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Zoonosis

Zoonosis	
Other names	Zoönosis
 A dog with rabies.	
Pronunciation	/zoʊˈɒnəsɪs, ˌzoʊəˈnoʊsɪs/[1]
Specialty	Infectious disease

A **zoonosis** (plural zoonoses, or zoonotic diseases) is an infectious disease caused by a pathogen (an infectious agent, such as a bacterium, virus, parasite or prion) that has jumped from a non-human animal (usually a vertebrate) to a human.[1][2][3] Typically, the first infected human transmits the infectious agent to at least one other human, who, in turn, infects others.

Major modern diseases such as Ebola virus disease and salmonellosis are zoonoses. HIV was a zoonotic disease transmitted to humans in the early part of the 20th century, though it has now mutated to a separate human-only disease. Most strains of influenza that infect humans are human diseases, although many strains of bird flu and swine flu are zoonoses; these viruses occasionally recombine with human strains of the flu and can cause pandemics such as the 1918 Spanish flu or the 2009 swine flu.[4] *Taenia solium* infection is one of the neglected tropical diseases with public health and veterinary concern in endemic regions.[5] Zoonoses can be caused by a range of disease pathogens such as viruses, bacteria, fungi and parasites; of 1,415 pathogens known to infect humans, 61% were zoonotic.[6] Most human diseases originated in other animals; however, only diseases that routinely involve non-human to human transmission, such as rabies, are considered direct zoonosis.[7]

Zoonoses have different modes of transmission. In direct zoonosis the disease is directly transmitted from other animals to humans through media such as air (influenza) or through bites and saliva (rabies).[8] In contrast, transmission can also occur via an intermediate species (referred to as a vector), which carry the disease pathogen without getting sick. When humans infect other animals, it is called reverse zoonosis or anthroponosis.[9] The term is from Greek: ζῷον *zoon* "animal" and νόσος *nosos* "sickness".

Contents

Causes

Zoonotic transmission can occur in any context in which there is contact with or consumption of animals, animal products, or animal derivatives. This can occur in a companionistic (pets), economic (farming, trade, butchering, etc.), predatory (hunting, butchering or consuming wild game) or research context.

Contamination of food or water supply

The most significant zoonotic pathogens causing foodborne diseases are *Escherichia coli* O157:H7, *Campylobacter*, *Caliciviridae*, and *Salmonella*.[10][11][12]

In 2006 a conference held in Berlin focused on the issue of zoonotic pathogen effects on food safety, urging government intervention and public vigilance against the risks of catching food-borne diseases from farm-to-table dining.[13]

Many food outbreaks can be linked to zoonotic pathogens. Many different types of food that have an animal origin can become contaminated. Some common foods linked to zoonotic contaminations include eggs, seafood, meat, dairy, and even some vegetables.[14] Outbreaks involving contaminated food should be handled in preparedness plans to prevent widespread outbreaks and to efficiently and effectively contain outbreaks.

Farming, ranching and animal husbandry

Contact with farm animals can lead to disease in farmers or others that come into contact with infected farm animals. Glanders primarily affects those who work closely with horses and donkeys. Close contact with cattle can lead to cutaneous anthrax infection, whereas inhalation anthrax infection is more common for workers in slaughterhouses, tanneries and wool mills.[15] Close contact with sheep who have recently given birth can lead to clamydiosis, or enzootic abortion, in pregnant women, as well as an increased risk of Q fever, toxoplasmosis, and listeriosis in pregnant or the otherwise immunocompromised. Echinococcosis is caused by a tapeworm which can be spread from infected sheep by food or water contaminated with feces or wool. Bird flu is common in chickens. While rare in humans, the main public health worry is that a strain of bird flu will recombine with a human flu virus and cause a pandemic like the 1918 Spanish flu. In 2017, free range chickens in the UK were temporarily ordered to remain inside due to the threat of bird flu.[16] Cattle are an important reservoir of cryptosporidiosis[17] and mainly affects the immunocompromised. Recent reports have shown Minks can also get infected.[18]

