The Community-Based Malaria Control Programme in Tigray, northern Ethiopia

A Review of Programme Set-up, Activities, Outcomes and Impact

Malaria Control Department
Regional Health Bureau, Tigray, Ethiopia

Technical Support and Capacity Development
Roll Back Malaria
Communicable Diseases
World Health Organization
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# TERMS AND ABBREVIATIONS

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Kushet</td>
<td>Village, usually 100 to 150 households with average household size 5.2, population ranging from 500 to 1000</td>
</tr>
<tr>
<td>Tabia</td>
<td>Locality, most peripheral administrative unit, from 1991 to 1997 consisting of a cluster of 3 to 5 kushets, population ranging from 1500 to 5000. In 1998 the administrative delineation of tabias was revised and the total number decreased from 1136 to 559. However for the purposes of this report the former definition (with a smaller catchment area) is applicable.</td>
</tr>
<tr>
<td>Wereda</td>
<td>District, administrative unit with population of about 97,000</td>
</tr>
<tr>
<td>Zone</td>
<td>Geographic administrative unit</td>
</tr>
<tr>
<td>Region</td>
<td>National Regional State</td>
</tr>
<tr>
<td>Baito</td>
<td>Local government council</td>
</tr>
<tr>
<td>Gemgam</td>
<td>Performance evaluation</td>
</tr>
<tr>
<td>CHW</td>
<td>Community health worker</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographic information system</td>
</tr>
<tr>
<td>HSDP</td>
<td>Health sector development programme</td>
</tr>
<tr>
<td>KAP</td>
<td>Knowledge, attitude, practice</td>
</tr>
<tr>
<td>SAERT</td>
<td>Commission for Sustainable Agriculture and Environmental Rehabilitation in Tigray</td>
</tr>
<tr>
<td>SP</td>
<td>Sulfadoxine-pyrimethamine</td>
</tr>
<tr>
<td>TBA</td>
<td>Traditional birth attendant</td>
</tr>
<tr>
<td>TTBA</td>
<td>Trained traditional birth attendant</td>
</tr>
<tr>
<td>TDR</td>
<td>Special Programme for Research and Training in Tropical Diseases, World Health Organization</td>
</tr>
<tr>
<td>TPLF</td>
<td>Tigray Peoples Liberation Front</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
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</table>
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PREFACE

Launched in October 1998, the Roll Back Malaria (RBM) partnership is committed to enabling people to halve their malaria burden by 2010, through intensified application of existing tools and development of novel cost-effective approaches. The Community-Based Malaria Control Programme in Tigray shows how a focus on reducing the malaria burden can catalyse community action for better health. The experience of Tigray highlights critical elements of RBM action within malaria-affected communities.

First: the people of Tigray perceive that malaria is a big problem. Communities want help to tackle this problem. This demand is recognised by all sectors of the government. There is a serious political commitment for action.

Second: The programme put emphasis on people’s involvement from the start. Local institutions were committed to supporting processes which would lead to a positive movement to tackle the malaria problem. Institutions worked together in a network, making optimal use of their resources through careful analysis, discussion and planning.

Third: The programme has a strong component of monitoring progress, so as to document trends, evaluate efficacy of interventions - and their coverage, and pay particular attention to the most vulnerable groups. Effort invested in this monitoring has paid off, as it has demonstrated how complex tasks can be undertaken with meagre resources.

Fourth: The programme has recognised the contribution made by community members. The months and years of silent and dedicated work of volunteer community health workers has been the key to success. This caring energy has proved essential for rolling back malaria in Tigray: people’s willingness to invest this energy will be important in other locations, too.

Fifth: Extra demands are placed on Government officials when they take on the task of supporting community action. All sectors of Government - agriculture, justice, security, education, social affairs, gender and health - promote the involvement of communities in their development actions. This is a feature of the cultural and political context of the Region, where people mobilise each other to provide services, and their efforts are complemented by the government-provided public services. Such an approach places heavy demands on government officers - whether they are being called on to provide information, or to participate in special forums where the performance of public services is openly evaluated.

Sixth: The Community-Based Malaria Control Programme in Tigray shows the importance of partnership at many levels. There is partnership at the community level, involving community members and their representatives for social affairs, the volunteer community-health workers, and the staff from the peripheral health services. There is partnership at the Regional level, where government, bilateral and international organisations (the Ethiopian and Italian Governments and the World Health Organisation) work together to support health sector development and the reduction of poverty through reducing the burden of diseases on poor communities. Within the partnerships, malaria has served as a valuable point of departure.

