Bednets for malaria control

by Robert Bourgoing

Fighting malaria: African women dip bednets in a natural insecticide

Gbaguidi XII -- the King of Savalou -- yawns widely. He has slept well and with good reason: he spends his nights under a mosquito net impregnated with insecticide, a practice that could save many lives in his small kingdom in central Benin. At the end of the rainy season, Savalou, 200 km. north of Cotonou, is also the kingdom of the anopheles, the mosquitos that transmit malaria. One of the world's most deadly diseases, malaria claims up to three million lives per year, a million of which are in Africa. Hardest hit are children under five.

LIKE CLEOPATRA

In her day, Cleopatra, Queen of Egypt, also slept under a mosquito net. Today, there is renewed interest in this method of preventing malaria. Despite the encouraging results from tests conducted in Tanzania on the anti-malaria vaccine developed by a Colombian doctor, an effective vaccine against malaria will not be available over the short or medium term. There is no longer any hope of eradicating the mosquito itself and drugs are increasingly ineffective against certain resistant strains. Therefore, the new approach of insecticide impregnation of bednets becomes one of the most promising avenues for limiting the number of deaths caused by malaria. In one of the areas where it was tested in Gambia, it cut the child mortality rate by more than half.

Researchers have been trying for the first time in Africa to find out why some people decide to sleep under mosquito nets and to discover how to convince others to make the same decision. Their test field: Benin, where less than 15% of the population use the nets. Over a 3-year period, researchers from Benin and Canada, funded by IDRC, sold tulle (the fabric used for making mosquito nets) curtains to 1,550 families in the Savalou region. Each week, survey takers visited about 400 families in twenty or more villages to check whether they had used the fabric.

CLEAR BENEFITS

The surveys reveal general agreement among the intended beneficiaries: the new mosquito net provides undeniable benefits. In contrast to the traditional mosquito net, this net is light, transparent and permits air circulation. People are less hesitant about installing it during periods of intense heat. Impregnating the nets with an insecticide that is odour-free and harmless to users increases protection.

However, this apparently simple method is confronting certain barriers. The household head sometimes appropriates it for his own use, although the project has had some succes in changing this behaviour by emphasizing the importance for children to be protected, owing to their delicate immune systems.

Local people are often unaware that only one mosquito bite can transmit malaria. The critical time for protection is around 1 a.m., the peak time of biting activity by the anopheles mosquito -- the one that transmits malaria.

DISEASE OF THE SUN

Dr Achille Massougbodji, a parasitologist at the Centre national hospitalier et universitaire du Bénin (Benin's national university hospital), considers animist religious beliefs and lack of knowledge to be the main barriers to the use of mosquito nets. "When you ask people in their own language, you have to take into account that malaria is associated with the sun and excess use of peanuts and red palm oil. However, the linkage between the mosquito and the disease is not always made".

Economics also play a part in net use. The tulle, like the insecticide, has to be imported from Canada. Nigeria manufactures this fabric, but it is expensive and of poor quality. According to Christophe Codjo Gbaguidi, President of the Organisation savaloise pour la solidarité et le développement (OSSD), this increases its costs and makes its use more difficult. "The tulle and the insecticide are funded by Canada. When the funding ends, I do not know if they will still be within peoples's financial reach. We are looking for ways to produce them at lower costs". A tulle net currently costs CFA6000 (US$17) and, since the insecticide evaporates, it costs CFA600 every 6 months to reimpregnate it, a problem for those coming from outside the region, or for those with limited incomes. Nonetheless, researchers believe that nets are being purchased by women in families where the woman's income is greater than the man's.

MARKETING IN THE BUSHLAND

A Savalou resident spends, on average, US$35 per year on drugs, medicated strips, insecticide sprays, and medical bills to combat malaria. The researchers are trying to convince people that the mosquito net will become less expensive. The researchers employ a variety of means to sell the mosquito net concept to the rural population: distribution of tee-shirts emblazoned with advertising slogans, a poster campaign to sell mosquito nets at a promotional price, a travelling theatre in the villages using the theme "the whole family under the mosquito net." The sale of mosquito nets more than tripled last year.