Veterinarians are exposed to unique occupational hazards and zoonotic diseases. In the US, studies have highlighted an increased risk to injuries and a lack of veterinary awareness for these hazards. Research has proved the importance for continued clinical veterinarian education on occupational risks associated with

musculoskeletal injuries, animal bites, needle-sticks, and cuts.[19]

A July 2020 report by the United Nations Environment Programme stated that the increase in zoonotic pandemics is directly attributable to anthropogenic destruction of nature and the increased global demand for meat, and that the industrial farming of pigs and chickens in particular will be a primary risk factor for the spillover of zoonotic diseases in the future.[20]

Wild animal attacks

- Rabies

Insect vectors

- African sleeping sickness
- Dirofilariasis
- Eastern equine encephalitis
- Japanese encephalitis
- Saint Louis encephalitis
- Scrub typhus
- Tularemia
- Venezuelan equine encephalitis
- West Nile fever
- Western equine encephalitis
- Zika fever

Pets

Pets can transmit a number of diseases. Dogs and cats are routinely vaccinated against rabies. Pets can also transmit ringworm and *Giardia*, which are endemic in both animal and human populations. Toxoplasmosis is a common infection of cats; in humans it is a mild disease although it can be dangerous to pregnant women.[21] Dirofilariasis is caused by *Dirofilaria immitis* through mosquitoes infected by mammals like dogs and cats. Cat-scratch disease is caused by *Bartonella henselae* and *Bartonella quintana* from fleas which are endemic in cats. Toxocariasis is infection of humans of any of species of roundworm, including species specific to the dog (*Toxocara canis)* or the cat (*Toxocara cati*). Cryptosporidiosis can be spread to humans from pet lizards, such as the leopard gecko. *Encephalitozoon cuniculi* is a microsporidial parasite carried by many mammals, including rabbits, and is an important opportunistic pathogen in people immunocompromised by HIV/AIDS, organ transplantation, or CD4+ T-lymphocyte deficiency.[22]

Exhibition

Outbreaks of zoonoses have been traced to human interaction with and exposure to other animals at fairs, live animal markets,[23] petting zoos, and other settings. In 2005, the Centers for Disease Control and Prevention (CDC) issued an updated list of recommendations for preventing zoonosis transmission in public settings.[24] The recommendations, developed in conjunction with the National Association of State Public Health Veterinarians,[25] include educational responsibilities of venue operators, limiting public animal contact, and animal care and management.

Hunting and bushmeat

- COVID-19
- HIV
- SARS

Deforestation

Kate Jones, chair of ecology and biodiversity at University College London, says zoonotic diseases are Increasingly linked to environmental change and human behaviour. The disruption of pristine forests driven by logging, mining, road building through remote places, rapid urbanisation and population growth is bringing people into closer contact with animal species they may never have been near before. The resulting transmission of disease from wildlife to humans, she says, is now “a hidden cost of human economic development".[26] In a guest article published by IPBES, Peter Daszak and three co-chairs of the 2019 *Global Assessment Report on Biodiversity and Ecosystem Services*, Josef Settele, Sandra Díaz and Eduardo Brondizio, write that "rampant deforestation, uncontrolled expansion of agriculture, intensive farming, mining and infrastructure development, as well as the exploitation of wild species have created a ‘perfect storm’ for the spillover of diseases from wildlife to people."[27]

Biodiversity loss and environmental degradation

An April 2020 study published in the *Proceedings of the Royal Society* Part B found that increased virus spillover events from animals to humans can be linked to biodiversity loss and environmental degradation, as humans further encroach on wildlands to engage in agriculture, hunting and resource extraction they become exposed to pathogens which normally would remain in these areas. Such spillover events have been tripling every decade since 1980.[28] An August 2020 study published in *Nature* concludes that the anthropogenic destruction of ecosystems for the purpose of expanding agriculture and human settlements reduces biodiversity and allows for smaller animals such as bats and rats, who are more adaptable to human pressures and also carry the most zoonotic diseases, to proliferate. This in turn can result in more pandemics.[29]

