

## VCH 502: ZOOSES AND ENVIRONMENTAL HEALTH (2UNITS)

### ***Concepts, Definitions and Classification of Zoonoses***

Zoonoses are among the most frequent and dreaded risks to which mankind is exposed. Human beings have always had contact with animals, relying on them for food, transport, draft-power, labour and companionship. But the domestication of animals also brings along with it the opportunities for the passage of pathogens from animals to man and *vice versa*. It is often believed that most of the infections which pose challenge to human health and welfare, originate either from animals directly or through their products and by-products.

World Health Organization (WHO) in 1959 defined Zoonoses as *“those diseases and infections that are naturally transmitted between vertebrate animals and man”*. Thus zoonoses are two or more hosts per one infectious agent system in which one of the hosts happen to be man. Zoonoses are thus interesting not only because of their relevance to human health, but because they are high profile models for multi-host infectious diseases in general.

Some humans are mostly at risk than others; like infants and small children (with immature immune systems, poor hygiene), pregnant women (immune systems are more susceptible and there are additional fetal hazards), elderly persons (whose immune systems may be impaired), immune-compromised people (undergoing cancer therapy, AIDS/HIV patients etc.), people who have received organ or bone marrow transplant, people born with congenital immune deficiencies. Veterinarians, farm workers, zoo/wildlife workers and other animal health care workers.

Zoonosis has been a social and economic burden. Zoonoses stunt the economic growth of the countries where they are endemic and inhibit the generation of capital needed for investments.

The developing countries suffer much greater losses than the technically advanced countries. Besides causing economic losses (related to treatment, zoonoses cause considerable loss of livestock, their productivity (dairy product, animal products and by-product industry) and reproductivity. Thus, zoonoses act as a “double-edge weapon” affecting both social fabric and economic development of a country.

The socio-economic losses from zoonoses, though significant, are difficult to quantify completely because, as with other human diseases, the actual cost in terms of lives and suffering cannot be measured. The losses in export and investment opportunities and the consequent losses in foreign exchange sustained by countries because of zoonoses cannot be estimated.

The following (not fully exhaustive though) are impact zoonotic diseases can have on a given human population:

1. Acute or chronic debilitating illness
2. Impairment of productivity
3. Mortality
4. Reduced reproductivity
5. Loss of man-hours
6. Monetary/financial loss (for diagnosis, treatment, surveillance and control)
7. Adverse effect on morale of personnel
8. Unfavourable publicity
9. Loss of export and foreign exchange

### **Classification of Zoonoses**

The enormity of zoonotic problems and complex epidemiological patterns of zoonoses necessitate their classification into suitable groups so as to facilitate their diagnosis and management. A number of approaches have been adopted to classify zoonotic infections.

#### **A. According to the Type of Causative/Aetiological Agents**

Zoonoses can be classified according to the type of causative/aetiological agents are follows:

- i. Viral zoonoses caused by virus e.g. rabies
- ii. Bacterial zoonoses caused by bacteria e.g. anthrax, brucellosis
- iii. Rickettsial zoonoses caused by rickettsia e.g. Q-fever
- iv. Chlamydial zoonoses caused by Chlamydia e.g. *Chlamydia psittaci*
- v. Mycotic zoonoses caused by fungi e.g. Aspergillosis, ringworm
- vi. Protozoan zoonoses caused by protozoa e.g. Ameobiasis, toxoplasmosis
- vii. Helminthic zoonoses caused by helminth parasites e.g. Taeniasis, schistosomiasis
- viii. Ectoparasitic zoonoses caused by ectoparasites e.g. scabies, myiasis

