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Over View of Some Emerging and Re-emerging Zoonotic Diseases: A review

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Abstract: Zoonotic diseases are infections that occur as a result of human interactions with animals and the environment. These diseases are transmissible from animals to humans and/or from humans to animals. Human–animal interactions occur mostly via human contact with animal-origin foods, domestic animals, pets, aquatic animals, edible insects and foodborne pathogens. Approximately 60% of all human infectious diseases recognized so far, and about 75% of emerging infectious diseases that have affected people over the past three decades have originated from animals. The twenty-first century has seen the emergence of many new, high-profile diseases that can be called emerging infectious diseases which are of serious public health concern. An emerging infectious disease is one that has appeared and affected a population for the first time or has existed previously but is rapidly increasing, either in terms of the number of new cases within a population, or its spread to new geographical areas. Many emerging and re-emerging diseases are zoonotic in origin, meaning that the disease has emerged from an animal and crossed the species barrier to infect humans. Emerging and re-emerging zoonotic diseases disrupt human activities and cause increased morbidity and mortality among human population, being responsible for about 2.4 billion cases of illness and about 2.7 million deaths in low and middle-income countries. The impact of zoonotic diseases on human health is evident from previous outbreaks that have plagued the human race on a global scale. Having full information on the occurrence, epidemiological distribution and measures to be taken to mitigate the impact of emerging and re-emerging zoonotic disease has paramount importance for those communities who are lagging behind in getting such information. Therefore, the objective of this article review is to compile useful information on the occurrence, epidemiological distribution and measures to be taken to reduce the impact of such important diseases.
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1. Introduction

Zoonotic diseases are infections that occur as a result of human interactions with animals and the environment [1]. These diseases are transmissible from animals to humans and/or from humans to animals [2]. Human–animal interactions occur mostly via human contact with animal-origin foods, domestic animals, pets, aquatic animals, edible insects and foodborne pathogens [3]. Approximately 60% of all human infectious diseases recognized so far, and about 75% of emerging infectious diseases that have affected people over the past three decades, have originated from animals [4].

From severe acute respiratory syndrome (SARS) to avian influenza A (H7N9), the twenty-first century has seen the emergence of many new, high-profile diseases that can be called emerging infectious diseases which are of serious public health concern. Not only can they cause large numbers of human deaths as they spread, they also have a huge social and economic impact in today's interconnected world. For instance, the estimated direct cost of SARS to Canada and Asian countries was US$ 50 billion [5]. Moreover, the impact of emerging infectious diseases is relatively higher in developing countries that have fewer resources. In the past 30 years, more than 30 new infectious diseases have emerged and unfortunately Asia, is often at the epicenter [4; 6].

An emerging infectious disease is one that has appeared and affected a population for the first time or has existed previously but is rapidly increasing, either in terms of the number of new cases within a population, or its spread to new geographical areas [2]. Many emerging and re-emerging diseases are zoonotic in origin, meaning that the disease has emerged from an animal and crossed the species barrier to infect humans. Several countries in the World Health Organization (WHO) South-East Asia Region have conditions that favor the emergence of such diseases, many of which can be lethal and spread rapidly. Scientific research on 335 emerging diseases between 1940 and 2004 indicated that certain areas of the world are more likely to experience the emergence of new infectious diseases [6].

Emerging and re-emerging zoonotic diseases disrupt human activities and cause increased morbidity and mortality among human population, being responsible for about 2.4 billion cases of illness and about 2.7 million deaths in low and middle-income countries [7]. The impact of zoonotic diseases on human health is evident from previous outbreaks that have plagued the human race on a global scale. To mention a few, the COVID-19 outbreak was first reported in Wuhan, China, and paralyzed human activities in 2020 with an ongoing negative effect on the world economy. Other notable zoonotic disease outbreaks include the Ebola virus outbreak in 2013, the Russian flu in 1977, the Spanish flu in 1918, the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) in 2012, Human Immunodeficiency virus in 1981 and Swine flu in 2009 [8].

Having full information on the occurrence, epidemiological distribution and measures to be taken to mitigate the impact of emerging and re-emerging zoonotic disease has paramount importance for those communities who are lagging behind in getting such information. Therefore, the objective of this article review is to compile useful information on the occurrence, epidemiological distribution and measures to be taken to reduce the impact of such important diseases.

Emerging and/or re-emerging viral zoonotic diseases

2.1 Avian Influenza

Avian influenza refers to certain viral infections or diseases often seen among wild birds, water fowl and poultry. It is caused by a strain of the influenza virus called “type A”. The infection causes a wide spectrum of symptoms in birds but does not normally infect humans. However, certain strains have managed to cross the species barrier and infect humans. Since humans have little or no immunity to such strains, they cause severe respiratory disease such as pneumonia or death. It has been revealed that the past three pandemics in the world have been due to influenza of avian origin [9].

