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Bovine Salmonellosis and Its Public Health Importance: A Review

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Abstract
Salmonellosis is an infectious disease of humans and animals caused by organisms of the two species of Salmonella (*Salmonella enterica*, and *S. bongori*). Although primarily intestinal bacteria, salmonellae are widespread in the environment and commonly found in farm effluents, human sewage and in any material subject to faecal contamination. Salmonella organisms are aetiological agents of diarrhoeal and systemic infections in humans, most commonly as secondary contaminants of food originating from animals and the environment, usually as a consequence of subclinical infection in food animals leading to contamination of meat, eggs, and milk or secondary contamination of fruits and vegetables that have been fertilised or irrigated by faecal wastes. Salmonella passes through M-cells overlying Peyer's patches or through the epithelial lining of the lower part of small intestine or proximal colon to arrive in the sub epithelial location which is also transported to extra intestinal sites such as the liver, spleen and mesenteric lymph nodes. Bovine salmonellosis is caused by *S. typhimurium* and *dublin*. The disease in cattle is characterized by septicemia, acute or chronic entritis or abortion. Salmonella entrica sub species entrica develop a resistance to multi antibiotics in which results in increasing failure of treatment and severity of infection. Basic hygiene practices and the implementation of scientific based management strategies can efficiently mitigate the risks associated with animal contacts. However, the general public is frequently unaware of the specific disease risks involved and high-risk behaviors are common. The disease can be also controlled by vaccination of cattle.
Keywords: Cattle; Foodborne; Human; *Salmonella;* Zoonosis

INTRODUCTION

The genus Salmonella was named after Daniel E. Salmon who first reported the isolation of *Salmonella* from a pig in 1885 and named the organism Bacterium choleraesuis (currently known as *Salmonella* enterica serovar Choleraesuis) (Rao, 2004). *Salmonella* causes gastroenteritis and typhoid fever and is one of the major foodborne pathogens of significant public health concern) (Fluit, 2005). Salmonellosis is a disease caused by many serotypes of *Salmonella* and characterized clinically by one or more of the three major syndromes; septicemia, acute and chronic enteritis(Davison and S, 2005).

Salmonellae are common in cattle. They are often concern due to disease of cattle and the potential to infect human that come in contact with cattle or consume dairy product or bovine meat product. Meat processing and packaging at the whole sale or retail level contribute to higher levels of contamination in minced beef product compared to beef carcass. The presences of even small number of *Salmonella* in carcass meat and edible offal may lead to heavy contamination of minced meat. When meat is cut in to pieces more microorganisms are added and increased surface area of exposed tissue from the contaminated equipment. Raw meat particularly, minced meat has a very high total count of microorganisms of which *Salmonella* are likely to present large number (Ejeta et al., 2004).

Bovine salmonelosis usually manifest clinically as a syndrome of septicemia, acute or chronic enteritis and abortion (Kemal, 2014). There are few serotypes that are associated with cattle and of this *Salmonella enterica* serotype Dublin *(S. dublin)* and *Salmonella enterica* subspecies *enterica* serotype Typhimurium *(S. typhimurium)* is the most common (McEvoy et al., 2003). The presence of *S. typhimurium* in cattle and the cross contamination of beef carcass tissue is one of the most common cause of *Salmonella* infection in developed countries (Kemal , 2014).

In addition to causing infection many *Salmonella* isolates particularly *S. typhimurium* definitive type (DT) 104 have developed resistance to multiple antibiotics (Piddock

2002). The resistance organism may act as donor of resistant determinant to another facultative pathogen of the human commensal flora of intestinal tract which may later be associated with disease and, in turn, supply the resistances gene to other pathogen (Kemal , 2014)

The economic loss associated in human salmonellosis is due to investigation, treatment and prevention of illness (Wray and Wray, 2000). Therefore, the objective of this review paper is to show the effect of eating of raw or undercooked meat, drinking of unpasteurized milk from the perspective of public health and to forward recommendation based on conclusion.