IMPROVES WOMEN'S STATUS

At the Centre de promotion sociale de Savalou [Savalou Social Advancement Centre], about thirty seamstresses sew up the polyethylene tulle manufactured by a Montreal company, Rentex. Two others put on long rubber gloves and plunge the new mosquito nets into a large tub of insecticide. "In the African family, it is the woman who takes care of the family's health," says Solange Laleye, who is the group animator. According to her, the project is seen as important and, therefore, enhances the esteem accorded to women. She also believes the initiative has contributed significantly to the emancipation of Savalou women. "In the beginning, their husbands were not too pleased because women spent less time at home. Afterwards, however, they realized that it was also to their advantage. There is less family illness. They have the benefit of the additional income of their wives and the bikes that are made available to them. Now, no husbands are bitterly opposed to the project. They are the ones reminding their wives that it is time to go. Some of them even drive their wives to work!"

ENCOURAGING RESULTS

The complete results from the user survey of the mosquito nets are not yet available. However, it is believed already that there has been an appreciable decline in the cases of malaria accompanied by anaemia in Savalou. These results are encouraging because, in addition to being one of the major causes of mortality, malaria, along with the guinea worm, is the main obstacle to the region becoming productive and developing. Christophe Codjo Gbaguidi believes that the benefits of the mosquito net strongly outweigh its limitations. He wants to extend the experiment to a much larger region and establish centres for impregnating mosquito nets. He is hoping for assistance from the Benin government and UNICEF.

Fagbedji Houehanu, village chief, claims that his life is no longer the same. "Before, I got up at about 3 a.m. and I never slept after that. During July, I was sick for 10 days, even with drugs. This year, I have felt some aches and pains, but I have had no malaria attack. Now, I get up at 5 in the morning. I sleep much better. If it was up to me, the whole village would be equipped with mosquito nets. However, not everyone has the money to obtain one". The piece of tulle has even received royal assent in Savalou. King Gbaguidi XII is converted. "Before, I used to scratch myself and I had to go to the hospital. I had a mosquito net, but it was not as well doused as yours. Now, I sleep very well. I don't feel a thing."

Robert Bourgoing, correspondent for Périscoop News Agency, reporting from Bénin.

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ISSN 0315-9981. This magazine is listed in the Canadian Magazine Index.

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ISSN 0315-9981 This magazine is listed in the Canadian Magazine Index.

Octubre 2003

Every six months nets are dipped in insecticide and dried before use

The Battle Against Malaria

DRAMATIC RESEARCH RESULTS

OTTAWA — In this Friday's edition of the new European journal *Tropical Medicine and International Health*, researchers will announce that they have found a way to prevent as many as one-third of child deaths in Africa using a relatively simple technology.

The studies in Kenya and Ghana involving almost 200,000 people indicate that sleeping under mosquito nets treated with an insecticide could save 500,000 children each year who would normally die from the direct or indirect effects of malaria.

"Economic studies, soon to be submitted for publication, indicate that the cost-effectiveness could make these nets equal childhood immunization and other very efficient interventions to save children," said Dr. David Evans, health economist at the World Health Organization (WHO) in Geneva.

"These studies and recent ones in The Gambia prove that insecticide-treated bednets can save the lives of millions of young children in Africa," said Dr. Don de Savigny, a scientist at Canada's International Development Research Centre (IDRC). "The results are dramatic — better than we had hoped," he said.

Mosquitoes that transmit the malaria parasite start biting after sunset. In Africa, the malaria parasite accounts for at least 25% of all childhood mortality below age five. The disease kills about 2,800 children a day in Africa, usually before they are old enough to build up any immunity to malaria. It is one of the leading causes of death and disability in the developing world. There are 300 to 500 million reported cases of malaria each year resulting in almost three million deaths worldwide.

"For the first time since 1967 when WHO said malaria could not be eradicated, there is real hope that malaria can be controlled in highly endemic areas of the world," said Dr. de Savigny. In the 1950s, WHO set a goal to eliminate malaria but hopes were dashed in the 1960s when mosquitoes developed resistance to DDT and the malaria parasite developed resistance to drugs. These factors and others, such as environmental degradation that creates more breeding grounds for mosquitoes, have led to an increase in malaria incidence and related deaths.

"But more importantly, you have here an intervention that people can easily see working and want to use," he added.

In the Africa trials, half the families were given mosquito nets impregnated with an insecticide called permethrin which is commonly used in medicated lice shampoo. The other half slept as usual without any nets. Recognition of the treated nets' positive effect spread so quickly that people without the nets clamoured for the trials to end quickly so they could have them too, said Dr. de Savigny.

Scientists in Kenya and Ghana conducted the research with backing from an international consortium including Canada's International Development Research Centre (IDRC), the Canadian International Development Agency (CIDA), WHO's Speical Programme for Research and Training in Tropical Disease in Geneva and Wellcome Trust based in London, England.

