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Malaria in The Gambia: A Stable Endemic

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Introduction

The sights, sounds, smells, and feel of The Gambia have been permanently impressed upon my memory. I return to The Gambia often in my mind, yearning to be immersed in their beautiful culture, so different from my own. I traveled to The Gambia to study the medical system; however, I found it incredibly difficult to focus upon a single aspect of their society. At the clinics, in the hospital, I found my mind and eyes wandering everywhere. The words of our leader became background music as I became engrossed in the intricacies of a woman's dress, the way that she straps her baby to her back, or peering at the vendors selling their mangoes and cashews outside. Everything was new to my eyes. I was interested in the medical system, but first I needed to study the people, their families, their work, the environment, their languages, and religions.

After some time of adjustment, I was finally able to concentrate on the medical system. I was constantly filled with contradictory feelings; I was amazed, disgusted, impressed, disturbed, nauseated, and joyous. With each new clinic or hospital visit, my appreciation for the work of doctors and nurses heightened. I eventually focused my learning experience on the study of malaria, in large part because of the extent and severity of the problem. We quickly learned that malaria is everywhere in The Gambia and affects everyone. Its associated problems take many lives annually, and the treatment and prevention of malaria are key issues in Gambian medicine. Multiple infections during the course of one's life is not uncommon, especially with children.

Within the Clinic Grounds

The Maternal Child Health Clinic in the town of Serrekunda is one of the busiest health clinics in The Gambia. The clinic has a sixteen-bed in-patient capacity, and the beds never seem to be vacant. The laboratory at Serrekunda is no bigger than a broom closet, but its size does not inhibit the three-member staff from testing between 200-400 blood samples a day. The window-sill of the lab is crowded with blue- and purple-stained slides. They dry quickly because the air is so dry. The laboratory equipment is minimal and in constant use: one microscope, one pipette, an antiquated spectrophotometer, chipped slides, mismatched and reused sample cups, and a bar of soap. The clinic grounds are swarming with small children, their sisters, brothers and mothers. The women are dressed in traditional Gambian garb. Most of the women are situated in a similar pose, with a bulging belly in prospect of the next child, or with a baby strapped to their back or latched to their breast.

Nurse listens to mothers explain children's illnesses at Serrekunda clinic

I visited the Serrekunda Maternal Child Health Clinic about six times during the course of our five-week stay. Whatever day I visited, the clinic always looked and functioned in the same way: like complete chaos. Anywhere between 500 and 1000 patients arrive at the clinic each day. Out of necessity, the nurses see patients and diagnose their ailments feverishly fast. Another patient, another antibiotic, another immunization, another blood test. Miraculously, all patients go home by the end of the day and most are feeling better than when they had arrived.

Our study group toured many major and minor health care facilities in The Gambia, which gave me a broad and accurate view of the country's health care system. Despite our place of travel, or person of interview, when asking about the country's major health concerns, we inevitably received the same response: "One of the most frequent diagnoses made is malaria, the most frequently run test is for malaria, the medication most frequently administered is for malaria, malaria is one of the biggest childhood killers

in The Gambia." Malaria is a undeniably one of the most serious health concerns to the people of the Gambia.

Background Information

Malaria is spread by the female Anopheles mosquito. Female mosquitoes feed on the blood of animals, including humans, to support the needs of

Female Anopheles mosquito atop her human prey

their developing eggs (Weatherall 1996). The parasites that cause malaria follow a complicated life cycle, alternating between human and mosquito hosts. There are four species of human malaria parasites: *Plasmodium falciparum, Plasmodium malariae, Plasmodium ovale*, and *Plasmodium vivax* (WHO 1980). According to Abi Jobe, Laboratory attendant at the Serrekunda Health Center Laboratory, *P.falciparum* is the most commonly seen species in The Gambia, *P. falciparum* is the most commonly seen species in The Gambia. We very rarely see *P.ovale* and *P.vivax* is nonexistent at the moment (Abi Jobe, personal communication, 6/ 23/98). Regardless of the parasite strain, within a short amount of time after the onset of noticeable symptoms, malaria parasites have begun to wreak havoc within a human body.

