Malaria

Introduction

Of all the insect borne diseases, malaria can be considered the most serious public health issue, even though deaths from malaria are generally preventable. (Perlmann, 1999: 22) This report firstly describes the malaria disease and its symptoms, the disease is then considered on a national and international basis. A detailed description of how the disease is transferred, before considering strategy and control measures.

Description of malaria and its symptoms

Malaria is an acute febrile illness with an incubation period of seven days or longer (Chiodini et al, 2007: 59). The most severe form is caused by *Plasmodium falciparum* (*P. falciparum*), in which variable clinical features include fever, chills, headache, muscular aching, weakness, vomiting, cough, diarrhoea, and abdominal pain. Other symptoms may supervene, such as acute renal failure, generalised convulsions, circulatory collapse, followed by coma and ultimately death. (WHO, 2007)

There are four types of *Plasmodium,* which infect humans:

1. *P falciparum,*
2. *P vivax,*
3. *P malariae,*
4. *P ovale.*

The symptoms of malaria are caused through the bite from the female (anopheline) mosquito, which produces toxins that are released by the ruptured red blood cells (discussed in detail later in the report). In areas where the disease is endemic, it is estimated that one percent of patients with *P. falciparum* infection die of the disease. (Centres for Disease Control and Prevention, 2006) Mortality in non-immune

travellers with untreated *P. falciparum* is significantly higher. The initial symptoms, which can be mild, may not be easily recognised as malaria. *P. falciparum* malaria should be considered in all cases of unexplained fever preliminary between seven days after the first possible exposure to malaria and three months after the last possible exposure. If treatment is delayed beyond twenty-four hours, it may be fatal. (Centres for Disease Control and Prevention, 2006) Young children, pregnant women, people living with HIV/AIDS (human immunodeficiency virus / acquired immunodeficiency syndrome), and older travellers are particularly at risk. (WHO, 2007)

The forms of malaria caused by other *Plasmodium* species cause significant morbidity, however, are rarely life threatening. *Plasmodium vivax* and *Plasmodium ovale* can remain dormant in the liver, and relapses caused by these persistent liver forms (hypnozoites) may appear months and, rarely up to two years after exposure. Latent blood infection with *Plasmodium malariae* may present for years, however, is not considered as life threatening. (WHO, 2007)

The illness and its relevance on both a national and international basis

Malaria is a issue at both national and international level, in 2006 malaria was present in 109 countries and territories (WHO, 2009). The majority of cases and deaths are in sub-Saharan Africa, however, Asia, Latin America, the Middle East and parts of Europe are also affected (WHO, 2009). Malaria therefore poses significant national problems for the affected countries however, internationally there is need to address malaria at a global level through the World Health Organisation and other international forums.

The Malaria Conference in Equatorial Africa, convened by the World Health Organisation (WHO) in 1950 in Kampala, Uganda, was a milestone in the history of modern malaria control activities on the continent of Africa. It assessed the available international information on epidemiological aspects of the disease and attempted to coordinate the various methods of research and control of malaria. The two main recommendations were that malaria should be controlled by all available methods, irrespective of the extent of malaria endemic within a region and that the benefits that malaria control might bring to the indigenous population should be evaluated. (Bruce-Chwatt, 1984).

The WHO Expert Committee on Malaria in the 1960's continually referred to the prejudicial effects of various forms of mobility in attempts at successful eradication. In practice little was done to deal adequately with mobility and with other human factors. Of the three related elements in human malaria; parasite, vector, and human, the latter received inadequate attention both in terms of time and the competence of people involved. (Prothero, 1977) The impact that malaria has in a population can be far reaching. This is illustrated in figure 1 below, "Manifestations of the malaria burden" (Breman, 2001).