There are different types of avian influenza infections reported in humans, depending on the different strains of the avian influenza virus that have crossed the species barrier from birds to humans. The risks, symptoms and treatments for different types of avian influenza may differ [9].

Geographical distribution

According to the United Nations Food and Agriculture Organization, viruses are thought to be circulating endemically in poultry in Bangladesh, China, Egypt, India, Indonesia and Viet Nam. Sporadic reintroduction into poultry populations is also thought to occur in Cambodia [10].

Agent

Avian influenza virus subtype A, are H5N1, H5N6, H6N1, H7N7, H7N9, H9N2, H10N8 [9].

Reservoir

The reservoir for avian influenza includes wild birds, water fowl and poultry [9].

Avian influenza A (H5N1)

This was the first avian influenza virus subtype observed to be transmissible to humans directly from infected poultry during a poultry outbreak in China, Hong Kong Special Administrative Region (Hong Kong SAR) in 1997. It then re-emerged in 2003 and 2004 and spread from Asia to Europe and Africa. From 2003 to 2013, of the 649 laboratory-confirmed human cases of A (H5N1) officially reported to WHO from 15 countries, 385 died. Of these, 228 cases (35%) and 181 deaths (47%) were from South-East Asia. Indonesia had the highest number of avian influenza cases in the world. Other countries in the WHO South-East Asia Region reporting human cases at this date were Bangladesh, Myanmar and Thailand [9].

Human infection

Risk factors

The primary risk factor for human infection appears to be direct or indirect exposure to infected live or dead poultry, contaminated environments [9] and young age. Slaughter, de-feathering, handling carcasses of infected poultry and preparing poultry for consumption especially in household settings are likely to be risk factors [11]

Mode of transmission

Infection of humans from poultry is rare, but most likely occurs through direct or indirect contact with sick or dead birds, or contaminated products such as fecal material. Human-to-human infection is even rare but is likely to be through a direct respiratory route such as coughing [9].

Clinical signs and symptoms

Clinical signs are the rapid onset of flu-like symptoms such as fever, chills, body ache, headache, sore throat, dry cough, frequent watery diarrhea, and progression to severe pneumonia and multi organ failure [9].

2.2 Ebola virus disease

Ebola virus disease (EVD) is a severe, often fatal illness in humans. Ebola virus disease outbreaks have a case fatality rate of up to 90%. Ebola first appeared in 1976 in two simultaneous outbreaks, in Nzara, Sudan, and in Yambuku, Democratic Republic of Congo [9; 12]. The latter was in a village situated near the Ebola River, from which the disease takes its name. It has not been reported in humans in the Asia Pacific region as of 31 July 2012. However, with global travel, it is possible that outbreaks in Africa could result in the spread of the virus to Asia [9].

There are different species of Ebola virus. Of these, the Reston Ebola virus was first discovered in laboratories in Reston, Virginia, United States of America (USA) in 1989 after some quarantined, crab-eating macaque monkeys originating from the Philippines became ill and died. In 2008, a virus identified in pigs was found to be very similar to the virus identified in monkeys imported into the USA for research from the Philippines in 1989 [13].

In 2009, six people tested positive for Reston Ebola virus antibodies after contact with sick pigs in the Philippines, but had no significant symptoms. The threat to human health is likely to be low for healthy adults but is unknown for all other population groups. Therefore, the Reston Ebola virus is not as great a threat as the other Ebola viruses that are known to be highly pathogenic for humans. However, it is of public health concern in the Asia Pacific region because, although very rare, it is a newly emerging disease in animals and humans [9].

Geographical distribution

Ebola virus disease outbreaks occur primarily in remote villages in Central and West Africa, near tropical rainforests. The virus is transmitted to people from wild animals and spreads in the human population through human-to-human transmission. Since 2008, Reston Ebola virus has been detected during several outbreaks of a deadly disease in pigs in the People's Republic of China and in Philippines, but no illness or death in humans from this species has been reported to date [9].

Causative Agent

Ebola virus belongs to the Filoviridae family (filovirus). Ebola virus comprises 5 distinct species namely Bundibugyo Ebola virus (BDBV), Zaire Ebola virus (EBOV), Sudan Ebola virus (SUDV), Reston Ebola virus (RESTV) and Taï Forest (formerly Côte d'Ivoire Ebola virus) Ebola virus (TAFV). Four of the five subtypes occur in an animal host native to Africa. Bundibugyo Ebola virus, EBOV, and SUDV have been associated with large EVD outbreaks in Africa, whereas RESTV and TAFV have not. Pathogenicity varies among Ebola viruses, from EBOV, which is highly lethal in humans, to RESTV, which causes disease in pigs and macaques but asymptomatically infects humans [9].