**B. According to the Reservoir Host/Direction of Transmission**

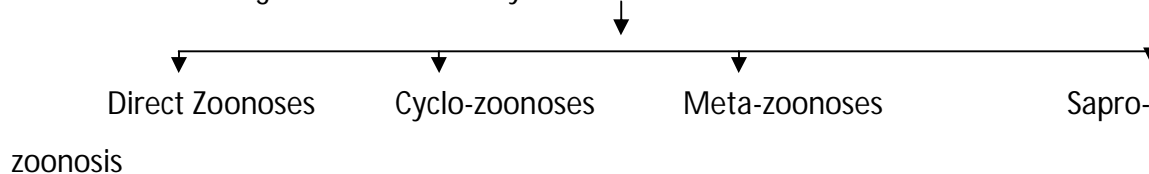
- i. **Anthropozoonosis:** are diseases transmitted from animals (lower vertebrates) to man e.g. anthrax, brucellosis, tuberculosis, rabies etc
- ii. **Zooanthroposis:** are human diseases shared naturally by animals or transmitted to lower vertebrate animals, e.g. diphtheria, human type tuberculosis, infectious hepatitis, measles etc.
- iii. **Amphixenosis:** this is a situation whereby infection is maintained in both man and lower vertebrate animals and may be transmitted in either direction, e.g. staphylococcosis, salmonellosis, *E. coli* infection

In the East-European countries, the animal to man transmission is described as zooanthroposis, and man to animal transmission is described as anthropozoonosis.

**C. According to Maintenance of Cycle in Nature/Live Cycle of the Agent**

This classification is considered to be of immense epidemiological value and useful in developing appropriate strategies for zoonoses management.

Zoonoses According to Maintenance Cycle in Nature



↓	↓	↓	↓
Direct Anthropozoonosis	Obligatory Cyclo-zoonoses	Sub-type 1: Meta-zoonosis	Sapro- anthropozoonosis
Direct Zooanthropozoonosis anthropozoonosis	Non-obligatory Cyclo-zoonoses	Sub-type II Meta-zoonosis	Sapro-
Direct Amphixenosis		Sub-type III: Meta-zoonosis	Sapro-meta- anthropozoonosis
		Sub-type IV: Meta-zoonosis	Sapro-cyclo- zoonosis

1. *Direct Zoonoses*: these are zoonoses that can be perpetuated in nature by a single vertebrate species. These are transmitted from an infected vertebrate host to a susceptible host by contact, vehicle or mechanical vector. The agent itself undergoes little or no propagative change during transmission, e.g. chlamydiosis, glanders, leptospirosis, ringworm, rabies, brucellosis, pasturellosis, staphylococcus etc.

The direct zoonoses may be of the following types;

- a) *Direct anthropozoonosis*, in which the lower vertebrates (various species of domestic and wild vertebrate animals) are the reservoir host of the infectious agents and human involvement often occurs only through accidental exposures. These infections can exist in nature independently of man.
- b) *Direct zooanthroponosis*: this includes those diseases which normally are transmitted from man to man but which may occasionally infect lower vertebrates, e.g. tuberculosis, diphtheria etc.
- c) *Direct amphixenosis*: some zoonotic infections may be maintained in nature either by lower vertebrate animals or by man. Transmission may occur in either or both directions. Man and lower vertebrates are equally suitable reservoir hosts and infection can occur in the absence of one or the other, e.g. staphylococcosis

2. *Cyclo-zoonosis*: Here, more than one vertebrate host, but no invertebrate host is required for completion of the agent's developmental cycle, e.g. tapeworm infection, hydatidosis etc. It may be obligatory or non-obligatory.
  - a) *Obligatory cyclo-zoonoses*: man must be one of the vertebrate host e.g. *Taenia saginata* infection
  - b) *Non-obligatory cyclo-zoonoses*: human involvement may not be involved, e.g. hydatidosis
3. *Meta-zoonoses*: here, cycle required both vertebrates and invertebrates, and are transmitted biologically by invertebrate vectors. The invertebrate host may or may not serve as a reservoir of infection.
4. *Sapro-zoonoses*, require a non-animal site to serve either as a true reservoir of infection or as site for an essential phase of development, besides vertebrate host. The inanimate site may be organic matter, water, food, soil or plants. The agent may propagate in the non-animate site (propagative or cyclopropagative) e.g. histoplasmosis, or may undergo essential development without propagation (developmental stage) e.g. *Ancylostoma braziliensis*
  - a) *Sapro-anthropozoonosis*: here infection is normally transmitted between a lower vertebrate and a non-animate site and human involvement is only accidental, e.g. erysipeloid.
  - b) *Sapro-amphixenosis*: man and lower vertebrates are equally susceptible host and infection can occur in the absence of one or another, e.g. histoplasmosis
  - c) *Sapro-meta-anthropozoonosis*: this requires both an invertebrate host as well as a non-animate site in their transmission cycle, e.g. fascioliasis