LITERATURE REVIEW

Etiology and Characteristics

*Salmonella*e are small, Gram-negative, non-spore forming; facultative anaerobic, rod-shaped, motile bacteria that belong to the family Enterobacteriaceae (Jay, 2000; Patterson and Isaacson, 2003).The cells are typically 0.7-1.5 µm by 2-5 µm. They grow at 7-48°C with an optimum growth at 37°C (mesophile) and at pH 4.05-9.5 with an optimal growth at pH 6.5-7.5 (neutrophile). *Salmonella* grows optimally at a water activity of 0.995 and are chemo-organotrophs. They have both fermentative and oxidative metabolism. The primary route for metabolism of carbohydrates is the Embden-Meyerhof pathway (glycolysis). They ferment glucose to formate (with the production of gas) and to ethanol, acetate, or lactate (Craig DE. and James MS 2006)

Strains of genus *Salmonella* are the group of family *Enterobacteriaceae*, they are straight rod usually motile with peritrichous flagella (except *S. pullorum* and *S. gallinarum*), facultative anaerobe, ferment glucose usually with production of gas (except *S. typhi* and *S. dublin*) (Johnson *et al*., 2007). *Salmonella* multiply optimally at a temperature of 35°C to 37°C, pH about 6.5-7.5. They are also able to multiply in the environment with low level or no oxygen (Kemal, 2014). The bacteria are sensitive to heat and will not survive a temperature above 70oC; so it is sensitive to pasteurization, but resist to drying even for years. Especially in dried feces, dust and other dry materials such as feed and certain food (Radostitis *et al*., 2007). The most common serovars of *Salmonella* that infect livestock and syndrome they induce are shown in the table 1.

Table 2: The most common serovars of Salmonella that infect livestock and syndrome they induce

Species	**Serovars**	**Common syndrome**
Cattle	**S. dublin *and* S. typhimurium**	**Septicimia, acute and chronic enteritis and abortion**
Sheep	**S. typhimurium**	**Septicemia, typhocolitis and abortion**
Pig	**S. choleraesuis S. typhimurium, S.typhisuis**	**Septicemia**
Horses	**S.typhimurium**	**Septicemia, acute colititus and abortion**
Chicken	**S. pullorum, S. gallinarum**	**Septicemia, acute and chronic enteritis**
Human	**S. enteritidis, S. typhi, S. paratyphi**	**Gastroenteritis, bacteremia**

Source: (Kemal, 2014).

Epidemiology

The epidemiology of *Salmonella* is complex which often makes control of disease difficult. Epidemiological pattern of prevalence of infection and incidences of disease differ greatly between geographical area depending on climate, population density, land use farming practice, food harvesting and processing technologies and consumer habits. In addition, the biology of serovar differs so widely that *Salmonella* infection or *Salmonella* contamination are inevitably complex (Radostitis et al, 2007).

S. entritidis is the most prevalent species followed by *S. typhimurium* which are a worldwide distribution. Change in the relative frequency of serotypes can be observed over a short period of time. Some times within one or two years only limited number of serotypes is isolated from man or animals in a single region or country and the predominance of one or other can vary over a time. Some serotypes like S. entritidis and *S. typhimurium* are found worldwide in contrast to S. weltevreden which seems to be confined to Asia (Kemal , 2014). Sibhat *et al*. (2011) found the serovars Newport, Anatum and Eastbourne to be the most prevalent in Ethiopia.

Salmonellae have a wide variety of domestic and wild animal hosts (Acha and Szyfres, 2001). All members of the genus are considered to be potentially pathogenic, although serovars may differ widely in their host range and the pathogenic syndromes that they produce (Table 2).

Some serovars appear to show a degree of host adaptation and primarily infect one animal species. They also tend to cause more severe illness than the other serovars. For epidemiological purposes, the *Salmonella*e can be placed in to three groups (Jay, 2000): Those that infect humans only: These include S. Typhi, S. Paratyphoid A and S. Paratyphi C. This group includes the agents of typhoid and the paratyphoid fevers, which are the most severe of all diseases caused by *Salmonella*e.The host adapted serovars (some of which are human pathogens and may be contracted from foods): included are S. Gallinarum (poultry), S. Dublin (cattle), S. Abortusovis (sheep) and S. Choleraesuis (swine).Unadapted serovars (no host preference). These are pathogenic for humans and other animals, and they include most foodborne serova (Wray and Davies, 2003).

Table 3: Host-specific Salmonella serovars and the diseases, disease symptoms and pathological effects

Serovar	Host	Disease, symptoms, pathological lesions
S. Typhi	Humans	Typhoid fever, paratyphoid fever
S. Paratyphi A, B, C	Cattle and calves	Cattle: diarrhea, fever necrotic enteritis
S. Dublin	Pigs	Calves: diarrhea, fever, enteritis
S. Choleraesuis	Chickens, turkeys	Septicaemia, pneumonia, hepatitis
S. Pullorum	Chickens, turkeys	Pullorum disease
S. Gallinarum	Horses	Fowl typhoid
S. Abortusequi	Sheep	Abortion
S. Abortusovis		Abortion

Source: (Poppe, 2002)

Worldwide there are 16 million annual cases of typhoid fever, 1.3 billion cases of gastroenteritis and 3 million deaths due to *Salmonella*. In the US annually there are 2-4 million cases with a death rate of 500-1,000 and an economic loss of about 3 billion dollars. A recent CDC report indicates that the incidence of *S. typhimurium* decreased significantly (42% decline) from 1996–1998 to 2005; however, the incidence of other serotypes are on the rise such as S. enteritidis and S. heidelberg, each of which increased by 25% and S. *enterica* serovar Javiana increased by 82% (Arun and Bhunia ,2008).

