

Emerging Bacterial Pathogens

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Emerging Disease: “Emerging infectious diseases/pathogens” are those “that have **newly appeared in a population** or **have existed but are rapidly increasing in incidence** or geographic range.

Newly identified & previously unknown infectious agents that cause public health problems either locally or internationally

Reemerging diseases are those that come back after they have been on a major decline.

Infectious agents that have been known for some time, had fallen to such low levels that they were no longer considered public health problems & are now showing upward trends in incidence or prevalence worldwide or have appeared in areas where they were not previously found.

Factors Contributing To Emergence

1. Agent

Evolution of pathogenic infectious agents (microbial adaptation & change)

Mutations

Development of resistance to drugs

Resistance of vectors to pesticides

2. Host

Human demographic change (inhabiting new areas)- increase contact with animals and natural environment

Human behaviour (sexual & drug use- sharing needles, drug abuse, body piercing)

Human susceptibility to infection (Immunosuppression)- stress and lifestyle changes

Nutritional changes, more use of pesticides

3. Breakdown of public health measures

Decrease in chlorine in water supplies lead to rapid spread of cholera in South America.

Non functioning water plant in Wisconsin, USA lead to outbreak of waterborne Cryptosporidium.

Inadequate vaccinations and Diphtheria in former USSR independent countries.

Discontinued mosquito control efforts and dengue and malaria re-emergence.

4. Environment

Climate & changing ecosystems

Economic development & Land use (urbanization, deforestation)

Technology & industry (food processing & handling)

Changes in agricultural & food production patterns- food-borne infectious agents (E. coli)

Reforestation in the USA **increased the number of deer & deer ticks**--Increased Human contact with deer -**Deer ticks are natural reservoir of Lyme diseases**-Human affection by **Lyme disease**

Deforestation forces animals into closer human contact- increased possibility for agents to breach species barrier between animals & humans- e.g. **clearing forests in Venezuela has resulted in an increased cane mouse population**, the probable reservoir host of the Guanarito virus and an outbreak of **Venezuelan hemorrhagic fever**.

Factors Contributing To Emergence

5. **Lack of Political will** (the lack of reporting of global infectious diseases of interest for political and economic reasons, e.g., SARS in China).

6. **Technology and industrialization.**

7. **Improved diagnosis.**

8. **Uncontrolled Urbanization & Population Displacement**

Growth of densely populated cities- substandard housing, unsafe water, poor sanitation, overcrowding, indoor air pollution (>10% preventable ill health)

Problem of refugees & displaced persons

Diarrhoeal & Intestinal parasitic diseases, ARI

9. **Climate changes –**

Heavy rains can result in increased breeding sites for mosquito vectors and increases in mosquito-borne infectious diseases

Global warming- spread of Malaria, Dengue, Leishmaniasis, Filariasis

Global warming- climatologists project temps to increase up to 5.8°C by 2100.

Elevated rainfall creates new breeding habitats for mosquitoes.

decreases salinity which can increase toxic bacteria.

increases vegetation which increases rodents.

increases runoff into drinking reservoirs

El Nino- Triggers natural disasters & related outbreaks of infectious diseases (Malaria, Cholera)

Possible increase in the frequency of epidemics of diseases linked to El Nino Southern Oscillation (i.e. Rift Valley fever, Sin Nombre Virus)

Building Dams- Emergence of Rift Valley hemorrhagic fever in Egypt. Slowed water flow AND allowed snails to go south introduced *S. mansoni* in Upper Egypt.

10. **Transmission of Infectious Agent from Animals to Humans- ZONOTIC diseases**

>2/3rd emerging infections originate from animals-wild & domestic

E.g Emerging Influenza infections in Humans associated with Geese, Chickens & Pigs

Animal displacement in search of food after deforestation/ climate change (Lassa fever)

Humans themselves penetrate/ modify unpopulated regions- come closer to animal reservoirs/ vectors (Yellow fever, Malaria)

Emerging & Re-emerging Diseases

Emerging Bacteria

- Drug resistant MTB- Both MDR and XDR
- MRSA
- VRE
- CR – GNB esp. Klebsiella
- E. coli O104: H4
- *Stenotrophomonas* spp.
- Extended spectrum beta- lactamase producing pathogens:

Re-emerging Bacteria

- Cholera, *H. pylori*,
- Neonatal tetanus
- *Yersinia pestis*
- Rickettsia
- Cl. Difficile
- Cl. Botulinum
- *Bacillus anthracis* (due to bioterrorism)
- Fransciella

Emerging Bacterial Infections in the World

1977	Campylobacter	Enteritis/Diarrhea
1982	E.coli O157:H7	HUS
1982	<i>Borrelia burgdorferi</i>	Lyme disease
1983	<i>Helicobacter pylori</i>	Peptic ulcer
1992	<i>Vibrio cholerae O139</i>	Cholera
1992	<i>Bartonella henselae</i>	Cat scratch
2001	<i>BT Bacillus anthracis</i>	Anthrax

E. coli O157:7

E. coli O157:7 is found in the **intestines of healthy cattle, goats, deer, and sheep**. According to the CDC, the transmission of these bacteria to humans may occur in the following manner: Meat, such as beef from cows, may become contaminated when organisms are accidentally mixed in with beef, especially when it is ground. **Virulent strains of EHEC O157:H7 are rarely harbored by pigs or chickens, but are found in turkeys.** The bacteria rarely occur in wildlife

Enterohemorrhagic Escherichia coli (EHEC) cause **hemorrhagic colitis** and are often associated with devastating or **life-threatening systemic manifestations**. The most severe **sequelae**, the **hemolytic uremic syndrome (HUS)**, results from **Shiga toxins (Stxs)** produced by the bacteria in the intestine and act systemically on sensitive cells in the kidneys, brain, and other organs.