Stable Malaria in the Gambia

The presence of malaria in a country can be classified as stable or unstable (Pasvol 1995: 216). The Gambia is considered to have "stable malaria" (as does most of Africa). Stable malaria is characterized by *everyone* becoming infected multiple times during the course of their lives with the first infection occurring in infancy, or very soon after (Pasvol 1995: 216). Unstable malaria is characterized by outbreaks of malaria. These outbreaks are dramatically evident as most individuals in an epidemic area are stricken by the disease (Weatherall 1996). The effects of an unstable malarial outbreak are typically more severe than those associated with stable malaria. The reason for this is that those living in an area of stable malaria deal with it routinely and are therefore more experienced in the management and treatment of its associated problems than those who encounter malaria cases occasionally.

Individuals living in areas of stable malaria gradually acquire immunity against the major local strains of malaria parasites. The incidence of malaria in stable regions is therefore dependent upon the level of acquired human immunity, whereas in regions of unstable malaria the incidence is dependent upon the number of infective mosquitoes (Weatherall 1996). In The Gambia, it has long been recognized by the people that children under the age of five are particularly vulnerable to malaria. Though this knowledge was not based on scientific data, their observations were accurate. At birth, the immune system of a child is immature and it takes approximately five years before a child's immune system is developed enough to defend against malarial parasites (Weatherall 1996). Consequently, children are the prime victims of malaria.

Stable malaria is also characterized by seasonal variation; cases of malaria occur year round but are sensitive to annual climatic events. During the summer rainy season, the number of malaria cases reaches towering proportions. The hot wet weather and summer rains during the months of July through October create ideal breeding grounds for the female Anopheles mosquito (Weatherall 1996). Standing pools of water can house thousands of developing mosquito eggs. The intensity of malaria infection climbs dramatically during these rainy months. Figure 1 is a graphic representation of the number of diagnosed malaria cases seen in children under five years of age. The data were tabulated monthly for the year of 1997, for the town of Bansang, and the villages of Galleh Manda, and Sare Soffie. Note the dramatic increase during the rainy season, with Bansang peaking in September and Sara Soffie and Galleh Manda peaking in October.

The incidence of malaria in most villages is distinguished by patterns of climatic variation. However, the intensity of malaria from village to village varies, and indicates a very patchy distribution (Pasvol 1995: 217). Factors contributing to the intensity of malaria may include population density, proximity to bodies of water, the degree of human immunity, and the specific type of malaria parasite strain present (Pasvol 1995: 214). These factors are known to influence the intensity of malaria, but these alone do not explain the uneven distribution commonly seen. For example, two villages