Source of infection and ways of transmission

Most *Salmonella* infection in farm animals are likely to acquire from animals of the same species, especially in the case of the host adapted serovars. In adult cattle there are important differences in the behavior of *S. dublin* and *S. typhimurium*. Those animals which recover from *S. dublin* infection may become persistent excreters, shedding up to 10^6 organisms per gram of feaces daily. Other herd may harbor infection and excrete the organisms only when stressed particularly at parturition. Aerosol transmission has long been suggested as a means by which *Salmonella* may be transmitted and experimental infection of calves by aerosol has been reported recently. In addition pasture contamination results when flooding occurs and there are many reports of clinical case in adult cattle arising from grazing recently flooded pasture (Kemal, 2014).

Human salmonellosis is generally foodborne and is contracted through consumption of contaminated food of animal origin such as meat, milk, poultry and eggs. Dairy products including cheese and ice cream were also implicated in the outbreak. However, fruits and vegetables such as lettuce, tomatoes, cilantro, alfalfa-sprouts and almonds have also been implicated in recent out-break (Kemal, 2014).

Acute gastroenteritis is usually acquired from consumption of food which may be directly or indirectly contaminated with Salmonella. A wide variety of animal species have been shown to be capable of harboring the organisms and in the developed world turkey, chicken, swine and cattle are found to be infected carriers in the studies conducted in the abattoirs. These carriers may readily shed Salmonella during transportation to the abattoir and contaminate abattoir workers or equipment during slaughter. The progressive trend forwards mass processing and distribution of food products has been an important factor in the increase incidences of Salmonella foodborne diseases. Person to person spread has been demonstrated on many occasions and may take place in young children and group living under poor socioeconomic condition where effective sanitation is lacking. Person to person spread also may occur in hospitals, nursing homes, mental institution in which large number of outbreak has occurred. Amplification of infection in these institutions may occur from contaminated food or asymptomatic carrier's babies being at special risk (Barrow *et al*., 2010). Direct or indirect contact with animals colonized with Salmonella is another source of infection, including contact during visits to petting zoos and farms (Friedman *et al.,* 1998).

Fecal oral route and vehicle born infection may result from ingestion of food or water that have been contaminated with human or animal feaces or from direct exposure to animals or their waste. A lower infectious dose of organism is usually required in the elderly, the immunocompromised, antibiotic users and those with achlorhydria or regular use of antacid and related medication. The commonly recognized vehicle of transmission includes inadequate cooked or raw meat, unpasteurized milk or milk product, contaminated and inadequately treated drinking water (Kemal, 2014).

Contamination of milk may occur by a variety of route. Animal may occasionally, excrete the organisms in milk during the febrile stage of the disease or more likely infected feaces, from either a clinically infected cow or healthy carrier may contaminate the milk during the milking process. Milk also may be contaminated from use of polluted water from dirty equipment or from dairy workers. Indirect contamination also has been described when cattle have become contaminated with *Salmonella*. Contamination of food also may occur directly from *Salmonella* infected food handlers or indirectly from sewage polluted water (Jones, 2005).

Pathogenesis

The outcome of infection with *Salmonella* depends essentially on three factors: the infective dose predisposing factor influencing the host and the level of immunity (Scherer CA *et al*, 2001). In cattle the common route of infection is ingestion of the bacteria through contaminated feed and water. It may disseminate to the rest body part of the host via the lymph fluid or blood and usually also lead to faecal excretion of bacteria. *Salmonellae* are normally inhibited by the high concentrations of volatile fatty acids and the normal pH below 7 in the rumen (Scherer et al., 2001). Invasion, virulence property and host defence mechanism of Salmonella once ingested from food and pathogenecity is indicated in the following tree diagram picture(Figure1).

