THE ARBOVIRUS

Arbovirus is a term used to refer to any virus that is transmitted by arthropod vectors. The word *arbovirus* is an acronym (**AR**thropod-**BO**rne virus). Arboviruses can affect both animals, including humans, and plants. In humans, symptoms of arbovirus infection generally occur 3–15 days after exposure to the virus and last 3 or 4 days. The most common clinical features of infection are fever, headache, and malaise, but encephalitis and hemorrhagic fever may also occur.

The arboviruses fall into four main classes known as families Bunyaviridae, Flaviviridae, Reoviridae and Togaviridae, the main arboviruses that are of public health significance in this country belong to the Flaviviridae, and Togaviridae families. YFV, ZIKV and DENV belong to the family Flaviviridae, while the Chikungunya virus belongs to the family Togaviridae genus Alphavirus.

Transmission

Arboviruses maintain themselves in nature by going through a cycle between a host, an organism that carries the virus, and a vector, an organism that carries and transmits the virus to other organisms. Arbovirus vectors are commonly mosquitoes, ticks, sandflies and other arthropods that consume the blood of vertebrates for nutritious or developmental purposes. Vertebrates which have their blood consumed act as the hosts, with each vector generally having an affinity for the blood of specific species, making those species the hosts.[

Transmission between the vector and the host occurs when the vector feeds on the blood of the vertebrate, wherein the virus that has established an infection in the salivary glands of the vector comes into contact with the host's blood. While the virus is inside the host, it undergoes a process called amplification, where the virus replicates at sufficient levels to induce viremia, a condition in which there are large numbers of viruses present in the blood. The abundance of viruses in the host's blood allows the host to transmit the virus to other organisms if its blood is consumed by them. When uninfected vectors become infected from feeding, they are then capable of transmitting the virus to uninfected hosts, resuming amplification of virus populations. If viremia is not achieved in a vertebrate, the species can be called a "dead-end host", as the virus cannot be transmitted back to the vector.

Person-to-person transmission of arboviruses is not common, but can occur. Blood transfusions, organ transplantation, and the use of blood products can transmit arboviruses if the virus is present in the donor's blood or organs. Because of this, blood and organs are often screened for viruses before being administered. Rarely, vertical transmission, or mother-to-child transmission, has been observed in infected pregnant and breastfeeding women. Exposure to used needles may also transmit arboviruses if they have been used by an infected person or animal. This puts intravenous drug users and healthcare workers at risk for infection in regions where the arbovirus may be spreading in human populations.

Signs and Symptoms

The incubation period - the time between when infection occurs and when symptoms appear - varies from virus to virus, but is usually limited between 2 and 15 days for arboviruses. The majority of infections, however, are asymptomatic. Among cases in which symptoms do appear, symptoms

tend to be non-specific, resembling a flu-like illness, and are not indicative of a specific causative agent. These symptoms include fever, headache, malaise, rash and fatigue. Rarely, vomiting and hemorrhagic fever may occur. The central nervous system can also be affected by infection, as encephalitis and meningitis are sometimes observed. Prognosis is good for most people, but is poor in those who develop severe symptoms, with up to a 20% mortality rate in this population depending on the virus. The very young, elderly, pregnant women, and people with immune deficiencies are more likely to develop severe symptoms

Diagnosis

Preliminary diagnosis of arbovirus infection is usually based on clinical presentations of symptoms, places and dates of travel, activities, and epidemiological history of the location where infection occurred. Definitive diagnosis is typically made in a laboratory by employing some combination of blood tests, particularly immunologic, serologic and/or virologic techniques such as ELISA, polymerase chain reaction, neutralization test, and hemagglutination-inhibition test.