Secondary transmission

- Ebola and Marburg

Lists of diseases

Disease[30]	Pathogen(s)	Animals involved	Mode of transmission	Emergence
African sleeping sickness	*Trypanosoma brucei rhodesiense*	range of wild animals and domestic livestock	transmitted by the bite of the tsetse fly	Occurred around 1900-1920 Only (Africa)
Angiostrongyliasis	*Angiostrongylus cantonensis*, *Angiostrongylus costaricensis*	rats, cotton rats	consuming raw or undercooked snails, slugs, other mollusks, crustaceans, contaminated water, and unwashed vegetables contaminated with larvae	
Anisakiasis	*Anisakis*	whales, dolphins, seals, sea lions, other marine animals	eating raw or undercooked fish and squid contaminated with eggs	
Anthrax	*Bacillus anthracis*	commonly – grazing herbivores such as cattle, sheep, goats, camels, horses, and pigs	by ingestion, inhalation or skin contact of spores	
Babesiosis	*Babesia* spp.	mice, other animals	tick bite	
Baylisascariasis	*Baylisascaris procyonis*	raccoons	ingestion of eggs in feces	
Barmah Forest fever	*Barmah Forest virus*	kangaroos, wallabies, opossums	mosquito bite	
Bird flu	Influenza A virus subtype H5N1	wild birds, domesticated birds such as chickens	close contact	2003-2019 Avian Influenza in Southeast Asia and Egypt
Bovine spongiform encephalopathy	Prions	cattle	eating infected meat	
Brucellosis	*Brucella* spp.	cattle, goats	infected milk or meat	
Bubonic plague, Pneumonic plague, Septicemic plague, Sylvatic plague	*Yersinia pestis*	rabbits, hares, rodents, ferrets, goats, sheep, camels	flea bite	Epidemics like Black Death in 1347, Third Plague Pandemic in China and India
Capillariasis	*Capillaria* spp.	rodents, birds, foxes	eating raw or undercooked fish, ingesting embryonated eggs in fecal-contaminated food, water, or soil	
Cat-scratch disease	*Bartonella henselae*	cats	bites or scratches from infected cats	
Chagas disease	*Trypanosoma cruzi*	armadillos, Triatominae (kissing bug)	Contact of mucosae or wounds with feces of kissing bugs. Accidental ingestion of parasites in food contaminated by bugs or infected mammal excretae.	

Clamydiosis / Enzootic abortion	*Chlamydophila abortus*	domestic livestock, particularly sheep	close contact with postpartum ewes	
COVID-19	*severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)*	suspected: bats, pangolins, felines, minks	respiratory transmission	COVID-19 pandemic Ongoing pandemic
Creutzfeldt-Jacob disease	PrP^{vCJD}	cattle	eating meat from animals with bovine spongiform encephalopathy (BSE)	1996-2001 United Kingdom
Crimean–Congo hemorrhagic fever	*Crimean-Congo hemorrhagic fever orthonairovirus*	cattle, goats, sheep, birds, multimammate rats, hares	tick bite, contact with bodily fluids	
Cryptococcosis	*Cryptococcus neoformans*	commonly – birds like pigeons	inhaling fungi	
Cryptosporidiosis	*Cryptosporidium* spp.	cattle, dogs, cats, mice, pigs, horses, deer, sheep, goats, rabbits, leopard geckos, birds	ingesting cysts from water contaminated with feces	
Cysticercosis and taeniasis	*Taenia solium*, *Taenia asiatica*, *Taenia saginata*	commonly – pigs and cattle	consuming water, soil or food contaminated with the tapeworm eggs (cysticercosis) or raw or undercooked pork contaminated with the cysticerci (taeniasis)	
Dirofilariasis	*Dirofilaria* spp.	dogs, wolves, coyotes, foxes, jackals, cats, monkeys, raccoons, bears, muskrats, rabbits, leopards, seals, sea lions, beavers, ferrets, reptiles	mosquito bite	
Eastern equine encephalitis, Venezuelan equine encephalitis, Western equine encephalitis	*Eastern equine encephalitis virus*, *Venezuelan equine encephalitis virus*, *Western equine encephalitis virus*	horses, donkeys, zebras, birds	mosquito bite	
Ebola virus disease (a haemorrhagic fever)	*Ebolavirus* spp.	chimpanzees, gorillas, orangutans, fruit bats, monkeys, shrews, forest antelope and porcupines	through body fluids and organs	2013-2016; possible in Africa
Other haemorrhagic fevers (Crimean-Congo haemorrhagic fever, Dengue fever, Lassa fever, Marburg viral haemorrhagic fever, Rift Valley fever[31])	Varies – commonly viruses	varies (sometimes unknown) – commonly camels, rabbits, hares, hedgehogs, cattle, sheep, goats, horses and swine	infection usually occurs through direct contact with infected animals	