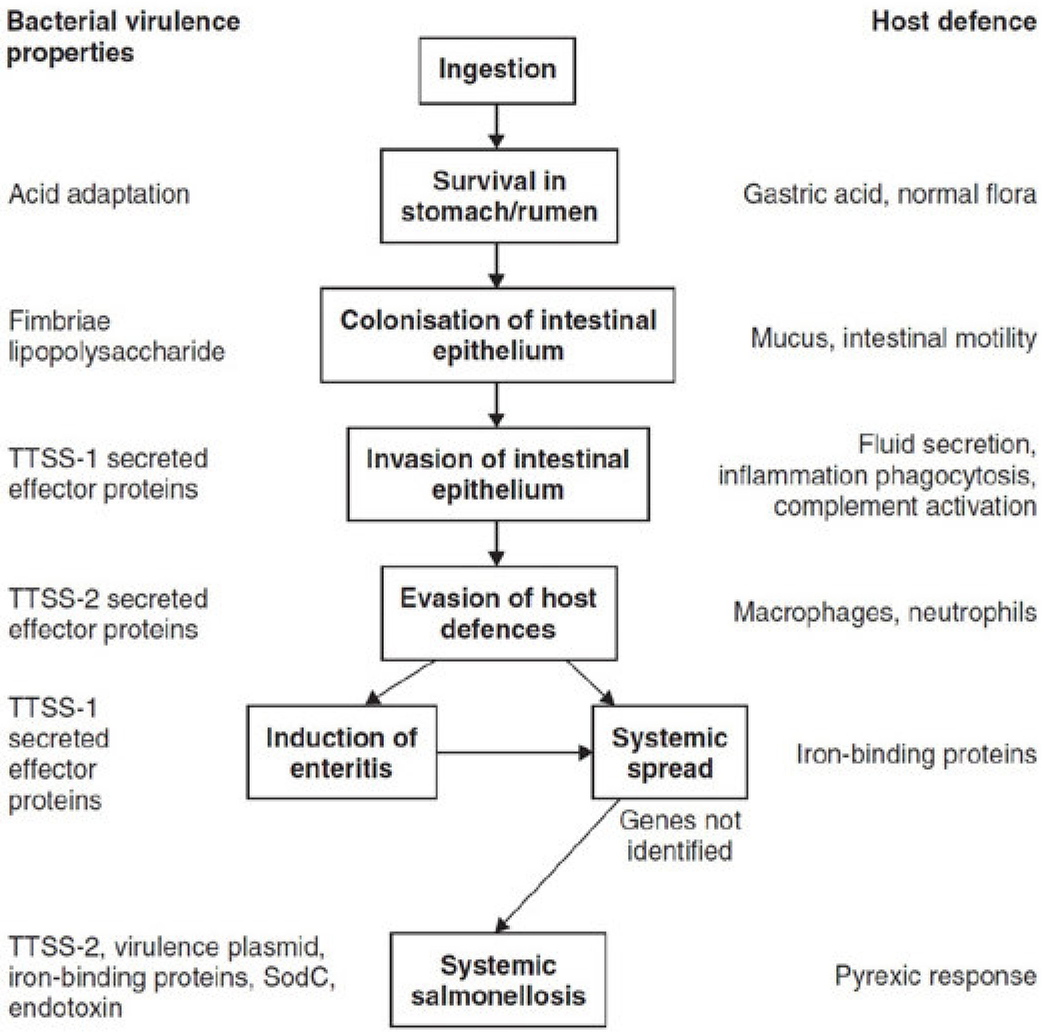

Figure 1: The attachment, colonization, invasion, virulence property and host defence mechanism of Salmonella once ingested from food and pathogenecity island function.

Source: (Jones *et al*., 2007)

These bacteria have developed mechanisms to survive and cope with the host inhibiting factors, but the normal inhibition of *Salmonella* is primarily disrupted in the rumen and small intestine when starvation or reduced feed intake occur (Bäumler et al., 2000).The bacteria adhere to and invade intestinal cells in the mucosa mainly associated with the Peyer's patches in the terminal jejunum and ileum through the columnar enterocytes and specialized microfold enterocytes (M cells). Once the bacteria have crossed the intestinal epithelium they enter macrophages in the underlying lymphoid tissue from where they are drained to the local lymph nodes, which are important barriers for further dissemination. If this barrier is overcome, the bacteria reach the reticuloendothelial tissue containing organs while surviving and replicating inside the macrophages (Scherer and Miller, 2000).