Prevention

Vector control measures, especially mosquito control, are essential to reducing the transmission of disease by arboviruses. Habitat control involves draining swamps and removal of other pools of stagnant water (such as old tires, large outdoor potted plants, empty cans, etc.) that often serve as breeding grounds for mosquitoes. Insecticides can be applied in rural and urban areas, inside houses and other buildings, or in outdoor environments. They are often quite effective for controlling arthropod populations, though use of some of these chemicals is controversial, and some organophosphates and organochlorides (such as DDT) have been banned in many countries. Infertile male mosquitoes have been introduced in some areas in order to reduce the breeding rate of relevant mosquito species. Larvicides are also used worldwide in mosquito abatement programs. Temefos is a common mosquito larvicide.

People can also reduce the risk of getting bitten by arthropods by employing personal protective measures such as sleeping under mosquito nets, wearing protective clothing, applying insect repellents such as permethrin and DEET to clothing and exposed skin, and (where possible) avoiding areas known to harbor high arthropod populations. Arboviral encephalitis can be prevented in two major ways: personal protective measures and public health measures to reduce the population of infected mosquitoes. Personal measures include reducing time outdoors particularly in early evening hours, wearing long pants and long sleeved shirts and applying mosquito repellent to exposed skin areas. Public health measures often require spraying of insecticides to kill juvenile (larvae) and adult mosquitoes.

Vaccination is available for a limited number of arboviruses -Yellow fever and Japanese encephalitis while vaccines for others like Zika, Dengue are under development.

YELLOW FEVER (YFV):

Yellow fever is an acute viral hemorrhagic disease transmitted by infected mosquitoes. The "yellow" in the name refers to the jaundice that affects some patients. It is one of the more prominent of the arboviruses occurring in the Africa region and it is caused by a virus of the genus *Flavivirus* which is transmitted to humans by the bites of infected *aedes* and *haemogogus* mosquitoes.

Yellow fever is difficult to diagnose, especially during the early stages. It can be confused with severe malaria, dengue hemorrhagic fever, leptospirosis, viral hepatitis (especially the fulminating forms of hepatitis B and D), other hemorrhagic fevers (Bolivian, Argentine and Venezuelan hemorrhagic fevers as well as other Flaviviridae such as the West Nile and Zika viruses) and other diseases, as well as poisoning.

Signs and symptoms

Once contracted, the yellow fever virus incubates in the body for 3 to 6 days. Many people do not experience symptoms, but when these do occur, the most common are fever, muscle pain with prominent backache, headache, loss of appetite, and nausea or vomiting. In most cases, symptoms disappear after 3 to 4 days.

A small percentage of patients, however, enter a second, more toxic phase within 24 hours of recovering from initial symptoms. High fever returns and several body systems are affected, usually the liver and the kidneys. In this phase people are likely to develop jaundice (yellowing of the skin and eyes, hence the name 'yellow fever'), dark urine and abdominal pain with vomiting. Bleeding can occur from the mouth, nose, eyes or stomach. Half of the patients who enter the toxic phase die within 7 - 10 days.

Yellow fever is difficult to diagnose, especially during the early stages. More severe disease can be confused with severe malaria, leptospirosis, viral hepatitis (especially fulminant forms), other haemorrhagic fevers, infection with other flaviviruses (e.g. dengue haemorrhagic fever), and poisoning. Blood tests can detect yellow fever antibodies produced in response to the infection. Several other techniques are used to identify the virus in blood specimens or liver tissue collected after death. These tests require highly trained laboratory staff and specialized equipment and materials

Transmission of Yellow Fever

The yellow fever virus is an arbovirus of the flavivirus genus and is transmitted by mosquitoes, belonging to the Aedes and Haemogogus species. The different mosquito species live in different habitats - some breed around houses (domestic), others in the jungle (wild), and some in both habitats (semi-domestic). There are 3 types of transmission cycles:

1. Sylvatic (or jungle): In tropical rainforests, yellow fever occurs in monkeys that pass the virus to mosquitoes that feed on them. The infected mosquitoes bite humans entering the forest resulting in sporadic cases of yellow fever, usually in young men working in the forest (e.g. loggers).