A Pan-Africa project is now looking at how to market and disseminate this simple technology in a cost-effective way that includes community manufacturing of the bednets.

THE HISTORY OF MALARIA

Main source of information: *The Malaria Capers* by Robert S. Desowitz

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- Deadly fevers - probably malaria - have been recorded since the beginning of the written word (6000-5500 B.C.) References can be found in the Vedic writings of 1600 B.C. in India and by Hippocrates some 2500 years ago.
- There are no references to malaria in the "medical books" of the Mayans or Aztecs. It is likely that European settlers and slavery brought malaria to the New World and the awaiting *anophelines* within the last 500 years.
- Quinine, a toxic plant alkaloid made from the bark of the Cinchona tree in South America, was used to treat malaria more than 350 years ago.
- Jesuit missionaries in South America learned of the anti-malarial properties of the bark of the Cinchona tree and had introduced it into Europe by the 1630s and into India by 1657.
- Malaria existed in parts of the United States from colonial times to the 1940s. One of the first military expenditures of the Continental Congress, around 1775, was for $300 to buy quinine to protect General Washington's troops.
- In the summer of 1828 "swamp fever" broke out in the settlement of Bytown (Ottawa) and along the construction route of the Rideau Canal. According to some accounts, the "malaria" was not native to North America but had been introduced by infected British soldiers who had returned from India. Numerous deaths had occurred by the time the epidemic subsided in September when the mosquitoes disappeared.
- During the American Civil War (1861-65), one half of the white troops and 80% of the black soldiers of the Union Army got malaria annually.
- More than an estimated 600,000 cases of malaria occurred in the U.S. in 1914, according to information from the Centers for Disease Control and Prevention in Atlanta, Georgia.
- In 1927, J. Wagner von Jauregg was awarded the Nobel Prize in Medicine for his work in treating syphilis using malaria. Patients were inoculated with a type of malaria to produce fevers that would literally burn up the temperature-sensitive syphilis bacteria. After three or four cycles of the fever, the patient was administered quinine for a relatively rapid parasitological cure for the malaria.

- Malaria therapy for syphilis, using monkey and human parasites, continued until the mid-1950s when it was replaced by antibiotic chemotherapy.
- The Dutch bought Cinchona seeds from British trader, Charles Leger, who brought them from Peru. They established Cinchona plantations in Java (Indonesia) in the mid 1800s and soon had a virtual monopoly on quinine.
- When the Japanese captured Java during the second World War, quinine, except for some old stocks became unavailable. The need for a new synthetic antimalarial became a priority at that time.
- In 1880, the first true sighting of the malaria parasite was made in Algeria by a French Army physician, Charles-Louis-Alphonse Laveran, while viewing blood slides under a microscope. Laveran's discovery was rejected by the medical community and it was not until 1886 that his discovery was accepted by Italian scientists, the leaders in the field at the time.
- In 1882 the mosquito transmission hypothesis - guilt by association - was first made.
- The December 18, 1897 issue of the *British Medical Journal* reported that Dr. Ronald Ross discovered malaria cysts in the stomach wall of *anopheline* mosquitoes that fed on a malaria patient.
- By July 1898, malaria transmission through the mosquito was established. At that time, Italian scientist Giovanni Batista Grassi traced the course of the parasite through the mosquito, and proved that human malarias were transmitted by species of *Anopheles*.
- Experiments in India in 1932, showed that the monkey malaria, *Plasmodium knowlesi*, which produced no clinical signs of malaria in Indian rhesus monkeys, was fatal to Malayan irus monkeys and produced a 24-hour fever cycle in humans that terminated in self cure.

- Unlike botanical quinine, chloroquine is a synthetically manufactured product that belongs to a class of compounds known as 4-amino quinolines, first developed in 1934 by a German pharmaceutical company.
- The first 4-amino quinoline was called Resochin. A slight modification a few years later produced Sontochin. In 1943, Sontochin was acquired by the Americans when Tunis was liberated from the Germans. Its composition was again changed slightly and it was renamed Chloroquine.

