

## Review on Emerging and Re-Emerging Bacterial Zoonotic Diseases

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**Abstract:** Zoonotic diseases are those diseases that are naturally transmitted between vertebrate animals and man with or without an arthropod intermediates. This manuscript paper is aimed at reviewing emerging and re-emerging bacterial zoonoses, factors of emergence and re-emergence and surveillance and control measures against these diseases. Bacterial diseases are one of zoonotic diseases that may emerge or re-emerge after once thought to be eradicated. Emerging infectious diseases are those for which the incidence in humans has increased in the past two decades or threatens to increase in the near future. Emerging bacterial zoonotic diseases results in social problem with tremendous consequences for the wellbeing of individuals and the world as well. Re-emerging bacterial zoonotic diseases are those diseases which are known and reappear after a decline in incidence. The main factors leading for the emergence and re-emergence of those bacterial zoonotic diseases are an increased risk of exposure to zoonotic agents, the breakdown of the host's defenses, the emergence of bacterial strains resistant to antibiotics and their widespread distribution and also conjunctive causes associated with the action or in action of man. In order to prevent both human and animal deaths and also to avoid potential economic problems resulted by emerging and re-emerging bacterial zoonotic diseases, there should be good surveillance and control methods of these diseases. The surveillance systems used may be of national or regional level while the controlling methods currently used are sanitary prophylaxis and medical prophylaxis. In conclusion, to combat these emerging and re-emerging bacterial zoonotic diseases it is better to know the epidemiology, route of entrance and the factors leading to such diseases.

**Key words:** Control • Emerging • Re-emerging • Surveillance • Zoonoses

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### INTRODUCTION

Zoonotic diseases are those diseases and infections that are naturally transmitted between vertebrate animals and men with or without an arthropod intermediates. These zoonotic diseases represent of the leading causes of illness and death from infectious diseases [1]. The infectious diseases such as bacterial, viral, fungal, protozoal and parasitic are responsible for most losses in the food animals and cause death of human beings through out the world and are, therefore, of great economic importance. These losses encountered the food animals are lowering the productivity of the animal and death of the animal. These losses affect the economy of the human beings. Therefore, today the infectious diseases are not only a health issue; they have become a social problem with tremendous consequences for the well being of the individual and the world we live in [2].

Worldwide, zoonotic diseases have a negative impact on commerce, travel and economies. In most developing countries, zoonotic diseases are among those diseases that contribute significantly to an already overly burdened public health system. But, in industrialized nations, zoonotic diseases are of particular concern for at risk groups such as the elderly, children, child bearing women and immune compromised individuals [1].

Emerging zoonotic infectious diseases are those infections, the incidence of which in humans and animal have either increased during the last two decades or threaten to increase in near future. This term includes newly appearing infectious or those spreading to new geographical areas. It also refers to those diseases which were previously easily controlled by antimicrobials but have new developed resistance to those drugs. Re-emerging infectious diseases are those that have reappeared after a significant decline in their incidence.

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A break down of public health measures for previously controlled infection or the development of antimicrobial resistance in prevalent infections may lead them to re-emerge as public health problems [3].

At times when basic rules of hygiene were not properly applied and vaccines nor antibiotics had been discovered yet, bacterial zoonoses such as bubonic plague, glanders, bovine tuberculosis and brucellosis caused human deaths than then ever will again. However, the incidence and impact of some bacterial zoonoses appear to have been increasing over the last several decades and new bacterial zoonoses could arise. By this context, over the last twenty to thirty years we have been observing the emergence or re-emergence of several bacterial zoonoses. In most cases, these diseases are the one that humans have contracted either when ingesting contaminated foods or by exposing themselves to wild bacterial reservoirs or vectors [4]. Therefore, this manuscript was initiated with reviewing emerging and re-emerging bacterial zoonoses, factors of emergences and re-emergences of these diseases and surveillance and control measures against emerging and re-emerging bacterial zoonotic diseases.

### **Emerging and Re-emerging Bacterial Zoonotic Diseases**

#### **Emerging Bacterial Zoonotic Diseases**

**Campylobacteriosis:** Campylobacter, although long recognized by veterinarians as a cause of animal disease, were not associated with human enteric infection until 1975. Since then the number of isolates in the United Kingdom has steadily increased until they have become the most numerous cause of human bacterial enteric infection [2].