#### **D. According to Mode of Transmission**

Zoonoses can be transmitted in many ways:

1. Contact-borne, e.g. brucellosis
2. Food and water-borne, e.g. *E. coli* infection, *Vibrio cholera*
3. Air-borne, e.g. anthrax
4. Vector-borne

- a) *Mechanical*; carry the infectious agent on their body parts to susceptible host, e.g. anthrax, colibacillosis
- b) *Biological*; in which the infectious agent undergoes some biological transformation before infecting the host
  - i) *Propagative*; if the agent multiplies in the vector before being injected into the host, e.g. yellow fever
  - ii) *Cyclo-propagative*: if the agent develops and undergoes cyclic changes within the vector e.g. dirofilariosis
- c) *Trans-ovarian*: the infection may be transmitted in vectors vertically from one generation to the next, e.g. Rift valley fever
- d) *Trans-stadial*: the infection may be transmitted in vectors from stage to stage.

Zoonoses as “those diseases and infections that are naturally transmitted between vertebrate animals and man”.

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## **SPECIFIC BACTERIAL ZONOSIS**

### **Tuberculosis**

This is a chronic bacterial disease of cattle, swine, sheep, goats and human caused by *mycobacterium spp.*

Horses, dogs and poultry are also susceptible, while wild animals which live in the wild are less susceptible to tuberculosis. However animals in captivity suffer from the infection, since it is mainly a disease of overcrowding.

The prevalence of cattle tuberculosis range from 2 – 14% in slaughtered cattle. Humans acquire the infection by inhalation, ingestion, and it could be also due to occupational hazards. The initial infection usually goes unnoticed.

Tuberculosis sensitivity appears within a few weeks. Lesions commonly heal leaving individual changes except occasional pulmonary or tracheo-brachial lymph-node calcification. Approximately 95% of those initially affected enter this latent phase, and may have life-long risk of reactivation.

In about 5%, the initial infection may progress directly to pulmonary tuberculosis or by lympho-haematogenous dissemination of bacilli to pulmonary, miliary, meningeal or other extra pulmonary involvement.

Serious outcome of the initial infection is more frequent in infants, very old and immunocompromised adults.

Extra pulmonary tuberculosis is much less common than pulmonary, e.g. bones and joints, larynx, skin, intestines, peritoneum and eyes.

### **Infectious agents**

*Mycobacterium tuberculosis* and *Mycobacterium africanum* primary for humans.

*M. bovis* for cattle, *M. avium*, for poultry

### **Occurrence**

Worldwide, but more common in developing countries; but even in developed countries, morbidity is high in areas and population groups with high prevalence of HIV infection.

Mortality and Morbidity rates increase with age, and in older persons, they are higher in males than females.

It is much higher among the poor than the rich.

### **Avian Tuberculosis**

This is due primarily to *M. avium*. Poultry TB has been reported in Nigeria and more likely to occur in old birds, especially old layers. Turkey is also susceptible to *M. avium* infection though not commonly reported. It can also affect humans.

Incubation period of Tuberculosis is about 4 to 12 weeks, while the subsequent risk of progressing from pulmonary to extra pulmonary is greatest within the first 2 years after infection and it may persist a lifetime as a latent infection.

#### *Clinical Manifestation of Tuberculosis*

There is initial fatigue, fever & weight loss with localizing symptoms of cough, chest pain, hemoptysis, and hoarseness which becomes prominent in advanced stages.

#### *Diagnosis*

Diagnosis of current active disease is made by demonstration of acid fast bacilli in stained smear from the sputum or other body fluid.

Confirmation of the disease is by isolation of the tubercule bacilli on culture, this is also useful in the determination of drug susceptibility of the infective organism.

