

Malaria

<i>Plasmodium</i> spp.	
Haematozoa	
Plasmodiidae	
Plasmodium ovale, trophozoite	
Occurrence	tropical belt
Disease	malaria, various forms
Infectious stage and method of infection	sporozoite - inoculative (for mosquito bites)
Diagnostics	microscopy (blood smear, thick drop)
Therapy	antimalarials
MeSH ID	D010961

Malaria is the most serious parasitic infection in the world. It occurs in the tropical zone and is one of the diseases that are transmitted by vectors - mosquitoes.

Epidemiology

Risk of malaria infection

- Southeast Africa, Asia, Amazon;
- does not occur in Europe, Australia, the Arctic, Antarctica and most of North America;
- does not occur above 2000 m above sea level.
- occurrence always focal;
- endemic areas in Czech republic in the years 1920-1950, 215 cases;
- worldwide: 1.5-3 million deaths / year, incidence: 300-500 million / year (500 inhabitants / 10,000).

Etiology

Vector

- Mosquitoes of the genus *Anopheles* - about 60 species, transmitted only by females;
- the most important *A. gambiae* (*Plasmodium falciparum*), lays eggs in water;
- in Asia, species lay eggs in rice fields;
- mosquitoes of the genus *Anopheles* also occur in South Moravia.

Parasite

- Parasite: *Plasmodium* spp. - there are 5 species (*P. vivax* , *P. falciparum* , *P. ovale* , *P. malariae* , *P. knowlesi*);
- protozoa, spores (apicomplexa)
- belongs to the blood apicomplexa - has an apical complex - an invasive apparatus enabling IC penetration;
- intracellular development in hepatocytes or erythrocytes ;
- transmitted by insects, they do not form any stages resistant to the external environment.

Life cycle

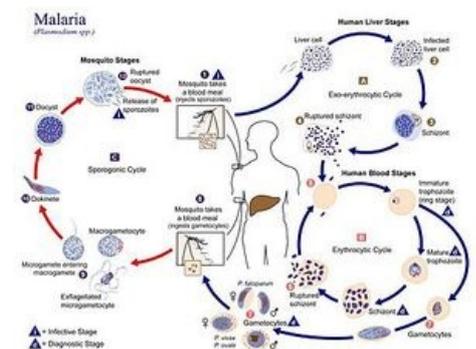
Plasmodia life cycle

Developmental forms of Plasmodia

1. *sporozoite* - a terminal stage of development in the carrier, infectious to humans;
2. *merozoite* ;
3. immature sexual stage - *gametocyte* - terminal stage of development in humans, infectious for mosquitoes.

Cycle

Mosquito sucks blood from humans (erythrocytes contain gametocytes) → *gametocytes* settle in the digestive tract of mosquitoes, body cavity and salivary glands, develop into *sporozoites* (sexual phase of division has taken place) → mosquito sucks humans again → sporozoites enter into blood → to the liver, in the liver it changes into *merozoites* (asexual phase of division) → blood → attacks erythrocytes → they multiply in them until erythrolysis occurs → some merozoites change into gametocytes → mosquito sucks again → the cycle is repeated.