Campylobacter species are significant zoonotic poultry pathogens and are the leading cause of bacterial gastroenteritis in the world and around 2.5 million human infections are reported annually in the United States. The disease is more common in children and there is an emergence of fluoroquinolone resistance. In addition, in developing countries it is reported 5-20% in childhood diarrhea [5]. These campylobacter species are slender, spirally curved, motile, gram negative rods that are associated with infections of the genital tract, resulting in abortion and infection of the gastrointestinal tract (GIT). *Campylobacter jejuni* or *vibrio jejuni* is a normal inhabitant of the intestinal tract of cattle, sheep, goats, dogs, cats, rabbits, many species of birds and probably many other animals. *Campylobacter jejuni* and some other campylobacters have emerged in recent years as an important cause of enteritis and diarrhea in humans,

dogs, cats, cattle, foals, rabbits, ferrets, hamsters, minks and non-human primates, either as primary pathogen or in concert with enteric viruses [6].

The campylobacter contains several species of importance for both public and animal health. In humans, the infection can be a zoonosis, acquired from dogs, cats, sheep, birds and other infected animals. The principal pathogenic species are *campylobacter jejuni* and *campylobacter fetus subspecies fetus* and *campylobacter fetus subspecies laridis* and *campylobacter upsaliensis* cause enteritis in man and other animals. Further more, the disease caused by *campylobacter jejuni* and those caused by *campylobacter fetus* are clinically very important than the others [1]. At present, *campylobacter jejuni* is considered to be one of the principal bacterial agents causing enteritis and diarrhea in man, particularly in developed countries. In these countries, the incidence is similar to that of enteritis caused by salmonella. But, as culture media and isolation methods have been perfected, the number of recorded cases caused by the *campylobacter jejuni* has increased [2].

According to Beneson [7], campylobacteriosis causes 5% - 14% of diarrhea cases world wide. The disease is primarily sporadic, although there are also epidemic outbreaks. The largest known epidemics originated from common sources, such as unpasteurized milk or contaminated water and in countries with a temperate climate, the disease is most prevalent in the warm months. The infection in man may be caused by cross contamination in the kitchen of meats with *campylobacter jejuni* and other foods that do not require cooking, or that are under cooked [8]. According to present knowledge of the epidemiology of the disease preventive measures can be only partial in scope. In a study of risk factors in Colorado (USA), where sporadic cases of infection were caused by *campylobacter jejuni* and it was estimated that approximately one third of the cases could have been prevented by such measures avoiding the consumption of untreated water, unpasteurized milk, or under cooked chicken [9].

**Enterohemorrhagic E.coli Infection:** It was first described in 1982 associated with consumption of under cooked beef. The isolation of Enterohemorrhagic E.coli (EHEC) in beef, cattle stools and in human patients of diarrhea has been reported in India [5].

There are hundreds of serotypes of *E.Coli* which are classified on the bases of various surface antigens referred to as Somatic (O), Capsular (K), Flagellar (H) and fimbrial (F). However, only a few *E. coli* can be

considered true pathogens. Among this pathogenic *E. coli* O<sub>157</sub>: H<sub>7</sub> Enterohemorrhagic *E. coli* are the most zoonotic. These are predominantly associated with enteric diseases and are referred to as enteropathogenic (Enterotoxic) *E. coli*; and they are important causes of diarrhea in humans, swine, cattle, sheep, horses and probably other species [6].

Enterohemorrhagic *E. coli* cause no signs of illness in its natural hosts, such as cattle and sheep, but has low infections dose in humans where it causes haemorrhagic colitis and hemolytic uraemic syndrome. In some areas detection of potentially pathogenic Enterohemorrhagic *E. coli* O<sub>157</sub>: H<sub>7</sub> in river water is alarming and some antibiotic enhance environmental stability of the pathogenic organism [5]. But non O<sub>157</sub> EHEC was reported in 1.4% of stools from cases of bloody diarrhea in Kolkata [10].

*E. coli* infections can become important especially in intensive production systems of the tropics in particular where the hygienic conditions of the premises of the animals are inadequate. Inadequate keeping and feeding are usually the cause for the out break of the disease. Badly ventilated dirty sheds as well as over feeding may stimulate *E. coli* as a normal inhabitant of the intestine to become pathogenic and the *E. coli* infection is often associated with other facultative pathogenic bacteria (clostridia, pasteurilla) or viral infections [11]. Enterohemorrhagic *E. coli* is emerging food borne and water borne zoonotic disease [5].

**Listeriosis:** Listeriosis is an emerging zoonotic disease [5]. It is a sporadic infectious disease affecting a wide range of animals, especially cattle, sheep, goats, sometimes horses and pigs, birds and man. The disease occurs throughout the world, but is more common in temperate climates such as USA, British Isles, Europe, Australia and New Zealand where it has a winter – spring prevalence [2]. Listeriosis is an infectious disease caused by *Listeria monocytogenes* and it is characterized by meningoenzephalitis, abortion, septicemia and sometimes enteritis. The organism is ubiquitous and inherently robust and can thus survive in food-processing and refrigeration of contaminated meat and dairy products [2,5,6].

