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Dr. Sonika Kapoor
Assistant Professor, Department of Zoology, Goswami Ganesh Dutta Sanatan Dharma College, Chandigarh, Punjab, India

Corresponding Author:
Dr. Sonika Kapoor
Assistant Professor, Department of Zoology, Goswami Ganesh Dutta Sanatan Dharma College, Chandigarh, Punjab, India

Impact of bacterial zoonotic diseases in India

Dr. Sonika Kapoor

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Abstract
Zoonoses is the term commonly used for zoonotic infections which are naturally passed by vertebrate animals to humans or from humans to animals. There are more than 250 types of Zoonotics contributing to the major portion of new and existing diseases in humans. These have been described by World Health Organisation as a major obstruction in the development of nation and poverty. For ages, humans are in immediacy to animals for various personal and professional reasons and hence vulnerable to Zoonotic diseases. India comprising many geographical hotspots and weather conditions varying from mild to extreme is having Zoonotic diseases as a major cause of morbidities and mortalities. Thus surveillance, public awareness and caution, is of utmost importance to put a curb on its expanding effect for mortality. Thus in order to emphasise the need of extensive work on bacterial zoonotic diseases the present review is conducted.

Keywords: Zoonoses, zoonosis, bacterial zoonotic disorders, symptoms, annual mortality

Introduction
Zoonotic diseases are the infectious naturally passed on by a variety of agents comprising bacteria, parasites, fungi, and viruses from vertebrate fauna to humans and vice versa. WHO has described zoonoses as a major obstacle in nation's development and poverty (WHO 2009). As per European Food Safety Authority report (EFSA 2013) [24] among the majority of human infections occurring, origin of almost 50% are zoonotic ones. The findings of Gebreyes *et al.* (2014) [10] revealed zoonotics responsible for a large toll on human mortality worldwide. Among the category of zoonotic diseases, the food-borne zoonotics share a large portion of mortality and morbidity worldwide. These cause a significant disablement to socioeconomic well-being as well. These disorders impose a huge burden on the world economy and still the full extent remains unknown and unexplored. As per the records of the National Centre for Disease Control (NCDC 2016-17) Zoonotic disorders contain nearly 75% of emerging and re-emerging infections. Every year millions of people get sick because of zoonoses from the pathogens of different species such as Vibrio, Cyclospora, E. coli, Salmonella, Shigella, Listeria, Crytosporidium and Campylobacteriosis. Covid-19 is one of the major outbreak of Zoonotic disease having global pandemic confirming nearly 7 million global deaths (WHO 2022) [25]. While emphasizing the zoonotic impact on the human population, Keesing *et al.* (2010) [14] suggested the escalating trend in zoonotic diseases, prospectively due to an amalgamation of demographic changes, land-use improvement, and professional exchange of food products. As per them, the different types of agricultural practices, invasion into the animal habitat, and lack of awareness could be the potential facet for an increased incidence of diseases.

Types of Zoonotic Diseases
The zoonotic diseases as per etiological agents are classified as bacterial, viral, helminthic, protozoal, fungal, ectoparasitic and rickettsial (Figure 1). Depending upon the agent and mode of dispersal there are multiple morbidities and diseases.
A range of disease-causing microbes or zoonotic pathogens can infect foods causing food-borne illnesses. The tainting of food may take place at any step in the from food making to its usage. The food-borne diseases including toxicities and food-borne infections are attained because of the intake of tainted food and are usually referred to as food poisoning. Other bacterial zoonotics comprise Anthrax, Brucellosis, infections by very toxigenic Leptospirosis, Tularaemia, Plague, Q fever, and Shigellosis. Jones *et al.* (2008) [13] in their findings revealed a significant elevation in the frequency of zoonotic disease manifestations since 1940s along with a comparable increasing incidence of emerging infectious disease because of food toxicity.