As a result, the Community-Based Malaria Control Programme in Tigray has evolved as a social movement, leading to improved access to care for poorer villagers who have limited access to peripheral health care facilities. I hope you will enjoy reading about how this all happened, and considering ways in which the Tigray experience can be applied elsewhere.

Dr David Nabarro
Project Manager
Roll Back Malaria
EXECUTIVE SUMMARY

Tigray is the northernmost regional state of Ethiopia, divided into northwestern and southern lowlands and central highlands. 85% of its estimated 3.6 million population is rural, and 56% live in malarious areas. As in the rest of Ethiopia, the region is prone to epidemics of malaria (60-70% P. falciparum), which affect all age groups. The health system infrastructure of the Region was severely affected by the Ethiopian civil war (1974-1991).

In 1992, following a year of large population movements and malaria outbreaks, the Government of Tigray decided to strengthen malaria control in the Region. The Malaria Department of the Health Bureau, in collaboration with the World Health Organization, and with financial support from the Italian Cooperation, designed a Community-Based Malaria Control Programme building on the practice of primary health care developed during the war.

The objective of the programme is to provide region-wide and sustained access to early diagnosis and treatment of malaria at village level, beyond the coverage of the general health services. The approach involves training community volunteers to provide chloroquine treatment for clinical malaria. These community health workers (CHWs) submit weekly reports to health clinics on number of treated cases; they are also involved in health education, provide chloroquine prophylaxis to pregnant women, and mobilize the community for general sanitation and environmental management for vector control.

First-level monitoring takes place at district clinics during monthly meetings, which are attended by health staff, CHWs and local authorities. Discussion of CHW activities, drug distribution and reporting is done at this level. Data from CHWs and health institutions are compiled at district level, and analysed at regional level to evaluate quality of data, performance of CHWs, outcomes and impact of the programme.

A large number of CHWs were trained in 1993 and 1994 (up to 681) with numbers stabilizing at 735 in 1998, and attrition rates of less than 3% per year; in 1998 CHWs served 2,327 villages with a population of almost 1.74 million. The CHWs treat a large number of patients in a temporal pattern that coincides with malaria transmission (an average of 489,378 patients yearly from 1994 to 1997), which represent 65-71% of patients treated for malaria in the region. Since 1994, the reporting pattern has remained the same, with 90% of CHWs reporting at least once monthly and 60% four times monthly. A decrease in reporting was observed after May 1998, when a number of CHWs volunteered for military service at the beginning of the border disputes with Eritrea.

Recognition of clinical malaria is similar for CHWs and health staff from clinics who have no access to microscopy, with 93-96% sensitivity and 13-16% specificity, versus that of hospital staff with access to microscopy (79% and 62%, respectively). The overall prevalence of malaria among febrile patients treated by CHWs is 24%, 49% among patients visiting clinics and 31% among hospital outpatients (all age groups combined in high-risk areas during high transmission). The positive predictive value (PPV) follows the prevalence trend: the average PPV of malaria diagnosis CHWs is 27.7% for patients below 15 years of age and 14.6% for adults.
Chloroquine tablets are given in doses appropriate for age, while assessment of syrup use is problematic because of irregular supply. Based on results of chloroquine efficacy studies, the Ministry of Health of Ethiopia has recently changed the malaria first-line treatment in sulfadoxine-pyrimethamine. Under utilization of CHWs by women and children has been documented and is related to responsibilities of women, time constraints and cultural norms. Low compliance with chemoprophylaxis by pregnant women is also related to these factors and to beliefs that chloroquine may induce abortion. A pilot project in one district showed an initial increase in treatment of children under 5 years and women and an increase in use of chemoprophylaxis by pregnant women through the involvement of female CHWs and traditional birth attendants (TBAs). However differences between female and male CHW coverage decreased over time. Assessment of adequacy of environmental management activities is not possible from the information available.

In 1996, a pilot community financing scheme of insecticide treated nets (ITN) was started in Humera, western Tigray, an important area of agricultural development that is also the Region's most malarious lowland. Preliminary surveys showed good knowledge and attitude towards bednet use and willingness to buy at a “balanced” cost, or at times of cash availability. Price were set at USD 5.50 for a new impregnated net and USD 0.70 for re-impregnation, and village bednet teams were elected to organize collection and deposit of monthly payments in community-specific bank accounts. CHWs were involved in health education, community mobilization, bednet distribution and re-impregnation. After two years, in the 4 pilot villages 78% of households have received at least one net and a total of USD 41,764 (58% of initial costs) has been collected and deposited in community bank accounts. Re-impregnation rates were 65% in 1997 and 27% in 1998, mainly related to war related upheaval.