*Listeria monocytogenes* is very widely distributed in nature. Soils, rotting vegetation, feed stuffs, faeces, surface water, sewage sludge, plants and even insects harbour it and it is a normal commensal in the intestine of mammals and man [2]. It is a common inhabitant of silage, but it does not multiply in good ensilage (PH 4 -4.5) and it may not be killed. But in spoiled silage with incomplete

fermentation and a PH above 5.5 the bacteria survive and multiply [12]. Listerias are also highly resistant to environmental influences and are able to multiply in the environment under appropriate conditions. They can still be found after 790 days in pond water at a temperature of 2-8°C and are able to multiply at a temperature from 18-20°C. In humid solid they can survive for 11 months; and wintery cold preserves the pathogens [11].

The infectivity and pathogenicity of *Listeria monocytogene* is sufficiently low to require a reduction in the hosts resistance before disease is produced. A number of predisposing agents has been proposed as causing lowering of the host animals' resistance and thus initiating the disease. Although gross nutritional deficiency is the commonest precursor of out breaks, heavy silage feeding is also well recognized as a predisposing influence and other circumstances thought to contribute to a high incidence and other circumstances thought to contribute to a high incidence are a sudden changes of weather to very cold and wet and long periods of flooding with resulting poor access to pasture [12].

In man Listeriosis is serious, often fatal and the fact that the organism occurs commonly in the milk of infected animals and may withstand pasteurization and adds a further reason for the prompt recognition and control of the disease [6]. It is estimated that *Listeria monocytogenes* is responsible for 28% deaths due to food borne illness in the United State and the carriage of the Pathogen has been reported in feces and genital tract of 5-10% humans. What ever, there has been a significant decline in the disease in countries where active surveillance and sale of dairy products and meat have been regulated [5]. The portal of infection in natural cases is uncertain but the prevalence of the particular forms of the disease under different environmental conditions suggests that infection may gain entrance by several ports. It seems probable that meningoenzephalitis results from inhalation or conjunctival contamination and the visceral infection with abortion from ingestion of infected material [12].

**Melioidosis:** There is growing evidence that the disease is an emerging global problem and the causative pathogen is an environmental saprophyte in rice, paddles, wet soil, mud and pooled surface water [5].

Melioidosis is primarily a disease of rodents with an occasional case occurring in humans but the disease has been observed in farm animals. The disease is caused by *pseudomonas (Malleomyces) pseudomallei* which occur in strains with varying pathogenicity [2, 6, 12].

The infection is acquired from other infected animals or from contaminated soil and water and it is most prevalent in Laos, Thailand and Ceylon but has also been reported in Malaysia and Australia. The disease also has come to recent attention in United States after importation of infected non-human primates to the area [6]. In tropical and sub-tropical areas melioidosis one of the major water borne infection where the cases are occurred in rodents, humans, animals in zoological gardens, dogs, cats, horses, cattle, pig, sheep and goats. The disease in rodents runs a protracted course, making these animals' important reservoirs of infection for man and possibly other species. The fatal nature of this disease in man makes melioidosis an important zoonosis. Most cases of the disease occur during the wet season and in low-lying swampy areas [2].

Lack of adequate health care facilities in rural population, low index of clinical suspicion and non-availability of diagnostic tests probably contribute to the paucity of reports in many countries of the world [5]. The preventive measures are mainly directed towards the prevention of wounds and their contamination and avoidance of ingestion of contaminated water and dust [2].

### Re-Emerging Bacterial Zoonotic Diseases

**Anthrax:** Anthrax is a per-acute disease characterized by septicemia and sudden death with the exudation of tarry blood from the body orifices of the cadavers and the failure of the blood to clot, absence of rigormortis and the presence of splenomegaly are the most important necropsy findings [12, 13].

*Bacillus Anthracis* is the specific cause of the disease [2, 5, 12-14]. When materials containing anthrax bacilli are exposed to the air, spores are formed which protract the infectivity of the environment for very long periods. It has remained viable in soil stored for 60 years and field observations indicate a similar duration of viability in exposed soil, particularly in the presence of organic matter, in an undrained alkaline soil and in a warm climate. However, acid soils reduce the survival of *Bacillus anthracis*. Therefore, out breaks originating from a soil-borne infection always in warm weather when the environmental temperature is over 15°C (60°F) and the occurrence of out breaks at isolated points when environmental conditions are warm and humid has made it possible to predict anthrax for a years and has led to the suggestion that vegetative proliferation may occur in the soil [14].