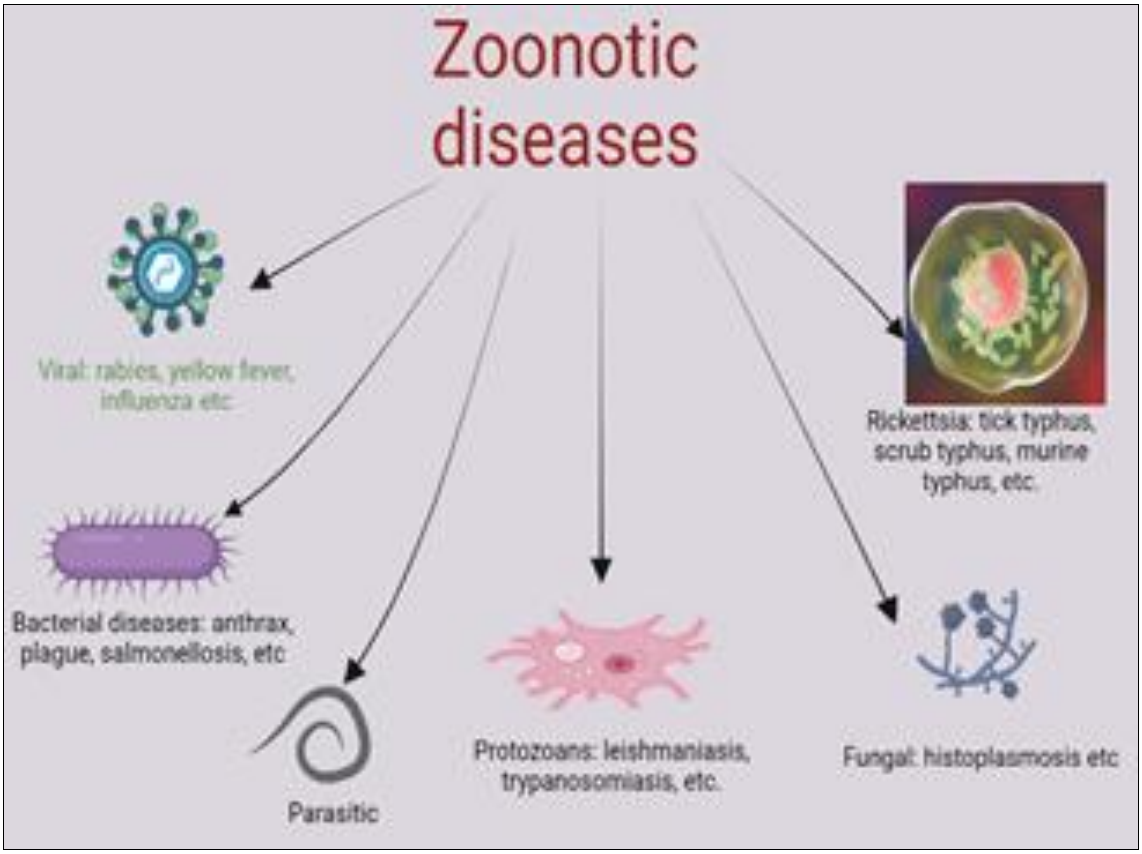

Fig 1: The various Types of Zoonotic Diseases

Classification on basis of host and spread

As the dispersal of zoonoses is from vertebrates to humans, it requires various means to cause infection. These are transmitted by both direct and indirect methods i.e. via arthropod vectors, pathogenic aerosols, ingestion of unclean water and food, and polluted fertilizer from animals and compost. As per the host and conditions requires the zoonoses are broadly divided into following four classes or categories.

1. **Direct Zoonoses:** In direct zoonoses transmission of the pathogens are directly to humans from animals through direct contact of the contaminated media like saliva, faeces, body discharge of infected animal or by infected air or water. The source can be aerosol containing droplets of infected animal, eating food contaminated with pathogen, by bite of insect carrying pathogen from infected animal, or it can be transferred through fomites of infected animal to a person (figure 2). Example are represented by plague, salmonellosis, lyme disease etc.
2. **Cyclozoonoses:** I t includes more than one vertebrate host which is requires by pathogen in order to complete its life cycle, but there is usually no involvement of any invertebrate host. It may be obligatory or non- obligatory depending upon the involvement of human beings. In obligatory cyclozoonoses human involvement is essential for completion of life cycle of pathogen. the most of helminth infection like infections of cestodes is example of obligatory cyclozoonoses. In case of non- obligatory cyclozoonoses man's involvement is either accidental but not essential. Example is infestation of *Echinococcus* in human host.
3. **Metazoonoses:** It is also known as Pherozoonoses and require both vertebrate and invertebrate hosts for the completion of their life cycle. The mode of infection mainly consist of viral infections and rickettsial ones. During metazoonoses in the invertebrate host the infectious pathogen only multiplies or is only source for propagative transmission. Incubation period exist in invertebrate host before it is transmitted to vertebrate host. The arboviral infections, plague and leishmaniasis disease are some common examples.
4. **Sporozoonoses:** These zoonotic disease need both a vertebrate host and non animal reservoir like soil, food or animal for their infective development, the most common example is Listeriosis. The abiotic environment is necessary for propagation and occupation often plays an important role in sporozoonoses.