Reservoir

Fruit bats of the Pteropodidae family are considered to be the natural host of the Ebola virus. Although non-human primates have been a source of infection for humans, they are not thought to be the reservoir but rather an accidental host like human beings. Since 1994, Ebola outbreaks from the EBOV and TAFV species have been observed in chimpanzees and gorillas [9]. Reston Ebola virus has caused severe EVD outbreaks in macaque monkeys (Macaca fascicularis) farmed in Philippines and detected in monkeys imported into the USA in 1989, 1990 and 1996, and in monkeys imported to Italy from Philippines in 1992 [9].

A recent study suggests that bats might be a reservoir for Ebola virus in Bangladesh. The study found antibodies against Zaire and Reston Ebola viruses circulating in 3.5% of the 276 bats scientists screened in Bangladesh [14]. Detection of antibodies to Ebola virus infection in Indonesian orangotans suggests the existence of multiple species of filoviruses or unknown filovirus-related viruses in Indonesia, some of which are serologically similar to African Ebola viruses [15].

Human infection

Human contact with infected fruit bats or monkeys/apes and the consumption of their raw meat leads to wild-life-to-human transmission of the virus. Human-to-human transmission is through direct or close contact with infected patients, and particularly through contact with blood and body fluids of an infected patient. Health-care workers caring for patients with suspected or confirmed Ebola are at risk if proper hospital infection control measures are not in place. Laboratory personnel handling infected material without proper biosafety measures are also at risk [9].

Mode of transmission

Ebola is introduced into the human population through close contact with the blood, secretions, organs or other bodily fluids of infected animals. In Africa, infection has been documented through the handling of infected chimpanzees, gorillas, fruit bats, monkeys, forest antelope and porcupines found ill or dead or in the rainforest. Ebola then spreads in the community through human-to-human transmission, with infection resulting from direct contact (through broken skin or mucous membranes) with the blood, secretions, organs or other bodily fluids of infected people, and indirect contact with environments contaminated with such fluids. Health-care workers have frequently been infected while treating patients with suspected or confirmed EVD. This has occurred through close contact with patients when infection control precautions are not strictly practiced [9].

Clinical signs and symptoms

Ebola virus disease is a severe acute viral illness often characterized by the sudden onset of fever, intense weakness, muscle pain, headache and sore throat. This is followed by vomiting, diarrhea, rash, impaired kidney and liver function, and in some cases, both internal and external bleeding. Laboratory findings include low white blood cell and platelet counts and elevated liver enzymes [9]. People are infectious as long as their blood and secretions contain the virus. Men who have recovered from the disease can still transmit the virus through their semen for up to 7 weeks after recovery from illness [9].

2.3 Rabies

Rabies is a common and preventable viral zoonotic disease; however, it is almost always fatal, and results in 55,000 deaths globally every year. Children are the main victims of rabies. Every year, more than 15 million people worldwide receive post-exposure rabies prophylaxis (vaccination after exposure to the virus to avert the disease) which is estimated to prevent an additional 327,000 rabies deaths [9]. Countries in the WHO South-East Asia Region contribute 45% of the global burden of the disease [16]. Despite substantial advances in the development and availability of efficient measures to control rabies, there has been no significant decrease in rabies incidence in Asia except in a few island countries [9].

Geographical distribution

Worldwide (except Antarctica), but more than 95% of human deaths occur in Asia and Africa [9].

Causative Agent

Lyssa virus is a genus of viruses belonging to the family Rhabdoviridae [9].

Reservoir

Warm-blooded mammals and bats are responsible for maintenance of the virus; urban rabies primarily by dogs, and sylvatic rabies by wild animals [9].

Human infection

In Asia, more than 4 billion people are at risk of contracting rabies. Of all documented human rabies cases, 94% are due to a rabid dog bite. Human deaths following exposure to mongoose, jackals, foxes, wolves, and other wild carnivore host species are very rare [9].

Mode of transmission

People are infected through the skin following a bite or scratch by an infected animal. Transmission can also occur when infectious material such as saliva comes into direct contact with human mucosa or fresh skin wounds. Rabies may be contracted via transplantation of an infected organ such as a cornea [9].

Clinical signs and symptoms

The incubation period is usually 4-8 weeks, but may extend to several years. Once clinical symptoms develop in a person who has been bitten by a rabid animal, the disease is almost always fatal. Symptoms appear in phases and include: initial pain or a tingling sensation at the site of the bite; fear of water (hydrophobia); restlessness; excess salivation; convulsions; and finally death [9].