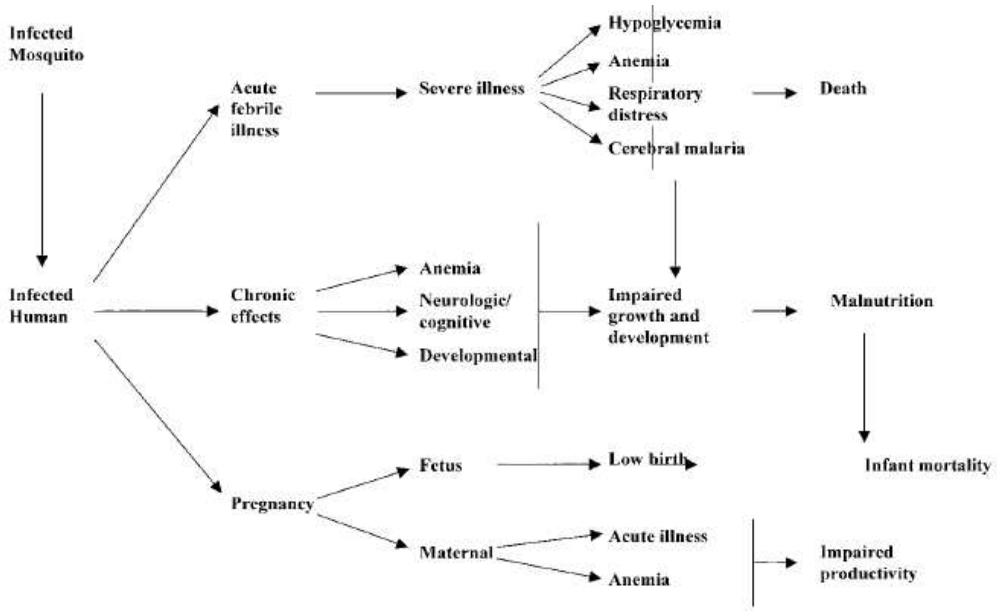

Figure 1.

With malaria giving rise to so many outcomes, it is imperative that the epidemiology of the disease is understood, to lessen the consequences for the populations affected. Africa endures most of the malaria burden, with estimates suggesting greater than 60% of the world's clinical cases and more than 90% of malaria deaths. (Worrall, et al, 2008) In heavily endemic areas, 30% of children acquire parasites by 3 months, which may explain the high numbers of infant mortality. The movement of the rural populations into the cities may increase the spread of the disease, as more people are potentially exposed to the mosquitoes from a given water source. Human engineering projects, for example, dam building, roads, industrial and residential centres can result in disruption to the terrain, allowing increased mosquito breeding (Breman, 2001).

Nationally and internationally malaria has also been addressed from a political angle, this has highlighted the importance of multilateral programmes, combining political advocacy, disease control and research. While a consensus on the optimal strategy to form the interface between research and control is emerging, scientists and control

specialists agree that a multilateral approach needs to be reinvented (Alilio et al, 2004).

The mode of spread of the disease

The Malaria parasites primary host and transmission vector is the female mosquito of the Anopheles genus. The Anopheles mosquito spreads the parasite and therefore the disease by feeding on an infected human carrier of the parasite and then transferring the parasite through the mosquito's saliva to a human in its next feeding session. The spread of the disease is determined on whether the malaria life cycle can be completed in its two hosts. The primary host is the Anopheles mosquito where the parasites complete the "invertebrate host" half of their life cycle, also referred to as 'extrinsic incubation period' (Centres for Disease Control and Prevention, 2009). The secondary host is the human where the parasite can complete the "vertebrate host" half of their life cycle (Centres for Disease Control and Prevention, 2009).

<u>The life cycle of Malaria</u>

Invertebrate host:

1. Mosquito feeds on infected human.
2. Parasite ingested.
3. Parasite gametocytes differentiate into gametes which fuse in the mosquito's gut.
4. Ookinete penetrates the mosquito's gut lining.
5. An oocyst is produced in the gut wall.
6. Oocyst ruptures releasing sporozites.
7. Sporozites migrate to the mosquito's salivary glands.

Vertebrate host:

1. Mosquito feeds on (uninfected) human inoculating sporozites through saliva into human.
2. Sporozoites infect cells in the liver.
3. Mature into schizonts which rupture releasing merozoites.
4. Parasites undergo asexual multiplication.
5. Merozites infect red blood cells

(Centres for Disease Control and Prevention, 2009; malaria hotspots, 2009).

In the vertebrate host stage a single malaria parasite (sporozoite) will infect the liver and grow in six days producing and releasing 30,000 - 40,000 daughter cells (merozites) into the blood. A single daughter cell will invade a red blood cell growing in 48 hours then rupturing to produce a further 8 – 24 daughter cells which are again released in to the blood (Centres for Disease Control and Prevention, 2009).