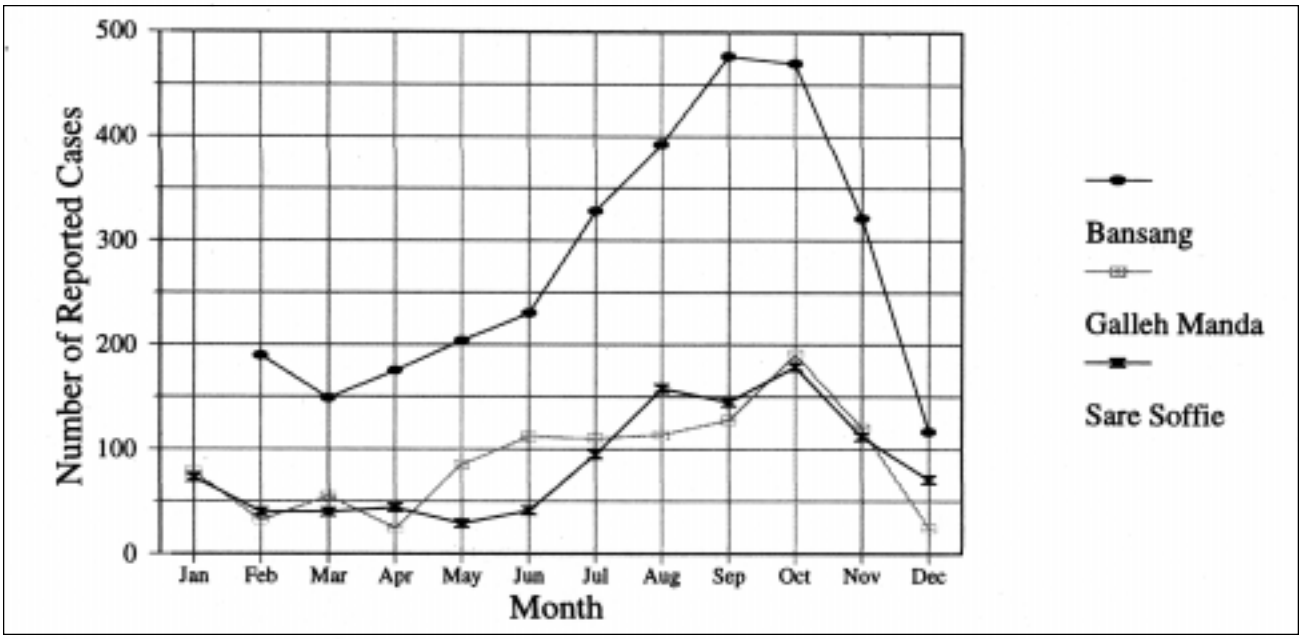

Figure 3.1 A graphic representation of the 1997 seasonal influence on the incidence of malaria in three locales in The Gambia; Bansang, Galleh Manda, Sara Soffie. Statistics were collected fromm Maternal Child Health Clinic records and include the reported cases of malaria for children under five years of age. Note: January statistic for the town of Bansang was missing from records.

in The Gambia, Keneba and Manduar (represented by the large dot in Figure 2), are quite near each other, but yet have shown a markedly different parasite rate for over forty years, as
noted in The Epidemiology of Malaria, (Pasvol 1995: 217). Cases such as these illustrate that malaria epidemiology is still not fully understood.

The Medical Research Council (MRC), a medical facility based out of the United Kingdom, has an important presence in The Gambia. It has a huge research facility where outpatient treatments and scientific research are conducted on topics such as malaria, tuberculosis, AIDS, and many other common afflictions of The Gambia. MRC has conducted malaria studies over the last four decades. MRC has made a strong impact upon Gambian life, providing many opportunities for work. It has improved medical practice for many people of the Gambia.

