SALMONELLA ENTERITIDIS: A MAJOR THREAT FOR DISEASE AND FOOD POISONING

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ABSTRACT: *Salmonella enteritidis* is a major threat to human health in relation to disease and food poisoning. Bacteria transfer from multiple animal origin food products and non-living contaminated surfaces to human being. Salmonellosis is fatal in individuals having immune suppression. Cause more damage to young and old age population. Number of cases and losses due to diseases can be reduced by in time and accurate diagnosis using rationale and advanced techniques. Molecular techniques provide promising results for diagnosis in shortest time. Timely treatment of Salmonellosis using appropriate antibiotics is a key component in cure of patients. In areas where infection is endemic vaccination using appropriate bacterial serotype and strain must be used for prevention of disease. Consumption of hygienic food is the major precaution to avoid infections with Salmonellosis.

Key words: Salmonellosis, food poisoning, diagnosis and prevention.

INTRODUCTION

Salmonella is a Gram-negative minuscule, non-spore-forming, short rods (Popoff and Le Minor, 2015) and member of Enterobacteriacea family (Sooka *et al.,* 2015). There are two types of Salmonella including *S. enterica* and *S. bongori.* Enteric is six species including *S. typhi, S. enteritidis, S. paratyphi, S. typhimurium, and S. choleraesuis* and almost 2,600 serotypes (Boyle *et al.,* 2014) . Salmonellae are chemotrophs, which derive nutrition by oxidation reactions of organic matter (Fookes *et al.,* 2015). Over the course of three decades, *S. enteritidis* (SE) has remained a target organism which cause foodborne illness in human (Popoff and Le Minor, 2015). *S. enteritidis* may enter the colon of the gastrointestinal epithelium (Abuelnaga *et al.,* 2015), translocate the cutaneous asymptomatic key, liver, and other internal organs, including peripheral tissues (Bassat *et al.,* 2015). In addition to the tightness of the internal tissues, *S. enteritidis* is able to outperform other Salmonella-tolerant serotypes with microbicidal elements of egg whites by transferring lipular-like lipopolysaccharide (Huang *et al.,* 2011). Fittingly, *S. enteritidis* is a genotypes associated with the eruption of salmonellosis during the planet (Karaboz *et al.,* 2010).

Sources: Salmonella species are widely distributed in the world (Wilkins *et al.,* 2006), however, the intestinal tract of animals is the most common biochemical material of the minute. Salmonella contamination occurs through contaminated materials such as egg, milk and chicken meat. Almost 20 percent of the world's poultry products are contaminated with Salmonella (Cloeckaert *et al.,* 2005), and can be tolerated long-term in animal and human conditions and in the workplace through biofilm development. *S. enteritidis* was recognized in other mammals (for example dairy cows, pigs), pets, wildlife, feeding (for example pork, burger, cheddar, breeding), and surface water, each as a starting point for illness of human (Ravel *et al.,* 2011). The isolated Enteritidis found in these sources and the open data were insufficient to investigate their function up to the level with individual pollution (Tauxe *et al.,* 2009).

On average isolation frequency of different Salmonella strains was 38.1% in used poultry, 21.7% in owners of poultry, soil contained 10.6%, water purifier had 9.4%, water contained 6.6%, animal feed containing 4.4%, wastewater from poultry-care areas contains 2.2%, and various sources contain 7.0%. Staples commonly contaminated with Salmonella strains were poultry meat (40%), dairy products (11%), baked goods (8%), mayonnaise (6%), frank (5%), and unsalted shell eggs

(4%), and there were other sources of food (26%). Handmade mayonnaise was the most widely recognized vehicle for Salmonella food allergy, and *Salmonella enteritidis* was the most isolated serotype (95%) from that source (Pärn *et al.,* 2015).