2.4 Rift Valley fever

Rift Valley fever (RVF) is a mosquito-borne viral disease first identified in Kenya in 1931 [17]. An outbreak of RVF in animals frequently manifests itself as mass mortality among their young, or a wave of unexplained abortions among livestock. Outbreaks usually occur first in animals and then in humans [18] particularly in those who work with animals. Heavy rains often precede outbreaks. The total case-fatality rate has varied widely between different epidemics, but overall has been less than 1% in those documented. However, post-infection complications are very high, and can have a severe socioeconomic as well as health impact.

Geographical distribution

Rift valley fever is widespread throughout Africa and occasionally reported in Middle East countries. However, there is a potential risk of introduction of RVF in countries in the South-East Asia Region due to livestock movement and trade [9].

Causative Agent

Rift valley fever is caused by the Phlebovirus, a member of the Bunyaviridae family.

Reservoir

Infected livestock (sheep, cattle, goats) can have high enough levels of the virus in the bloodstream to infect a variety of mosquito vectors. These amplifying hosts help establish the disease in the environment and can lead to large epizootic epidemics. The virus often enters the bloodstream during early clinical illness in humans [19].

Human infection

Risk factors

Currently there is very little risk in the South-East Asia Region. Rift valley fever may, however, be introduced through the illegal import of infected animals. The disease mainly affects persons in certain occupational groups such as veterinarians, animal handlers and slaughterhouse workers who are at an increased risk of contracting the virus from an infected animal. Sleeping outdoors at night in areas where outbreaks occur exposes individuals to potentially infected mosquitoes and other insect vectors. Travellers increase their chances of getting the disease when they visit rift valley fever endemic locations during periods when sporadic cases or epidemics are occurring [20].

Mode of transmission

Transmission can be through the bite of infected mosquitoes or other insects, contact with tissues and body fluids of infected animals during slaughtering or butchering, assisting with animal births, conducting veterinary procedures, or from the disposal of carcasses or fetuses, contact with the aborted material from infected animals, through inoculation; for example, via a wound from an infected knife, contact with broken skin, or inhalation of aerosols produced during the slaughter of infected animals [9].

Clinical signs and symptoms

Incubation period is 1 week. Most human cases are relatively mild. Some patients develop severe flu-like symptoms such as sudden onset of chills, muscular and back pain, headache, nausea and fever, which last for a week or more. However, a small percentage of people develop a much more severe form of the disease that manifests as one or more of three distinct syndromes: ocular, meningo-encephalitis and haemorrhagic. Most fatalities occur in patients who develop the haemorrhagic syndrome (internal bleeding) [18].

2. Emerging and/or re-emerging bacterial zoonotic diseases

3.1 Anthrax

Anthrax is a bacterial disease that usually affects herbivorous animals, but outbreaks involving humans are increasingly being reported. An outbreak in Bangladesh in 2010, involving 607 human cases in 3 months, was the biggest outbreak in the country's history [21]. The disease does not spread from human to human, and most forms are curable when diagnosed early and treated with antibiotics. However, case-fatality estimates for inhalation of anthrax spores, although based on incomplete information, are extremely high that can reach 75-100%, even with all possible supportive care, including appropriate antibiotics. The case-fatality rate for cutaneous anthrax, which accounts for the vast majority of cases, is usually low which is about 20%, if untreated [22].

Geographical distribution

The geographical distribution of anthrax is worldwide. Usually outbreaks are sporadic and small, but outbreaks of epidemic proportion can occur if contaminated animal feed becomes a common source of infection [9].

Agent

The bacteria Bacillus anthracis is the causative agent anthrax.

Reservoir

Reservoir hosts include domestic and wild animals such as cattle, buffalo, sheep, goats, pigs and horses [9].

Human infection

Although anthrax spores can live in the soil for many years, anthrax infection in humans is rare. Skin contact with, or inhalation of, aerosolized spores and consumption of undercooked or raw meat or dairy products from infected animals can cause the disease [9].

Mode of transmission

People can become infected in four main ways: by the cutaneous route, e.g. direct skin contact of anthrax spores with a cut or abrasion; by contact with infected animals or animal products (usually related to occupational exposure); through consumption of undercooked or raw meat or dairy products from infected animals (gastrointestinal form and by inhaling a large number of anthrax spores suspended in the air (the pulmonary form of anthrax), which is the rarest and most severe [23].

Clinical signs and symptoms

Incubation period is 1-7 days for the cutaneous form; 12 hours-5 days for the gastrointestinal form; and 1-5 days for the pulmonary form. Clinical symptoms include red marks on the exposed area of skin, which swells and forms blisters. The skin tissue then dies, leaving a black central scar, loss of appetite, fever, vomiting, diarrhea, cough, and difficulty in breathing, respiratory failure and, in severe forms, death within 24 hours. Generally, animals exhibit sudden acute illness, high fever, localized swelling, bleeding from natural orifices (nose, mouth, ear, anus), or death [9].