- 1950 saw the launch of a pilot project for the control of malaria by spraying with DDT.
- WHO initiated strategies for the global eradication of malaria in the mid-1950s.
- In the 1960s, chloroquine resistant strains of *Plasmodium falciparum* had arisen; the result of over usage and probably under dosage. At the time, there was no drug to treat chloroquine-resistant malaria except the ancient antimalarial, quinine.
- By 1966, it had been shown that 10 species of *Plasmodium*, naturally present in monkeys and apes, were capable of infecting humans. Often an infection in one species that produces no clinical signs of malaria can cause severe illness and death when transferred, through inoculation, to another.
- Quinine has now been completely synthesized. Its synthetic analogue is called mefloquine.
- A "new" antimalarial is a drug called Qinghaosu that is derived from the sweet wormwood (Qinghao) plant (genus *Artemisia*). It has been used in China for more than two thousand years to treat fevers associated with malaria. The drug has been shown to be effective in the treatment of the most deadly forms of *falciparum* malaria and has been effective against strains of *Plasmodium falciparum* that are solidly resistant to chloroquine.
- From 1956 to 1969, the United States, through the U.S. Agency for International Aid, (USAID) gave $790 million to the Global Eradication of Malaria Program. From 1955 to about 1970, USAID gave approximately $1 billion to WHO and various national malaria eradication programs.
- In 1967, WHO realized that the global eradication of malaria was impossible for a variety of reasons and the focus shifted to control of the deadly disease. In 1972, the Global Eradication of Malaria Program was formally declared dead.
- In 1987, Dr. Manuel Elkin Patarroyo, a biochemist from Colombia, developed the first synthetic vaccine against the *Plasmodium falciparum* parasite. The vaccine is still being developed and has not yet proven to reduce deaths in Africa. In 1992, Dr. Patarroyo donated the vaccine to the World Health Organization.

Desowitz, Robert S. **The Malaria Capers** (More Tales of Parasites and People, Research and Reality). W.W. Norton & Company, New York, 1991.

Children are particularly vulnerable to malaria

MALARIA: A DEADLY DISEASE

- Malaria is a potentially deadly tropical disease characterized by cyclical bouts of fever with muscle stiffness, shaking and sweating. It is caused by a tiny parasite (genus *Plasmodium*) that is transmitted by the female mosquito (genus *Anopheles*) when it feeds on blood for its developing eggs.
- Severe malaria is not readily distinguishable from other severe diseases, such as pneumonia typhoid and meningitis that require very different therapy.
- Almost all vertebrates, birds, snakes and monkeys, for example, can be infected by *Plasmodium* (malaria) parasites. Different animal species can only be infected by their own specific species of *Plasmodium*.
- Humans are generally host to four species of malaria parasites: *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium ovale*, and *Plasmodium malariae*. *Plasmodium falciparum* causes the most dangerous complications, such as cerebral malaria. It is the species that is most virulent and potentially lethal to humans.
- Because of its dependence on human/vector (mosquito) contact, malaria is considered to be a disease of poverty. Poor people can be physically marginalized and live closer to degraded land and conditions where mosquitoes thrive. They are also less likely to have physical barriers such as screens or nets to protect them and they often lack the education and resources to access proper care and treatment.
- Intense and costly control programmes targeting malaria, that incorporate a variety of approaches such as environmental modification and indoor spraying with DDT, have succeeded in eliminating or significantly reducing the disease in many countries. Malaria has been eliminated in former Soviet Republics, the USA, Italy, Korea and many Caribbean Islands.
- The *Anopheles gambiae* mosquito selects small, sunlit collections of water to lay its eggs. The intact forest provides few such breeding sites so there are few malarious mosquitoes in dark jungles and tropical forests. Replacing tropical forests with agricultural land provides the mosquitoes with the conditions and proximity to human hosts that they require to thrive.
- Malaria is transmitted by an infected, female mosquito; *Anopheles gambiae*. It can also be acquired

from an infected blood transfusion or even from the shared needles of drug addicts.

- Human malaria parasites only develop in *Anopheles* mosquitoes. The parasites move to the salivary glands of the mosquito and are injected into a human host by the feeding insect.