2. Intermediate: In humid or semi-humid parts of Africa, small-scale epidemics occur. Semi-domestic mosquitoes (that breed in the wild and around households) infect both monkeys and people. Increased contact between people and infected mosquitoes leads to transmission. Many separate villages in an area can suffer cases simultaneously. This is the most common type of outbreak in Africa. An outbreak can become a more severe epidemic if the infection is carried into an area populated with both domestic mosquitoes and unvaccinated people.

3. Urban: Large epidemics occur when infected people introduce the virus into a densely populated area with a high number of non-immune people and *Aedes* mosquitoes. Infected mosquitoes transmit the virus from person to person.

Treatment

Good and early supportive treatment in hospitals improves survival rates. There is currently no specific anti-viral drug for yellow fever but specific care to treat dehydration, liver and kidney failure, and fever improves outcomes. Associated bacterial infections can be treated with antibiotics.

Prevention

Multiple strategies exist for the prevention and control of Yellow Fever and they include;

1. Vaccination

Vaccination is the most important means of preventing yellow fever. In high-risk areas where vaccination coverage is low, prompt recognition and control of outbreaks using mass immunization is critical for preventing epidemics. It is important to vaccinate most (80 % or more) of the population at risk to prevent transmission in a region with a yellow fever outbreak.

Several vaccination strategies are used to protect against outbreaks: routine infant immunization; mass vaccination campaigns designed to increase coverage in countries at risk; and vaccination of travelers going to yellow fever endemic areas.

The yellow fever vaccine is safe and affordable and a single dose provides life-long protection against yellow fever disease. A booster dose of yellow fever vaccine is not needed.

Certain category of persons and situations are usually excluded from vaccination including:

- infants aged less than 9 months, except during an epidemic when infants aged 6-9 months, in
- areas where the risk of infection is high, should also receive the vaccine; pregnant women – except
- during a yellow fever outbreak when the risk of infection is high; people with severe allergies to egg
- protein; and people with severe immunodeficiency due to symptomatic HIV/AIDS or other causes,
- or who have a thymus disorder.

- In accordance with the International Health Regulations (IHR), countries have the right to require
- travelers to provide a certificate of yellow fever vaccination. If there are medical grounds for not
- getting vaccinated, this must be certified by the appropriate authorities. The IHR are a legally
- binding framework to stop the spread of infectious diseases and other health threats. Requiring the
- certificate of vaccination from travellers is at the discretion of each State Party, and it is not
- currently required by all countries.

2. Mosquito control

The risk of yellow fever transmission in urban areas can be reduced by eliminating potential mosquito breeding sites by applying larvicides to water storage containers and other places where standing water collects. Insecticide spraying to kill adult mosquitoes during urban epidemics can help reduce the number of mosquitoes, thus reducing potential sources of yellow fever transmission.

3. Epidemic preparedness and response

Prompt detection of yellow fever and rapid response through emergency vaccination campaigns are essential for controlling outbreaks. WHO recommends that every at-risk country have at least one national laboratory where basic yellow fever blood tests can be performed. One laboratory-confirmed case of yellow fever in an unvaccinated population is considered an outbreak. A confirmed case in any context must be fully investigated, particularly in an area where most of the population has been vaccinated. Investigation teams must assess and respond to the outbreak with both emergency measures and longer-term immunization plans.

Credits-World Health Organization

DENGUE FEVER

Dengue fever virus (DENV) is an RNA virus of the family *Flaviviridae*; genus *Flavivirus* the same genus as yellow fever virus. Most are transmitted by arthropods (mosquitoes or ticks), and are therefore also referred to as arboviruses (*ar*thropod-*bo*rne viruses).[25]There are five[7] strains of the virus, called serotypes, of which the first four are referred to as DENV-1, DENV-2, DENV-3 and DENV-4.[16] The fifth type was announced in 2013.[7] The distinctions between the serotypes are based on their antigenicity.[30]

Signs and Symptoms

Dengue fever is a severe, flu-like illness that affects infants, young children and adults, but seldom causes death.