Serious out breaks of anthrax and persistence of the infection in the soil are most commonly encountered in

tropical and subtropical countries. But, in temperate cool climates sporadic out breaks due to accidental ingestion of contaminated bone meal of tannery effluents areas do exist. The tendency, in infected districts for the heaviest incidence to occur in the late summer at that time but an effect of higher temperature on vegetative proliferation of *Bacillus anthracis* in the soil is more likely [12].

Anthrax is principally a disease of herbivorous animals, but it may affect a wide variety of species, including humans. Humans usually acquire anthrax from contact with infected animals or animal products (hide, wool, shaving brushes made from infected hog bristles) and the infection can follow ingestion or inhalation of spores or vegetative forms of the organism or entry of the organism through broken skin [1, 6]. The infection in humans is correlated with the incidence of the disease in domestic animals. According to data from the recent years, epidemic outbreaks continue to occur despite the availability of excellent preventive measures for animal anthrax and therefore, for the occurrence of the disease in humans. This disease in human shows three clinical forms such as cutaneous, pulmonary or respiratory and gastrointestinal form [1].

The organism can grow and sporulate in alkaline soils and organic materials; highly resistant spores released from infected animals can cause contamination of the location in which infection has occurred, rendering it potentially hazardous for many years [6].

The control of anthrax disease requires coordination between public health, agriculture and animal husbandry department and the industry. The control measures are immunization of high risk individuals, disposal of animal carcasses and subsequent disinfection and mandatory reporting of all human cases and unexplained sudden animal deaths [5].

**Brucellosis:** Brucellosis is a widespread and of major economic importance in most countries of the world, particularly among the dairy cattle [12]. Brucellosis is a febrile disease of humans already described by Hippocrates 450 A.D. is one of the most important zoonoses in the tropics. Not only does brucellosis present a serious hazard to human health but it is also a disease in domestic animals with important economic consequences [11].

The discovery and identification of the bacteria now grouped in the genus *Brucella* were important steps in the development of knowledge concerning the complex disease of humans and animals now known as brucellosis. *Brucella melitensis*, the first genus to be recognized, was isolated in 1887 from the spleen of patient dead of

“Mediterranean fever” or “gastric fever” latter called “Malta fever” by David Bruce, whose name identifies the organism and the disease. In 1897, the isolation and identification of *Brucella abortus* from aborted bovine fetuses and fetal membrane by the Danish Veterinarian, Frederic Bang. The infection of cattle caused by that organism has since been known as “Bang’s disease” or “Bang’s abortion disease.” Eventually it was proven that the causative organism was ubiquitous and natural infections occur not only in cattle, but also in humans, horses, fowls, sheep, dogs, deer and bison. Traum in 1914 identifies the organism *Brucella suis* from aborted swine fetuses which can also affects humans and has been isolated from naturally infected horses, cattle, fowl and dogs. *Brucella ovis* and *Brucella canis* were also recently identified in 1950s and 1960s respectively [1].

The important disease of animals caused by *Brucella* species are those caused by *Brucella abortus*, *Brucella suis* and *Brucella melitensis*, their host preference in order being cattle, swine and goats [12]. But at present, six species of pathogens are classified as; *Brucella abortus* which causes bovine brucellosis and Bang’s disease in humans, *Brucella melitensis* which is the causal organism of brucellosis in small ruminants and undulating or Malta fever in humans, *Brucella ovis* which causes brucellosis in sheep, *Brucella suis* which is the causal organism of brucellosis in pigs which also can be transmitted to humans, *Brucella neotomae* which in desert rats in USA, and *Brucella canis* which causes brucellosis in dogs and also can be transmitted to humans [11].

Brucellosis affects primarily the livestock and transmitted to humans by ingestion, close contact, inhalation or accidental inoculations. The prevalence of Brucellosis in different geographical areas varies with standards of personal and environmental hygiene, animal husbandry practices, species of the causative agent and local methods of food processing [5].

The organism can survive on grass for variable periods depending on the environmental conditions. The program of control and eradication of bovine brucellosis markedly reduce the incidence of the disease in humans. However, the importance of the disease in humans is an important justification for its eradication [12]. Moreover, when the incidence of brucellosis controlled in the animal reservoirs, there is corresponding and significant decline in the incidence in humans [15].

The geographical distribution of brucellosis is constantly changed with new foci of re-emerging. The epidemiology of human brucellosis has drastically changed over the past few years because of various

sanitary, socio economic and political reasons, together with increased international travel [16]. Besides the public health concern of such an important Zoonosis, *Brucella* infections in animals have an important economic impact especially in developing countries as they cause abortion in the pregnant animals, reduce milk production and cause infertility [15].

