *Salmonella* Pullorum produce an acute disease in chicken during their first few days of life and is characterized by a sever enteritis and bacteramia [18]. Significant difference in susceptibility have been breeds, particularly white leg horn have revealed fewer resistance among infected flocks than heavy breeds [16].

In acute fowl typhoid there is a severe hemolytic anemia with a loss of more than 70% of the original total circulating erythrocytes. The modification of the erythrocyte in vivo by endotoxin leads to their clearance by the reticloendothelial system (RES) with subsequent development of hemolytic anemia. A functional impairment of the erythrophagocytic and endotoxin-detoxifying functions of the RES develops, resulting in increase susceptibility to endotoxin leading rapidly to death [16].

Clinical Sign: Infection transmitted via egg or hatchery usually results in mortality during the first few days of life and up to 2-3 weeks of age [8]. In a setting of fertile egg with a few, infected embryos there may be reduce hatchability, the newly hatched birds appears weak or soon die and others that develop bacterimia, morbidity and mortality began to increase around the 4th and 5th days [10]. Chicks dying after hatching often exhibit on signs of ill health before death but older chicks appear sleepy, huddle together with eye closed, a "pot-bellied" appearance and sometimes urates stains in vent region [14]. Death of birds takes place from second day and decline by about 5th day and usually stops by about 8th month [7].

Sign of fowl typhoid and Pullorum disease are similar in birds less than one month old, semi mature and mature birds with fowl typhoid often, have pale head part (comb, wattle and face), shrunken comb and wattle, diarrhea and mortality can be substantial [10]. In endemic area outbreaks are often chronic nature's birds dying sporadically at irregular interval [15]. In acute case, the disease is increased in mortality, following by drop in egg production, depression, ruffled feathers and closed eye is common feather [15]. Greenish -yellow, evil smell dropping, have a greatly increased thirst, show very pale (anemic) head part and there are also a number of sudden death [19].

Post- Mortem Lesion: In case of Pullorum disease the newly hatched chickens, which die from the disease, may not show any gross lesions. Some of them may show hemorrhagic streaks on normally yellowish liver of newly hatched chicks. The chicks, which die later, may show grayish necrotic spots of 1 to 2 mm size in the liver, raised, white spots on heart and spleen [7]. Carrier hens, discolored cystic ova, some of miss shaped and pedunculated, oviduct may be impacted causing extensive peritonitis and adhesions in the various abdominal viscera. Also in male, the testis may be atrophy with thicken in of tunica albuginea and multiple small abscess [13]. In growers affected with arthritis the hock joints are usually enlarged due to the presence of excess lemon or orange colored gelatinous material around the joints [15].

The fowl typhoid encountered more frequently in growing and adult chickens and turkey [16]. Older bird may be dehydrated and have a swollen, friable and often bile stained liver, with or without necrotic foci; enlarged spleen and kidneys, anemia; enteritis [8]. The carcasses of birds dying in acute phase have septicemic, jaundiced appearance, congested skeletal muscle and dark in color [15]. If the bird dies at the hyper (very) acute stage the signs are few, apart from congestion of internal organ, especially liver and lungs, in sub acute stage yellow nodules in the liver, yolk sack filled with pus like "sludge" [19].

Diagnosis: Lesion may be highly suggestive, but diagnosis should be confirmed by isolation and identification of *S.* Pullorum [20]. Definitive diagnosis of Pullorum disease requires isolation and identification of *S.* Pullorum, flock history and sign are of limited value in arriving at a diagnosis because of the similarity to a number of other diseases [16]. In its acute form, Pullorum is almost exclusively a disease of young chickens and the agent can be recovered from almost abdominal organs, tissues and feces. In older birds that have become carriers, *S.* Pullorum is most commonly recovered from the ova and oviducts and it is recovered only occasionally from other organs and tissue including the alimentary tract [11].