Transmission: *S. enteritidis* can get all the standard lifestyles from animal feeds, basic creations, and right from families or food organizations and organizations (Wigley *et al.,* 2001). Salmonellosis in humans is usually contracted with the use of contaminated food from animals (primarily eggs, meat, poultry and milk), but various support, including raw vegetable waste, is related to its distribution. Individual to one-to-one transmission is similarly possible through the fecal-oral route (Guraya *et al.,* 2014). Human events also occur when humans interact with contaminated animals, including pets (Velilla *et al.,* 2019).

Pathogenesis: In the small intestine, Salmonella species penetrate the intestinal mucosa, usually on the edge of Peer. These bacteria cause the microvilli of the M cells to disappear, and the bacteria then penetrate through insertion into the epithelial component (Fàbrega and Vila, 2013). Intracellular bacteria can pass through cells to the opposite, and even cause M cell detachment (Gkrania-Klotsas *et al.,* 2016). CD18-positive cells also appear to play a role in intestinal permeability. In a fight with typhoid fever, infected macrophages migrate to the intestinal lymph nodes where Salmonella multiplies before fleeing these cells and into the bloodstream that will spread throughout the body (Xia *et al.,* 2019). Polymorph neutrophils (PMNs) kill Salmonella, and it is thought that these cells, as well as subtle macrophages, effectively control bacterial growth (Doosti et al., 2015). During enteritis, there is severe local intestinal obstruction, including neutrophil infiltration, and fluid leakage.

S. enteritidis, like most serovars, often causes local gastro-enteric infections, rather than systemic infections. Although it seems to be well adapted to the cause of infection in birds, it is not limited to its host list. Like other Salmonellae including Typhimurium and Dublin, Enteritidis also has a large virulence plasmid (Munir *et al.,* 2000). This holds for the association of genes, the spv operon, which is crucial for the fight against crime in the mouse. It does not appear to be affected, however, in the entry of the disease into the chicken. Difficulties belong to different classes of organisms but the differences between the groups are not clear.

Clinical Menifestations: The most common clinical presentation of salmonellosis is acute enteritis. After an incubation period of 6–72 hours, there is an onset of nausea and severe abdominal pain especially in the peripheral and lower right quadrant, followed by severe diarrhea and sometimes with diarrhea blood and mucous. The flu affects about 70% of patients. Abdominal examination reveals some tenderness (Argyraki *et al.,* 2011). Symptoms last within 2-7 days in healthy children, and fatalities are rare. In certain high-risk groups, the course of *S. enteritis* may be more difficult (Wagener *et al.,* 2004). Neonates, infants, and children with primary or secondary immunodeficiency may have persistent symptoms for several weeks. In patients with inflammatory bowel disease, especially ulcerative colitis, *S. enteritidis* may cause intestinal attacks with rapid development of toxic mega colon, systemic toxicity (Su and Chiu, 2007) and death.

In contrast to adults, the majority of children has no predisposing risk factors and develops bacteremia as a complication of acute enteritis. Transient bacteremia during non-typhoid Salmonella gastroenteritis is believed to occur in approximately 5% of patients. Salmonella bacteremia is associated with fever, chills, and often with a toxic appearance. Bacteremia has been documented, however, in afebrile, well-appearing children, including neonates. Patients with certain underlying conditions, such as malignancies, collagen vascular diseases, inflammatory bowel diseases, and AIDS, are at increased risk of bacteremia, which may lead to extra intestinal infection (Dhara *et al.,* 2019). In patients with AIDS, septicemia often recurs despite antibiotic therapy, often with a negative stool culture for Salmonella and sometimes with no identifiable focus of infection. Adults with persistent bacteremia may have endocarditis, arteritis, or an infected aortic aneurysm.