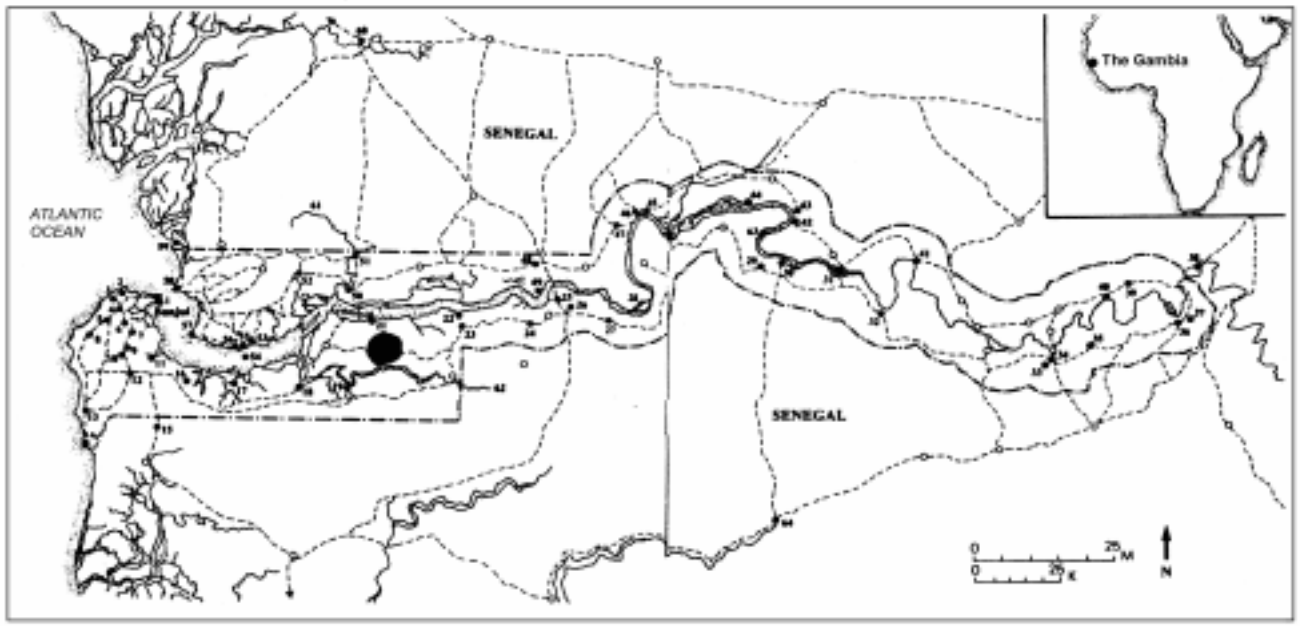

Figure 3.2 A map of The Gambia pointing out the villages of Keneba and Manduar (Gamble 1988: 136-137).

Damage Caused During the Life Cycle P. falciparum

The life cycle of malaria parasites consists of a two-stage cycle alternating between a human host and a female anopheline mosquito. The cycle within a human host begins upon being bitten by a female Anopheles mosquito carrying the malaria parasite in its salivary glands (Pasvol 1995: 213). When the mosquito bites, malaria parasites enter human blood circulation. The parasites then travel within the blood stream to the liver where asexual multiplication begins (Pasvol 1995: 213). Asexual replication produces yet another morphological form of the parasite that breaks free from the liver cells and enters the bloodstream where it attaches to circulating red blood cells. Once inside the red blood cells another round of asexual division begins. During this period, malaria parasites go through a well known series of morphological changes that take approximately 48 hours to complete (Pasvol 1995: 213). At the end of parasite differentiation and growth, the red blood cell bursts, freeing more parasites into the blood stream. The new parasites immediately invade uninfected red blood cells and begin another cycle of parasite replication (Weatherall 1996).

A small proportion of malaria parasites take an alternate pathway to form male and female parasite sex cells (Weatherall 1996). This serves to pass the malaria parasite from a human host back into the body of a mosquito. If another mosquito bites an individual and ingests the circulating parasite sex cells, these cells will fuse to form a zygote within the midgut of the mosquito. The zygote differentiates and then travels to the insect's salivary glands, thus fully completing the cycle (Weatherall 1996).

The rampant spread of infectious mosquitoes is easily understood, given its mode of replication and transmission. For example, we were in the Gambia for five weeks, and despite my best efforts I was bitten *at least* ten times by a mosquito. Suppose that I had not been taking a malaria prophylactic and let's say that mosquito number five was infected by malaria parasites. About five days after being bitten by mosquito number five, I would have had a 30,000-fold increase in the number of parasites in my body, and replication would continue (Pasvol 1995: 213). Because I could now have been infected, I would have transmitted the malaria parasite to mosquitoes 6-10. In turn, mosquitoes 6-10 would transmit the malaria parasite to other individuals when they subsequently bit other people. If it were not for the Larium/ Mefloquin medication, I would most likely have been in the hospital with a severe case of malaria. This example illustrates how one infectious mosquito rapidly and relatively easily turns into many.