Echinococcosis	*Echinococcus* spp.	commonly – dogs, foxes, jackals, wolves, coyotes, sheep, pigs, rodents	ingestion of infective eggs from contaminated food or water with feces of an infected, definitive host or fur	
Fasciolosis	*Fasciola hepatica*, *Fasciola gigantica*	sheep, cattle, buffaloes	ingesting contaminated plants	
Foodborne illnesses (commonly diarrheal diseases)	*Campylobacter* spp., *Escherichia coli*, *Salmonella* spp., *Listeria* spp., *Shigella* spp. and *Trichinella* spp.	animals domesticated for food production (cattle, poultry)	raw or undercooked food made from animals and unwashed vegetables contaminated with feces	
Giardiasis	*Giardia lamblia*	beavers, other rodents, raccoons, deer, cattle, goats, sheep, dogs, cats	ingesting spores and cysts in food and water contaminated with feces	
Glanders	*Burkholderia mallei.*	horses, donkeys	direct contact	
Gnathostomiasis	*Gnathostoma* spp.	dogs, minks, opossums, cats, lions, tigers, leopards, raccoons, poultry, other birds, frogs	raw or undercooked fish or meat	
Hantavirus	*Hantavirus* spp.	deer mice, cotton rats and other rodents	exposure to feces, urine, saliva or bodily fluids	
Henipavirus	*Henipavirus* spp.	horses, bats	exposure to feces, urine, saliva or contact with sick horses	
Histoplasmosis	*Histoplasma capsulatum*	birds, bats	inhaling fungi in guano	
Influenza	*Influenza A virus*	horses, pigs, domestic and wild birds, wild aquatic mammals such as seals and whales, minks and farmed carnivores	droplets transmitted through air[32][33]	Spanish Flu in 1918 after WWI
Japanese encephalitis	*Japanese encephalitis virus*	pigs, water birds	mosquito bite	
Kyasanur Forest disease	*Kyasanur Forest disease virus*	rodents, shrews, bats, monkeys	tick bite	
La Crosse encephalitis	*La Crosse virus*	chipmunks, tree squirrels	mosquito bite	
Leishmaniasis	*Leishmania* spp.	dogs, rodents, other animals[34][35]	sandfly bite	2004 Afghanistan
Leprosy	*Mycobacterium leprae*, *Mycobacterium lepromatosis*	armadillos, monkeys, rabbits, mice[36]	direct contact, including meat consumption. However, scientists believe most infections are spread human to human.[36][37]	