2.2 Listeriosis

Listeriosis is a serious bacterial infection and is most commonly caused by eating contaminated food such as unpasteurized dairy products or ready-to-eat foods that have not been hygienically packaged. Changing food habits and new technologies such as refrigeration and vacuum packing of dairy, meat and fish products are contributing factors in the emergence of listeriosis. The overall case-fatality rate among non-pregnant adults is approximately 30%. In pregnant women, infection can lead to miscarriage, stillbirth, premature delivery, or infection of the newborn. The disease is known as "circling disease" in young animals [9].

Geographical distribution

Listeriosis is worldwide in distribution.

Causative Agent

The bacterium Listeria monocytogenes is the causative agent of listeriosis.

Reservoir

Listeria monocytogenes mainly occurs in soil, forage, water, mud, livestock food and silage. Animal reservoirs include infected domestic and wild mammals, fowl and humans. Animals can carry the bacterium without appearing ill and can contaminate foods of animal origin such as meat and dairy products [24].

Human infection

Unlike most other foodborne pathogens, Listeria can multiply in refrigerated foods that are contaminated [24]. Although rare, listeriosis primarily affects older adults, pregnant women, newborns and adults with weakened immune systems [24]. The disease often intensifies existing debilitating illnesses or conditions such as organ transplantation, diabetes, cirrhosis, renal disease, heart disease, HIV infection, and in persons with malignancies or on corticosteroids. Pregnant women are about 20 times more likely to get listeriosis than other healthy adults [24]. Babies can be born with listeriosis if their mothers eat contaminated food during pregnancy.

Salmonellosis is one of the most common and widely distributed foodborne diseases. It constitutes a major public health burden and represents a significant cost in many countries. It is estimated that tens of millions of human cases occur worldwide every year and the disease results in more than 100,000 deaths [25]. Although outbreaks of salmonellosis have been reported for decades, it is considered an emerging disease because it has recently increased in incidence in many continents. Since the beginning of the 1990s, strains of salmonella that are resistant to a range of antimicrobials have emerged and threaten to become a serious public health problem [25].

Geographical distribution

Worldwide in distribution and most animals are susceptible to infection.

Causative Agent

The causative agent of salmonellosis is bacteria of the Salmonella species such as Salmonella typhimurium, Salmonella enteritidis and more than 2500 known types and/or serotypes [25].

Reservoir

The main reservoir for salmonella is poultry, domestic and wild animals [9].

Human infection

Children are the most likely to get salmonellosis; the rate of diagnosed infections in children under five years

Mode of transmission

Most human infections follow consumption of foods contaminated with Listeria monocytogenes (a variety of raw foods, such as uncooked meats and vegetables, foods that become contaminated after cooking or processing, such as soft cheese, smoked seafood, unpasteurized milk and foods made from unpasteurized milk). In neonatal infections, the organism can be transmitted from mother to fetus in utero, or during passage through the infected birth canal [24].

Clinical signs and symptoms

Incubation period is uncertain, but probably a few days to 3 weeks. Listeriosis can present in different ways depending on the type of infection. Manifestations of listeriosis are host-dependent. In older adults and persons with serious medical conditions, septicemia (blood poisoning) and meningitis are the most common clinical presentations. Pregnant women may experience a mild, flu-like illness followed by fetal loss, or meningitis in their newborn. People with normal immune systems may experience acute gastroenteritis with high fever [24].

2.3 Salmonellosis

is higher than in all other age groups. Groups at greatest risk for severe or complicated disease are infants, the elderly, and persons with compromised immune systems. Most people recover without treatment. However, in the very young and the elderly, and in cases when the bacteria enter the bloodstream, antibiotic therapy may be needed [9].

Mode of transmission

Salmonellosis is generally contracted through the consumption of raw or improperly cooked food of animal origin (mainly meat, poultry, eggs and milk), although many other foods, including green vegetables contaminated from manure, have been implicated in its transmission [9].

Clinical signs and symptoms

Incubation period is from 6–36 hours, but may be up to 72 hours. Most infections remain subclinical. Main symptoms include diarrhea, vomiting and low-grade fever and can progress to dehydration, extreme exhaustion and sometimes death, especially in the very young or very old people. Persons with diarrhea usually recover completely, although it may be several months before their bowel habits are entirely normal. A small number of persons with Salmonella develop reactive arthritis (pain in their joints, irritation of the eyes, and painful urination). This can last for months or years, and can lead to chronic arthritis which is difficult to treat [9].