Dengue should be suspected when a high fever (40°C/104°F) is accompanied by 2 of the following symptoms: severe headache, pain behind the eyes, muscle and joint pains, nausea, vomiting, swollen glands or rash. Symptoms usually last for 2–7 days, after an incubation period of 4–10 days after the bite from an infected mosquito.

Severe dengue is a potentially deadly complication due to plasma leaking, fluid accumulation, respiratory distress, severe bleeding, or organ impairment. Warning signs occur 3–7 days after the first symptoms in conjunction with a decrease in temperature (below 38°C/100°F) and include: severe abdominal pain, persistent vomiting, rapid breathing, bleeding gums, fatigue, restlessness and blood in vomit. The next 24–48 hours of the critical stage can be lethal; proper medical care is needed to avoid complications and risk of death.

Transmission

The *Aedes aegypti* mosquito is the primary vector of dengue. The virus is transmitted to humans through the bites of infected female mosquitoes. After virus incubation for 4–10 days, an infected mosquito is capable of transmitting the virus for the rest of its life.

Infected symptomatic or asymptomatic humans are the main carriers and multipliers of the virus, serving as a source of the virus for uninfected mosquitoes. Patients who are already infected with the dengue virus can transmit the infection (for 4–5 days; maximum 12) via *Aedes* mosquitoes after their first symptoms appear.

The *Aedes aegypti* mosquito lives in urban habitats and breeds mostly in man-made containers. Unlike other mosquitoes *Ae. aegypti* is a day-time feeder; its peak biting periods are early in the morning and in the evening before dusk. Female *Ae. aegypti* bites multiple people during each feeding period. *Aedes albopictus*, is a secondary dengue vector.

Treatment

There is no specific treatment for dengue fever.

For severe dengue, medical care by physicians and nurses experienced with the effects and progression of the disease can save lives – decreasing mortality rates from more than 20% to less than 1%. Maintenance of the patient's body fluid volume is critical to severe dengue care.

Immunization

In late 2015 and early 2016, the first dengue vaccine, Dengvaxia (CYD-TDV) by Sanofi Pasteur, was registered in several countries for use in individuals 9-45 years of age living in endemic areas.

WHO recommends that countries should consider introduction of the dengue vaccine CYD-TDV only in geographic settings (national or subnational) where epidemiological data indicate a high burden of disease. Complete recommendations may be found in the WHO position paper on dengue:

Prevention and control

At present, the main method to control or prevent the transmission of dengue virus is to combat vector mosquitoes through:preventing mosquitoes from accessing egg-laying habitats by environmental management and modification;disposing of solid waste properly and removing artificial man-made habitats; covering, emptying and cleaning of domestic water storage containers on a weekly basis; applying appropriate insecticides to water storage outdoor containers; using of personal household protection such as window screens, long-sleeved clothes, insecticide treated materials, coils and vaporizers; improving community participation and mobilization for sustained vector control; applying insecticides as space spraying during outbreaks as one of the emergency vector-control measures; active monitoring and surveillance of vectors should be carried out to determine effectiveness of control interventions.

Careful clinical detection and management of dengue patients can significantly reduce mortality rates from severe dengue.

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ZIKA VIRUS DISEASE

Zika virus disease is caused by a virus transmitted primarily by *Aedes* mosquitoes. The Zika virus is a flavivirus that was first identified in Uganda in 1947 in monkeys. It was later identified in humans in 1952 in Uganda and the United Republic of Tanzania. The latest outbreak of Zika virus was reported in Brazil in 2015. An association has been reported between Zika virus infection and Guillain-Barré syndrome and microcephaly.

Signs and Symptoms

The incubation period (the time from exposure to symptoms) of Zika virus disease is not clear, but is likely to be a few days. The symptoms are similar to other arbovirus infections such as dengue, and include fever, skin rashes, conjunctivitis, muscle and joint pain, malaise, and headache. These symptoms are usually mild and last for 2-7 days.