The virulence of *Salmonella* is related to their ability to invade host cell and resist both digestion by phagocytes and destruction by complement system(Quinn and Markey 2003). The specific O antigen is important for the virulence strain of *Salmonella* (specific antigen) by decreasing the susceptibility of phagocytosis and ability to activate the alternative complement pathway (L.Plym and M.Wierup, 2006). Three toxins namely endotoxin, enterotoxin and cytotoxin play an important role in the pathogenesis of *Salmonella*. The endotoxin produce fever, the enterotoxin produce mucosal damage in the cell culture and cytotoxin inhibit protein synthesis (Kemal, 2014).

Clinical Sign

Adult cattle generally contract either acute or subacute enteric salmonellosis and pregnant animal may abort during the early stage of acute enteric disease. Severely affected animals show fever, depression, inappetence and drop in milk yield. These sign are followed by diarrhea which is fowl smelling, the faces being mucoid and usually containing a clot of blood and shred of necrotic intestinal mucosa. Sign of colonic congestion of mucus membrane and dehydration may be evident. The acute disease last for about a week. *S. dublin* in particular but also other serovars may cause abortion in cows at any stage of pregnancy. Abortion may either precede the onset of dysentery or follow it within two or four weeks. Alternatively abortion may occur in cows that show no sign of illness, septicemia and/or placentitis being the case of death of fetus. Retention of the placenta occurs in approximately 70% of cases that abort but subsequent fertility is not usually affected (FDA/CFSAN , 2008).

In calves clinical disease is most common 2-6 week of age. Clinical sign vary but typically the enteric form of diseases predominate which is characterized by pyrexia, dullness and anorexia, followed by diarrhea that may contain fibrin and mucus. The feaces may become blood stained and “stringy” due to the presences of necrotic intestinal mucosa. Calves rapidly become weak and dehydrated unless treated. Infected calves usually die 5-7 days after the onset of disease. At this stage the organisms has become systemic as a result of reduced innate immunity and may be isolated from variety of tissue including blood. Calves that recover from infection do not typically remain carrier. Salmonellosis is very variable and in some animals particularly in very young animals rapid multiplication occur both in intestine and systemically associated with poor absorption of specific immunoglobulin G from colostrums or with calves receiving in sufficient or no colostrums (L. Plym et al., 2006).

In human the effect and clinical sign depends on the incubation period and the number of bacteria ingested,and varies from 5-72 hours to be manifested. Affected individual’s experience sudden nausea, vomiting and watery fowl smelling diarrhea which is in most case last only a few hours. If the colon is affected, the stool may also contain blood and or mucus. Fever up to 39°C is not uncommon. Convalescences within 1-2 days but the illness may last for 5-7 days (Krauss *et al*., 2003).

More severe symptom may occur in people who are at high risk like those extreme age groups (the young because their immune system are immature and the elderly because the immune system are declining), person with decreased gastric acidity (because gastric acid is the first line of defense for the ingested *Salmonella*), person with altered gastric intestinal bacteria (including those taking broad spectrum antibiotics, purgatives or who have had bowl surgery) and person taking opiate drug in which the bowl movement is decreased. In these highest risk groups of people *Salmonella* may invade beyond the gastrointestinal tract (GIT) to cause severe systematic illness (Kemal, 2014).

Gastroenteritis caused by Salmonella is usually a self-limiting illness and fatality is uncommon. Biopsy and endoscopic examination have demonstrated the colon to be a major site of infection. The change in the colon ranges from edema of lamina propria with a focal or diffuse inflammatory infiltrate to a more intensive inflammation with disruption of the surface epithelium and multi-focal micro abscesses. In more severe cases, vascular congestion, infiltration of the lamina proporia with polymorphonuclear leucocytes and abscess formation has been recorded (L. Plym *et al*., 2006).

Post mortem findings

There may be no gross lesion in animals that have died peracutely but extensive submucosal and subserosal petechial heamorrhage are usually evident (Radostitis, *et al.,* 2007). In adult cattle, a typical case reveals acute muco/necrotic enteritis, especially of the ileum and large intestine. The wall is thickened and covered with yellow-grey necrotic material overlying a red, granular surface. The mesenteric lymph nodes and spleen may be enlarged. In calves, the small intestine typically shows a diffuse mucoid or mucohaemorrhagic enteritis and the mesenteric lymph nodes are oedematous, congested and greatly enlarged (Barrow *et al*., 2010).