3. Emerging and/or re-emerging parasitic zoonotic diseases

4.1 Taeniasis/cysticercosis

The most important tapeworms for humans are Taenia saginata and Taenia solium. The tapeworm lives in the intestine of humans and the adult stage is known as taeniasis. These humans shed the proglottids containing the eggs in their faces. The eggs are ingested by cattle (T. saginata) or pigs (T. solium), where a cysticercus develops in the muscle; this larval stage of tapeworm is known as cysticercosis. Encystment of larvae can occur in the brain, which is known as neurocysticercosis and is one of the main causes of epilepsy in many developing countries [9].

Taenia solium has significant public health importance as it causes human cysticercosis, which affects sensitive organs like the brain and eyes, and is difficult to treat. There is a general misconception that human cysticercosis is reported only in pig-raising or pork-eating communities; however, it has also been reported among vegetarian populations, as it is transmitted through food/vegetables contaminated by human faces [9].

Geographical distribution

Taenia solium and T. saginata are distributed worldwide. Taenia saginata can be found worldwide in countries where cattle and buffaloes are raised for human consumption; T. solium where pigs are raised for human consumption. The distribution of cysticercosis coincides with the distribution of T. solium. More than 80% of the world's 50 million people who are affected by epilepsy live in low-income and lower-middle-income countries, many of which are endemic for T. solium infections in people and pigs [26].

Causative Agent

Taenia solium (pork tapeworm) and T. saginata (beef tapeworm). Taenia solium is responsible for human cysticercosis.

Reservoir

Reservirors are Cattle and buffaloes for beef tapeworm and pigs for pork tapeworm.

Human infection

Taeniasis and cysticercosis are parasitic infections related to pig husbandry practice, and poor hygiene and sanitation. Taeniasis is reported in countries where open defecation is common and scavenging pigs are found in the community. Other important risk factors may be lack of meat inspection, and consumption of raw or undercooked meat [9].

Mode of transmission

Humans acquire the infection by ingestion of raw beef/pork containing the cysticercus. Humans are the final host for both T. saginata and T. solium, but humans can also be the intermediate host for T. solium. The great majority of T. saginata and T. solium carriers are unaware of their infection, as these tapeworms did not kill their host. However carriers of T. solium carry a substantial risk of acquiring cysticercosis by faeco-oral autoinfection and members of their households are also at increased risk [9].

Clinical signs and symptoms

Incubation period for taeniasis (adult worm) is from 6–8 weeks after ingestion of contaminated pork infected with larvae (cysticerci). For human cysticercosis (larval stage) the incubation period is variable, and infected people may remain asymptomatic for years. Persons who have the tapeworms T. saginata and T. solium in their intestine may not notice the existence of the tapeworm unless there are multiple adult worms. Intermittent fecal shedding of proglottids (segments), gastrointestinal discomfort, nausea, and diarrhea, loss of appetite and loss of weight may be observed. The clinical signs and symptoms of human cysticercosis depend on the location and number of larvae in brain, eye or other organs. Seizures, headaches, learning difficulties and convulsions are symptoms of neurocysticercosis [9].

4.2 Toxoplasmosis

Toxoplasmosis is an infection caused by a parasitic protozoon, usually transmitted from animals to humans. It can have severe consequences in pregnant women and individuals with a compromised immune system [9].

Geographical distribution

Toxoplasmosis is worldwide in distribution.

Causative Agent

The causative agent of toxoplasmosis is the protozoa Toxoplasma gondii.

Reservoir

The reservoir for the causative agents of toxoplasmosis is cats and other feline species. Intermediate hosts include most species of birds and mammals. Cats become infected by eating these small birds and mammals and then passing oocysts in their faces, which are infective to humans [9].

Human infection

Toxoplasmosis is very common and up to 95% of some populations across the world have been infected with Toxoplasma [27]. Infection is often highest in areas that have hot, humid climates and low altitudes. Persons with weakened immune systems may experience severe symptoms if infected with Toxoplasma. If a woman is infected prior to pregnancy, she will have developed immunity that will protect the child. However, if a woman is infected with Toxoplasma during or just before pregnancy, she can pass the infection to her unborn baby [28].

Mode of transmission

The mode of transmission includes ingestion of undercooked, contaminated meat, Eating without washing hands thoroughly, after accidentally or unknowingly handling contaminated food, eating food contaminated by knives, utensils and cutting boards, and food that has had contact with raw, contaminated meat, drinking water or milk contaminated with Toxoplasma gondii, mother-to-child (congenital) transmission or mother-to-fetus through the placenta, animal-to-human (zoonotic) transmission, accidentally swallowing the parasite through contact with cat faces that contain Toxoplasma, such as while cleaning cat litter, accidentally ingesting contaminated soil and consuming food or water contaminated with cat faces [9].

