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Current Status and Challenges of Malaria in Zambia

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Abstract. Malaria is a mosquito-borne infection caused by the Plasmodium parasite, which infects a person carrying the parasite through mosquito bites or blood transfusions. It is the world's leading parasitic disease. There are four species of Plasmodium in the human body, Plasmodium falciparum, Plasmodium vivax, Plasmodium malariae and Plasmodium ovale. More than 100 countries and regions are reported to be affected by malaria to varying degrees. Malaria has a high incidence in Zambia, which seriously endangers people's life and health, and increases the social and economic burden of the affected communities to a certain extent. In addition, the number of malaria deaths remains high, the number of malaria cases has even risen, and the eradication of malaria has stagnated. Therefore, timely and accurate diagnosis is of great significance to effectively prevent malaria, control its spread, and give patients early treatment. This article describes the current progress and challenges of malaria elimination in Zambia, and Outlines current malaria elimination strategies and key interventions.

Keywords: malaria, Zambia, current status, challenges

1. Introduction

Malaria is an insect-borne infectious disease that is widely prevalent in tropical and subtropical areas. It is caused by plasmodium infection caused by the bite of female Anopheles mosquitoes or the blood of infected persons. Especially, young children, pregnant women, the elderly, and people with poor immune and resistance ability in the epidemic areas are all susceptible groups. Malaria is divided into Plasmodium vivax, nauseous malaria, ovate malaria and Plasmodium vivax. The first-time patients may have prodromal symptoms such as low fever, fatigue, headache and poor appetite. At the first attack, the fever was more irregular and gradually changed to regular periodic attacks. Cold period: sudden chills, severe chills, cyanosis of lips, pale or cyan skin, rapid and full pulse, headache, myalgia, fatigue, nausea, vomiting, upper abdomen. Department discomfort, etc. The patient has flushed face, headache and thirst. In severe cases, delirium, convulsion and coma may occur. Malaria in pregnancy can cause abortion, premature birth and stillbirth[1].

As of December 18, 2020. Malama Permanent Secretary of the Ministry of health of Zambia, said at the southern African Development Community malaria week that Zambia had reported a total of 6million malaria cases, a significant increase compared with 4million in 2019, and about 1336 people died of malaria. Malaria is an insect borne disease caused by Plasmodium infection.

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On the pathogenesis of malaria. Plasmodium parasitizes on red blood cells and destroys red blood cells in large numbers, causing anemia in patients. Plasmodium falciparum is mainly parasitized in the red blood cells in the capillaries of the brain. The surface of the infected red blood cells has adhesive protrusions, which can adhere to the endothelial cells of the capillaries, and cause local capillary obstruction and cell hypoxia through mutual agglutination and adsorption, which can cause serious swelling and brain cell damage[1]. Therefore, it is essential to do a good job in malaria treatment and prevention.

This paper mainly discusses the impact of malaria on Zambia, the relevant pathological information of malaria and the prevention and treatment measures for malaria by reviewing the relevant literature on malaria.

2. Epidemiological characteristics of malaria

Malaria is a worldwide infectious disease. Currently, it is still one of the most serious parasitic diseases threatening human health in Asia and Africa, and the cases are mainly concentrated in Africa and Southeast Asia.

Placenta, the damage of the barrier or the contamination of maternal blood in the process of delivery can be manifested in fetal wounds. Congenital malaria can occur soon after birth age. The younger the child, the less typical the symptoms are, and in addition, there may be developmental delay and camp. Poor nutrition, anemia, and other manifestations. The World Malaria Report 2021 shows that from 2000 to 2020, antimalarial drugs and medical work saved 10.6 million lives worldwide and prevented about 1.7 billion cases. However, in 2020, the number of malaria cases increased rather than decreased, especially in Zambia and other Central African countries.

With global warming, the temperature in summer in different countries has increased, greatly increasing the rate of mosquito reproduction, resulting in faster transmission of malaria, the peak of transmission is more lasting, and the malaria incidence rate in tropical rain forests and tropical islands is much higher than the inland incidence rate. The Lancet Planetary Health The latest research published in April further verified this point. The research group collected about 180000 malaria cases in Hainan, China from 1984 to 2010, and found that the cases were mainly concentrated in the rainy season and tropical climate[1].

