14 Arthropod borne infections

The carrier is a mosquito

Malaria (water related)

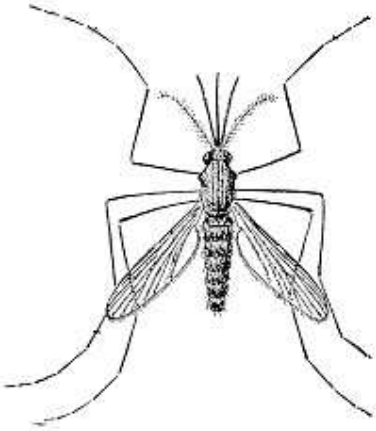
Malaria means ‘bad air’ and this disease actually also comes from the air; not however from evil fumes, but from infected mosquitoes. About 100 million people suffer from the different kinds of this disease and 300 million people in total carry the parasite (prevalence); annually more than 2 million people die from malaria (almost 1/20 of the registered deaths in the world); nearly as much as for deaths by tuberculosis (3 million; however not much attention is paid in this lecture book to this disease being an infection of the airways). The CFR is especially high of ‘malaria tropica’. In approximately 100 countries 2 milliard people are potentially exposed to mosquitoes infested with plasmodium (be aware that it does not say infected).

Malaria can exist through the following number of factors: the presence of a carrier (mosquito Anopheles), sufficient availability of suitable (breeding) water and climate preferable to the mosquito, an endemic reservoir of people, who have the malaria parasite in their blood (plasmodium), and enough opportunity for the female mosquito to prick humans. Do changes occur in one or more of the mentioned factors, malaria will de-or increase in the country. We will come back to that later.

It may seem surprising, but The Netherlands is only officially declared malaria free by WHO since the seventies. A number of various forms of malaria occurred, mainly in North- and South The Netherlands. Brackish water of ditches around IJselmeer was a preferable biotope of the Dutch Anopheles sorts. The change of the fresh water from the IJselmeer was a positive turn; together with an increasing water contamination. Approximately every twenty years epidemics of ‘tertian fever’ was known, also use to be called ‘exchange fever’. The last great outburst was in 1946 directly after the war. A morbidity of 15,000 existed, mainly in the river Zaan area.

The pathogen of malaria is a micro organism, a sporozoon ‘plasmodium’ described by the French surgeon Laveran in 1880. A part of the parasite’s life cycle is in humans and partly in mosquitoes (see diagram). A female mosquito of he gender Anopheles, which is looking for a blood meal of a human, is attracted by our body compounds, especially methane gas. She settles down on the skin and pricks through the skin in a blood vessel with her sucking muzzle. She then injects several things to widen the vessels, to restrain coagulation of blood and soften the skin. This is of vital importance, because the operation has to be as short as possible and she should be able to withdraw and get away in a fraction of a second.

Most anophelines, heavy with blood (sometimes 3-4 times their weight is taken), don't fly far after their meal. In the house they often settle on a wall. For at least one hour a pinkish fluid drips from the cloaca; this is the blood fluid squeezed out of the blood mass. In her belly a kind of blood pudding, much less in weight, allows her to fly on and the processing of the blood by enzymes begins.



Picture: Anopheles mosquito.

Due to this injection, which occurs before the sucking, possible present parasites in her salivary gland (not all mosquitoes are infected), can get into the vessels of the person, who is pricked. The plasmodia, which in that stage are called sporozoon, are circulated with the blood passing the liver many times per day. In the liver the sporozoon forces itself in and starts a hidden existence. Then they are called cryptozoon (κρυπτος = kryptos= hidden). After some time they fall apart into hundreds of cells and swarm off (their name are now merozoon, diagram) to look up red corpuscles: the erythrocyte phase.

They then feed themselves to the red coloured blood compound, hemoglobin as trofozoon (τροφειν = trofein= to eat). This molecule, essential for the transport of oxygen and carbon dioxide, contains iron; the iron compounds can be seen as pigment in the parasite. After the loss of the red corpuscles the parasites are released; this often happens together in big numbers; the more or less simultaneously released compounds then cause a fever attack. Two important characteristics of malaria are therefore: anaemia, characterized by the reduction of red corpuscles and decline of oxygen transport, and fever attacks. This fever attacks show a characterized pattern in the development of the parasites, often named after the peaks and intervals (see diagram and picture); along with a characteristic spleen enlargement.