Clinical signs and symptoms

Incubation period is from 5-23 days. Primary infections may not produce symptoms. The disease can affect the brain, lung, heart, eyes and/or liver. Symptoms in otherwise healthy people include fever, mild flu-like symptoms, enlarged lymph nodes in the head and neck, muscle pain, pneumonia, central nervous system disturbances, complications of eyesight and other systemic diseases. Infection during pregnancy can result in inflammation of an area behind the retina in the fetus, fluid in the fetal brain (hydrocephaly) or fetal death [9].

The consequences of infection are more serious in mother-to-child (congenital) transmission. The case-fatality rate and number of complications are high during the last trimester of pregnancy, but lower during early trimesters. Damage to the unborn child is more severe and pregnancy can result in miscarriage, stillbirth, or a child born with signs of toxoplasmosis (abnormal enlargement or smallness of the head). Infants infected before birth often show no symptoms at birth, but develop them later in life with potential vision loss, mental disability and seizures. Toxoplasmosis contracted during infancy may lead to permanent disabilities such as poor sight, hearing loss or learning disorders [9].

4. Prevention, control and eradication of emerging and re-emerging zoonotic diseases

There is an important distinction among the term prevention, control and eradication. Prevention is defined as inhibiting the introduction of a disease agent into an area, a specific population group or an individual. Control efforts consist of steps taken to reduce a disease problem to a tolerable level and maintain it at the level. The term control is more appropriate when a given infectious disease agent is already present [29].

Eradication is the final step in a disease control program. It consists of the elimination of a disease producing agent from a defined population or geographical area. To achieve eradication of a disease producing agent from an area or population, it is necessary to obstruct transmission until endemicity (including carriers) ceases and prevent the reestablishment of the agent from imported sources of infection [30].

The basic principles of zoonoses prevention control and eradication programs are focused upon breaking the chain of transmission at its epidemiologically weakest link. Three factors are involved: the reservoir, transmission from the reservoir to the susceptible hosts, and the susceptible hosts [31].

Reservoir Neutralization:

The ultimate source of zoonotic infection is the infected reservoir host. Whenever infection in the reservoir can be reduced or eradicated, other sources of infection progressively become less significant or disappear. Three method used to neutralize the reservoir are removing infected individual, rendering infected individuals, and manipulating the environment. Increasing host resistance can also neutralize a reservoir if the number of infected animals is reduced. Removal of infected individual can be accomplished in two ways: test and slaughter and mass therapy [31].

Infection may be removed from a herd by testing and slaughtering those found to be infected. To be effective, a sufficiently sensitive and specific test is required, i.e. all infected animals need to be detected by the test if all infection is to be erased without removing large numbers of false-positive animals. When such a test is not available it may be necessary to use a less sensitive test, such as clinical diagnosis, on which to base a decision. Two factors that affect the decision to use test and slaughter are expense and the method of transmission. This method has been most effective with agents spread by direct transmission and in which a limited number of reservoir species are involved. The high cost to government and industry has prevented its use in many countries [30].

A second method for neutralizing the reservoir by removing infected individual is mass therapy. Mass therapy is usually restricted to a local situation in which all potentially infected animals or people are treated without first testing them to identify infected individuals. In certain situation particularly with endemic diseases in the less-developed portion of the world where diagnostic resources may be minimal, treatment without prior screening may reduce the cost factor 2 to 6 times. Risks associated with mass therapy, particularly if improperly done, are the development of resistant strains of infectious agents and adverse side effect [32].

Environmental manipulation is a method of reservoir neutralization designed to break the chain of transmission between the portal of exit of the infected (shedder) host and the susceptible host by reducing survival of the agent in vector of vehicle (food, water, soil, vegetation). The environment of concern is wherever the agent may be found outside the vertebrate host. A limitation is that it is a local measure, effective only in the immediate area where the control is instituted. Various parasitic control strategies that provide example of this approach are proper fecal waste disposal (acting on the portal of exit), disinfection of fecal wastes, and pasture rotation to decrease exposure of susceptible hosts (portal of entry) [31].

Provision of adequate toilet facilities, coupled with education and supervision to ensure their use, will prevent the spread of Taenia saginata from feedlot employees to cattle. If facilities are not convenient, employees may use haystacks, feed bunks, or other location, which can result in contamination of cattle feed [33].

Reducing contact potential:

A basic principle in preventing direct transmission of an infectious agent from an infected individual to a susceptible host is to reduce the opportunity for contact. In disease control two population are considered, the known infected and the potentially exposed susceptible. Three methods are used: isolation and treatment of cases, quarantine of possibly infected individuals, and population control. Isolation is designed to keep the agent in, whereas quarantine is designed to keep the agent out. The laminar flow hood, familiar to all who have worked in a microbiology laboratory is an application of the basic principle of isolation, keeping the agent in (the hood), thereby protecting the technician. Herd immunity is a method for reducing contact potential. When the proportion of immune animals in a given population is sufficiently great, a disease agent transmitted by direct contact cannot enter and spread because the opportunity for contact between infected (shedder) animals and susceptible animals has been reduced [32].