Symptoms of a P. falciparum Attack

There is a seven-to-fourteen-day incubation period after a person is bitten by an infective mosquito before the malaria symptoms appear (Weatherall 1996: 846). Parasite development in the liver begins within a few hours after the initial mosquito bite. With this bite, parasites enter into the human bloodstream and begin their cycle of replication. Five to fifteen days later, a fresh brood of parasites burst from the cells, having replicated 30,000 fold, and invade red blood cells (Pasvol 1995: 213). The form of parasites entering the red blood cells requires a 48-hour cycle of replication. Because of this two-day cycle, clinical manifestations will frequently follow a similar periodicity. Malarial attacks of this type are characterized by bouts of fever alternating with asymptomatic periods, reflecting the "developmental synchronicity of blood stage parasites" (Wernsdorfer 1988: 716). Symptoms of malaria are commonly described as flu-like: fever, shivering and chills, vomiting, nausea, diarrhea, body aches and weakness, flushed dry skin, and bright eyes (Wernsdorfer 1988: 716). Diagnosis is routine and uncomplicated; a finger prick and blood smear, and a slide with *Field's Stain* to reveal the presence of any malaria parasites (WHO 1980). I had the

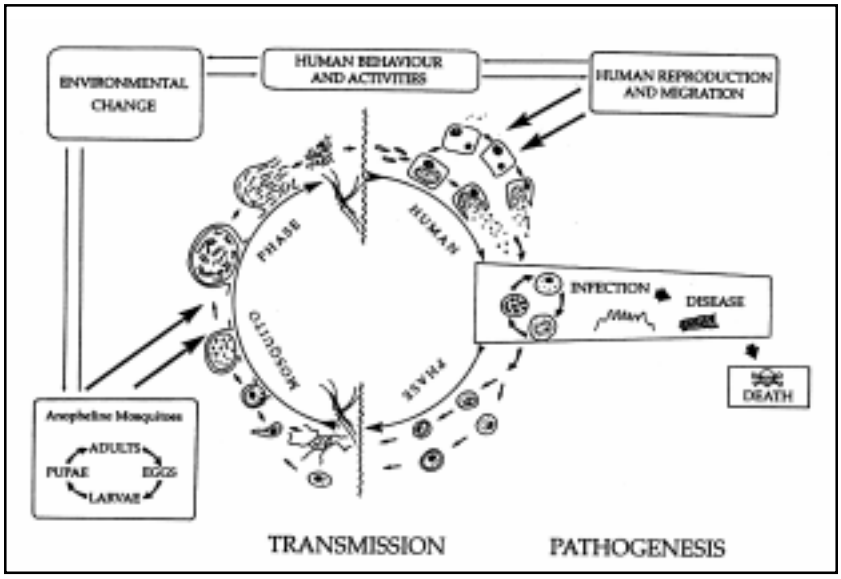

Figure 3.3 Diagram of the life cycle of human malarial parasites, also including some factors affecting transmission (Pasvol 1995: 212).

opportunity to go on patient "rounds" with Abdullah Dyusuf, a pediatric nurse specialist at the Serrekunda MCH clinic. "Rounds" do not last very long as the in-patient clinic only holds up to sixteen patients. A thin curtain separates the in-patient ward from the labor and delivery ward, allowing the sounds of childbirth to intermingle with the sounds of sick children. The windows of the in-patient ward were open, but no air appeared to circulate. I had the overwhelming desire to hold my breath, a futile attempt to keep what I perceived as malignant air outside of my body. Nearly all of the beds were occupied at the time of my visits, and most were occupied by both mother and child. Proceeding down the line of patients, their diagnoses and prognoses were announced to me (the notion of patient confidentiality does not appear to exist): "malaria, malaria, respiratory infection, malaria, respiratory infection, malaria, malaria, etc." I was astounded. I had never realized the magnitude of the problem until that point. Malaria is a *common* ailment, almost analogous to the common cold, or winter flu in the United States.

Children in The Gambia face annual bouts with malaria.

Treating Malaria

In endemic areas, malaria is a relatively easy infection to diagnose and treat. The commonality of the disease has enabled most individuals to readily recognize symptoms at an early stage. Medical facilities are prepared to rapidly analyze samples for the presence of malaria parasites, and the medicine to treat malarial infections is almost always in supply. Medical aid must be sought at the first sign of symptoms because the *presence* of symptoms indicates that a large number of parasites are already circulating in the blood.