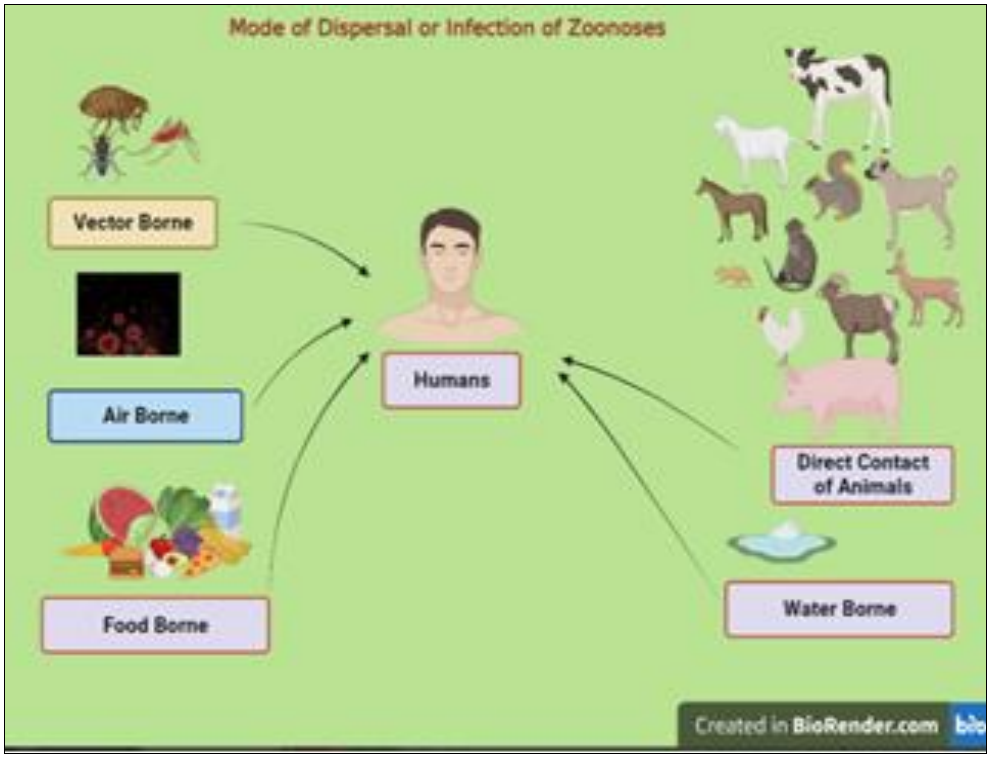

Fig 2: The various modes of direct spread of zoonotic diseases to humans

Symptoms

The infection communicated by zoonotic disease to the host usually appear in the form of gastrointestinal symptoms; however, such diseases can also have symptoms related to disorders of the nervous system, gynecological issues, immune breakdown, and other functional malfunctions (figure 3). Their multi symptomatic expression is the reason why most of the times these get misinterpretations also. Most common site of infection is gastro intestinal system so zoonotics can cause multi-organ failure and even various types of cancer such as those of the alimentary tract. The ingestion of infected products with zoonotics thus reveal a considerable load of disability as well as fatality.

Among sources for food-borne zoonotics, Singh *et al*. (2014) [22] described several ailments are because of bacteria, viruses, rickettsia, and parasitic origins which might be communicated from animal protein to humans like Campylobacteriosis, Salmonellosis, Staphylococcosis, Tuberculosis, Listeriosis, Bird flu and *E. coli* etc. Certain parasites such as Giardia, Trichinella and Toxoplasma are communicated among animals and humans through the intake of tainted food or drinking water. In India major zoonotic diseases are rabies, Japenese encephalitis, plague etc, but in present review only bacterial zoonotics are included.