There are a several climatic factors affecting the mosquito vector; temperature, rainfall, and humidity (WHO, 2009). Temperature can affect the speed of the parasites growth cycle with warmer temperatures shortening the extrinsic incubation period, whereas at lower temperatures the parasite is unable to complete its growth cycle; for example *P falciparum* cannot complete its growth cycle below 20°C and *Plasmodium vivax* below 15°C (Centres for Disease Control and Prevention, 2009). Rainfall also contributes to the creation of mosquito breeding sites at locations where water can naturally collect.

Additionally, climatic factors also affect human behaviour increasing risk in certain groups; such as sleeping outdoors or going out at dawn or dusk, when mosquitoes are more abundant (Centres for Disease Control and Prevention, 2009).

The particular species of Anopheles mosquito present in an area can also influence the prevalence of malaria transmission with different species having varying abilities to act as a vector of the parasite. Additionally, different mosquito species demonstrate different behaviour which again influences their capabilities as malaria vectors, with species where "the females prefer to get their blood meals from humans ("anthropophilic") and prefer to bite indoors ("endophagic") being more effective malaria vectors" (Centres for Disease Control and Prevention, 2009).

There is also the issue of 'imported malaria' due to increased travel to malaria endemic countries, "the UK is one of the biggest importers of malaria among industrialised countries" (malaria hotspots, 2008). There is also the potential for malaria parasites to be transmitted without the mosquito vector, from mother to unborn child in congenital malaria and through transfusion or needle sharing.

Strategy and control measures

Eradication was tried in the 1950's and 1960's conversely; this was abandoned to a strategy of control. However, recent developments indicate that eradication could be reconsidered, given sufficient time and money. (Perlmann, 1999: 126)

The three elements of control for malaria are:

1. Case management of the patient
2. The prevention of infection through vector control
3. The prevention of the disease by the administration of anti-malarial drugs to particularly vulnerable population groups. (Centres for Disease Control and Prevention, 2006)

Case management: accurately diagnosing malaria it is essential to ask the patient where they were eight to ten days prior to the symptoms starting. Malaria is generally over diagnosed in patients who attend health centres or pharmacies in Africa. The next question should be whether they were taking prophylaxis. Prophylaxes with malarone, mefloquine, doxyclycline and primaquine phosphate are very effective, although malaria should still be considered. The symptoms should then be considered, and if there is any risk of malaria, a thick blood film should be taken.

Vector control: indoor residual spraying (IRS) is the application of long acting chemical insecticides on the walls and roofs of all houses and domestic animal shelters in a given area, to kill the adult vector mosquitoes that land and rest on these surfaces. The primary reasons to use IRS to curtail malaria transmission are to; reduce the lifespan of vector mosquitoes so that they can no longer transmit malaria parasites from one person to another, furthermore reduce the density of the vector mosquitoes. (WHO, 2006)

One of the compounds used for IRS is dichlorodiphenyltrichloroethane, (DDT) which is an organochlorine compound, which was first synthesised in 1874. In 1935, it was discovered to be a highly effective insecticide, which led to its widespread use as a

general pesticide in agriculture. In recent years the use of IRS has declined, this is due in part to lack of government commitment and financing to sustain these efforts over the long term, and to concerns about insecticide resistance and community acceptance. However, another important factor has been general disapproval of DDT use, due to fears of its harmful effects on the environment and on human health; fears that WHO state are unjustified when DDT is used appropriately.

The prevention of the disease by the administration of anti-malarial drugs:

Historically, Chloroquine was suggested as the preeminent antimalarial drug however, over time this has generally lost its effectiveness in most regions of the world where *P. falciparum* malaria is prevalent. (WHO, 2006) Failure of one of our most useful medicines presents a major challenge in malaria controls and to Public Health. Currently, WHO recommends five combination therapies for deployment depending on their efficacy in different geographical areas, these being:

1. Artemether and Lumefantrine
2. Artesunate and Amodiaquine
3. Artesunate and Sulfadoxine Pyrimethamine
4. Artesunate and Mefloquine
5. Amodiaquine and Sulfadoxine Pyrimethamine

Artemether and Lumefantrine have been co formulated into a fixed dosed tablet named Coartem. To date, no resistance has been reported against either component. With the introduction of combination therapies, a two pronged case management strategy has been proposed based on microscopic diagnosis at more central locations for example hospitals, whereas rapid diagnostic tests should be utilised for more

remote communities or highly mobile populations. In high transmission areas, the use of rapid diagnostic can be effective, if they compliment clinical diagnosis to target treatment to those who are clinically ill.