- The *anopheline* mosquito only feeds in the evening. The parasite is injected into the host when the mosquito feeds and then progresses through a number of stages and transformations. The threadlike malaria parasites enter the bloodstream and are carried to the liver where they invade liver tissue cells, transform into spores and replicate repeatedly.
- The spores, formed within cyst-like structures in the liver, are released into the bloodstream where they attack and destroy red blood cells. In the process, they undergo another transformation that allows a form of the parasite to attack and invade new red blood cells.
- The synchronized development of different stages of the parasite is responsible for the characteristic cycles of fever in infected humans. A form of the parasite periodically bursts from demolished cells and is released into the blood stream to invade new blood cells. Different species produce different fever cycles.
- *Plasmodium falciparum* has a forty-eight hour period between fever peaks. The process is repeated over and over until natural or acquired immunity, or antimalarial chemotherapy, or death brings the repetitive process to an end.
- When an *anopheline* mosquito takes blood from a malarious human, the parasite enters the mosquito and goes through a number of complex changes over a 14 to 21 day period. It becomes an infectious form and moves to the mosquito's salivary glands where it is ready to reinfect and complete the cycle.
- Many people in Africa and other areas with intense malaria transmission, carry parasites without being ill. Having been infected repeatedly, they have built up immunity to the disease.
- The malaria situation around the world is worsening. Social and environmental factors are bringing more humans into closer contact with the mosquito carrier. The widespread use of chloroquine has allowed the emergence of resistant strains of *Plasmodium falciparum* that no longer respond to the drug. *Plasmodium falciparum* has become resistant to the most common antimalarial drugs in most of its area of distribution. Mosquitoes are also becoming more resistant to chemical insecticides.
- Changes in the immune system make women particularly vulnerable to life threatening infections from malaria during pregnancy. In addition to the acute effects, malaria causes anaemia in children and pregnant women and increases their vulnerability to other diseases. Repeated bouts of malarial fever in young children reduces their immunity and interferes with feeding, thus increasing their vulnerability to other diseases and death.

Street vendors sell the popular nets

MALARIA AND INSECTICIDE-TREATED BEDNETS

COMMONLY ASKED QUESTIONS

Is this method more cost effective than others?

Nets cost between US$5 - $10 and between US$.50 - $1.00 per year thereafter to re-treat with the insecticide. Polyester nets can last up to 5 years and have to be re-dipped every 6 months. At present, families who can afford it are paying for anti-malarial drugs, insecticide sprays, coils, or traditional control methods. In the long term, treated nets are expected to be more cost effective as the nets are durable and can be re-dipped in insecticide locally. In fact, local industries can be created around the manufacturing of these nets.

Is it better than other methods?

No single method has been found to eradicate the disease or stop its spread in tropical countries. Many countries, including the United States, the former Soviet Republic and many Caribbean Islands, have eliminated malaria through intensive and costly control programs using a variety of environmental approaches and spraying. In 1967, WHO realized that global eradication of malaria was impossible and the focus shifted to control. Bednets may eventually prove to be the single most effective malaria intervention for Africa.

Can people in the Third World afford these bednets?

The areas where malaria is most prevalent are often the poorest regions of the world. Families now spend

considerable portions of their disposable income on health care, often for malaria treatment. As with other public health programs and control methods, governments and donor agencies could contribute to the costs. However, studies have shown that families who use the bednets do better overall. Family members can be more productive, have fewer bouts of illness, and do not have to spend hard earned money on a variety of prevention methods and treatments.

What about the recent malaria vaccine developed by Colombian biochemist, Dr. Manuel Patarroyo?

In 1987, Dr. Manuel Elkin Patarroyo developed the world's first synthetic vaccine, the first vaccine against a parasite and the first vaccine against *Plasmodium falciparum* (the most common and deadly malaria paraiste). Still under development, the vaccine has not yet proven to reduce deaths in Africa. In 1992, Dr. Patarroyo donated the vaccine to the World Health Organization. The combined use of immunization and bednets might provide the highest possible potential for stopping deaths from malaria in the future.

Is there a danger of insecticide poisoning for children sleeping under these nets?

WHO gave approval to pyrethroids in general and permethrin in particular for use in bednets. This household insecticide is commonly used in medicated lice shampoo. It also has no tendency for bioaccumulation and is rapidly broken down in both soil and sunlight. The treated nets are deadly to mosquitoes but do not affect people. Earlier research also helped determine the minimal amount of insecticide needed to be effective and the appropriate hole size of netting to ensure protection from mosquitos while providing sufficient ventilation.

Is there a danger that mosquitoes will become resistant to the insecticide used?

Yes. The development of resistance to any particular insecticide can occur. Acceptable solutions will have to be determined in conjunction with the people involved and could include finding alternative insecticides in anticipation of this happening or promoting scheduled shifts in the insecticides used.

How will this research be used?

With these significant results, researchers can now seek additional donor support to ensure the results are implemented quickly and reach the children who need it most. Researchers would like to find ways to reduce the cost of the nets to people by changing the policies on import duties, encouraging local mass production, providing community credit, or other financial schemes, for example. Studies are also being conducted on net fabric that would last up to 20 years. Dissemination and proper use education programs also need to be developed further.