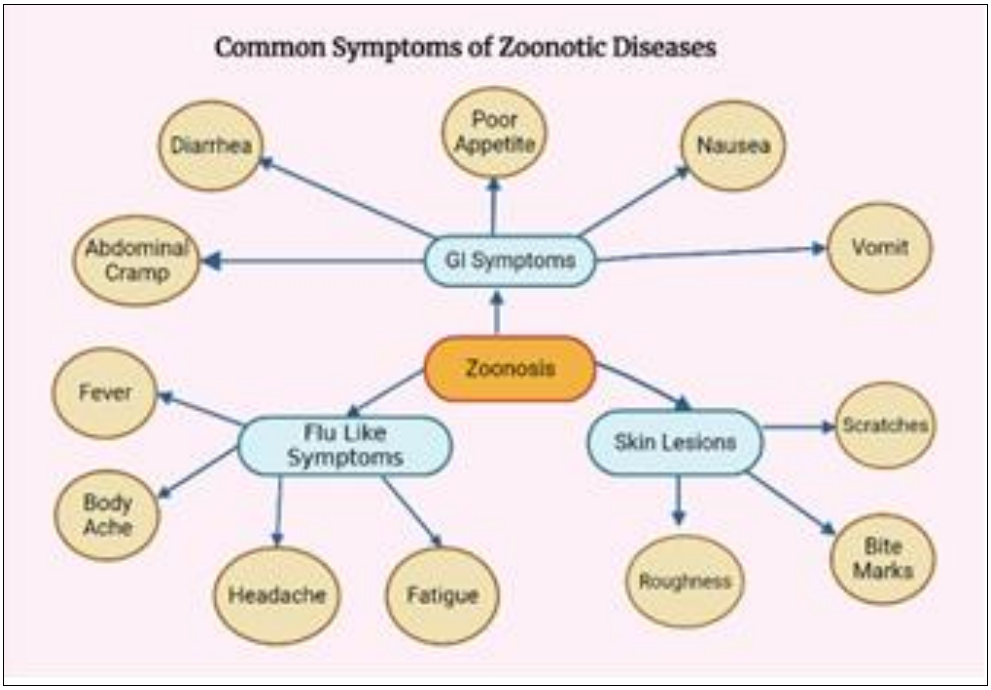

Fig 3: The various symptoms commonly associated with Zoonotic diseases

Bacterial Zoonotic Diseases

Both Gram positive as well as Gram negative bacteria are responsible for zoonoses. On the basis studies conducted by Mc Daniel *et al* (2014) [16] among the bovine zoonotic diseases 42% accounts for bacterial infections. The bacterial zoonotic diseases are mainly spread by Cattle, horses, sheep, deer, goat, monkeys and other mammals which act as the reservoirs. The bacterial zoonoses are majorly spread by contaminated food or oral route. Some of the major bacterial zoonotic diseases, their host and organ involve and incubation period are enlisted below in Table 1

Table 1: Major Bacterial zoonotic disorders, their major causative specie, host and major organs involved in humans