After salmonellae enter the circulatory system, they have a unique ability to aggregate and cause a primary infection from any organ. Areas of previous variants from the normal are always included. Abnormal diagnosis is usually basic in the first 3 months of life, in those with cellular disorders, and in people who have had a previous gastric bypass procedure. The most prominent diseases include the skeletal system, the arteries, and the areas of the brain. Salmonella is a common cause of osteomyelitis in patients with sickle cell disease. Salmonella osteomyelitis and joint septic pain additionally occur in areas of previous injury or skeletal prosthesis. Subsequent concomitant treatment may follow Salmonella enteritis, most commonly in youths with the HLA-B27 antigen. Meningitis happens more often now than bacteremia. Despite the fact that meningitis can occur at any age, the occurrence of spinach is still in the early stages. Patients may not provide fever and nonspecific symptoms, or sudden seizures, and neurologic follow-up despite appropriate anti-microbial treatment (Mølbak *et al.,* 2002).

The alarming inclusion of Salmonella bacteremia in the elderly is the development of unsafe endarteritis. A large proportion of patients with mycotic aneurysm due to Salmonella pre-illness are localized to

the area where there is a contaminated aneurysm. In the progression of patients with bacteremia due to Salmonella, 25% of those> 50 years of age develop endothelial disease. This includes the Salmonella dose, which has been calculated to attack the normal blood intima, causing endothelial disease within atherosclerosis. The passing of more established patients with- or without hypertension among patients with Salmonella aortitis is likely due to the increased rate of atherosclerosis and greater injury to these patients. Salmonella bacteremia has been noted in HIV-infected patients; however it may be aortitis rarely occurs in these patients as they are usually young and without the above risk factors. In a nutshell, most of the details of what happened came from the narrated reports or the review, and as a result, the precise risk factors were not hidden. The best-known clinical images with fever, abdominal pain, and back pain, eventually point to a meeting place (Sjölund-Karlsson *et al.,* 2015).

Few uncommon clinical conditions can occur in people who are associated with non-typhoid Salmonella, depending on their specificity and specific serotype. The most commonly seen clinical presentation of salmonellosis is abnormal metastasis. In certain high-risk situations in the community, the course of Salmonella enteritis may be gradually cleared. Neonates, newborns, and infants with primary or apparent primary defects may have symptoms that persist for most of the month (Dhara *et al.,* 2019).

Food Poisoning: Salmonella bacteria live in the intestinal tract of humans and animals and are excreted in feces. Poultry, beef, milk, and eggs all can contain Salmonella bacteria. Salmonella infection is a foodborne illness that occurs from consumption of raw meats and eggs, contaminated dairy foods such as unpasteurized (raw) milk, or fruits and vegetables contaminated by food handlers. A Salmonella bacterial infection causes gastrointestinal symptoms, including diarrhea, abdominal pain, nausea, and vomiting. Symptoms develop within 12-72 (James *et al.,* 2019) hours and typically last four to seven days (Edwards *et al.,* 2004). Some types of Salmonella bacteria cause the illness known as typhoid fever. In most cases, no specific treatment is needed other than adequate hydration. Most cases of salmonellosis are not life-threatening and resolve on their own without complications. People at risk for complications or those with particularly severe illness or a weakened immune system may need antibiotic therapy.

There is no vaccine to prevent Salmonella infection. Salmonella may infect reptiles, rodents, and birds (Beirão *et al.,* 2015). Contact with these animals increases the likelihood of getting the infection. People may prevent infection by following established food safety practices, including attention to hygiene during food preparation and handling of animals.

Salmonella infection, or salmonellosis, is another name for Salmonella food poisoning. Salmonella are a type of bacteria known to cause food-borne illness for over 125 years. Specific strains of the bacteria can be responsible for outbreaks of the disease (Dewulf *et al.,* 2011). The diarrhea is typically loose and not bloody. Nausea, Vomiting, Headache and muscle aches are other issues (Fyfe *et al.,* 2002; Mølbak *et al.,* 2002). The symptoms usually go away on their own after four to seven days. Poultry, beef, milk, and eggs may contain Salmonella bacteria, since the bacteria live in the intestines of humans and animals. Thorough cooking of these foods destroys the bacteria. Foods, including vegetables and fruits, may also be contaminated during handling or processing of the food, and this is another common source of outbreaks. For example, food may be contaminated by the feces of infected people or animals or from the unwashed hands of a person handling or preparing the food (Guraya *et al.,* 2014).