**Leptospirosis:** Leptospirosis is a re-emerging as an important public health problem; there is a sudden upsurge in the number of reported cases in past few years. Leptospirosis is caused by the Genus *Leptospira* which is aerobic and is thought to be the most widespread zoonosis in the world. It is a direct occupational anthroozoonosis with significant economic importance due to its wide range of host susceptibility and worldwide distribution [17].

The genus *Leptospira* is currently composed of two species; *Leptospira biflexa* which as non pathogenic and the pathogenic species it self is subdivided into over 200 serovars serotypes [2]. The serotypes or serovars which are pathogenic are not limited to a single host species. The various serovars cause leptospirosis, a disease of humans and animals with varying clinical and pathological manifestations. *Leptospira* can be remain viable in moist areas for extended periods [6].

The disease caused by *Leptospira interrogans* is naturally seen in rodents. Man and cattle are incidental hosts [5]. According to Roth [18] wild rodents carrying *Leptospira* can serve as a reservoir of infection for many species of animals and humans.

Leptospirosis is primarily a monsoon disease which affects the domestic and wild animals as well as man. Rats are the most common source of infection for humans and get as reservoir host. Rural farm workers are at high risk; man gets infection accidentally through direct or indirect contact with the infected animal and considered to be a “dead end host.” Several epidemics of Leptospirosis have been reported world wide during the past century [17].

One of the most important features of Leptospirosis is its transmissibility and veterinarians [12]. Humans get infected by contact with water or soil contaminated with rat urine and the farm workers, the sewer workers, fisher men and minders are at high risk of infection wounds or abrasions in the skin or through mucous membrane (usually conjunctiva, naves and vaginal) and the disease in man is called well’s disease [2]. Leptospirosis has been recorded through out the major continents of the world. Alkaline PH of the environment provides favourable conditions for the survival and multiplication of Leptospirosis [17].

**Tuberculosis:** Tuberculosis (TB) is one of the oldest diseases known to man kind and it is also a leading cause of death among adults and kills almost 500 children each day world wide. More than 90% of TB related death occur in developing countries and TB was declared as a global emergency by the World Health Organization in 1993, with around 8-10 million new cases of the disease each year and over 2-3 million deaths worldwide [19].

In nature several strains of mycobacterium which is the causative agent of TB are found that could be distinguished culturally and by their pathogenicity to animals. These strains are: - the human strain *Mycobacterium tuberculosis* which is infective to humans and animals, the bovine strain *Mycobacterium bovis* is infective to cattle, humans and other animals, *Mycobacterium avium* strain which is infective to fowls and other animals, the cold blooded strain which is infective to cold blooded animals; and the vole bacillus *Mycobacterium microti* which is infective to voles only [20]. Nearly on third of the world's population are latently infected with *Mycobacterium tuberculosis*, which produces the disease in immuno compromised individuals, such as HIV infection, Consequently, large regions of Sub-Saharan Africa, Asia and Eastern Europe, where HIV is prevalent and general populations have low immunity due to social deprivation and poverty, are particularly vulnerable and have seen considerable rise in cases of TB during the past decades. TB cases have also been increasing in the USA and Western Europe since the 1990s. This trend is likely fuelled by record, increasing migration of populations from Eastern European countries to Western Europe [21].

Tuberculosis occurs in every country of the world and is of a major importance in dairy cattle. The disease can occur in all species including man and is of importance for public health reasons as well as for its detrimental effects on animal production. The causative organism does not form spores but it is moderately resistant to heat, desiccation and many disinfectants. In warm, moist, protected positions, it may remain viable for very long periods [12].

In 1980, the discovery of tuberculin by Koch, its use for the diagnosis of bovine tuberculosis in cattle by Guttman and the generalization of the method led by Bang, Nocard or John were the basis for the eradication of the disease in Europe within a half a century [4]. The method used to eradicate bovine tuberculosis from large area, will depend on the incidence of the disease, methods of husbandry, attitude of the

farming community and the economic capacity of the country to stand losses from a test and slaughter program [12].

**Salmonellosis:** Salmonellosis occurs universally and in all species. Its occurrence seems to have increased greatly over the past 30 years. As an example, in the United Kingdom there has been a nine fold increase in notification or emergence of *Salmonella Dublin* and *Salmonella typhimurium* infections during the period 1959-1971 [12].

Salmonellosis is a disease of all animal species caused by a number of different species of salmonellae and manifested clinically by one of the three syndromes such as per-acute septicemia, acute enteritis or chronic enteritis [12]. The term salmonellosis indicates infection of poultry due to various members of the genus *Salmonella*, other than infections caused by *Salmonella pullorum* and *Salmonella gallinarum* [20]. In humans, typhoid fever is the classical form of salmonellosis and remains today a major world health problem and in animals, the infections are referred to as paratyphoid. Certain salmonella species are host specific, where as other may infect a wide variety of animal species. Although, it is host-specific, *Salmonella typhimurium* produces gastro enteritis, occasionally leading to septicemia, in cattle, horses, rodents, swine, humans and other species of animals [6].