Increasing Host Resistance:

In addition to neutralization of reservoirs or contact reduction, zoonoses may also be controlled by increasing host resistance to infection. Preventing infection is ideal, but in many instances, increasing host resistance may only lessen the severity of disease, without an equal increase in resistance to infection [31].

Maintaining animals at a proper level of nutrition not only increase their ability to resist infection but also increases their ability to respond properly to immunization. Reduction of stress, by providing improved shelter and nutrition is not only an end but is also a means to reduce the ravages of epidemics by increasing the survival ability of the affected population. This is well recognized with greater case fatality rates among starving population during epidemics. There are two procedures for increasing host resistance which is appropriate for presentation; chemoprophylaxis and immunization [34].

Chemoprophylaxis:

Contrasts with mass therapy in that, in the latter, medication is administered on the assumption that the recipient is infected whereas chemoprophylaxis attempts to prevent infection or at least reduced the severity of the disease. In contrast to immunization it is passive means of increasing host resistance, lasting only if the drug lasts. Active response to immunization, however, lasts for months or even a lifetime. Typically, no host response is elicited [35].

Chemoprophylaxis is used in laboratories when personnel are accidentally exposed to an agent (including several zoonotic) known to be susceptible to a drug. This is to prevent infection which differs from mass therapy, which is used to eliminate infection. On the other hand, mass therapy may leave some immunity in those who were previously infected. Chemoprophylaxis may involve adverse reaction to the drug in some instance the agent may be resistant [36]. Chemoprophylaxis is a consideration for any high–risk groups when an effective drug is available and suitable immunization or adequate protective clothing is not [37].

Immunization:

Vaccine is used for two purposes, to protect susceptible individual from infection or disease and to prevent transmission of infectious agents by creating an immune population. To be most effective in controlling disease, the stimulus of immunization should be sufficient to prevent infection as well as disease. In maintenance hosts, no reduction in the reservoir of infection occurs if only disease is prevented. The risk of disease remains from any susceptible individuals introduced into the population if carriers persist. The level of immunity needed to prevent disease is not necessarily the same as the level needed to prevent infection. The efficiency of immunization as a method for disease control is measured in terms of the percentage of the population developing the desired level of protection in relation to the resources expended (vaccine, equipment, labor, promotion etc.). Efficiency increases as the number of doses needed decreases. Assuming a similar percentage of the population reaches a level of protection enough for control by either method, vaccine in the drinking water would be far more efficient than administration by injection [31].

In planning any immunization program, the first step is to identify the population at risk (population likely to be exposed) and then to decide on the specific disease control goal, e.g. reducing the incidence of disease to just a few sporadic cases elimination of the agent. The decision to vaccinate or not to vaccinate is based on relative risk. When choosing which route to take in relation to each disease, ask the question where, when, who, and why? The answer to one or more of these questions may be crucial to determine the correct decision [34]. Immunization as a method of disease control is generally so effective and commonplace that all too often, the many variables associated with the procedures are ignored [36].

Conclusion and recommendations

Zoonotic diseases are infections that occur as a result of human interactions with animals and the environment. These diseases are transmissible from animals to humans and/or from humans to animals. Human–animal interactions occur mostly via human contact with animal-origin foods, domestic animals, pets, aquatic animals, edible insects and foodborne pathogens. The twenty-first century has seen the emergence of many new, high-profile diseases that can be called emerging infectious diseases which are of serious public health concern. Emerging and re-emerging zoonotic diseases disrupt human activities and cause increased morbidity and mortality among human population, being responsible for about 2.4 billion cases of illness and about 2.7 million deaths in low and middle-income countries. The impact of zoonotic diseases on human health is evident from previous outbreaks that have plagued the human race on a global scale. Therefore, based on the above facts, the following recommendations are forwarded:

- Since zoonotic diseases can infect both humans and animals, medical and veterinary communities should work jointly in clinical, epidemiological, public health and research settings so as to strengthen the collaboration between them implementing one health approach;
- Strong active and passive surveillance system should be established so that emerging and re-emerging zoonotic diseases can be identified before they cause serious impact on the public and economy of the country;
- Continuous awareness creations and educations focusing on the integrative approach for disease prevention and control should be given for responsible bodies in animal, human, and environmental health sectors;
- Early warning and emergency preparedness plan at national level should be set both in public and animal health aspects;
- Due emphasis should be given to those factors that contribute directly and/or indirectly to the emergence and re-emergence of zoonotic diseases in developing countries where there is resource limitation.

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