We distinguish the tertian fever, with a peak on day one, day three, day five, etc. When we see fever peaks on day one, day four, day seven, etc then we speak of a four daily fever or malaria quartana. The infamous malaria tropica often has a irregular fever pattern. The

different forms have their own pathogens: *Plasmodium ovale* and *vivax* with malaria tertian, *P.malariae* with malaria quartana and *P.falciparum* with malaria tropica (diagram).

Table: Scheme of several types of malaria. The pattern of fever: 1 = day with fever and 0 = day without.

parasite	**name malaria**	**Fever pattern**	**Severity**
P. ovale/ p. vivax	Tertiana NL: anderdaags	1-0-1-0-1-0-1-0-1	Moderate
P. malariae	Quartana NL: vierdedaags	1-00-1-00-1-00-1	More serious
P. falciparum	Tropica	Irregular	Very serious

One third of a prominent symptom of malaria is the strong enlargement of the spleen (hypersplenia), which was described in ancient times.

The parasites continue a number of developing stadiums (diagram) in humans. When a carrier gets bitten by a mosquito on the right moment, the mosquito will get the parasites in its body. The parasites are able to undergo the next stages of development in their body. They arrive in the salivary gland where the whole cycle can be repeated, if they again find a human victim.

People can die from malaria of heavy fevers; our various life processes and their accompanying enzymes each have their own optimum and maximum temperature. These processes can be disturbed so much by the fevers resulting in one's death. However the most important death cause is the so-called brain malaria with a coma; a serious brain tissue infection, which especially can be fatal for children; lung oedema and shock are also feared and often deadly complications.

For centuries people have tried to defend themselves against malaria. The most obvious method is of course to prohibit getting bitten by a mosquito. A number of measures are as follows:

a. A mosquito net and wearing of protecting clothes (rather uncomfortable in a hot climate; however most necessary after sun set);
b. Disrupting the biotope of mosquito: reclaiming swamps and pools; disrupting life cycles of mosquito (oil on the water surface);
c. Exterminating Anopheles mosquitoes (with e.g. insecticides. Often first effective; in the long run not feasible.

Prophylaxis with anti malaria pills, used consequently, is the best guarantee of preventing malaria after a mosquito bite. Kina (quinine) used to taken which was discovered in South America; however not used by the local population against malaria. Later on it was grown

much in Indonesia (after being secretly shipped over by a Dutch war ship). Many derivatives are developed since then, like the much-used paludrin and chloroquin; not equally effective against each form of malaria. A good thing to do before travelling to a malaria area is getting informed about the indicated medicines. Each medicine should be taken from the start of the stay. Extremely important is the consequently swallowing of the medicine during a period of 4-6 weeks after departure from the malaria area. The parasite can as it happens be obtained in the last few days of the stay. Like all medicines, anti malaria medicines also have side effects. A too high dose of quinine (several grams) is already known for poisoning; after a number of serious symptoms breathing stops. Infamous side effects are ear ringing, dizziness and deafness.

An old dream for a number of wide spread diseases is the availability of an effective vaccine. After years of research one has (still) not succeeded for malaria. The cause is the fact that the plasmodium has an nearly endless source of tricks in the box: the expression of his genome (genetic material) can be varied infinitely, which gives him a different 'jacket' each time. The immune system is therefore tricked; this is also the case with the AIDS virus (HIV) that shows another outside to the immune system. Mutations (real genome changes) also happen, which lead to other 'jackets' of these micro organisms.

An experimental vaccine (1995) was tested in great field studies. Up till recently was thought that the data privacy was about several numbers of percentages of the vaccinated people, which is too little to justify general usage. At the end of 1995 it became known that the data privacy was probably about zero. The dream again had not come true.