The child population, especially under five years of age, is the group hardest hit by malaria. It is not uncommon for childhood cases to turn severe because of a delay in medical care. For children who do not yet talk, a parent must first recognize the symptoms in the child before obtaining medical attention. Because the symptoms are flu-like, many will wait to see if the problem passes. Time is crucial in a parasitic infection because of the rapid course of replication. The body of a small child can literally be taken over by a malaria infection, causing rapid degradation of the child's health. Malaria weakens the child, allowing for the development of other opportunistic infections.

In visiting the MCH clinics I saw first-hand the sensitivity of time in malarial infections. Some children were diagnosed and treated for malaria on an out-patient basis, while others were extremely ill, mandating admission to the in-patient clinic for treatment. The in-patient children with malaria were visibly "sick." Their tiny bodies looked so frail; they just lay lifeless on their beds. Every so often, you heard a moan of pain, or the sound of a child vomiting. The severity of their malarial infections is a consequence of the delay in medical treatment, compounded by their age. Unfortunately, it will take a longer period of time for the beneficial effects of medication to be realized as a consequence of the large number of malaria parasites already circulating in their blood.

Chloroquin is the antimalarial drug of choice. This medication can be given orally or intramuscularly and is given to children and expectant mothers. Chloroquin is not known to cause deleterious side-effects to the recipient or to a developing fetus (Weatherall 1996). Chloroquin acts by disrupting parasite feeding behavior and forces death upon the malarial parasites (Weatherall 1996). This medication is effective against most strains of malaria parasites. However, there is an increasing number of parasite strains that are resistant to chloroquin, i.e., the parasites of these strains are not affected by chloroquin treatment, and the patient will not improve in health (see Figure 4). For such strains, a combination of other drugs has been used that usually serve as an effective means to rid an individual of malarial parasites. However, not all chloroquin-resistant strains are receptive to these medications. Consequently, research to find new and better malaria medicines is an active field.

Though still in developmental stages, there is hope for a new malaria vaccine. Scientists at the National Institute of Allergy and Infectious Diseases are working to breed goats whose milk could be used to vaccinate children against malaria (Cowley 1998: 49). Thus far they have bred goats and mice that

produce pieces of MSP-1, a protein displayed on the surface of the malaria parasite (Cowley 1998: 49). Testing is currently being carried out now to see if the treatment is effective in protecting monkeys, and then will move to human trials. This treatment has the potential to radically change the lives of many children in endemic areas if, in fact, the treatment proves effective.

Resistance: Inborn and Acquired

Gambian adults are resistant to the majority of malarial strains indigenous to the country. However, building immunity to this level is a long and arduous process. Because children's immune systems take years to mature, they generally become ill multiple times each year with malarial infection (Pasvol 1995: 216). In fact, as noted in *Baillere's Clinical Infectious Diseases*, "At any time, over three quarters of the primary school children will have parasites in their blood" (Pasvol 1995: 216). The constant battery of infections gradually declines as the immune system is built to a level that is capable of fending off the predominant strains of malaria parasites. However, because there are so many parasite strains in existence, adults periodically come down with a malaria infection.

In regions of endemic malaria, natural selection has favored the formation of populations with a high incidence of genetic mutations causing various blood disorders. These traits have been shown to impart some level of immunity against malaria (Pasvol 1995: 257). The sickle cell trait is the most well known of these immunity features. Heterozygosity for the sickle cell trait confers a selective advantage to the carrier that counterbalances the deleterious effect of the homozygous state, thus allowing for the perpetuation of the sickle cell gene. The sickle cell gene causes red blood cells to change in shape; the normal biconcave disc changes to a sickle shape. Sickled red blood cells have a reduced capacity to carry oxygen; consequently, parasites cannot develop in these cells due to the lower oxygen level (Wernsdorfer 1988: 747). Individuals carrying the sickle cell trait can become infected by malaria parasites, but the parasites cannot survive within a "sickled" human host.

There are many other human blood disorders, such as hemoglibinopathies and thalassemias, that provide protection against malarial disease. The mechanisms of protection are all similar; due to an abnormality in red blood cells, usually in shape or surface membrane, parasite growth is retarded. Regardless of the type, acquired or inborn, immunity is a necessity when living in any endemic area.