Clinical observation and necropsy finding may be suggestive of fowl typhoid infection when a supportive history is available and may permit one to reach a tentative diagnosis as a basis for early treatment or control [16]. *S.* Gallinarum should be isolated and identified for diagnosis and carefully differentiated from other *Salmonella* [10].

Differential Diagnosis: In young chicken and pullet the sign and lesion produced by Pullorum disease and fowl typhoid are quiet similar but are different from other *salmonellae*. Other *Salmonella* infection produce lesion of liver, spleen and intestine which cannot be distinguished grossly or microscopically from those produced by Pullorum disease. *Aspergillus* or other molds may produce similar abscesses and lesions in the lungs, but the lesions are more discrete than fowl typhoid. Rarely *S.* Gallinarum may localize in the joint and tendon sheaths and be confused with other infections associated with synovitis. In growing and mature chicken and turkeys other septicemic disease may be confused with fowl typhoid; fowl cholera, *Erysipelas,* acute *Staphylococcus* and acute *Colibacillosis*. Blood or tissue smears stained with gram stains may be help full in making tentative differential diagnosis. Also the agglutination test may be helpful in chronic case. Pericardium and ovary may appear identical to those produced by other bacterial infection such as coli form, *Staphylococcus, Micrococcus* and other *Salmonella* [16].

Morbidity and Mortality by Pullorum and Gallinarum Disease: Pullorum disease severely threatens the developing poultry industry because it cause severe losses in newly hatched chicken and carried by adult chicken [21]. Both morbidity and mortality are highly variable in chicken and turkey and are influence by egg, strain susceptibility, nutrition, flock management and characteristics of exposure. Mortality may vary from less to 100% in serous outbreaks [16]. The mortality from Pullorum disease as a result of horizontal transmission in non-treated contact chicken was approximately 68% [22]. The greatest losses usually occur during the 2nd week after hatching, with spread declines during the 3rd and 4th weeks of age. Morbidity is often much higher than mortality, with some of the affected birds recovering spontaneously. Birds hatched from infected flock and raised on the same premises will usually exhibit less mortality than those subjected to the stress of shipping [16].

Fowl typhoid is frequently referred to as a disease of adult birds though there are reports of high mortality in young chicken [23]. Both morbidity and mortality may vary in chicken and turkey flocks. An extreme investigation of fowl typhoid in chickens, that the mortality varied from 10% to 50% or more [16]. Mortality at all ages usually is high [8].

Treatment: Treatment of Pullorum infected bird is in defensible and should not be recommended under any circumstance [10]. A number of anti-bacterial agents will reduce the morbidity and mortality, however, no treatment is likely to effect the complete elimination of the carrier from uninfected flock [15]. The addition of *furazolidone* to the mass at a level of 0.04% for 10 days is generally effective in reducing mortality and if instituted early in the outbreak the carrier rate is low [14] and mass treatments can give *cocoban* 20% (*Amprolium*) at a dose rate of 0.012% in drinking water. *Oxytetracycline* at dose rate of 0.022% with feed for 5 to 6 days when outbreaks occurred [17] and Use vaccine made from rough strain of *S.* Gallinarum (9R) is usually in controlling mortality [8].

Public Health Importance: Avian Salmonellosis is a problem of all phase of the poultry industry from production to marketing, zoological park administrations, pigeon and farcy birds' raisers and those interested in wild game are also concerned with this disease. As they occur in poultry and poultry products, the normally motile salmonella are also of very significant interest to those engaged in work in the field of public health [16].

Humans appear to be susceptible to all Salmonella serotypes, the most important source of which are animals and their byproduct. Poultry and poultry products (egg and meat) are major source of Salmonella in humans; *Salmonella* Enteritidis is especially adapted for egg transmission [9]. Any Salmonella is a potential human

health hazard, factors such as type of salmonella evolved, the weight and distribution of infection and other circumstances of the outbreak will have a bearing when assessing the human risk from incidents involving poultry [15].