Diagnosis of Salmonellosis

The clinical sign and finding at postmortem examination are not unique to salmonellosis although a tentative diagnosis may be made. They should confirm either in diseased animal or at necropsy by isolation of organisms in their feces and determination of viable counts. Fecal samples rather than swabs should be taken and these should obviously be obtained before administration of antibiotics. It may be also possible to isolate organism from oral secretion and by blood culture although these are less reliable than feces culture and must be taken with care to avoid contamination. Animal that died of salmonellosis usually have large number of *Salmonella* distributed throughout their tissue and sample of spleen, liver, hepatic, mediastinal and bronchial lymph nodes may yield count in excretion of 10^6 organisms/gram. Similar concentration may be present in the wall and content of the ileum, cecum, colon and associated lymph nodes. Sample should be taken from internal organs in order to distinguish animal that have died of enteritis without septicemia (Jones *et al*., 2007).

Culture Methods

The traditional Salmonella culture method involves pre-enrichment, selective enrichment, isolation of pure culture, biochemical screening and serological confirmation, which requires 5-7 days to complete. The USDA and FDA recommended method involves a 6-24 h pre enrichment step in a nonselective broth such as lactose broth, tryptic soy broth, nutrient broth, skim milk, or buffered peptone water with a recommended incubation temperature of 37°C. The selective enrichment step requires additional 24 hours incubation in Rappaport-Vassiliadis (RV) broth, selenite cystine (SC) broth, or Muller Kauffmann tetrathionate broth. The inoculation temperature of 41.5°C ± 1°C for RV broth and 37°C ± 1°C for SC and MKTT broth is used. Bacterial cells are isolated from selective agar plates such as Hektoen enteric agar (HEA), xylose lysine deoxy-cholate (XLD), and/or brilliant green agar (BGA). Biochemical testing is done using triple sugar iron agar and lysine iron agar, which requires an additional 4–24 hours (Hans *et al.,* 2006).

Detection of antibodies by enzyme immunoassay (EIA)

The detection of antibodies to Salmonella by EIA offers a sensitive and cost-effective method for mass screening of animal herds for indications of a past/present *Salmonella* infection. The limitation of the method is that the immune response of the individual animal is not elicited before 1-2 weeks after infection takes place. A number of commercial kits are available for testing poultry, cattle and pigs. An obvious advantage of this method is that it can be automated and no incubation is required to increase the numbers of bacterial cells (Zamora and Hartung , 2002).

The EIA is a well-established technique for assaying antigens. Antibodies labeled with an enzyme are bound to Salmonella antigens, and the level of antigen present is determined by enzymatic conversion of a substrate, usually resulting in a color change which can be read visually or by a spectrophotometer. The EIAs rely on the standard cultural procedures for pre-enrichment and selective enrichment to provide enough *Salmonella* cells for detection. EIA technology that enables detection at an earlier stage of resuscitation and/or culture can provide even more rapid results. Serological test, such as ELISA, serum agglutination and complement fixation can be used for the retrospective diagnosis of salmonellosis or the detection of carriers (Kemal , 2014).

Nucleic acid-based assays

Real-time quantitative polymerase chain reaction using PCR (Q-PCR), reverse transcriptase PCR (RTPCR), and nucleic acid sequence-based amplification (NASBA) have been used for detection of *Salmonella* from various food samples. NASBA method has been used for detection of viable *Salmonella* cells and it has been demonstrated to be more sensitive than RT-PCR, and moreover, it requires fewer amplification cycles than the conventional PCR methods (Arun and Bhunia, 2008).

Public Health Aspect of Bovine Salmonellosis

Salmonellosis is an important global public health problem causing substantial morbidity and thus also has a significant economic impact. Although most infections cause mild to moderate self-limited disease, serious infections leading to deaths do occur (de Jong and Ekdahl, 2006). In spite of the improvement in hygiene, food processing, education of food handlers and information to the consumers, foodborne diseases still dominate as the most important public health problem in most countries (Domínguez *et al*., 2002).

Salmonellosis incidence is defined as the identification of Salmonella from animals or group of animal’s product or surrounding which can be specifically related to identifiable animals or from animals feed. On the human side, a registered medical practitioner in the US required under the Public Health (Control of Disease) act to notify the local authority, if the patient is suffering from or suspected of having foodborne disease (Kemal *et al*., 2014).