Although most **EHEC strains produce Stxs**, EHEC O157:H7 are especially virulent and are responsible for the majority of HUS cases of bacterial etiology worldwide.

EHEC O157:H7 in domesticated ruminant animals - Reservoir and Sources of Human Infection

The major animal carriers are healthy domesticated ruminants, primarily cattle (Gyles, 2007) and, to a lesser extent, sheep and possibly goats.

Lyme borreliosis - *Borrelia burgdorferi*

Lyme borreliosis is a bacterial, tick-transmitted disease of animals (dogs, horses, possibly cats) and people. Transmission of *Borrelia burgdorferi* occurs during the blood meal of *Ixodes* spp ticks, and ticks may be active anytime temperatures are $>4^{\circ}\text{C}$ (40°F).

Lyme borreliosis - **Dogs** typically present with intermittent, lameness, fever, inappetance, lethargy, and focal lymphadenopathy. Infrequently reported, clinical manifestations in horses include neurologic abnormalities, uveitis, and cutaneous lymphoma.

Is *Borrelia* a zoonotic disease?

Lyme disease is among the most frequently diagnosed zoonotic tick-borne diseases worldwide. The number of human cases has been on the increase since the first recognition of its aetiological agent. Lyme disease is caused by spirochete bacteria belonging to the genus *Borrelia*.

Treatment consists of an extended (eg, 30-day) course of antibiotics, supportive measures including analgesia, and immunosuppressive therapy in the case of autoimmune reaction.

Antimicrobial Resistance Strains

Multidrug-resistant (MDR) and Extensively drug-resistant (XDR) strains of *M. tuberculosis*

- The development and emergence of multidrug resistance in animals has gained worldwide attention owing to the possibility of pathogen transmission to humans.
- **Multidrug-resistant TB (MDR-TB)** is caused by TB bacteria that are resistant to at least two most potent TB drugs including **isoniazid (INH)** and **rifampin (RIF)** which are used to treat all patients with TB disease.
- **Extensively drug-resistant tuberculosis (XDR-TB)** is a rare type of MDR-TB in which at least four of the most powerful and core anti-TB drugs cannot act against bacterial activity. These drugs include **INH** and **RIF**, **levofloxacin/moxifloxacin**, and at least one second-line injectable drug such as **capreomycin, amikacin, or kanamycin**.
- **Misuse or mismanagement are the major causes of the development of resistance to anti-TB drugs** .
- According to a WHO report (2019), in 2018 alone, there were approximately half a million (range, 417,000–556,000) new cases of RR-TB, of which 78% had MDR-TB. Moreover, among cases of MDR-TB in 2018, 6.2% were estimated to have XDR-TB

Methicillin-resistant *Staphylococcus aureus* (MRSA)

- Introduction of β -lactamase–stable antimicrobial drugs into clinical use, methicillin-resistant *Staphylococcus aureus* (MRSA) strains have emerged worldwide as important nosocomial pathogens.
- *S. aureus* is known to be one of the most common causes of bovine mastitis and other severe animal diseases such as septicemia and wound, bone, and joint infections, **MRSA strains have been rarely isolated from animals.**
- MRSA strains have been isolated from cows with mastitis, horses and dogs with lesions, and dogs and cats that were carriers

What sets MRSA apart is that it is resistant to an entire class of antibiotics called beta-lactams. This group of antibiotics includes methicillin, and the more commonly prescribed penicillin, amoxicillin, and oxacillin among others

Meticillin or **methicillin** is a narrow spectrum beta-lactam antibiotic of the penicillin class

Seven common antibiotics used against MRSA, which are: vancomycin, daptomycin, linezolid, Sulfamethoxazole and trimethoprim (TMP-SMZ), quinupristin-dalfopristin, clindamycin and tigecycline.

Vancomycin-resistant *Enterococcus* (VRE)

- Enterococci are facultative anaerobic gram-positive cocci in pairs/chains that live in the gastrointestinal (GI) tract and ordinarily function commensally with humans.
- Can cause a variety of infections, most commonly **urinary tract infection (UTI), intraabdominal infection, bacteremia, or endocarditis**. Rarely, they can cause **meningitis, osteomyelitis, septic arthritis, or pneumonia**.
- Vancomycin-resistant *Enterococcus* often **exists as a colonizing organism that does not always contribute to infection**, making it more difficult to determine when and how to treat these infections.
- Infection of vancomycin-resistant *Enterococcus* has been shown to increase both cost and mortality when compared to vancomycin-susceptible isolates.

Members of the genus *Enterococcus* can cause bovine mastitis, endocarditis, septicemia and amyloid encephalopathy with sudden death in chickens, and diarrhea in dogs, cats, pigs, and rats

Prevention of Emerging Infectious Diseases

- Global Outbreak Alert & Response Network Coordinated by WOAHA & WHO
- Mechanism for combating international disease outbreaks
- Ensure rapid deployment of technical assistance, contribute to long-term epidemic preparedness & capacity building

- Surveillance at national, regional, global level
 - epidemiological,
 - laboratory
 - ecological
 - Anthropological
- Investigation and early control measures
- Implement prevention measures
 - behavioural, political, environmental
- Monitoring, evaluation

THANKS