Complications of Zika virus disease

Zika virus infection during pregnancy is a cause of congenital brain abnormalities, including microcephaly. Zika virus is also a trigger of Guillain-Barré syndrome. Intense efforts are continuing to investigate the link between Zika virus and a range of neurological disorders, within a rigorous research framework.

Transmission

Zika virus is primarily transmitted to people through the bite of an infected mosquito from the *Aedes* genus, mainly *Aedes aegypti* in tropical regions. *Aedes* mosquitoes usually bite during the day, peaking during early morning and late afternoon/evening. This is the same mosquito that transmits dengue, chikungunya and yellow fever. Sexual transmission of Zika virus is also possible. Other modes of transmission such as blood transfusion are being investigated.

Diagnosis

Infection with Zika virus may be suspected based on symptoms and recent history of travel (e.g. residence in or travel to an area with active Zika virus transmission). A diagnosis of Zika virus infection can only be confirmed through laboratory tests on blood or other body fluids, such as urine, saliva or semen.

Treatment

Zika virus disease is usually mild and requires no specific treatment. People sick with Zika virus should get plenty of rest, drink enough fluids, and treat pain and fever with common medicines. If symptoms worsen, they should seek medical care and advice. There is currently no vaccine available**.**

Prevention

Mosquito Control

Protection against mosquito bites is a key measure to prevent Zika virus infection. This can be done by wearing clothes (preferably light-coloured) that cover as much of the body as possible; using physical barriers such as window screens or closing doors and windows; sleeping under mosquito nets; and using insect repellent containing DEET, IR3535 or icaridin according to the product label instructions. Special attention and help should be given to those who may not be able to protect themselves adequately, such as young children, the sick or elderly. Travellers and those living in affected areas should take the basic precautions described above to protect themselves from mosquito bites.

It is important to cover, empty or clean potential mosquito breeding sites in and around houses such as buckets, drums, pots, gutters, and used tyres. Communities should support local government efforts to reduce mosquitoes in their locality. Health authorities may also advise that spraying of insecticides be carried out.

Sexual transmission

Zika virus can be transmitted through sexual intercourse. This is of concern due to an association between Zika virus infection and adverse pregnancy and fetal outcomes. For regions with active transmission of Zika virus, all people with Zika virus infection and their sexual partners (particularly pregnant women) should receive information about the risks of sexual transmission of Zika virus. WHO recommends that sexually active men and women be correctly counselled and offered a full range of contraceptive methods to be able to make an informed choice about whether and when to become pregnant in order to prevent possible adverse pregnancy and fetal outcomes.

For regions with no active transmission of Zika virus, WHO recommends practising safer sex or abstinence for a period of six months for men and women who are returning from areas of active transmission to prevent Zika virus infection through sexual intercourse. Sexual partners of pregnant women, living in or returning from areas where local transmission of Zika virus occurs should practice safer sex or abstain from sexual activity throughout the pregnancy.

Credits- World Health Organization

CHIKUNGUNYA

Chikungunya is a mosquito-borne viral disease first described during an outbreak in southern Tanzania in 1952. It is an RNA virus that belongs to the alphavirus genus of the family Togaviridae. The name “chikungunya” derives from a word in the Kimakonde language, meaning “to become contorted”, and describes the stooped appearance of sufferers with joint pain (arthralgia).

Signs and symptoms

Chikungunya is characterized by an abrupt onset of fever frequently accompanied by joint pain. Other common signs and symptoms include muscle pain, headache, nausea, fatigue and rash. The joint pain is often very debilitating, but usually lasts for a few days or may be prolonged to weeks. Hence the virus can cause acute, subacute or chronic disease.

Most patients recover fully, but in some cases joint pain may persist for several months, or even years. Occasional cases of eye, neurological and heart complications have been reported, as well as gastrointestinal complaints. Serious complications are not common, but in older people, the disease can contribute to the cause of death. Often symptoms in infected individuals are mild and the infection may go unrecognized, or be misdiagnosed in areas where dengue occurs.