STATISTICS ON MALARIA

- Malaria is one of the planet's deadliest diseases and one of the leading causes of sickness and death in the developing world. According to the World Health Organization there are 300 to 500 million clinical cases of malaria each year resulting in 1.5 to 2.7 million deaths.
- Children aged one to four are the most vulnerable to infection and death. Malaria is responsible for as many as half the deaths of African children under the age of five. The disease kills more than one million children - 2,800 per day - each year in Africa alone. In regions of intense transmission, 40% of toddlers may die of acute malaria.
- About 40% of the world's population - about two billion people - are at risk in about 90 countries and territories. 80 to 90% of malaria deaths occur in sub-Saharan Africa where 90% of the infected people live.
- Sub-Saharan Africa is the region with the highest malaria infection rate. Here alone, the disease kills at least one million people each year. According to some estimates, 275 million out of a total of 530 million people have malaria parasites in their blood, although they may not develop symptoms.
- Of the four human malaria strains, *Plasmodium falciparum* is the most common and deadly form. It is responsible for about 95% of malaria deaths worldwide and has a mortality rate of 1-3%.
- In the early 1960s, only 10% the world's population was at risk of contracting malaria. This rose to 40% as mosquitoes developed resistance to pesticides and malaria parasites developed resistance to treatment drugs. Malaria is now spreading to areas previously free of the disease.
- Malaria kills 8,000 Brazilians yearly - more than AIDS and cholera combined.
- There were 483 reported cases of malaria in Canada in 1993, according to Health Canada and approximately 431 in 1994. The Centers for Disease Control and Prevention in the United States received reports of 910 cases of malaria in 1992 and seven of those cases were acquired there. In 1970, reported malaria cases in the U.S. were 4,247 with more than 4,000 of the total being U.S. military personnel.
- According to material from Third World Network Features, in Africa alone, direct and indirect costs of malaria amounted to US $800 million in 1987 and are expected to reach US $1.8 billion annually by 1995.

Sources : The Malaria Control Programme, World Health Organization, *Third World Network Features, Health Canada,* The Centers for Disease Control and Prevention,

and Desowitz, Robert S. *The Malaria Capers (More Tales of Parasites and People, Research and Reality).* W.W. Norton & Company, New York, 199

MALARIA AND BEDNETS

- Mosquito nets made of silk were first used by the Chinese, and they were brought to Japan more than a thousand years ago. Mosquito nets made from hemp became popular in Japan in the 17th century.
- Anti-malaria bednets, treated with DDT, were first used during World War II by the Russian, German and US armies.
- In the late 1970s, synthetic pyrethroids were developed to mimic natural insecticidal compounds found in chrysanthemums. Pyrethroids are widely used as household insecticides and are effective against mosquitoes. Unlike DDT, for example, pyrethroids such as permethrin do not accumulate in the food chain and are rapidly broken down in both sunlight and the soil.
- The World Health Organization's interest in mosquito nets began in the early 1980s. It has given its approval to the use of pyrethroids in general and of permethrin in particular for the treatment of bednets.
- IDRC is funding a project in Tanzania to test the effectiveness of insecticide-treated bed curtains made from locally available sacking material used for agricultural products. The research was in response to promising results from community trials of insecticide-treated mosquito nets and interest in substituting locally available material.
- Impregnated Bednets and Community Prevention of Malaria (Benin) is an ongoing IDRC project begun in 1992 to evaluate mosquito nets treated with permethrin and to examine the feasibility of integrating bednets into other components of a malaria control and primary health care strategy.
- IDRC's bednet project in Benin led to the identification of Rentex Inc. of Montreal as a supplier of the material used for bednets. Rentex produces polyester material for a variety of apparel and agricultural uses and was able to create a suitable fabric for bednets used in the project.
- Rentex worked in collaboration with the McGill University Centre for Tropical Medicine at the Montreal General Hospital to create a strong, durable netting that would last for five years. The

100% polyester netting was designed and woven to have the appropriate hole size to ensure protection from mosquitoes while providing sufficient ventilation.