Sr. No	Disease	Strain	Causative Agent	Host	Organ involved /Symptom	Incubation period
1	Actinomycosis	Gram +	*Actinomyces bovis*	Cattle, sheep, horse	Lymph nodes	7 – 10 Days
2	Anthrax	Gram +	*Bacillus anthracis*	Cattle, sheep, horse	Respiratory system	1-7 days
3	Infections of *Arcobacter*	Gram -	*Arcobacter butzleri*, *A. cryaerophilus*, *A. skirrowii*	Cattle, sheep and chicken	GI	3-9 week
4	Bordetellosis	Gram -	*Bordetella bronchiseptica*	Cats and dogs	Respiratory system	10 -90 days
5	Brucellosis	Gram -	*Brucella abortus*, *B. melitensis*, *B. suis*, *B. canis*,	Cattle, goat and sheep	GI	5 days- 6 month
6	Bubonic plague	Gram -	*Yersinia pestis*	Rat, squirrel	GI	2-8 days
7	Campylobacter enteritis	Gram -	*Campylobacter jejuni*, *C. coli*	Cattle, sheep, chicken and turkey	GI	1-10 days
8	Infection of *Campylobacter fetus*	Gram -	*Campylobacter fetus* subsp. *fetus*, *C.fetus* subsp. *testudinum*	Cattle, goat and sheep	GI	2-5 days
9	*Clostridioides difficile* infection	Gram +	*Clostridioides difficile*	Cattle, horse and birds	Skin	48 hr – 3 month
10	*Corynebacterium ulcerans* and *C. pseudotuberculosis* infections	Gram +	*Corynobacterium ulcerans*, *C. pseudotuberculosis*	Cattle, dog and cat	Respiratory system, GI	1- 10 days
11	Ehrlichiosis	Gram -	*Anaplasma phagocytophilum*, *E. ewingii*, *E. chaffeensis*, *Neorickettsia sennetsu* *Ehrlichia canis*	Cattle, deer and dog	GI and Skin	1- 3 weeks
12	Enterohemorrhagic *Escherichia coli* infections	Gram -	*E coli*	Cattle, sheep and Pig	GI and Immunological	3 – 8 days
13	Glanders	Gram -	*Burkholderia mallei*	Horse, donkeys	Immunological	6 days – 6 weeks
14	*Helicobacter* infection	Gram -	*Helicobacter pullorum*, *H. suis*	Poultry and pigs	Stomach	2 -3 days
15	Leprosy *or Hansen's Disease*	Gram +	*Mycobacterium leprae*	Monkey, rat, cat	Skin	3 – 5 years
16	Leptospirosis	Gram -	*Leptospira interrogans*	Wild and domestic animals	GI and Immunological	2 – 30 days
17	Lyme disease	Gram -	*Borrelia burgdorferi*	Cat, dog and horses	Immunological and skin	3 – 30 days
18	Pasteurellosis	Gram -	*Pasteurella multocida*	Poultry	GI and skin gangrene	12 – 24 hrs
19	Salmonellosis	Gram -	*Salmonella enterica*, *Salmonella bongor*	Dog,Birds	GI	12-72 hrs
20	Tuberculosis	Gram +	*Mycobacterium bovis*, *M. Caprae*, *M. microti*	Cattle, sheep etc	Respiratory organs	3 – 9 weeks
21	Tularemia	Gram -		Rabbit, squirrel	Immunological	3 – 15 days
22	Vibriosis	Gram -	*Vibrio parahaemolyticus*	Poultry	GI	4 – 96 hrs

*GI = gastro intestinal disorder

The incidence of bacterial zoonotic diseases takes share of nearly 60% mortality among zoonotics. To describe the importance of bacteria some of the major Bacterial Zoonotic diseases are described ahead:

Anthrax

It is one of the most serious infections caused by gram positive bacteria *Bacilus anthracis* commonly found in soil. It is causative of serious illness among animals as well as humans. The mode of dispersal is usually sporozoic. It is most commonly found in agricultural regions of Central, South America, Sahara and Caribbean. The incubation period is from 1 day to more than 2 months. The symptoms mainly show development of small itchy blisters, lumps with swelling with onset of fever, dizziness, body ache and flu like symptoms. It is most likely agent to be used in biological warfare. The disease is curable by antibiotics and vaccine for high risk group.

Salmonellosis

Salmonella sp. causes salmonellosis among humans it is generally found in the intestine of healthy aves and mammals. The disease can reach to humans through infected consumables such as infected eggs and unprocessed pork,

flesh of turkey and fowl. Traditional symptoms of human salmonellosis include fever, abdominal cramps and diarrhoea and these can be life-threatening if it infects the bloodstream. Rodrigue *et al*. (1990) [20] described *S. enteritidi's* pandemic in the 1980s as the founder cause of enhanced affliction of *Salmonella* infection in tamed domestic animals across the world. The similar fact was supported by Poppe (1998) [19] for the raised incidence rate of *Salmonella* infection cases. He predicted same rate to continue over the period from 1985 till next one and half decades. The extensively elevated incedences of food toxicity in humans due by *Salmonella* were related with infected animal products, which markedly lead to a comparable rise in human cases.