Reptiles may also harbor Salmonella bacteria. In the 1970s, outbreaks were associated with baby turtles kept as pets. Further, the infection may be spread by contaminated surfaces (such as cutting boards) that have had contact with contaminated foods. Contaminated foods usually look and smell normal. Over the past years, outbreaks of salmonellosis have been associated with a number of different foods, including chicken, cucumbers, alfalfa sprouts, bean sprouts, ground beef, mangoes, peanut butter, and cantaloupe. These are just a few examples (Whitehead *et al.,* 2009).

There is no vaccine available to prevent Salmonella infection. However, one can take the following steps to help ensure good hygiene and food safety, reducing the likelihood of getting the infection. Wash hands thoroughly after using the bathroom. Cook meats and eggs thoroughly. Do not consume raw eggs or unpasteurized milk. Wash hands and kitchen surfaces with soap and water after contact with raw meat or eggs(Marder *et al.,* 2019). Do not allow uncooked meats to come in contact with other foods in the kitchen, including utensils and work surfaces that will be used to prepare other foods. Wash hands thoroughly after contact with animal feces and after all contact with reptiles, birds, and small rodents. Chill foods after serving and when transporting from place to place.

Diagnosis: Stool samples are the most frequently tested clinical materials for *Salmonella*. Animal feces and water sources may also be tested. Large numbers of food ingredients and food products are routinely tested by the food industry, since the presence of *Salmonella* in any ready-to-eat food is not acceptable. A wide variety of foods may be tested, but meat products, eggs and dairy products are a particular concern. Other foods and ingredients where regular tests are required include chocolate confectionary, herbs and spices, fresh salads,

fruits, seeds and nuts, flour and shellfish. Sampling from animal carcasses at slaughter may also be carried out.

Salmonella is not able to grow at low temperatures and samples should be refrigerated if they cannot be sent for analysis immediately. The cells survive well in frozen foods and other materials, but samples should be kept frozen prior to testing. Typically, 25g food samples are cultured in detection testing, but dried foods require a resuscitation stage for sub-lethally damaged cells in non-selective pre enrichment media, before further culture. Furthermore, some dried foods, notably herbs and spices and dried onions, contain compounds that could inhibit *Salmonella* growth in enrichment cultures. These compounds should be neutralized, either by the addition of a suitable neutralizing agent, or by additional dilution (Asrade *et al.,* 2013).

Screening for salmonellosis requires bacteriologic isolation of living organisms from appropriate clinical models. News coverage has been used as such. All contain specific masters to limit different fragments of the gastrointestinal greenery. These blends are required to obstruct the run of the mill fecal vegetation, anyway may control the pathogens to some degree. Along these lines there is a concordance among assurance and demonstrative yields. Bile salts will decide forever frames that have the entrails. Progressively explicit in spite of everything is sodium desoxycholate, found in xylose lysine desoxycholate (XLD) agar, or desoxycholate citrate agar (Gast and Beard, 1992; Collinson *et al.,* 1993).

The accompanying stage in the characteristic technique is the use of biochemical screening tests to remember them from Proteus settlements, which have near appearances. These development reactions use mix media, for instance, Kligler iron agar, triple sugar agar, or Kohn's chambers. Modernly conveyed units in like manner perceive the trademark development of preformed mixes (API ZYM). Living creatures giving trademark reactions are then presented to full biochemical and serological distinctive confirmation. The biochemical tests consolidate sugar development tests, decarboxylation and dehydrogenation reactions and hydrogen sulfide creation.