Leptospirosis	*Leptospira interrogans*	rats, mice, pigs, horses, goats, sheep, cattle, buffaloes, opossums, raccoons, mongooses, foxes, dogs	direct or indirect contact with urine of infected animals	1616-20 New England infection United States-Native Americans
Lassa fever	*Lassa fever virus*	rodents	exposure to rodents	
Lyme disease	*Borrelia burgdorferi*	deer, wolves, dogs, birds, rodents, rabbits, hares, reptiles	tick bite	
Lymphocytic choriomeningitis	*Lymphocytic choriomeningitis virus*	rodents	exposure to urine, feces, or saliva	
Melioidosis	*Burkholderia pseudomallei*	various animals	direct contact with contaminated soil and surface water	
Microsporidiosis	*Encephalitozoon cuniculi*	Rabbits, dogs, mice, and other mammals	ingestion of spores	
Middle East respiratory syndrome	*MERS coronavirus*	bats, camels	close contact	2012–present Saudi Arabia
Monkeypox	*Monkeypox virus*	rodents, primates	contact with infected rodents, primates, or contaminated materials	
Nipah virus infection	*Nipah virus (NiV)*	bats, pigs	direct contact with infected bats, infected pigs	
Orf	*Orf virus*	goats, sheep	close contact	
Psittacosis	*Chlamydophila psittaci*	macaws, cockatiels, budgerigars, pigeons, sparrows, ducks, hens, gulls and many other bird species	contact with bird droplets	
Q fever	*Coxiella burnetii*	livestock and other domestic animals such as dogs and cats	inhalation of spores, contact with bodily fluid or faeces	
Rabies	*Rabies virus*	commonly – dogs, bats, monkeys, raccoons, foxes, skunks, cattle, goats, sheep, wolves, coyotes, groundhogs, horses, mongooses and cats	through saliva by biting, or through scratches from an infected animal	Variety of places like Oceanic, South America, Europe; Year is unknown
Rat-bite fever	*Streptobacillus moniliformis*, *Spirillum minus*	rats, mice	bites of rats but also urine and mucus secretions	
Rift Valley fever	*Phlebovirus*	livestock, buffaloes, camels	mosquito bite, contact with bodily fluids, blood, tissues, breathing around butchered animals or raw milk	2006-07 East Africa outbreak
Rocky Mountain spotted fever	*Rickettsia rickettsii*	dogs, rodents	tick bite	
Ross River fever	*Ross River virus*	kangaroos, wallabies, horses, opossums, birds, flying foxes	mosquito bite	

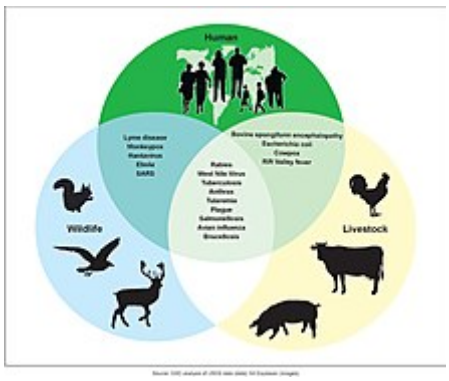
Saint Louis encephalitis	*Saint Louis encephalitis virus*	birds	mosquito bite	
Severe acute respiratory syndrome	*SARS coronavirus*	bats, civets	close contact, respiratory droplets	2002-2004 SARS; started in China
Swine influenza	any strain of the influenza virus endemic in pigs (excludes H1N1 swine flu, which is a human virus)	pigs	close contact	2009-10
Taenia crassiceps infection	*Taenia crassiceps*	wolves, coyotes, jackals, foxes	contact with soil contaminated with feces	
Toxocariasis	*Toxocara canis*, *Toxocara cati*	dogs, foxes, cats	ingestion of eggs in soil, fresh or unwashed vegetables or undercooked meat	
Toxoplasmosis	*Toxoplasma gondii*	cats, livestock, poultry	exposure to cat feces, organ transplantation, blood transfusion, contaminated soil, water, grass, unwashed vegetables, unpasteurized dairy products and undercooked meat	
Trichinosis	*Trichinella* spp.	rodents, pigs, horses, bears, walruses, dogs, foxes, crocodiles, birds	eating undercooked meat	
Tuberculosis	*Mycobacterium bovis*	infected cattle, deer, llamas, pigs, domestic cats, wild carnivores (foxes, coyotes) and omnivores (possums, mustelids and rodents)	milk, exhaled air, sputum, urine, faeces and pus from infected animals	
Tularemia	*Francisella tularensis*	lagomorphs (type A), rodents (type B), birds	ticks, deer flies, and other insects including mosquitoes	
West Nile fever	*Flavivirus*	birds, horses	mosquito bite	
Zika fever	*Zika virus*	chimpanzees, gorillas, orangutans, monkeys, baboons	mosquito bite, sexual intercourse, blood transfusion and sometimes bites of monkeys	2015-16 in the Americas and Oceanic