- The Benin project is examining community participation in the local production, distribution and use of bednets, as well as variables pertaining to the process of periodically treating the bednets with insecticides.
- Rentex is now producing a stronger material made from high density (HD) polyethylene that is expected to last 20 years. The company is researching the incorporation of insecticide into the fabric to be effective for up to two years. The conventional nets need to be retreated every six months.
- Permethrin is now being used as the insecticide for bednet treatment with a dose of up to 500 milligrams per square metre of net. IDRC has funded research to develop effective methods for the production and distribution of bednets and to prolong the insecticidal effects while ensuring the safety of the insecticide impregnation process.
- The results from the first mortality study of insecticide-impregnated mosquito nets in The Gambia showed a reduction in deaths from all causes in children under the age of five of 63%. (Lancet 1994; 344: 1175-82)
- The mortality study in the Gambia prompted the Malaria Intervention for Child Survival program, begun by IDRC in 1993, in collaboration with WHO. Trials were conducted in Burkina Faso, The Gambia, Ghana, and Kenya to confirm the efficacy of bednets to reduce mortality.
- The results of the second study in The Gambia confirmed the earlier study results showing a reduction in mortality of 25 to 38% in children under 9 years of age. (Lancet 1995, 345: 479-83)
- More than 20 studies of insecticide-treated nets (ITNs) have been conducted in different areas of the world where malaria is endemic. Most studies have documented a reduction in malaria disease rates between 20 and 63% following the introduction of ITNs.
- The results from two large-scale trials in Kenya and Ghana, funded primarily by WHO and IDRC/CIDA, are now available and demonstrate a substantial impact on child survival. These studies, also supported by a number of other international development organizations, are helping to define new research priorities and strategies for the effective implementation of ITN programmes.

The whole family is well protected

MALARIA AND IDRC

- At present, IDRC funds 20 projects relating to malaria, including five projects dealing specifically with the introduction of insecticide impregnated bednets to countries in Africa. Malaria and bednets.
- Since 1976, IDRC has contributed almost $11 million to 50 projects dealing with malaria. The Centre funds related research into such areas as natural botanical pesticides (plants to repel or kill mosquitoes and other pests). It continues to promote research capacity building in endemic areas and the exchange of information on prevention and control of malaria.
- IDRC has funded research into the treatment of malaria and the evaluation of alternative drug treatment regimens in areas of chloroquine resistance. It has funded the distribution of malaria field incubators to research teams to monitor the response of parasites to anti-malaria drugs.
- The Centre is funding research on the biological control of mosquitoes using naturally occurring bacteria (*Bti*) that kills mosquito larvae. It has funded the development of a kit that communities can use to grow the Bti bacteria using coconuts as incubators. The fermented coconuts are then broken open and introduced into ponds infested with mosquito larvae.
- IDRC has also funded research into traditional medicines. In Cuba, the Centre supported a project to detect insecticide resistance in mosquitoes. It has funded the assessment of biological and environmental control methods and the assessment of risks of infection due to different ecological systems.
- IDRC supports research on Geographic Information Systems (GIS),* a computer-based system which processes and integrates a variety of spatial data and displays the results of different scenarios on digital maps. IDRC is supporting the use of GIS as a research tool for disease control in Botswana and Senegal. GIS is being used to correlate environmental variables with information on endemic diseases such as malaria to enable planners to make well-informed decisions.See IDRC's new publication: *GIS for Health and the Environment -- Proceedings of an international workshop held in Colombo, Sri Lanka, 5-10 September 1994*, edited by Don de Savigny and Pandu

Wijeyaratne, published by IDRC. ISBN 0-88936-766-3.

- IDRC supports malaria control strategies around the world. In Brazil, a GIS computer software program that evaluates malaria in municipalities and produces information for prevention and control is being developed.
- IDRC supports the integrated use of satellite images with other data collection systems in the Amazon to monitor environmental changes that impact on the spread of malaria. Information about the interplay between environmental and socioeconomic risk factors is used for control strategies.
- IDRC also supports a satellite-based communications project to promote the exchange of information on health issues such as malaria.

PREVENTING MALARIA DEATHS IN CHILDREN

Highlights of two studies on insecticide treated bed nets published in the April 1996

edition of the new European journal *Tropical Medicine and International Health*.

KENYA STUDY:

Randomized, controlled trials conducted in rural communities in the eastern Kenyan coast involving 60,000 people including 11,000 children under five years of age. It is an area of low malaria transmission throughout the year (fewer than 10 infective bites per person per year). The study showed:

- a 33% reduction in mortality in children from all causes, not just malaria, in children under five years of age.
- a 44% reduction in severe life-threatening malaria (morbidity).
- a 41% reduction in admissions to hospital of children with malaria.