Plague

It is caused by *Yersinia pestis* found in rodents and their fleas. The incubation period usually consist of 1 to 7 days. The mode of dispersal is by bite of infected fleas, inhaling respiratory droplets and direct contact with the infected tissue. Plague is having two clinical forms i.e. bubonic plague and pneumonic plague. Bubonic plague causes swelling of lymph nodes and is causing nearly 50% fatalities. In case of pneumonic plague is respiratory and can be fatal if not diagnosed early as within 18 to 24 hr of onset it can be fatal if not treated. WHO reported outbreak of Plague in 2021 in Madagascar claiming fatalities and emphasised on finding and stopping source of infection along with Surveillance for bubonic plague.

Campylobacteriosis

The zoonotic agent *Campylobacter* causes campylobacteriosis which is transmitted to animals and humans through food such as raw poultry. The pathogen shows symptoms among humans as diarrhoea along with abdominal cramps. The bacteria may live in the intestine of healthy birds, pigs and cattle also. The undercooked chicken and ready to use contaminated food is major source of infection and is responsible for the most frequent reported food borne illness from non-vegetarian diets. Aboderin *et al*. (2002) [2] projected campylobacteriosis to attain serious leap making it one of the top 10 infectious diseases on global level by 2020. Considering the higher incidence of campylobacteriosis in developing countries, disability adjusted life years (DALYs) for the disease in developing countries they predicted the incidence to be higher than even that of the Dutch population. Epps *et al.* (2013) [9] described Campylobacter infections as a thoughtful public health concern because of the continual emergence of antibiotic resistant strains along with its partially identified physiological aspects. WHO (2012) report on the global view of Campylobacteriosis, elucidated need of control measures and made various recommendations for handling and trade of poultry meat. Murray *et al*. (2010) [17] in same pattern described global burden of *Campylobacter* to be 7.5 million or 8.4% of the total burden of diarrheal diseases and among identified pathogens ranked it fourth after rotavirus (18.7 million) and typhoid fever (12.2 million) and cryptosporidiosis (8.3 million).

Listeriosis

Listeriosis is a wide-reaching infectious zoonotic disease and one of the significant among the food-borne bacterial diseases caused by *Listeria* spp. Mateuse *et al*., (2013) [15] described its most frequent effect on cattle and small ruminants on one hand and at the other hand recognized it to cause disease in humans, horses, swine, rabbits, and poultry. Next to Salmonella infections, the bulk (99.0%) of human food borne infections, Listeriosis infections were described as second most frequent cause of fatal food borne illness by Abbas and Jaber, (2012) [1]. They described mode of infection for humans mainly from smoked fish, meats, raw vegetable as salads and raw cheese. European Food Safety Authority (EFSA) Zoonoses Report (2013, 2018) [23] described Listeriosis is a comparatively uncommon but severe ailment with fatality rate of approximately 20-30%.The report documented prevalence of *Listeria* in soil, water, plants and animals like cattle and those feeding or grazing upon contaminated plants. It was also described by Desai *et al*. (2015) that *L. monocytogens* is capable to survive in refrigeration of temperature +2 °C and 4 °C and even in salty environments, these extensive environmental conditions as one of responsible contributory factor for the increased the risk of infections to human being from contaminated foods. The pathogen has become a major concern for the foodstuff industry and public health authorities in developed countries. Their intermittent cases as well as epidemics have been linked to contaminated food. Regarding pathogenesis Kumar *et al.* (2014) [3] elucidated impact of Listeriosis characterized by meningoencephalitis, abortion, septicaemia and sometimes enteritis. They also described it as one of the important food borne pathogen and a cause of substantial mortality and morbidity in humans and livestock.

Tuberculosis

Human tuberculosis chiefly associated with *Mycobacterium tuberculosis* and *M. bovis* species are infective to bovines and many other animals. Infected people usually lack effective or self-limited immune response causing rapid proliferation of bacteria affecting tissues and thereafter via blood to other organs of body. Most common route to infection is pulmonary via contaminated milk and milk products. Anaelom *et al*. (2010) [4], Cadmus *et al.* (2006) [5] and Davies (2006) [6] in their respective findings emphasised urgent need of research on diagnosis as well as control of its epidemiological, immunological and socioeconomic impacts.