Stages of development in humans

1. Hepatic phase - EE (extraerythrocytic), 10–14 days, sporozoites - 15–60 minutes in the bloodstream, invasion into hepatocytes (in *P. falciparum* and *vivax* the infectious dose is only 10 sporozoites), penetrate fenestrations or Kupffer cells;
 - in Disse's space, they attach to hepatocytes and penetrate;
 - asymptomatic phase, no immune response develops;
 - protected against complement by circumsporozoite protein in the blood, loses it after penetration into the hepatocyte;
 - inside the hepatocyte - the sporozoite rounds, grows, the nucleus repeatedly divides (>1000), the cytoplasm gets segmented between the nuclei - schizogonia;
 - so-called *hypnozoites* - sporozoites that remain in the liver and do not divide, clinical symptoms are only when the immunity is reduced;
 - return to the blood, entering the erythrocytes;
2. blood phase - erythrocyte phase;
 - the merozoite must enter the erythrocytes within 30 seconds of entering the blood, otherwise it dies;
 - in the erythrocyte it enlarges, rounds (*ring* stage), divides, the cytoplasm is segmented between the nuclei, in one erythrocyte - there can be up to 20 merozoites, which are released by the rupture of the erythrocyte;
 - merozoites enter other erythrocytes;
 - the length of development in the erythrocyte varies by species;
 - *Plasmodium malariae* - one cycle - 72 hours;
 - *Plasmodium falciparum*, *vivax*, *ovale* - 48 hours;
 - gametocytogenesis - formation of gametocytes, some merozoites do not divide, but transform into gametocytes;
 - lasts 2-3 days in the blood, temporarily taken up in capillaries.

Plasmodium falciparum

- The causative agent of tropical malaria, found in tropics and subtropics, where the temperature does not fall below 20 °C;
- the most severe - in non-immune individuals: if untreated, it is lethal;
- liver phase - does not form hypnozoites, up to 30 thousand merozoites in one hepatocyte, plasmodia do not remain in the liver after completion → infection is not recurrent;
- erythrocytic phases - able to infect all stages of erythrocytes, erythrocytes do not enlarge, sticky growths on their surface;
 - up to 30% of erythrocytes, "rings" in peripheral blood, gametocytes;
 - erythrocytes attach to the endothelium, placenta, formation increases (capillary clogging at higher developmental stages);
 - protection of erythrocytes from destruction in the spleen;
 - attachment to CD36, ICAM-1, placental chondroitin sulfate → cerebral malaria, in grav.

Plasmodium vivax

- Tertiary malaria (three days) (according to the length of the erythrocyte multiplication phase);
- the tropics, mostly higher temperature areas, are not in West Africa;
- liver phase - forms hypnozoites - begin to develop after a week but also after years, the cause of relapses (2x - 4x);
- erythrocyte phase - infects only reticulocytes (Duffy +), erythrocytes enlarged, but not sticky, in the peripheral blood parasitemia - corresponds to parasitemia throughout the circulation;
 - Schiffner dotting;
 - in peripheral blood all developmental stages.

Plasmodium ovale

- It infects erythrocytes without Duffy antigen (Duffy-), a three-day malaria (West Africa).

Plasmodium malariae

- The cause of four-day malaria (quarter) - slower development in mosquitoes and humans;
- liver phase - does not produce hypnozoites;
- erythrocyte phase - infects only old erythrocytes, persists in the blood for several decades,
 - in one erythrocyte - 6-12 merozoites;
- low parasitemia, sudden activation.

Clinic

Video in English, definition, pathogenesis, symptoms, complications, treatment.

Malaria attack

- Induced at the time of erythrocyte breakdown and merozoite release;
- the attack is repeated after one cycle (thermal paroxysm) - directly proportional to the length of the cycle (in

P. falciparum the population is not as synchronized as in *P. ovale* and *P. vivax*);

- 72 hours of development in erythrocytes → fourth day erythrocyte breakdown - fever fourth day = quarter ;
- 48 hours → fever third day = tertiary ;
- after rupture of the erythrocyte - merozoites, but also waste products of plasmodia are released:
 - malarial pigment (hemozoin) - degradation product of Hb , phagocytosed by monocytes , inhibits their function with toxic iron → immunosuppression;
 - malarial toxin (GPI) - released from the merozoite membrane, activates macrophages and T-lymphocytes → TNF- α production (pyrogen, NO production - CNS inhibitory neurotransmitter → deep coma).

INCUBATION TIME

the PERIOD of
TIME BETWEEN
INFECTION and
SYMPTOM ONSET

Clinical picture of malaria

- Fever first irregular, then in cycles - tertiary and quarter;
- before the onset of fever, chills, then delusional states ;
- hepatosplenomegaly , hemolytic anemia ;
- tropicana - life threatening!
- symptoms of imported tropicana - irregular fever, persistent headache, arthralgia, shoulder pain, loose stools;
- it must be kept in mind by all those with a fever who have lived in the malarial area.