Transmission

The virus is transmitted from human to human by the bites of infected female mosquitoes. Most commonly, the mosquitoes involved are *Aedes aegypti* and *Aedes albopictus*, two species which can also transmit other mosquito-borne viruses, including dengue. These mosquitoes can be found biting throughout daylight hours, though there may be peaks of activity in the early morning and late afternoon. Both species are found biting outdoors, but *Ae. aegypti* will also readily feed indoors.

After the bite of an infected mosquito, onset of illness occurs usually between 4 and 8 days but can range from 2 to 12 days.

Diagnosis

Several methods can be used for diagnosis. Serological tests, such as enzyme-linked immunosorbent assays (ELISA), may confirm the presence of IgM and IgG anti-chikungunya antibodies. IgM antibody levels are highest 3 to 5 weeks after the onset of illness and persist for about 2 months. Samples collected during the first week after the onset of symptoms should be tested by both serological and virological methods (RT-PCR).

The virus may be isolated from the blood during the first few days of infection. Various reverse transcriptase–polymerase chain reaction (RT–PCR) methods are available but are of variable sensitivity. Some are suited to clinical diagnosis. RT–PCR products from clinical samples may also be used for genotyping of the virus, allowing comparisons with virus samples from various geographical sources.

Treatment is supportive and the objective is to relief symptoms and maintain patient in a stable condition until the virus wears itself out. Prevention of Chikungunya is the same for all mosquito borne diseases. There is no vaccine yet for Chikungunya.

Credits-World Health Organization

Common Vectors and Diseases transmitted

S/No	**Vector**		**Diseases**
1	Moquitoes		
	a	Anopheles	Malaria (parasitic protozoan), lymphatic filariasis (parasitic roundworm), West Nile virus;
	b	Culex	Filariasis West Nile virus, lymphatic filariasis/ elephantiasis (parasitic roundworm);
	c	*Aedes aegypti*, *Ae. albopictus*, and other *Aedes spp*:	Chikungunya virus, dengue virus, West Nile virus, yellow fever virus, Zika virus, lymphatic filariasis/ elephantiasis (parasitic roundworm);
	d	*Haemagogus* species; Sabethes species:	yellow fever virus
2	Flies		
	a	House fly	Amoebic dysentery Typhoid, Leprosy Cholera, Plague
	b	Black fly (Simulium)	Onchocerciasis/river blindness
	c	Horse fly	Anthrax

		d e	Sandfly Phlebotomine sandflies	The most important diseases are cutaneous and visceral leishmaniasis caused by *Leishmania* species of protozoa. Sandflies also transmit several bacterial and viral diseases including bartonellosis and pappataci fever.
			Glossina species. Tsetsefly	African trypanosomiasis/ sleeping sickness, caused by two subspecies of the protozoan *Trypanosoma brucei*: *T. b. gambiense* and *T. b. rhodesiense*.
3	Lice	a b	Body louse, *Pediculus humanus humanus*. Head louse, *Pediculus humanus capitis*.	Epidemic typhus, *Rickettsia prowazekii*; Murine typhus, *Rickettsia typhi*; Trench fever/ bartonellosis, *Bartonella quintana*; Relapsing fever, *Borrelia recurrentis*.
S/No	**Vector**			**Diseases**
4	Culicoid (bitting midges)			Crimean Congo haemorrhagic fever (virus),
5	Rats			Rodents carry a large number of diseases including bacteria, viruses, protozoa and helminths (worms). Specific diseases of importance include: • Leptospirosis via urine, • Various food-borne diseases such as Salmonella\ • Murine typhus and the plague carried via fleas on rodents;
6	Fleas	a b	Rodent fleas *Xenopsylla cheopis* and *Nosopsyllus fasciatus*; Cat flea: *Ctenocephalides felis*; human flea, *Pulex irritans*; *Oropsylla montana* on ground squirrels in the US.	Bubonic plague, Bacteria *Yersinia pestis, Rickettsia typhi* Flea-borne typhus (also called murine typhus, endemic typhus, urban typhus),