GHANA STUDY:

Randomized, controlled trials conducted in rural communities in Ghana's northern savannah involving 175,000 people including 26,000 children under five years of age. It is an area of high seasonal transmission (100 - 1,000 infective bites per person per year). The study showed:

- a 17% reduction in mortality in children from all causes, not just malaria, in children under five years of age.

WHAT WE CAN CONCLUDE:

- This single, malaria intervention could significantly reduce deaths from all causes, not just malaria, in young children in diverse areas of Sub-Saharan Africa where malaria is prevalent.
- The findings confirm the efficacy of insecticide-treated nets for improving child survival and provide the first evidence of their specific role in reducing severe, life-threatening illness from malaria (morbidity).
- Malaria infection may be underestimated as a cause of child death.
- The results suggest that the lives of as many as 500,000 children could be saved each year in Africa if the nets treated with insecticide were widely distributed and used.

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Tropical Medicine and International Health, published by Blackwell Science, UK.

IDRC Reports
STORIES ON RESEARCH IN THE DEVELOPING WORLD

Vol. 23, No. 3 (October 1995)

VIEWPOINT: THE INTELLECTUAL ARROGANCE OF THE NORTH

by John Eberlee

Credit: Eco Latino, Ottawa

Large-scale production of the world's first vaccine showing both safety and efficacy against malaria could begin as early as 1997. But the vaccine might already have been in use if not for the "intellectual racism" of scientists in the North.

That is the view of the vaccine's developer, Colombia's Dr Manuel Patarroyo, WHO bore 6 years of attacks from the international research community after reporting his work. "When we first published our data in 1987, they said, 'It's impossible that a malaria vaccine is coming from Colombia.' They were reluctant to accept that there was not just a malaria vaccine, but the world's first chemically synthesized vaccine."

Patarroyo, founder and director of the Immunology Institute at the National University of Colombia in Bogota, joked during an Ottawa luncheon sponsored by IDRC and the Canadian Science Writers Association that had he been American "I might have already received the Nobel Prize."

Patarroyo's experience is featured in *Southern Lights: Celebrating the Scientific Achievements of the Developing World*. The Colombian immunologist has a message for the developed world: "There are lots of good scientists in the developing world working hard to solve the problems of mankind." Patarroyo's war on malaria began in the early 1980s when he organized a monkey colony in the Amazon jungle as an

experimental model for malaria. His team isolated different molecules of the malaria parasite, then immunized the monkeys with each one.

"We found four molecules to concentrate on. We then went back to the Amazon and identified the specific pieces of the structures that induced protective immunity. We mixed them up and made a vaccine cocktail," explained Patarroyo.

Critics dismissed the results, published in *Nature*, on grounds that the vaccine had not been tested on humans. When data showed the vaccine to be safe in humans, they criticized the method of transmitting the parasite -- via intravenous injection rather than by a mosquito bite. In fact, injections are more scientifically defensible, since it is impossible to tell whether a mosquito harbours the malaria parasite or in what numbers.

While this issue was debated, Patarroyo launched a major clinical trial involving 25,000 Colombians. Although the results clearly showed the vaccine's efficacy, critics charged that the trial had been improperly designed. Nor were they satisfied by subsequent trials in other countries, which met standard epidemiological criteria.

"The efficacy rate of the vaccine was 40% in Colombia, 55% in Venezeula, 60% in Ecuador, and 35% in Brazil," said Patarroyo. But the critics said that it might not work in Africa where the malaria challenge is greatest. However, a recent trial in Africa places the vaccine's efficacy at 31% for malaria morbidity. The next steps in Africa will be to determine the vaccine's impact on malaria mortality in order to understand its public health effectiveness.

The scientific world has now bestowed over 50 awards on Patarroyo. But Patarroyo has refused offers from drug companies of up to $68 million for the vaccine rights, choosing instead to donate them to the WHO.

"It is not my project in life to become a millionaire, or to be powerful or famous, but really to solve what I want to solve. That is my life project, my life purpose," he declared.

John Eberlee is an Ottawa writer.

Southern Lights: Celebrating the Scientific Achievements of the Developing World by David Spurgeon IDRC Books isbn 0-88936-736-1 CA$19.95

ISSN 0315-9981. This magazine is listed in the Canadian Magazine Index.

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Impregnated bednets and malaria: A bibliography

prepared by:
Alison Ball, Research Information Specialist
International Development Research Centre Library
created: March 1996
updated: August 1996

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