The Mechanisms of Destruction

The destruction seen in P. falciparum malarial infections is a result of parasite invasion into the red blood cells. The red blood cells become sticky and adhere to capillary walls, thus blocking blood flow through this circuitry (Wernsdorfer 1988: 720). Parasites have a tendency to go into deep vasculature, blocking the small veins and capillaries leading into internal organs. In effect, this keeps oxygen from reaching vital organs, resulting in cell death (Wernsdorfer 1988: 720). If the parasite infection is not treated, the continual lack of oxygen will result in organ failure and can eventually lead to death.

Cerebral malaria is one of the most devastating examples of organ suffocation. Symptoms are caused by the blocking of capillaries in the central nervous system, thus extensively interfering with the brain's vascular supply (Wernsdorfer 1988: 720). Cerebral malaria acts rapidly; it is possible to see a patient in the outpatient clinic in the morning, complaining only of a headache, yet he may be brought in with a coma in the afternoon (Wernsdorfer 1988: 720). Patients first lose consciousness, then their eyes bulge as their brain swells. Even with the best available treatment, the mortality in young children may be as high as 25% (Wernsdorfer 1988: 721). Surprisingly, of those who do survive, reports of mental defects and neurological abnormalities are uncommon (Wernsdorfer 1988: 721).

Anemia is one of the most common problems resulting from malarial parasitemia. Unlike the complications wrought by cerebral malaria, anemia is much easier to control and to treat. Anemia results from the extensive loss of red blood cells (Wernsdorfer 1988: 758). The red blood cells that parasites invade are destroyed after being utilized for parasite replication. In addition to this type of red blood cell loss, malaria is also associated with a disruption in the production of new red blood cells. Consequently, the degree of anemia is directly proportional to the severity and duration of malarial parasitemia (Wernsdorfer 1988: 758).

Nutritional deficiency is another common problem associated with malaria. Malaria brings vomiting and diarrhea, making it difficult for individuals, especially young children, to take in the necessary vitamins and nutrients for healthy living. It is normal for a patient to lose weight during a bout with malaria; however, when a child must battle malaria four times a year, the weight loss cumulates. Children who are being weaned (12 - 24 months) are particularly vulnerable and thus need to be monitored more closely. Weight loss is common for children being weaned, but this loss becomes even more dramatic when compounded by

Kristin with Ramu Sarge-Njie at our last dinner in The Gambia

weight loss from a malaria episode. Making sure that a child does not become nutrient deficient is paramount in fighting malaria. General malnourishment affects the strength of the immune response, thus inhibiting the child's ability to fend off malaria and other illnesses (Wernsdorfer 1988: 756). This factor puts the child at greater risk; common colds can turn deadly when they are playing upon an already weakened child.

Malaria and Pregnancy

A study completed in 1984 demonstrated that malaria is up to twelve times more common in pregnant women than in their non-pregnant counterparts (Pasvol 1995: 240). Especially during the first trimester, the immune system is depressed and pregnant women have a greater susceptibility to infection. This is a particular health concern in areas with characteristically large family sizes, like The Gambia. However, it should be noted that there are active attempts to increase awareness of "population control," in an effort to decrease the average family size. Educational programs have been incorporated into female schooling, family planning facilities are being established, and reliable birth control measures (Depoprovera shots and birth control pills) are available through most Maternal Child Health clinics.

Parasite infection during pregnancy is associated with increases in spontaneous abortion, stillbirths, and low birth weights, but these effects are usually only seen in first pregnancies (Pasvol 1995: 258). Therefore, it is imperative for women in endemic areas to take extra precautions during pregnancy. In all of the Maternal Child Health clinics that I visited, I was pleased to see educational posters illustrating precautionary measures that could be taken (within the villager's means) to prevent malaria. The posters featured pregnant women and small children coming indoors at dusk (it is common to remain outdoors to socialize and to sleep where it is cooler), sleeping under a mosquito net, and dipping these nets into a solution that repels mosquitoes. This is especially important during the rainy season when mosquitoes are more prevalent. The efficacy of such programs has proven itself; despite the many potential problems that are caused by malaria during pregnancy, very few surface in the health clinics in The Gambia.