Economic Importance: Salmonelosis in poultry causes heavy economic loss through mortality and reduced production [24]. Pullorum disease and fowl typhoid are economically important diseases, without their effective control through organized national regulatory program; the profitable production of poultry would be impossible [25]. Economic loss due to outbreak could be very high, not only from loses due to mortality but also from other cost that may be involved, such as removal of dead animals, disinfection and preparation of hen house for the entrance of new flocks [26].

Control and Prevention: The control of Pullorum disease and fowl typhoid is accomplished by the same program in composed in the national poultry improvement plans [10]. The method for control of this disease has been to eliminate infected breeders from the flock [21]. All visible affected birds should be destroyed and the carcasses together with those of dead birds cremated or buried in lime and should be isolation between affected and non-affected groups [14]. Chicken are tested by tube-agglutination or whole blood method [20]. Repeatedly blood test the birds in breeding flocks and remove reaction. This must be combined with high flock management standards and hatcheries discipline [15].

Good bio-security is essential including all- in-all- out policy forms, where all birds are of the same and all brought in at the same time and disposed to allow for proper cleaning and disinfection [27]. Good hatchery sanitation and a vigorous program of detecting and eliminating reactors from breeding stock [21]. The best method of control is by preventing the introduction of Salmonellae with infected birds by using plated feed and by high standard of management and flock security. However, once a primarily breeding flock is infected with salmonella which have an affinity for poultry, it is very difficult to eliminate. Administration of intestinal flora from adult birds has been shown under same circumstances to protect chickens against challenge with Salmonellae [15].

If possible, all birds should be sold after one lay season thus eliminating carriers. While the premises should be thoroughly cleaned and disinfected. Raise new broods of birds in the all- in all- out system do not permit contact with wild birds, mammals, rodents, or reptiles, control insect population. Provide uncontaminated animal proteins in the ration, pellet feeds are more likely to be free of Salmonellae [10].

Vaccines although both live and inactivated vaccines have been prepared for use against *S*. Gallinarum; the vaccine most wildly used is made from the rough 9R strain. It has only been employed in chickens. In addition, vaccination with 9R may same times precipitate high mortality in infected birds and may stimulate the production of transient antibodies. It is usual to vaccinate at 8 weeks and again at 16 weeks of age. Antimicrobial should be avoided before and after vaccination [11].

CONCLUSION

This review presented on *S.* Pullorum/ Gallinarum show that the disease has a potential of causing tremendous loss in the farm. These diseases always occur along with intensification and mostly affect chicken young chicken. It causes high morbidity and mortality resulting higher economic losses. Because of this most farm which positive chicken founded were undergone all out procedure to control spread to other farm nearby and to the farmer.

Based on the conclusion above the following points are recommended:

- Application of strict bio-security measure and vaccination together with appropriate routine disinfection of premises, bedding material and drinking water.
- All visibly affected birds should be destroyed and the carcasses together with those birds cremated or buried in lime.
- A preferred method to avoid salmonella infection in the flock is to test serology and remove the positive reactor from the flock and then destroy them. Non reactors should then be moved to fresh ground and fresh premises
- There should be strict isolation between affected and non affected group and attention should be given to the general hygiene.
- The addition of *Furazolidone* to the mass at the level of 0.04% for 10 days is generally effective in reducing mortality and if instituted early in outbreak, the carrier rate is low.
- When a poultry is depopulated, all dropping and litters should be removed from the house prior to cleaning and disinfecting, equipment and vectors

such as rodents especially rats and mice control must be integrated in the control of *Salmonellosis*. After removal and taking hygienic measure, the house should be left empty for 2-4weeks before restocking the new salmonella free flock.

ACKNOWLEDGEMRNT

- We would like to express our thanks to Hawassa university and Allage ATVET College, for provision of literature materials and preparation of this review paper
- Next I acknowledge all veterinary staff member of Allage ATVET College. For their comment on the paper that we review.

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