Brucellosis

It is among the most widespread but neglected bacterial zoonotic disease which is found to be responsible for nearly 5 Lakh world wide cases. (Hull and Schumaker 2018) [12]. The infection of brucellosis is composing flu like symptoms and is spread by *Brucella* sp. It chiefly infects farm animals like livestock, pig, goat, sheep and dogs. The infection spreads to individuals by infected animal's discharge fluids or by air borne agents along with contaminated milk and meat. Singh *et al* (2015) [21] among Indian population described loss of nearly USD $3.4 billion because of consequences of brucellosis. The disease is usually considered as occupational disorder for people working in livestock sector. Though prolonged course of antibiotics is available for the disease yet consumption of pasteurised milk, proper handling and thorough cooking of meat is important for preventing the transmission of disease to humans.

Leprosy or Hansen's disease

Mycobacterium leprae is infective agent. It usually spreads via direct contact of droplets from nasal discharge, mouth droplets of infected case. It is curable disease having multiple drug therapy. The bacteria leads to infection of eye, skin,

nasal mucosa. It was earlier considered as highly contagious and devastating disease which on extreme condition lead to nerve damage, paralysis and even blindness. In 2019 nearly 2 lakh new cases were reported by WHO (2019) [28] at global and mainly consisting of children. Regarding emerging cases nearly half of cases are reported from India posing a remarkable load of morbidity among youngsters (WHO Factsheet on Leprosy 2023).

Challenges

The information on regional distribution of zoonotic is scarce because of underreporting of infectious diseases. The epidemiologists and health economists are burdened with various globally life threatening diseases like HIV, TB so less emphasis is provided to Zoonotics. Certain antibiotic resistant strains of bacteria like *Salmonella*, *Campylobacteria* are emerging which may be a future threat to mankind as these may enter the food chain and lead to major concern. The multiple level control plan for direct protection of humans, reduction of reservoir and health education are important in controlling zoonotic diseases.

Future perspective

The surveillance of zoonotic diseases is required to be enhanced. Among contact diseases the social burden of zoonoses is to be re-evaluated to access the economic loss. The integrated analysis of animal and human disease with a social perspective is the need of the hour. The intervention of Government at community level along with local non government bodies to improve the water and sanitation level is much required. The general masses are to be educated for health and sanitation practices and deploy those for controlling human as well as animal diseases. With the expansion of digital era the digital media can play an important and vibrant level to curb the zoonotic diseases.

Conclusion

The zoonotics reach to humans by means of infected foods directly or indirectly along with various agents. Confined and secured management of uncooked animal products and other food components consumed unprocessed should be done with precautionary measures. High-quality pantry cleanliness and thorough cooking can be instrumental in preventing the risk instigated by tainted food. Zoonosis a major concern for human health and are causative for nearly 2.7 million human deaths per year and decline in human health. Thus the role for surveillance and caution is of utmost importance.