History

During most of human prehistory groups of hunter-gatherers were probably very small. Such groups probably made contact with other such bands only rarely. Such isolation would have caused epidemic diseases to be restricted to any given local population, because propagation and expansion of epidemics depend on frequent contact with other individuals who have not yet developed an adequate immune response. To persist in such a population, a pathogen either had to be a chronic infection, staying present and potentially infectious in the infected host for long periods, or it had to have other additional species as reservoir where it can maintain itself

until further susceptible hosts are contacted and infected. In fact, for many 'human' diseases, the human is actually better viewed as an accidental or incidental victim and a dead-end host. Examples include rabies, anthrax, tularemia and West Nile virus. Thus, much of human exposure to infectious disease has been zoonotic.

Many modern diseases, even epidemic diseases, started out as zoonotic diseases. It is hard to establish with certainty which diseases jumped from other animals to humans, but there is increasing evidence from DNA and RNA sequencing, that measles, smallpox, influenza, HIV, and diphtheria came to humans this way. Various forms of the common cold and tuberculosis also are adaptations of strains originating in other species. Some experts have suggested that all human viral infections were originally zoonotic.[38]



Possibilities for zoonotic disease transmissions

Zoonoses are of interest because they are often previously unrecognized diseases or have increased virulence in populations lacking immunity. The West Nile virus appeared in the United States in 1999 in the New York City area, and moved through the country in the summer of 2002, causing much distress. Bubonic plague is a zoonotic disease,[39] as are salmonellosis, Rocky Mountain spotted fever, and Lyme disease.

A major factor contributing to the appearance of new zoonotic pathogens in human populations is increased contact between humans and wildlife.[40] This can be caused either by encroachment of human activity into wilderness areas or by movement of wild animals into areas of human activity. An example of this is the outbreak of Nipah virus in peninsular Malaysia in 1999, when intensive pig farming began on the habitat of infected fruit bats. Unidentified infection of the pigs amplified the force of infection, eventually transmitting the virus to farmers and causing 105 human deaths.[41]

Similarly, in recent times avian influenza and West Nile virus have spilled over into human populations probably due to interactions between the carrier host and domestic animals. Highly mobile animals such as bats and birds may present a greater risk of zoonotic transmission than other animals due to the ease with which they can move into areas of human habitation.

Because they depend on the human host for part of their life-cycle, diseases such as African schistosomiasis, river blindness, and elephantiasis are *not* defined as zoonotic, even though they may depend on transmission by insects or other vectors.

Use in vaccines

The first vaccine against smallpox by Edward Jenner in 1800 was by infection of a zoonotic bovine virus which caused a disease called cowpox. Jenner had noticed that milkmaids were resistant to smallpox. Milkmaids contracted a milder version of the disease from infected cows that conferred cross immunity to the human disease. Jenner abstracted an infectious preparation of 'cowpox' and subsequently used it to inoculate persons against smallpox. As a result, smallpox has been eradicated globally, and mass vaccination against this disease ceased in 1981.

See also

- Animal welfare#Animal welfare organizations – The well-being of (non-human) animals
- Conservation medicine
- Cross-species transmission

- Emerging infectious disease – Infectious disease of emerging pathogen, often novel in its outbreak range or transmission mode
- Foodborne illness – Illness resulting from food that is spoiled or contaminated by pathogenic bacteria, viruses, parasites, or toxins
- Spillover infection – Occurs when a reservoir population causes an epidemic in a novel host population
- Wildlife disease
- Veterinary medicine – Deals with the diseases of animals, animal welfare, etc.
- Wildlife smuggling and zoonoses – Health risks associated with the trade in exotic wildlife
- List of zoonotic primate viruses – Wikipedia list article

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External links

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- WHO tropical diseases and zoonoses (http://www.emro.who.int/entity/zoonoses/)
- Detection and Forensic Analysis of Wildlife and Zoonotic Disease (https://inlportal.inl.gov/portal/server.pt/community/idaho_national_laboratory_biological_systems/352/molecular_forensics/2691)
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