As a zoonosis the disease has assumed increasing importance in recent years because of the much more frequent occurrence of human Salmonellosis, with animal salmonellosis as the principal reservoirs. Although transmission to man does occur via contaminated drinking water, milk and meat ingestion, particularly sausage, the important path way today has become that through pigs and poultry [12].

**Plague:** Plague is an ancient disease which caused three pandemics since the 6<sup>th</sup> century but the global transmission has been low in recent years. It is a bacterial zoonosis with rodents being the principal reservoir. The changes in rodent ecology have been identified as the risk factor for the re-emergence of plague [5]. *Yersinia pestis* is the cause of plague in humans. The disease is principally an infection of rats, ground squirrels and other rodents. It is transmitted between rodents and to humans by the rat flea (*Xenopsylla cheopis*). The bacteria infect the flea, causing esophageal obstruction and regurgitation of the deadly bacteria when they take their

blood meal [6]. In human patients and susceptible domestic animal species (mainly cats), plague manifest a local lymphadenitis (bubonic plague); pneumonia (pneumonic plague) or septicemia (septicemic plague) [22].

Human to human transmission occurs by inhaling droplet nuclei from patient with pulmonary infection (pneumonic plague) which is highly contagious. Massive human epidemics have occurred sporadically or in a limited out breaks. Example in USA, >90% of human plague occurs in the South West, especially New Mexico, Arizona, California and Colorado [23].

The control measures against plague require early clinical suspicion, prompt laboratory diagnosis, strict isolation of patients of pneumonic plague, appropriate antibiotic therapy and case contact management. A vaccine is available for person who has repeated contact with the pathogen. But, the best plague prevention strategy is an aggressive rodent population control [5].

**Tularemia:** Tularemia is a highly contagious zoonotic disease. It is caused by *Francisella tularensis*. The disease appears to be confined in the northern hemisphere, having been recorded in Czechoslovakia, France, Norway, Sweden, British Isles, USA, Canada, China and Japan [2] and its southern limits being in Mexico and Mediterranean Africa [22].

The history of tularemia begins in 1910, with the isolation of bacterial organism from lesions of “a plague like disease” of ground squirrels by Mc Coy. He named the organism *Bacterium tularensis* after Tulare country, California, in which the first infected ground squirrels had been found. The organism was subsequently designated *pasteurella tularensis* and more recently as *Francisella tularensis* [6].

There are two biovars of *Francisella tularensis* with different virulence. The biovar *tularensis* which is found in North America is virulent while the biovar *palaeoarctica* which is found in Europe, Asia and the America is less virulent and is maintained in wild rodents [22].

Tularemia is most important as a disease of humans and wild rabbits and rodents; however, it may occur in dogs, sheep, horses, non human primates. Accidental infection of laboratory workers with this organism was soon to follow and eventually the natural occurrence of the human disease was established. The disease in human is described as “Ulceroglandular” when the site of entry and initial lesion is cutaneous; “Oculo glandular” when the site of entry is via conjunctiva; or “glandular” when the site of entry is not explicit [6].

**Factors of Emergence and Re-emergence of Bacterial Zoonotic Diseases:** There are many conditions that favour the emergence or re-emergence and spread of bacterial zoonoses, even if the severity of such infections seems to be less serious than for many emerging viral zoonoses [4]. An increased in the prevalence and the incidence of some bacterial zoonoses and the specific cause of such an increase which are reported by many national sanitary statistics have been discussed by several authors in the present issue [24]. However, it is useful to list these specific factors for a better surveillance and control of the disease as follows:

**An Increased Risk of Exposition of Zoonotic Agents:** The number of human food-borne infection due to the ingestion of pathogenic bacteria such as campylobacter, *Enterohemorrhagic E. coli* including *E. coli O<sub>157</sub>*; *H<sub>7</sub>* and salmonellosis has considerably increased with the development of fast food restaurant. These diseases are emerging or re-emerging as a result of animal and human diet changes. And also food borne infectious caused by zoonotic agents have become more frequent throughout the last decades. *Listeria monocytogenes* carried by the cattle is caused due to the ingestion of contaminated silage [4].