The epidemiological data survey study shows that the prevalence of malaria in Zambia increased to 21% between the 2010 and the 2015. Zambia was one of only 13 countries out of 91 monitored by the WHO to see an increase in malaria rates in 2015[2].The clinically emphasized interventions may help reduce the incidence of malaria, but compared with the factors that lead to the increase of its risk, they seem insignificant, such as changes in the population structure, such as the increase in the proportion of children under 5 years old and high-risk groups in rural residents.

3. Diagnosis of malaria

Delayed diagnosis has always been considered as an important cause of malaria death, and in the past, the main reason for delayed diagnosis was attributed to the deterioration of malaria diagnosis ability of laboratory personnel. However, the key to delayed diagnosis lies in the clinician, not the examiner. When receiving patients, clinicians should first think of the possibility of malaria, especially those patients with atypical clinical manifestations and no epidemiological history. There are three main methods for diagnosis of malaria, and these three diagnosis are widely used in the whole world.

The first one is called rapid diagnostic test, it is a medical diagnostic test that is quick and easy to conduct. It is suitable for RDTs to use in preliminary or emergency medical screening and for use in medical facilities with little resources. They also allow point-of-care testing in primary care for things that formerly only a laboratory test could measure. They provide same-day results within two hours, typically in about 20minutes[3].

The second one is called microscopy, it allows people to detect different malaria-causing parasites, their stages, including gametocytes, and the quantification of parasite density which can make it easy for people to monitor response to treatment. The recommended stain for malaria microscopy is

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Giemsa, and the examination of both thin and thick films from the same patient is a requirement of diagnosis. Light microscopy is the diagnostic standard against which other diagnostic methods have traditionally been compared. Microscopy has been used for a long time in malaria diagnosis, and it is also the only detection technology that can identify the type of Plasmodium. It is the gold standard for malaria diagnosis. However, the microscopic examination method has high requirements on operation, staining, clinical experience, etc., which is limited in the practical application at the grass-roots level, and it is time-consuming and labor-consuming, so it is difficult to achieve the rapid inspection effect[3].

The last one is called nucleic acid amplification-based diagnostics, although the primary choices for diagnosing malaria in the field are microscopy and rapid diagnostic tests, but neither method is capable of detecting low density malaria infections. On the contrary, the nucleic acid amplification tests can make it possible for people to sensitive detection of low density malaria infections (below 1 parasite/μL). The NAAT procedure works by first amplifying – or making many copies of – the virus's genetic material, if any is present in a person's specimen. By amplifying those nucleic acids, people can detect low density malaria infections through the virus's genetic material[4,5].

4. How to control the spread of malaria

For the perspective of infectious disease, the control of infectious diseases can start from the three elements of infectious diseases. The first one is that protecting vulnerable people, then the next one is that cutting off transmission routes, and the last one is that reducing the source of infection. At the beginning, people did not really familiar with the ways that how to protect public from the malaria, so there are many successful and unsuccessful interventions which accord to the abovementioned three elements that have been implemented in Zambia. Firstly, for some successful interventions which have been implemented in Zambia that accord to those three elements.

The first one is from protecting vulnerable people. This can be achieved by intermittent preventive medication, like malaria chemoprophylaxis. It means that people can prescribe healthy individuals medication for an infection before they have had this infection. In Zambia, the atovaquone proguanil, doxycycline, mefloquine, and tafenoquine all these four medicines are the most useful among people. However, these medicines can not be used all the time, because people need to consider specific itinerary, length of trip, cost of drug, previous adverse reactions to antimalarials, drug allergies, and current medical history[6]. For atovaquone proguanil, people cannot eat it if they have severe kidney disease. In addition, this medication can protect visitors who are non-immunes and want to go to Zambia. These people can choose atovaquone proguanil to eat before they go to Zambia or other countries where malaria is common. For doxycycline, people is supposed to take it on an empty stomach, and it is better to take this at least 1 hour before meals or 2 hours after meals. Also, people cannot lay down soon after they take this medicine. [7] For mefloquine, it is better for people to take it on a regular schedule, like if you take it on this Monday, and then you need to take it on next Monday. Also, mefloquine can be taken one week before if someone wants to travel to an area where has malaria, so this function can the same with atovaquone proguanil. [8] For tafenoquine, if people miss a dose of it, take it as soon as possible. However, if the time is really close to your next dose, you can skip this dose and go back to your regular dosing schedul [9] .