Video v angličtině, definice, patogenese, příznaky, komplikace, léčba.

Uncomplicated malaria (tertiary)

- originators - *Plasmodium vivax* , *Plasmodium ovale* ;
- benign malaria;
- incubation for 2-3 weeks, after 2-3 days of non-specific symptoms - febrile paroxysms;
- seizure after 48 hours;
- cold stage: 15-60 minutes, cold dry skin, cold limbs, fast pulse, chills, headache, paleness
- hot stage: 2-6 hours, fever 40-41 ° C, intense headache, flushing, fever, very intense sweating → hypovolemia;
- relapse.

Plasmodium malariae (quarter)

- good prognosis.

Tropical malaria - tropicana

- non-specific flu-like symptoms for several days;
- continuous fever, irregular;
- microcirculation disorders - DIC , multiorgan failure;
- severe anemia, metabolic acidosis, renal failure, pulmonary edema, hypoglycaemia, shock, spontaneous bleeding, hyperpyrexia;
- cerebral malaria - comatose state , impaired consciousness, convulsions;
- travel history! Quick diagnosis - very quickly it can turn into a very serious illness!

Diagnosis

Plasmodium in blood smear

- Travel history - ask about prophylaxis, the mode of transport (it is possible to get infected even when changing at the airport);
- direct detection of peripheral blood plasmodia on stained slides, collection at any time during infection, immunochromatographic methods , PCR ;
- microscopy - finds species identification, determines developmental stages, determination of parasitaemia, presence of hemozoin, is fast, cheap, we can monitor the effectiveness of drugs;
 - Giemsa-Romanovski staining.

Treatment

- Quinine - severe tropical malaria, effective against all species, does not affect hypnozoites;
 - chloroquine - effective against *P. vivax* , *P. ovale* , *P. malariae* , there is resistance throughout Africa;
 - primachin - anti-relapse therapy (against hypnozoites);
 - mefloquine - against the tropics;
- vaccination - insufficient effectiveness;
- natural resistance - sickle cell disease, ovalocytosis.

Prophylaxis and prevention

Malaria prevention is an integral part of the fight against rising malaria imports into the Czech Republic. The malaria vaccine does not yet exist . Malaria prevention can be divided into 3 groups:

1. Exposure prophylaxis: use of repellents and insecticides, fumigation, use of mosquito nets, use of nets in windows and doors, wearing white loose clothing with long sleeves and trousers.
2. Chemical prophylaxis: involves the use of antimalarials before, during and after a stay in an endemic area. Mefloquine, chloroquine, proguanil, atovaquone and doxycycline are used as antimalarials in prophylaxis.
3. "Stand-by therapy": if a person travels to an area with a low risk of malaria or plans to stay in the endemic area for a very long time, it is possible to take an antimalarial for "emergency treatment" instead of (long-term) prophylactic use of antimalarials , ie. have an antimalarial with you and start taking it immediately if you have any symptoms or suspicion of malaria.

Comment:

- *Plasmodium vivax* and *Plasmodium ovale* - tertiary agents.
- *Plasmodium malariae* - the causative agent of the quarter.
- *Plasmodium falciparum* - the cause of tropical malaria (tropics).
- *Plasmodium knowlesi* - the cause of malaria in macaques in SE Asia; however, the disease has already been reported in humans.
- bad air italian: "mal aria"

Links

Related Articles __ edit source]

- Blood-borne infections
- *Trypanosoma cruzi*
- Vaccination

External links __ edit source]

- Malaria by Osmosis - video with English subtitles on youtube.com

References _ _ _ edit source]

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- BENEŠ, Jiří, et al. *Infectious medicine*. 1st edition. Galén, 2009. 651 pp. ISBN 978-80-7262-644-1 .
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- CHALUPA, Pavel. Internship in infectious medicine. Department of Infectious Diseases, First Faculty of Medicine, Charles University and FNB, 2011.