The other factor that increase the risk of exposition to zoonotic agents is increased densities of production of animal or wild life populations, which is associated with current breeding methods for domestic animals. In this case increased population density and poverty and overcrowding are one of the factors that influence the emergence or re-emergence of infectious diseases [3]. Naturally this favors the development of some pathogens such as *Mycobacterium bovis*, *Brucella* species or *Francisella tularensis* [25]. The increment of the number of pets in developed countries and the increased interest for exotic pet animals has led to the emergence and re-emergence of new viral and bacterial infections [4].

The displacement of human or animal is also one of the factors that increase risk of exposition to zoonotic agents. This increase the contact between human and livestock population in Africa which led to the major health problems [4]. The development of various outdoor leisure activities, such as hunting, fishing or tourism, especially ecotourism may expose humans to bacteria excreted by wild life reservoirs, such as *Francisella tularensis*, *Leptospira* species. As an example, a high seroprevalence was detected for several zoonotic agents among hunters in Australia when compared to non-hunter controls [24].

Accelerated degradation of the natural environment, notably in developed countries by deforestation, building of dams, land consolidation may cause wild life species to move to new areas, favoring their relocation in sub-urban zones, therefore entering into contact with humans [26]. All species translocation sometimes between continents is accompanied by the stirring of infectious agents, which may lead to unexpected exchanges of genetic material. Following such stirring, in the 1980's, a commercial *E. coli* of the human intestine acquired an aggravated pathogenic power by becoming verocytotoxic (*E. coli* O<sub>157</sub>: H<sub>7</sub>), while exchanging genetic material with a bacteria from the shigella genus [4]. In other way rapid means of transportation to and from any part of the world, resulting in geographical distribution of the pathogen give rise the emergence of infectious diseases [4].

Human activities such as global warming are also a cause of the emergence of viral and bacterial vector borne disease. Example, outbreaks of plague have been associated with increased rainfall in both Africa and North America [4]. Industrialization and other developmental activities causing global warming are the factor for the emergence or re-emergence of bacterial and other infectious disease [3].

**Breakdown of the Host's Defenses:** An immune depression following either medication or infection caused by pathogenic agents capable of weakening the host's immune defenses allowing infection by opportunistic organism can resulted from the breakdown of the host's defenses. One of the best known examples is that of the acquired immuno deficiency syndrome (AIDS) during which certain bacteria, for which humans are usually healthy carriers multiply to a level such that they lead to the death of their host. The re-emergence of *Mycobacterium bovis* and *Leptospira monocytogenes* are formed due to this factor [4].

Weak public health system and individual host determinants such as a specific risk behaviors which includes, risk factors leading to sexually transmitted diseases, risk factors pertaining to food preparation and a storage in the home leads the infectious diseases to emerge or re-emerge [3].

**Emergence of Bacterial Strains Resistant to Antibiotics and Their Widespread Distribution:** New pathogens may emerge as a result of mutation, recombination and reassortment leading to enhanced virulence and also other pathogens develop antimicrobial resistance [3].

The existence of these multi drug resistance strains caused, following an excessive usage or misuse in both human and veterinary medicines considerably hinder the certain infections. They are usually the results of an increase in the number of these infections, which offer, many occasions for the appearance of resistant mutants amongst zoonotic bacteria. This is one of the reasons for the emergence or re-emergence of food borne disease such as *Salmonella enteritidis* and *Salmonella typhimurium*, patients with multi drug resistant *Salmonella typhimurium* infection were significantly more likely to have received an antimicrobial agent [4].

**Conjunctural Causes Associated with the Action or in Action of Man:** The contribution of human in the emergence and re-emergence of certain zoonotic diseases are nowadays increasing and these zoonotic agents may be considered for deliberate release to cause harm, since they can simultaneously and adversely affect human and animal health [27].

The development of industrial in the food production system for animals and humans followed by its world wide distribution can be also increase the risk of contamination [3, 4].

The emergence of bacterial zones, in some countries of the world may be due to lack of surveillance or lack of appropriate control measures associated with the breakdown of public services. This resulted from a lack of financial and human resources that may be the effect of economic crisis, social uprising, wars or natural disasters [4]. Wild life species exposed to the causal agents of the disease due to the environmental pollution can disseminate the pathogenic organisms to the environment [26].

The presence or absence of harmonization and coordination of control systems, when two neighboring countries practice different methods of prophylaxis, can be a factor of re-emergence. Thus in a country where there is good eradication and disease control programme is available, a zoonoses disease may reappear if the neighboring country practice only a limited sanitary prophylaxis or no prevention at all. The other factor in the emergence or re-emergence of bacterial zoonoses is the impoverishment of some human populations amongst which all zoonoses can find suitable hosts due to poor hygiene [4]. In other cases the risks are associated with the financial problems of upper social classes, which make hobbies easier, to practice, such as tourism, hunting,

or fishing. The integration and globalization of food treatment chains, which multiply the risk of contaminations is another factor for the emergence or re-emergence of food borne infections [26].