The second one is from cutting off transmission route. People in Zambia always use insecticide-treated nets to protect themselves from being bitten by mosquitos. This net is a form of personal protection that has been proved that it can reduce the death due to malaria in endemic regions. It also can reduce the death of children under 5 years old by about 20%. The most important point about this net is the insecticides which are used to kill the mosquitos. There are two insecticides that are approved for use on the net, pyrroles and pyrethroids. These two insecticides have very low health risks to humans. People just need to dip the net in a mixture of water and insecticide and make them dry, then the insecticide-treated net is done. There is the other method that can cut off transmission route, which called strengthen quarantine inspections. People can have more testing in their countries, and this method is using widely in Africa. If there are enough testing areas, then workers can

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effectively isolate those people who may be infected. Country like Zambia is also sticking to encourage the general public to seek care early for suspected malaria. During lockdown, workers are able to treat the patients efficiently with some treatments.

The third one is from reducing the source of infection. This can be achieved by mosquito control, the most environment-friendly insect pest control method is called sterile insect technique. Gamma rays and X-rays can sterilize male mosquitoes. These Male mosquitoes do not bite or spread diseases to people. The sterile males mate with wild female mosquitoes can result in no offspring and a reduction in biting female mosquitoes. The unusual point for this is that these male mosquitoes cannot produce offspring but remain sexually competitive. Non-native species will not be introduced into an ecosystem by this kind of mosquito[10].

5. Interventions for malaria

Nowadays, Artemisinin-based combination therapies (ACT) are used as a first-line malaria therapy in endemic countries worldwide. The drug combinations of ACT which have different mechanism can not only improve their efficacy, but also reduce the chances of appearance of drug resistance to each component drugs. Six ACT are presently recommended by the World Health Organization (WHO) for treating malaria cases worldwide: i) artesunate + amodiaquine (AS + AQ), ii) artemether + lumefantrine (AL), iii) artesunate + sulfadoxine-pyrimethamine (AS + SP), iv) artesunate + mefloquine (AS + MQ), v) artesunate + pyronaridine (AS + PY) and vi) dihydroartemisinin + piperaquine (DHA + PPQ)[8].

In Zambia, the government of the Republic of Zambia also adopt the idea to use ACT to be a main treatment of malaria. Therefore, in Zambia, Artemether-lumefantrine (AL) and Dihydroartemisin-Piparaquine (DHA-PQ) are both recommended to use in treatment usually. There is a paper which showed that AL was highly effective for the treatment of uncomplicated falciparum malaria in northern Zambia during the study period.The government of the Republic of Zambia does not recommend using Quinine as an alternative first line medicine. Furthermore, in order to limit the emergence of antimalarial drug resistance, the government of the Republic of Zambia decides not to use DHA-PQ in areas where there is active DHA-PQ mass drug administration. To be more specific, treatment in pregnancy is different that during the first trimester, pregnant women should be treated by using Inj quinine and then pregnant women who are in the second and third trimester, should accept to use Inj artesunate for treatment. Because it is important to acquire information about malaria and parasites, medical institutions and communities both pay attention to monitoring patients with severe malaria regularly to figure out the causes and the changes of parasites and environment so that governments and local communities can solve the problems and provide information to scientific research institutions, hence they can adjust timely and have more detailed and comprehensive reports and data for researching and developing malaria vaccines and antimalarial drugs or offering new methods which can prevent malaria more effectively[9-11].

Mosquito control plants had been widely used in Zambia. Mosquitoes can be chased away by actually two plants. One is the well-known citronella plant, which has been regarded as a natural mosquito repellent for a long time, and the other one is a hybrid. The hybrid is combined from two different plants, hardy perennial geranium and the citronella plant. Its attractive foliage and sweet lemon scent successfully makes itself become the most popular choice with homeowners. However, the deficiency of this method is that the life mission for a mosquito to obtain blood is strong enough to overcome an annoying odor, so this way cannot be effective[12].

DDT was considered as the first of the modern synthetic insecticides in the 1940s. It was firstly used to combat malaria, and the other insect-borne human diseases. It was also effective to control the population of insects in crop or homes. The success of DDT as a pesticide and widely use in Zambia or some other countries made it possible for the insects to develop the resistance. However, as the DDT became more widely used, there were many disadvantages that were exposed[13].