#### *Prevention and Control*

- Avoid overcrowding which is the major predisposing factor.
- Pasteurization of milk before consumption
- BCG vaccine administration in man as preventive measure
- Detection and slaughter policy in affected herds: Detection is done by injecting Purified Protein Derivative(PPD).

### **Anthrax**

This is a gram positive bacterial zoonoses primarily of ruminants but infective to man.

#### **Aetiology:** *Bacillus anthracis*

In humans, it causes a hyper acute infectious disease characterized by fever, septicemia, and rapid death. It localizes in skin causing malignant pustules or malignant cabuncles

If the spores of anthrax are inhaled by human beings, there may be fatal pneumonia or what is regarded as Wool Sorters Disease. It may also assume Acute Meningitis Syndrome following either cutaneous or respiratory infection.



Intestinal form of anthrax may follow consumption of contaminated meat.

**Diagnosis:** Signs on dead animals e.g. blood oozing out of orifices, no rigor mortis. Blood doesn't clot and the animal is bloated.

**Laboratory diagnosis:** Demonstration of causative organism in blood

**Control:**

- Ensure you have provision for rapid diagnosis
- Do an immediate destruction of an opened carcass of animals, either by incineration or deep burial with lime.
- Vaccinate cattle annually; but with vaccination, avoid treating animals with penicillin, which knocks off the effect of vaccine.
- Education of the agricultural populations to report any sign of the disease. If any farm is suspected, effect a quarantine, if infected animals were moved away from an area or slab, disinfect with lime or put petrol or diesel or kerosene in the area and burn with rags.

### **Glanders**

This is a highly communicable disease of horse, mules or donkeys.

Human infection can occur, but rarely and if it occurs, it is usually fatal.

**Aetiology:** *Malleomysis mallei* or *Pseudomonas mallei*

**Diagnosis:** Organism Isolation and characterization

### **Colibacillosis**

**Synonym:** Colibacteriosis / Colitoxaemia / White Scours.

**Etiology:** *Escherichia coli*

This is a major cause of traveller's diarrhea, and the diarrhea causing *E. Coli* are of 5 major categories: Enterotoxigenic, Enteropathogenic, Enteroinvasive, Enterohaemorrhagic, Enteroaggregative

Each has a different pathogenicity, possesses distinct virulence, properties and comprises a separate serotype, differing clinical syndromes and epidemiologic patterns.

### **Diarrhea Caused by Enterohaemorrhagic (EHEC)**

It is characterized by intestinal toxemia, and the commonest serotype is O157:H7 which causes bloody diarrhea in infants and the aged. It has also been linked to Hemolytic Uremic Syndrome. Other serotypes such as O26:H11 and O111:H8 have been implicated.

**Hosts:** Cattle and Horses, although it may be shed by dogs and all domestic animals.

**Mode of Transmission:** Transmission occurs by means of contaminated food, most often poorly cooked beef. Transmission by direct contact may occur in high risk populations.

**Diagnosis:** is by demonstrating the presence of Shiga-like toxins, by serotyping (e.g. identifying characteristic serotypes) or by DNA probes that identify the toxins genes or the presence of the EHEC plasmid.

**Prevention and Control:** Similar to that of Salmonellosis.

### **Tetanus/ Lockjaw**

**Aetiology:** *Clostridium tetani*

Found in the soil and in animals and human faeces. It is more common in the tropics than in the cold climate. Horses are the most affected, although sheep, goat and cattle can develop the disease. All herbivores are primarily susceptible to infection.

The disease in man is characterized by tonic spasm of masseter muscles and other muscles. The reflexes are exaggerated and convulsion may occur.

The disease in animals is similar in signs and symptoms as in humans. The major source of infection is through wounds and during routine procedures like dehorning, shaving and tail docking. Iatrogenic tetanus can also occur during routine procedures like castration.

Both animals and man may contribute to the contaminated environment, since the organism is a normal inhabitant of the soil.

**Prevention & Control:** Immunization plays an important role in prevention. Wounds should be handled aseptically, and operations such as dehorning, docking, and castration should be carried out aseptically.