### **Surveillance and Control Methods of Emerging and Re-Emerging Bacterial Zoonoses**

**Surveillance Methods:** Until 1995, WHO coped with public health problems posed by emerging and re-emerging disease through each disease-specific program. This was done by working with governments to prepare disease control plans, implement emergency preparedness activities and mobilize and coordinate international collaborations. The resolutions requested by WHO are to improve disease surveillance of emerging and re-emerging infectious diseases through the strengthening of laboratory diagnosis; to accelerate information exchange on infection zoonotic diseases among the member states; to prepare for outbreaks of communicable diseases at global, regional and national levels; and to respond to outbreaks by coordinating urgent disease control activities [1].

The two surveillance systems applied today on the world are the National or regional surveillance system and the international or the world systems. The organization of regional or national surveillance systems for bacterial zoonoses is based on the analysis and synthesis of information usually collected by official public health or animal health systems. In this case data may be provided to health authorities through partnership and networks organized with the help of medical practitioners, veterinarians, animal health and wild life specialists or livestock breeders grouped together for the sanitary defense of their livestock as developed in many countries by commodities, such as cattle farmer associating egg production association. Such networks usually receive some financial aid from their government for setting prevention measures. The value of world wide or international net work for zoonoses surveillance can only be the result of that of national networks, since any interference into the zoo-sanitary information of a country is currently impossible without the agreement of this country [4].

The establishment of such world wide networks has still to overcome several obstacles. However, such systems are important to be set in a more and more interdependent economy and are usually a booster for improving national systems. The example of surveillance system at global level are WHO, Global Outbreak Alert and Response Net Work (GPHIN) [4].

**Control Methods:** The control of infectious zoonotic disease is dependent on knowledge of the etiology and epidemiology, routes entrance, mode of transmission of the diseases [4]. The control measures for zoonotic disease requires the proper surveillance of the disease, control of the disease in animals, control of vectors or vehicles, preventing the disease in humans and selecting the controlling programmes [2].

Generally the current methods used to control bacterial zoonoses are mainly aimed it reducing the burden of the zoonotic agent in its animal reservoirs, or eradicating it using the classical methods of sanitary or medical prophylaxis. The sanitary prophylaxis of zoonoses, which consists in slaughtering and destroying all infected or contaminated animals, has largely been proven useful for the control of bovine tuberculosis. Due to this in many countries, humans are safely protected from any risk of contamination by *Mycobacterium bovis*. However, this method reaches its own limits when wild animal reservoirs are concerned or when the disease is spread all over the world. In the case of medical prophylaxis of zoonotic disease parenteral vaccination of animals or on chemoprophylaxis destroying the vectors of the disease. However, medical prophylaxis is usually more expensive than sanitary prophylaxis on the long run and also prevents to achieve the eradication of the pathogenic organisms from its animal reservoirs, since some vaccinated individuals can remain healthy carriers [4].

### **CONCLUSION AND RECOMMENDATIONS**

Nowadays emerging and re-emerging bacterial zoonotic diseases are one of the global problems, those are causing many economic loss and death of human beings. The ecological changes caused due to destruction of the natural environment increase the exposure of animals and humans to the vectors and reservoirs of unknown pathogenic micro-organisms. In addition to this, weak public health system, other natural disasters, absence of better surveillance and controlling systems against the disease and unhygienic living conditions are the main factors for the emergence and re-emergence of the bacterial zoonotic diseases in many countries of the world. There is also a spread of antimicrobial resistance emerging and re-emerging disease that becomes the global public health issue. However, the effects of these diseases are predominantly endangering the developing countries where there is lack of fund (financial problem), lack of many trained man power, lack of awareness about

the disease by the people, lack of record keeping about the past diseases to implement the controlling and eradication methods of the diseases. Therefore, based on these facts, the following recommendations are forwarded:-

- Increasing the awareness of the society on the disease epidemiology (ecology).
- Keeping the natural environment from disasters (avoiding the global warm).
- Increasing record keeping and active disease surveillance programmes.
- Providing proper laboratory facilities and trained personnel to collect samples.
- Controlling the vector and reservoirs by using chemical prophylaxis or biological methods.
- Improving the living standards of the society and keeping the environmental hygiene.

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Emerging and reemerging zoonotic diseases, foodborne and waterborne diseases and diseases caused by multiresistant organisms constitute the major threats in India. This review of bacterial emerging and re-emerging diseases should be of critical importance to microbiologists, clinicians, public health personnel and policy makers in India. PMID: 19208980.