In addition, in Zambia, after treatment failure, there are also comprehensive managements to ensure that patient could have a full examination, and then have an instantly treatment if parasites are found.

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At the same time, if parasites are not found, patient who have the symptoms, which may be caused by other reasons, can also be diagnosed and treated accordingly[10].

For fighting malaria better, communities in Zambia also have full-scale and precise roles to diagnose and treat, thus communities usually have community health workers and community health assistants so as to execute the roles effectively and scientifically. It is helpful to relieve stress of hospital and control epidemic more precisely and efficiently[10].

6. Related vaccines against malaria

With global warming, the temperature in summer in different countries has increased, greatly increasing the rate of mosquito reproduction, resulting in faster transmission of malaria, the peak of transmission is more lasting, and the malaria incidence rate in tropical rain forests and tropical islands is much higher than the inland incidence rate. The Lancet Planetary Health The latest research published in April further verified this point. The research group collected about 180000 malaria cases in Hainan, China from 1984 to 2010, and found that the cases were mainly concentrated in the rainy season and tropical climate. In order to fight malaria more effectively, the world's first malaria vaccine (RTs, s/as01 malaria vaccine) has been developed, but the success rate of this vaccine is only about 30%, and it still needs to be vaccinated for 4 times. The time of immune protection is short, and the cost is high. In some countries with relatively backward economy, it is impossible to vaccinate citizens[14].

There are 3 types of malaria vaccines, pre-erythrocytic vaccines, erythrocytic vaccines and transmission blocking vaccines, which mainly focus on one of the three phases. However, right now, there is only an approved vaccine that is RTS,S/AS01, known by the brand name Mosquirix in the market. In addition, RTS,S/AS01 is one of the pre-erythrocytic vaccines and at the same time, it is recommended using in Africa by World Health Organization (WHO). It is known that parasites which are successfully introduced by the bite of an infected Anopheles mosquito are called "sporozoites". Some sporozoites can follow the blood flow to the liver for attacking hepatocytes. For pre-erythrocytic vaccines, in this phase, they can play a role by targeting sporozoites to produce antibody for restraining the infection of sporozoites in order to protect hepatocytes from being invaded. Therefore, Zambia have already written officially to express interest for RTS,S/AS01, which means that it is possible for the government of the Republic of Zambia to make children vaccinated by using RTS,S/AS01[15,16].

In Zambia, this kind of vaccine will increase the government's medical expenditure, Moreover, the anti malaria effect of the vaccine is not strong, and there is still the possibility of recurrence. At present, it is difficult to achieve the comprehensive promotion of the vaccine. Since 2013, Zambia's economy has been gradually recovering. For example, about one-third of the medical infrastructure of hospitals and clinics in Lusaka province is gradually improving standards, but the main demand of Zambia's national market is still low-cost products. Rural areas have a heavy disease burden due to the difficulty in obtaining medical equipment, low quality of medical services and lack of medical equipment, which also increases the burden of disease treatment in the country.Early studies have shown that difficult access to medical facilities is one of the important reasons for the high incidence rate and mortality of malaria.

7. Pharmacovigilance

In Zambia, there is an authority for pharmacovigilance named Zambia Medicines Regulatory Authority (ZAMRA). ZAMRA plays an essential role in supervising and regulating so as to ensure that all of medicines, which are provided to the public in Zambia, could meet the set standards of quality, safety and efficacy. ZAMRA is important, since it can actually avoid something wrong on medicines which is used as treatment on malaria and then decrease the proportion of treatment failure[17].

8. Conclusion

In November 2018,WHO director general Dr. Tan Desai said in Mozambique: "no one should die of malaria. However, the world is facing a new reality, that is, the current progress has stalled, which may destroy the hard work, investment and achievements of people in reducing the number of sick people over the years. We recognize that we must take different actions from the past from now on.". Therefore, all countries and the international community must pay common attention to the current situation and carry out a series of effective malaria control work. How to improve the level of malaria diagnosis and treatment is an important measure to strengthen the monitoring of imported malaria and prevent the re transmission of malaria cases in non-malaria areas or basically non-malaria areas. All countries need to attach great importance to it, especially Zambia.

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