Serological conspicuous evidence of Salmonella without biochemical confirmation is conniving, considering the many cross-reactions with commensal gut verdure. Full serological making out of Salmonella is simply shown for the ID and assessment of scenes. Traditional detection and confirmation methods are long established and typically take 3-5 days to obtain a result. Rapid detection and confirmation methods are widely available and are capable of reducing detection times to 48 hours or less. As well as being the cause of enteric (typhoid) fever, an important infectious disease, *Salmonella* is perhaps best known as a cause of bacterial food poisoning. Although typhoid fever has been largely eradicated in the developed world, *Campylobacter* is now the most frequent cause of foodborne human infections, but *Salmonella* remains a very important and widespread pathogen. It is a major concern for food industry, where its control is vital for products ranging from cooked meats to chocolate and from fresh produce to peanut butter. Individual serovars can be further characterized (typed) (Hickman-Brenner *et al.,* 1994) by a number of methods, including phage typing and antibiotic resistance profiles. Serological identification of *Salmonella* without biochemical confirmation is unreliable, because of the many cross-reactions with commensal gut flora. Full serological typing of *Salmonella* is only indicated for the identification and investigation of outbreaks (Vuento *et al.,* 1989; Low *et al.,* 2001; Karaboz *et al.,* 2010).

Immunological methods detect unique *Salmonella* molecules using two antibodies; a surface-bound primary antibody to capture the target molecule and a reporter antibody to detect the antibody target complex. Immunological techniques (Mutalib *et al.,* 2015) can replace isolation agars, lowering the time to presumptive positive result to one to two days. The immunological assays available for *Salmonella* detection are lateral flow devices (LFD), enzyme linked immunosorbant assay (ELISA), and Enzyme-linked fluorescent assay (ELFA). LFDs follow the format of pregnancy test kits, giving results within 20 minutes of the enriched sample being loaded into the device. ELISA and ELFA are more complex and incorporate washes between capture and reporter steps to remove non-target molecules that cause false positive results. The adoption of automated ELISA and ELFA systems enables high sample throughput with presumptive results within 19 to 25 hours. ELFA sensitivity has been increased in recent years by using bacteriophage as capture molecules in place of antibodies. Antibodies can also be coated onto magnetic beads in a technique known as immunomagnetic separation (IMS). IMS concentrates *Salmonella* from food samples for either subculture for colony isolation or as part of the sample preparation for molecular-based detection assays. The IMS removes inhibitors from food matrices and other background flora that can impede assay performance (Zheng *et al.,* 2019).

Molecular-based detection of *Salmonella* spp. delivers one of the fastest times to result, with run times after enrichment and DNA extraction of 45 min to 3h. The predominant molecular approach is polymerase chain reaction (PCR) that detects DNA regions specific to *Salmonella*. Commercial PCR detection kits are usually in a user-friendly format for sample set up and result interpretation (Salehi et al. 2010). A system subject to the precise strengthening of a brief target DNA real time PCR (qPCR) is used. This technique joins increase and ID periods of the strategy with the goal that nucleic destructive upgrade is watched and recorded continually from now on clearing out the need for post-improvement

ventures, as an example, gel electrophoresis (Bunge *et al.,* 2007). Various researchers visited RNA heightening procedures using mRNA as a degree since it's a molecule with an incredibly short half-presence of 0.5 to 2 minutes on account of the fast debasement by endogenous RNases. More recent advances in molecular assays have introduced isothermal amplification methods which operate at a single temperature rather than cycling through a set temperature profile. Isothermal amplification systems tend to be cheaper, take up less bench space, and have a time to detection of 45 to 90 minutes from the enrichment culture. A range of 'off the shelf' *Salmonella* detection assays are available for food analysis. When choosing a new method, several factors need to be considered, including ensuring that they are fit for purpose. Method performance is a key point in this decision-making process. Several *Salmonella* detection kits possess third party method assessments by organizations including AOAC, MicroVal, and NordVal. Campden BRI is an expert laboratory for these validation organizations and carries out validations to recognized ISO16140 standards.

All commercially produced *Salmonella* detection kits still require confirmation of presumptive positive results (Hussain *et al.,* 2015). Advances in *Salmonella* confirmation techniques have improved turnaround time and result interpretation.