Studies provide increasing evidence of adverse human health consequences due to the occurrence of resistant microorganisms. Use of antimicrobial agents in human and animal affects the intestinal tract placing those concerned at increased risk of certain infection. This is defined as the proportion of *Salmonella* that would not have occurred if the *Salmonella* were not resistant. In addition antimicrobial agent used in animal can result in increased transmission of resistant microorganisms between animal and therefore would results in case of transmission of such microorganisms to human through food. Increased frequency of treatment failure and increase severity of infection may be manifested by prolonged duration of illness. *Salmonella dublin* is largely but not entirely specific to cattle with average 10 human case reported in each year in Ireland. Apart from its pathogenicity two other characteristics of *S. dublin* make it particularly important for Ireland from a public health viewpoints. First, it is very prevalent on Irish farms and secondly in evolutionary terms, it is only one step away from *S. enteritidis*, a common *Salmonella* serotype in poultry and the main case of clinical salmonellosis in humans. In genetic terms, difference between the serovars *S. dublin* and *S. enteritidis* are no greater than those found within each serotypes. This indicates that, *S. dublin* and *S. enteritidis* share a common ancestor. One branch evolved in to a poultry adapted serotype capable of causing disease in human, the other in to host specific cattle pathogen. If *S. dublin* has been confirmed in breeding herd there is a significant risk of persistent infection in carrier cows for as long as animal which were present at the time of the outbreak remain in the herd(Jones *et al*., 2007).

Treatment

Treatment of non-typhoidal *Salmonella* infection is different from typhoidal infection. In treatment of non-typhoidal *Salmonella* infection antibiotics should not be used routinely, as used in typhoid. Antibiotic should be only used if required as most infection with non-typhoidal *Salmonella* is self-limiting type and duration of diarrhea and fever are not much affected by use of antibiotics. Additionally antibiotic therapy can increase relapse of infection and also prolong the duration of gastrointestinal carrier states. The main treatment should be aimed at correcting dehydration that may arise due to prolonged diarrhea by fluid and electrolyte replacement (Kemal, 2014).

Although *Salmonella*e are usually sensitive in vitro to many antibiotics, their use for treatment of uncomplicated gastroenteritis until recently has been generally contraindicated by their lack of favorable effect on the course of the disease and by prolongation of *Salmonella* shedding. Following the introduction of fluoroquinolones a number of clinicians have advocated their use for treatment of only on enteric fever but also of *Salmonella* gastroenteritis because of their efficacy in reducing the duration of illness and of *Salmonella* shedding. In case of patient with bacteremia and other complication antimicrobials are used. Likewise the treatment of enteric fever necessitates the use of antimicrobial drugs with chloramphinicol, ampicillin, amoxicillin, trimethoprim, sulfamethoxazole and newer fluoroquinoazoles being drug of choice against sensitive *Salmonella*. Proper management of fluid and electrolyte balance is impotant in all patients with *Salmonella* gastroenteritis but is crucial in young children and elder individuals (Jones *et al*., 2007).

In animal treatment supportive treatment with intravenous fluid is necessary for patients that have anorexia, depression, significant dehydration. Individual patient may be treated aggressively following acid base and electrolyte assessment. Oral fluid and electrolyte may be somewhat helpful and much cheaper than IV fluid for cattle demand to be mildly or moderately dehydrated. The effectiveness of oral fluid may be somewhat compromised by malabsorption and maldigestion in salmonellosis patient but still should be considered useful. Cattle that are willing to drink can have specific electrolyte (NaCl, KCl) added to drinking water to help correcting electrolyte (Kemal, 2014).

The implementation of broad prophylactic strategies that are efficacious for all *Salmonella*e may be required in order to overcome the diversity of *Salmonella* serovars present on farms, and the potential for different serovars to possess different virulence factors Mohler VL. et al. 2009). Ea rly treatment is essential for septicemic salmonellosis but there is controversy regarding the use of antimicrobial agent for intestinal salmonellosis. Oral antibiotic may alter the intestinal micro flora and interfere with competitive antagonism and prolong shading of the organism. There is also a concern that antibiotic resistance strain of *Salmonella* selected by oral antibiotic may subsequently infect human. Antibiotic such as ampicillin or cephalosporin lead to lyses of bacteria with release of endotoxin. NSAID may be used to reduce the effect of endotoxemia (Davison, 2005).

Prevention and Control

Prevention and control in animals

Condition that contribute to an increasing incidence of epidemic salmonellosis include large herd size, more intensive and crowded husbandry and the trend of free-stall barn with loose housing, which contribute to the feacal contamination of the entire premise. When salmonellosis has been confirmed in a herd, the following control measure should be considered; isolate obviously affected animals to one group if possible, treat severely affected animals, affected animals institute measure to minimize public health concern like (no raw milk should be consumed) physically clean the environment and disinfect the premise following resolution of the outbreak or crises period. A mastitis survey should be conducted that include bulk tank surveillance. Prevention is best accompanied by maintaining a cross herd and culturing new feed additives and components before using the entire ration (Rebhun, 1995).