7	Ticks	Hard ticks, *Ixodidae*, .	Lyme disease (bacteria), Crimean-Congo haemorrhagic fever (virus), Kyansur Forest disease (virus), Tick typhus (bacteria), Tularaemia (bacteria), Crimean Congo haemorrhagic fever (virus), Relapsing fever (bacteria), Colorado tick fever African tick bite fever Tick-borne encephalitis (virus) Babesiosis
8	Cocroaches	German Cockroach	Bacteria, including *Salmonella*, *Staphylococcus*, *Listeria*, *E. coli*, *Campylobacter* and viruses, fungi, protozoans and parasitic worms. They also produce particles that can cause asthma.

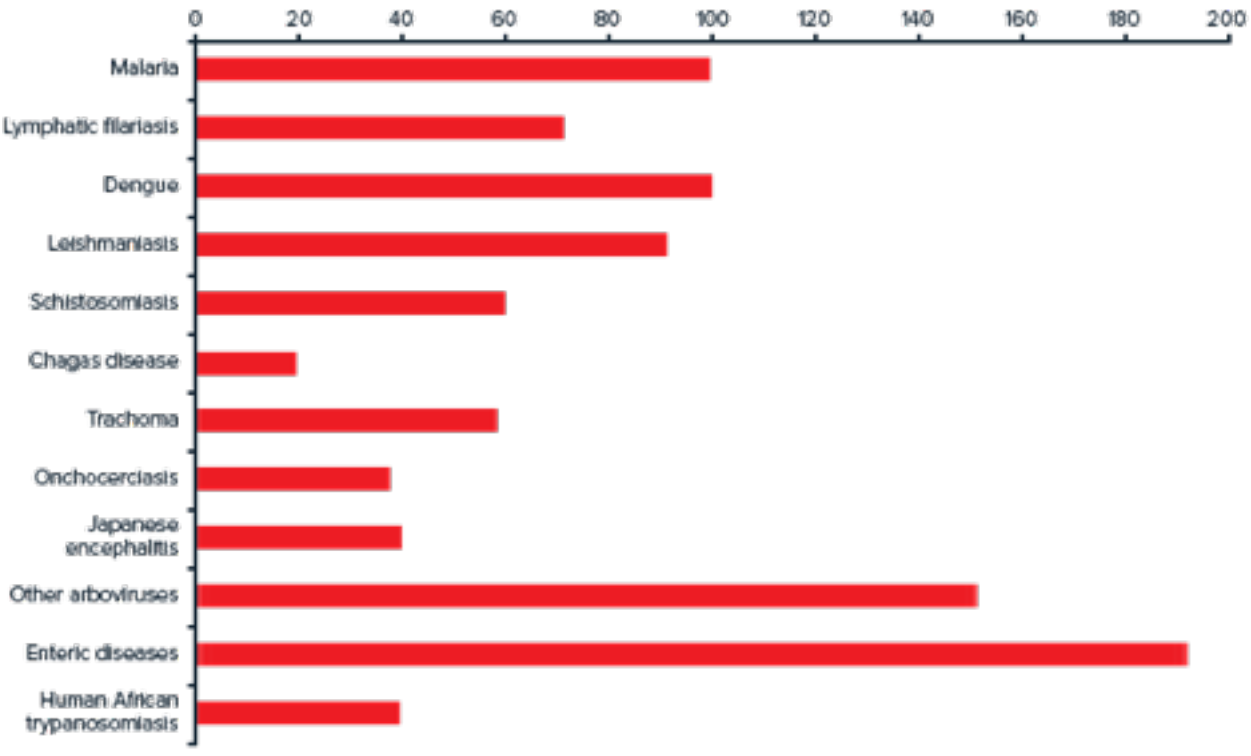

Figure 1: Prevalence of disease in the world

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