In recent years, another instrument based identification system Matrix Assisted Desorption Ionisation time of Flight (MALDI-ToF) has been introduced. (MALDI Biotyper Receives OMA for Identification of Food Pathogens.) The MALDI-ToF instrument directs a laser onto the prepared colony sample which has been dried onto a metal plate. This generates a profile of fragments that are detected within the system. Each isolate specific pattern created is compared to a library to identify the bacteria. MALDI ToF provides a very rapid time to result of approx 15 minutes and the potential for high sample throughput. Campden BRI is now offering a rapid *Salmonella* confirmation service to genus level using the MALDI-ToF. The evolution of DNA sequencing has significantly reduced analysis costs, making whole genome sequencing (WGS) possible for *Salmonella* species.

Treatment: Ciprofloxacin, azithromycin, ceftriaxone, trimethoprim/sulfamethoxazole (TMP/SMX) are recommended only for high-risk patients and patients with systemic or focal infections. Uncomplicated gastroenteritis due to non-typhoid Salmonella infections is treated symptomatically with oral or IV fluids (Velilla *et al.,* 2019). Antibiotics do not hasten resolution of gastroenteritis, may prolong excretion of the organism, and are unwarranted in uncomplicated cases (Temitope, 2015). However, in older nursing home residents, infants, and patients with hemoglobinopathies, HIV infection, or other immunocompromising conditions, increased mortality dictates treatment with antibiotics. Acceptable antibiotic regimens include the following: TMP/SMX 5 mg/kg (of the TMP component) orally every 12 hours for children Ciprofloxacin 500 mg orally every 12 hours for adults Azithromycin 500 mg orally on day 1 followed by 250 mg once a day for 4 days for adults Ceftriaxone 2 g IV once a day for 7 to 10 days for adults (Tang, Davies *et al.,* 2019)

Non immunocompromised patients should be treated for 3 to 5 days; patients with AIDS may require prolonged suppression to prevent relapses. Systemic or focal disease should be treated with antibiotic doses as for typhoid fever (Mahyudin *et al.,* 2016). Sustained bacteremia is generally treated for 4 to 6 weeks. Abscesses should be drained surgically. At least 4 week of antibiotic therapy should follow surgery. Infected aneurysms and heart valves and bone or joint infections usually require surgical intervention and prolonged courses of antibiotics .The prognosis is usually good, unless severe underlying disease is present (Holt *et al.,* 2000).

Prevention: Stores for non-typhoid *Salmonella Enteritidis* living creatures join a wide extent of neighborhood and wild animals, for instance, steers, poultry, pig, rodents and pets. In individuals corrupted with Salmonella, the release of infinitesimal living beings can last over the range of defilement and as a temporary conveyor state for a serious long time. The technique for transmission may recall ingestion of the existence structures for food got from polluted animals or spoiled by compost of a sullied animal or person. The source may be degraded meat, poultry, eggs, milk, and their things, similarly as water; nourishments developed starting from the earliest stage. Preventive measures therefore should join the preparation of food handlers about hand tidiness, refrigerating sustenance in little parts, totally cooking all goods, avoiding recontamination of arranged food, and keeping up a sterile kitchen to keep from contamination by rodents and bugs (Kitazawa *et al.,* 2006). General society should be told about the essentialness of eating up particularly arranged food. Adequate Salmonella control ventures should be set up for feed control, vector control, and other sterile measures in the animal development (Ellakany *et al.,* 2012).

Oral vaccination furthermore diminished shedding of an oral test with the destructive strain. In any case, intramuscular inoculation inside the underlying 24 h of deliver didn't decrease shedding of an oral test and truly extended it (Holder *et al.,* 2014). Live choked salmonellae are acknowledged to give more vital confirmation (Özoğlu and Altuntaş, 2019) than killed. Regardless, the ampleness of vaccination of these animals in lessening Salmonella transmission through the

developed lifestyle to individuals is dark (Holder *et al.*, 2014).

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