Malaria: Morbidity and Mortality

In The Gambia, malaria is the second most common childhood killer after diarrhea (Dr. Margaret Grant, personal communication, 6/16/98). Dr. Margaret Grant, Peace Corps Volunteer working with the Central River Division's Public Health Team, stated that in the town of Kuntaur there are approximately 4000 cases of malaria, per 1000 children, per year (Dr. Margaret Grant, personal communication, 6/16/98). This means that, on average, a child will battle a malaria infection four times a year. A small child's body is weakened considerably after fighting four cases of malaria in one year. This often leaves the child too frail to fend off minor infections or illnesses. Therefore, malaria is frequently the morbidity that weakens the child enough that a normally non-life threatening illness turns fatal.

Eradication of Malaria ?

Is world-wide eradication of malaria possible? Continual research has provided in-depth understanding of disease pathology. Science has provided better treatments, educators have taught prevention, world organizations have given supplies and support, but the malaria problem persists. The number of insecticide-resistant mosquitoes and drug-resistant parasites will forever hinder attempts at eradication. Therefore, eradication of malaria is not a practical goal. The best way to help those living in

endemic areas is with continued support of education, health, and research. Keeping treatments available is one of the keys to keeping the incidence of malaria and mortality and morbidity associated with malaria to a minimum.

Malaria is a tremendous problem in The Gambia; countless lives are taken each year from infection. However, the management of malaria in The Gambia is a well-rehearsed routine. Fighting malaria is a part of life for Gambians. The country has focused on making health care and education accessible to the population. Posters illustrating health education messages hang on many clinic walls, family planning and population control classes are becoming incorporated into the school curriculum, and traditional and modern medicine are finally making a connection. The health care system in the country is extensive, and the majority of villages are regularly visited by trained medical personnel. The Gambia has malaria under managed care. The effects of education and health accessibility are far reaching and the country continues to maintain control over such a dangerous problem.

Conclusion

Our trip to the Gambia opened my eyes to a way of life radically different from my own. Studying the Health Care System was my main research interest. Prior to our arrival, I knew that their health care system was not *as advanced* as that in the United States, and I knew that I would be in for a shock. However, never in my wildest dreams did I imagine the conditions that I saw. Health care in The Gambia is strange. It is extensive, as nearly every village is regularly visited by some sort of health team. However, it also appears to be severely limited. There is an obvious shortage of doctors. The primary health providers are nurses that require only 24-48 months of education and training. This training has made the health workers excellent at identifying the common maladies; however, it seemed that if your symptoms fell outside of their scope of knowledge, then the patient had little or no further recourse. Yet, the health care that The Gambia does have is amazingly effective; their methods for communicating the proper ways to maintain good health and how to practice healthy habits is ingenious and far reaching. They have done so much with what seems like so little.

Seeing The Gambia's health care system has influenced my way of thinking and ultimately my life ambitions. In The Gambia, the first priority in the practice of medicine is prevention through education. But when sickness does occur, the first priority becomes helping those who are sick, treating them, and trying to make them better. Even if the patient just received an antibiotic and a Band-Aid, their appreciation is sincere. This seemingly minor contribution just made someone's life a lot more bearable. I want to go into medicine to provide a service to the public, to help those who are sick. But achieving this goal has become more and more difficult in the States as the first priority has become collecting insurance information and the correct billing address. Our trip to The Gambia inspired me. I want to become a doctor that can give back to society. I would love to return to The Gambia or any place that is in need of medical assistance. I want to provide care in the kind of place where I will feel rewarded at the end of each day.

Acknowledgements

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Personal Interviews

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Mrs. Abi Jobe, Laboratory Attendant. Maternal Child Health Clinic, Serrekunda, The Gambia. Interviewed on: 06/23/98

Momadou Dramé, a marabout from Pakao in the Casamance, southern Senegal

Young children eating food prepared for ritual ceremony to remove a "curse" placed on one individual by another