Vaccination of calves at 1-3 weeks of age with a modified aromatic dependant *S. dublin* bacteria have detectable anti-lipoplisaccharide immunoglobins after immunization. Safe live oral vaccine against *S. typhimurium* and *S. dublin* has been constructed and shown to control protection against experimental infection with virulent wide type strain of the organisms. A virulent S. choleraesuis vaccine is efficacies experimentally against salmonellosis due to *S. dublin* in calves to protect young calves. The best program is to vaccinate the cow during pregnancy which will give passive protection to calves for 6 weeks (Radostitis *et al*., 2007).

Generally it is generally agreed that supportive therapy and good nursing are important. These include oral or parentral re-hydration, correction of electrolyte balance and stabilization of acid base equilibrium (Venter *et al*., 1994). Both live and attenuated vaccines produced from rough strain in bacteria commercially. There is some evidence that inactivated bacterins can induce a lower level of protection (Danielle, 2006). The veterinarian research institute produced vaccine against bovine salmonellosis in activated bacteria prepared from isolate of *S. dublin*, S. typhomurium and S. bovismorbificans and a live attenuated vaccine containing a virulent rough mutant of *S. dublin* (Kemal, 2014).

Prevention and control in human

There is no vaccine to prevent salmonellosis in human whereas, vaccine against *Salmonella* typhi has been developed, especially in children, but is only 60% effective. A person given this vaccine would still have a strong chance of developing salmonellosis. It is not expected that there will be a single vaccine that is effective against all the different forms of Salmonella soon. Ongoing research is investigating what can be done to produce a useful human vaccine for *Salmonella* (Danielle, 2006). People should not eat raw or uncooked meat, they should not drink raw milk or unpasteurized dairy product, cross contamination of food should be avoided. Uncooked meat should be kept separate from cooked food ready to eat. Hands, cutting boards or knifes and other utensils should be washed thoroughly after handling uncooked food. Hands should be washed before handling any food and in between handling different food items. People should have to wash their hands after contact with animal's feces (Arun and Bhunia , 2008).

Pasteurization of milk and treating municipals water supply for reducing risk of *Salmonella* infection, improvement in farm animal hygiene in slaughter process in food harvesting and in packaging operation have helped to prevent salmonellosis (Hans *et al*., 2006). A periodic surveillance of the level of *Salmonella* contamination in different food product and environment is necessary to control spread of the pathogen. Reducing Salmonella prevalence requires comprehensive control strategy in animal and animal foodstuff with restriction in the infected flock until they have been cleaned from infection. In addition mandatory testing before slaughter should be conducted like the one implemented in Sweden (Boqvist and Vågsholm, 2005). Ensuring safe food production requires knowledge on the nature and origin of animal, animal feed, the health status of animals at the farm, the use of veterinary medicinal data regarding antimortem and postmortem findings and the risk association with post harvests production strategies (Kemal , 2014).

CONCLUSIONS AND RECOMMENDATIONS

Salmonella is a leading cause of foodborne disease in human and consumption of both meat and milk has been implicated in salmonellosis outbreaks of people. Having animals and raw products it is not possible to be free from zoonotic agent; however the occurrences can be minimized by applying high standard of hygiene in all steps of the food production. Infected animals can present with a great variety of clinical symptoms, and risk factors for transmission to humans clearly differ by animal species, age groups, animal purpose and geographic region. In addition, strains of Salmonella resistant to multiple antibiotics have been isolated from dairy cow during salmonellosis outbreak on dairy operation. The same strains have also been isolated from ill people. A high degree of interaction between medical and veterinarian surveillance is needed. Finally, implementing basic and applied research to the agent that cause foodborne salmonellosis will be a crucial point for new approaches to prevent and control the disease.

Depending on the above facts the following points are recommended:

- ✓ Strict hygiene of the slaughter house and lairage
- ✓ People should not drink unpasteurized milk or milk products and should not eat raw meat
- ✓ Education of food handlers
- ✓ Vaccination of cattle
- ✓ Maintenance of cold chains
- ✓ Sanitary examination of the product
- ✓ Collaboration between government agencies, professional organizations and special interest groups.

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LIST OF ABBREVIATIONS

BGA: brilliant green agar; DT: definitive type; HEA: Hektoen enteric agar; MKTT: Muller Kauffmann tetrathionate; NASBA: nucleic acid sequence-based amplification; Q-PCR: quantitative polymerase chain reaction: RT-PCR: Real-time polymerase chain reaction; RT-PCR: reverse transcriptase polymerase chain reaction; PCR-RV: polymerase chain reaction Rappaport- Vassiliadis; SC: selenite cystine; XLD: xylose lysine deoxy-cholate

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