Conclusion

This report has described the malaria disease and its symptoms, the disease was then considered on a national and international basis. A detailed description of the mode of spread of the disease is then given before considering strategy and control measures. In summary, each year there are more that one hundred million deaths from malaria. Worse affected are children under five and pregnant mothers. Key among the causes of mortality and morbidity are widespread resistance to drugs and poor diagnosis. To control malaria adequate case management is required and intervention strategies such as vector control and the administration of intermittent preventative treatment to particularly vulnerable population groups such as pregnant women and infants must be prioritised. The control and possible eradication of malaria requires a global commitment.

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Appendix A

(i) Agenda for meeting one
(ii) Minutes for meeting one
(iii) Minutes for meeting two

(iv) Minutes for meeting three
(v) Minutes for meeting four

Appendix A (i)

AGENDA FOR MEETING ONE ON TUESDAY 3rd FEB 2009

- Initial discussion in relation to report and presentation. Get views of all group members on possible ways to structure report.

- Discuss with group suitable times to hold group meetings taking into account group members outside commitments.

- Initial ideas for presentation.

- Next meeting date, location and time.

"AOB" (please add)

Appendix A (ii)

MINUTES FOR 1st MEETING

Date: Tuesday 3rd Feb 2009

Time: 11.15-11.40am

Venue: York House

Members Present: Andrea Palfreman (taking minutes)
Thomas Bolsher
Claire Thomas
Keane Hamilton

MATTERS	ACTION
1. Initial discussion in relation to report and presentation. Get views of all group members on possible ways to structure report. Everyone contributed with ideas. Was decided that at this stage we would all generally look in to the subject topic.	All
2. Group discussed suitable times to hold group meetings. It was agreed that Tuesday mornings was convenient for all.	All
3. Initial ideas for presentation discussed. No definite ideas yet.	All
4. Next meeting agreed for Tues 10th Feb, York House, 11.00am.	All
5. AOB - No	

Appendix A (iii)

MINUTES FOR 2nd MEETING
Date: Tuesday 10th Feb 2009
Time: 11.15-11.40am
Venue: York House
Members Present: Andrea Palfreman
Thomas Bolsher (taking minutes)
Claire Thomas
Keane Hamilton

MATTERS	ACTION
1. Each member reported back on initial findings.	All
2. Looked at marking schedule and identified sections for report.	All
3. Discussed who would like to do each section. Allocated sections to each member.	
4. Presentation discussed. No definite ideas yet.	All
5. Next meeting agreed for Tues 17th Feb, York House, 11.00am.	All
6. AOB - No	All

Appendix A (iv)
MINUTES FOR 3nd MEETING

Date: Tuesday 17th Feb 2009
Time: 11.15-11.40am
Venue: York House
Members Present: Andrea Palfreman
Thomas Bolsher (taking minutes)
Keane Hamilton

MATTERS	ACTION
1. Discussed allocation of sections due to Claire being unable to contribute at the moment. Andrea will take this on.	All Andrea
2. Discussed progress of each member.	All
3. Presentation discussed.	
4. Next meeting agreed for Tues 24th Feb, York House, 11.00am.	All
5. AOB - No	All
	All

Appendix A (v)
MINUTES FOR 4th MEETING
Date: Tuesday 24th Feb 2009

Time: 11.15-11.40am
Venue: York House
Members Present: Andrea Palfreman
Thomas Bolsher
Keane Hamilton (taking minutes)

MATTERS	ACTION
1. Discussed progress of each member. Was decided that will communicate each other sections by e-mail, so each member can read sections.	All
2. Was decided Thomas will put report together.	Thomas
3. Andrea will proof read report.	
4. Presentation discussed.	Andrea
5. Further meetings will be informal up to hand in of report.	All
6. AOB - No	All