References

1. Abbas BA, Jaber GM. Occurrence of Listeria monocytogenes in raw milk of ruminants. Iraqi Journal of Veterinary Sciences. 2012:26(1):47-51.
2. Aboderin AO, Smith SI, Oyelese AO, Onipede AO, Zailani SB, Coker AO. Role of Campylobacter jejunilcoli in Ile-Ife, Nigeria. East African Medical Journal. 2002;79(8):423-426.
3. Kumar A, Latha VJ, Sunil B, Dhanya VR. Comparison of different cultural techniques in isolation of Listeria monocytogenes from various samples. Journal of Foodborne and Zoonotic Diseases. 2014;2(1):10-14.
4. Anaelom NJ, Ikechukwu OJ, Sunday EW, Nnaemeka UC. Zoootic tuberculosis: A review of epidemiology, clinical presentation, prevention and control. Journal of Public Health and Epidemiology. 2010;2(6):118-124.
5. Cadmus SIB, Adesokan HK, Adejuwon TA, Adeyemi MO. Retrospective Study of Bovine Tuberculosis and other diseases of Public Health Importance in Oko-Oba Abattoir, Lagos State. Book of Abstracts, Nig. Vet. Med. Assoc. 2008;89:72-73.
6. Davies PDO. Tuberculosis in humans and animals: are we a threat to each other? J. R. Soc. Med. 2006;99(10):539-540.
7. Desai ND, Nayak JB, Brahmbhatt MN, Patel SN, Kaje VS. Listeriosis: An Important Food-borne Zoonosis. Journal of Foodborne and Zoonotic Diseases. 2015;3(1):15-18.
8. Dhiman RC, Tiwari A. Emergence of Zoonotic Diseases in India: A Systematic review. Med Rep Case Stud.; c2018. DOI: 10.4172/2572-5130.1000163
9. Epps SVR, Harvey RB, Hume ME, Phillips TD, Anderson RC, Nisbet DJ. Foodborne Campylobacter: Infections, Metabolism, Pathogenesis and Reservoirs. Int. J. Environ. Res. Public Health. 2013;10:6292-6304.
10. Gebreyes WA, Dupouy-Camet J, Newport MJ, Oliveira CJ, Schlesinger LS, Saif YM, *et al*. The global One Health paradigm: challenges and opportunities for tackling infectious diseases at the human, animal, and environment interface in low-resource settings. PLoS Negl Trop Dis. 2014;8:e3257. 10.1371/journal.pntd.0003257
11. Global Report for Research on Infectious Diseases of Poverty Available online at: www.who.int/tdr/capacity/global_report WHO fact sheet 2009-10.
12. Hull N.C. and Schumaker B.A. Comparisons of brucellosis between human and veterinary medicine. Infect. Ecol. Epidemiol. 2018;8:1500846.
13. Jones KJ, Patel NG, Levy MA, Storeygard A, Balk D, Gittleman JL, Dazak P. Global trends in emerging infectious diseases. Nature. 2008;451:990-993.
14. Keesing F, Belden LK, Daszak P, Dobson A, Harvell CD, Holt RD, *et al*. Impacts of biodiversity on the emergence and transmission of infectious diseases. Nature. 2010;468:647-652.
15. Mateus T, Silva J, Rui LM, Paula T. Listeriosis during Pregnancy: A Public Health Concern. Obstetrics and Gynecology. 2013;5:1-6.
16. McDaniel CJ, Cardwell DM, Moeller RB, Gray GC. Humans and cattle: A review of bovine zoonoses. Vector Borne Zoonotic Dis. 2014;14:1-19. DOI: 10.1089/vbz.2012.1164.
17. Murray CJ, Vos T, Lozano R, Naghavi M, Flaxman AD, Michaud C. Disability adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet. 2010;380(9859):2197-223.
18. National centre for Disease Control (NCDC) annual report 2016-17. www.ncdc.gov.in.
19. Poppe C. Epidemiology of Salmonella enteric Serovar Enteritidis. In Salmonella enteric Serovar Enteritidis in humans and animals: the epidemiology, pathogenesis, and control (A.M. Saeed, ed.). Iowa State University Press, Ames; c1998. p. 3-18.
20. Rodrigue DC, Tauxe RV, Rowe B. International increase in Salmonella enteritidis: a new pandemic. Epidemiol. Infect. 1990;105:21-27.
21. Singh BB, Dhand NK, Gill JP. Economic losses occurring due to brucellosis in Indian livestock

populations. Prev Vet Med. 2015;119(3-4):211-215.
22. Singh VK, Jain U, Yadav JK, Bist B. Assessment of bacterial quality of raw meat samples (carabeef, chevon, pork and poultry) from retail meat outlets and local slaughter houses of Agra Region, India. Journal of Foodborne and Zoonotic Diseases. 2014;2(1):15-18.
23. The European Union One Health 2018. Zoonoses Report; c2019. DOI:10. 2903/j.efsa.2019.5926.
24. The European Union Summary Report on Trends and Sources of Zoonoses, Zoonotic agents and Food-borne Outbreaks. 2013. DOI 10.2903/j.efsa.2015.3991
25. WHO Factsheet detail leprosy 2022: https://www.who.int/news-room/fact-sheets/detail/leprosy
26. The Global view of Campylobacteriosis Report of Expert Consultation Utrecht, Netherlands WHO Report 2012, www.who.int/iris/bitstream/10665/80751/1/9789241564601_eng.pdf
27. World Health Organisation Factsheet 2009. https://www.who.int/news-room/fact-sheets/detail/zoonoses
28. World Health Organisation Factsheet 2022 Cornavirus disease (COVID-19) pandemic. https://www.who.int/emergencies/diseases/novel-coronavirus-2019.