Parasites	

Protozoa (Protozoa)	Amoeboid protozoa	Exchange offices	<i>Acanthamoeba spp.</i> • <i>Balamuthia mandrillaris</i> • <i>Naegleria fowleri</i>
	Whips	Leishmania	<i>Leishmania braziliens</i> • <i>Leishmania donovani</i> • <i>Leishmania infantum</i> • <i>Leishmania major</i> • <i>Leishmania tropica</i>
		intestinal parasites	<i>Dientamoeba fragilis</i> • <i>Entamoeba histolytica</i> • <i>Giardia intestinalis</i>
		Trichomonads	<i>Trichomonas vaginalis</i>
		Trypanosomes	<i>Trypanosoma cruzi</i> • <i>Trypanosoma gambiense</i> • <i>Trypanosoma rhodensiense</i>
Rinning	<i>Balantidium coli</i>		
Sporozoa	Babesie	<i>Babesia bovis</i> • <i>Babesia divergens</i> • <i>Babesia microti</i>	
	Coccidia	<i>Cryptosporidium parvum</i> • <i>Cyclospora cayetanensis</i> • <i>Isospora belli</i>	
	Microsporidia	<i>Enterocytozoon bieneusi</i> • <i>Encephalitozoon spp.</i>	
	interhost	<i>Toxoplasma gondii</i>	
	Plasmodia	<i>Plasmodium falciparum</i> • <i>Plasmodium malariae</i> • <i>Plasmodium ovale</i> • <i>Plasmodium vivax</i>	

Helmint	Trematoda (Motolice)	liver and lung mites	<i>Clonorchis sinensis</i> • <i>Fasciola hepatica</i> • <i>Opisthorchis spp.</i> • <i>Paragonimus spp.</i>
		Schistosomes	<i>Schistosoma haematobium</i> • <i>Schistosoma japonicum</i> • <i>Schistosoma intercalatum</i> • <i>Schistosoma mansoni</i> • <i>Schistosoma mekongi</i>
		intestinal tapeworm	<i>Fasciolopsis buski</i> • <i>Heterophyes heterophyes</i> • <i>Metagonimus yokogawai</i>
	Nematode (Nematode)	Filaria	<i>Brugia malayi</i> • <i>Dirofilaria immitis</i> • <i>Dirofilaria repens</i> • <i>Loa loa</i> • <i>Mansonella perstans</i> • <i>Onchocerca volvulus</i> • <i>Wuchereria bancrofti</i>
		intestinal nematodes	<i>Ancylostoma duodenale</i> • <i>Ascaris lumbricoides</i> • <i>Enterobius vermicularis</i> • <i>Necator americanus</i> • <i>Strongyloides stercoralis</i> • <i>Trichuris trichuria</i>
		tissue nematodes	<i>Dracunculus medinensis</i> • <i>Toxocara spp.</i> • <i>Trichinella spiralis</i>
Cestoda (Tasemnice)	intestinal cestodes	<i>Diphyllobothrium latum</i> • <i>Dypilidium caninum</i> • <i>Hymenolepis nana</i> • <i>Taenia saginata</i> • <i>Taenia solium</i>	
	tissue cestodes	<i>Echinococcus granulosus</i> • <i>Echinococcus multilocularis</i> • <i>Taenia solium</i>	

Arthropods	Insect	<i>Anoplura</i> (lice) • <i>Diptera</i> (diptera) • <i>Cimex lectularius</i> • <i>Siphonaptera</i> (fleas)
	Spiders	<i>Ixodes ricinus</i> • <i>Sarcoptes scabiei</i>

Intracellular	
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parasites

Chlamydia

Chlamydia pneumoniae • *Chlamydia psittaci* • *Chlamydia trachomatis*

Portal: Microbiology