Fortunately therapy of malaria seems to improve much from products derived from an already long-existing medicine in China: extracts of an Artemisia type (Qing Hao Su, one year old worm wood). These medicines, like artemisine, are probably the fastest working, safest and a remedy to the increasing resistance. It kills the parasite in the blood; for the moment patients still get symptoms again after ceasing the medicine; so still much has to be improved.

Yellow Fever (water related)

Annually still thousands of people die from this disease that in principal can be prevented, because a cheap and very effective vaccine exists. This is more and more included in children vaccination programs in exposed countries.

The carrier is again a mosquito, a pathogen of the genus Aedes, mostly *Aedes egypti*. As the name suggests, the yellow fever occurs in Africa. From Africa the disease has been exported to Middle and South America; Asia is nearly totally free from the mosquito and the disease (diagram). In the new west regions the disease has increased in a big plaque, which demands ten thousands victims per year. The construction of the Panama Canal in the nineteenth

century failed by the first attempt for a great deal because of the yellow fever and by the second attempt was seriously hindered by the disease.

The well-known phrase:

"A man, a plan, a canal: Panama!"

(that can also be read from back to front) then gives a rather simplistic picture of the enormous medical problems that had to be overcome.

Around the turn of the century the American military doctor Reed succeeded in Cuba to proof the cause of the yellow fever (but not yet the pathogen). The mosquito as carrier is essential, as he proved through experimental research with military 'volunteers'.

A difference with malaria is the microbial pathogen: a virus, which needs cells from his human host for his multiplication. Especially the liver cells, from which the disease gets the symptom as jaundice; together with this, as the name implies, fever occurs. Another difference with malaria is that for already several years a good working vaccine exists against yellow fever, which is made compulsory for travellers to a number of countries (diagram).

Humans are not the only hosts of the yellow fever virus; all sorts of apes can serve as hosts. This is why two types are distinguished: the forest yellow fever, that one gets in the jungle from mosquitoes, which have pricked primates, and city yellow fever, that directly is obtained from fellow humans.

Japanese encephalitis

In Japan, and also in the whole of East and Southeast Asia, the Japanese encephalitis virus that causes meningitis, can be transmitted by mosquito bites (mainly Aedes aegypti). The CFR is approximately 20 percent. There is a good vaccine, for one that not stays in the cities as a visitor.

Dengue

The virus that causes dengue (or knuckle fever) is also transmitted by the vector mosquito *Aedes aegypti*. The disease is common in (sub)tropical areas in Africa and Asia. Fever comes in two waves of several days, after which the patient is exhausted and depressed and he only recovers slowly. Since no immunity is build up a second episode (years later) is possible and this is often worse with bleedings and shock. The severe authorities in Singapore give high penalties to citizens who create a pond in their garden, but also car tires and open cans on someone's terrain are heavily fined. For every little pool of stagnant water can supply Aedes with a breeding spot. Recently dengue has lapsed to South-America, where Aedes was already present, but only as the vector for the yellow fever virus. In several regions of Brazil already hundreds of victims have died.

Lyme disease

The most well known tick disease of this moment, especially in The Netherlands, is the disease of Lyme. This disease thanks his name from the American town Old Lyme, where an epidemic of arthritis (inflammation of the joints) was identified in 1975. Other symptoms were neurological complaints and heart and eye disorders. The infection is usually sub clinical. Research showed diseases obtained from a by tick transmitted bacterium, the spirochaeta *Borrelia burgdorfii*. In America the tick seemed to mainly jump from high grass, although always is believed that mammals like humans and sheep obtain their tick from around and under bushes. The ticks end up in this grass for instance through deer.

In The Netherlands about 15 percent appears to be infected by ticks. Possibly there are several hundreds of cases each year. They are working on a vaccine abroad; if it ever comes it will still take a long time.

Other tick diseases are Q- fever and 'Rocky Mountain Spotted Fever'; furthermore the Tick Borne Encephalitis (TBE), which occurs mainly in Middle Europe.

The carrier is a fly

River blindness (Similium (water related)

The carrier is a flea

Plague(*Yersinia pestis*) Xenops (hygiene/ rodents) (see previous chapter)

The carrier is a louse

Typhus (Rickettsiose) (water washed)

The carrier is a cockroach
(through legs)