Training of health professionals in management of severe malaria and epidemic preparedness, training of laboratory technicians in malaria microscopy, and training of malaria staff are also important programme activities to support the community-based initiative. Evaluation of physicians’ performance after a WHO training on severe malaria management showed improved use of a loading dose of quinine, but persistent need for improvement in clinical practice.

In spite of difficulties in using health institution data for programme monitoring, indicators from hospitals, health centers and malaria laboratories show a progressive increase in malaria morbidity from 1993/4 to 1997/8. Repeated mortality surveys in children under five showed a 40% reduction in under 5 deaths from 1994 to 1996 and a 10% increase from 1996 to 1998. Mortality increased in spite of concomitant health interventions, including an increase in coverage by measles vaccination. It is possible that increases in malaria deaths in 1997 and 1998 due to El-Niño related increased transmission and possibly chloroquine resistance, might have contributed to the increase in child mortality. Since 45-52% of children who died in each survey period received no medical care, and under utilisation of CHWs by children and women has been documented, higher impact of the programme could be expected by improving coverage of the most vulnerable groups. However, without appropriate control groups, it is not possible to attribute changes in mortality to definite factors.

The programme has been successful in four major aspects: 1) the Community-Based Malaria Control Programme is a major component of the Region’s malaria control strategy and has facilitated the integration of the malaria programme with the general health services; 2) a significant proportion of the rural population at risk for malaria is now being treated at village level by volunteer CHWs who, despite their agricultural responsibilities, continue to carry out treatment activities on a regular basis; 3) the activities have been implemented region-wide and sustained over six years, with limited external financial support in 1994 and 1996; and 4) intensive monitoring through the health information system and special surveys has identified problems and pilot solutions have been tested through operational research.
From 1993 to 1998 the malaria programme has been progressively integrated into the general health services. Technical staff has been mobilized at the district level to establish malaria control units in 20/26 districts where malaria is a priority, and malaria laboratories have been relocated to health institutions. District teams and zonal (provincial) health departments have responsibilities for making decisions about malaria control including vector control. This demands capacity development for malaria control in the general health service staff.

In spite of increased coverage of the health services over the years (from 36% to 46% in 1998), a significant proportion of the rural population still remains without easy access to the general health services. Strengthening of community-based preventive and curative services will remain a crucial intervention for improving the health of the population.
INTRODUCTION

In Ethiopia, malaria is a major public health problem. Climatic factors and altitude make the country prone to epidemics. Malaria control in Ethiopia has a history of more than 40 years, but control activities in Tigray Region were interrupted during the Ethiopian Civil War from 1974 to 1991. At the end of the war in 1991, traditional malaria control strategies (institution-based diagnosis and treatment, selective indoor residual spraying and larviciding, and epidemic control) were reintroduced in Tigray. In addition, the Tigray Regional Government and the National Organization for the Control of Malaria and Other Vector Borne Diseases, in collaboration with WHO and with financial assistance from the Italian cooperation, designed a Community-Based Malaria Control Programme, building on the strengths of community participation developed during the civil war.

Tigray’s experience provides valuable lessons for several reasons. First, the Community-Based Control Programme is a major component of the Region’s malaria control strategy, which is based on all technical elements in the Global Malaria Control Strategy (1). Second, community-based control activities have been implemented region-wide and sustained for more than six years. Third, proper monitoring and evaluation of the various components of the programme has been possible through strengthening of the health information system and specific surveys.

This document reviews Tigray’s experience in a community-based approach to malaria control from 1992 through 1998. Details of the programme set-up and activities are given, and an assessment of outcomes and impact is presented. Factors with potential to influence programme effectiveness are discussed. Strengths and weaknesses are evaluated in the context of the current status of the general health services.
I - DESCRIPTION OF THE AREA

GEOGRAPHIC, DEMOGRAPHIC, AND CLIMATIC FEATURES

Tigray is the northernmost national regional state of Ethiopia and is located between latitude 12° and 15° North. The region is divided into north-western and southern lowlands (700-1500 metres above sea level) and central highlands (1500-3000 metres above sea level). Population in the 1994 census was 3.16 million and growth rate is estimated at 3% per year. 85% of the population is rural and engaged in subsistence agriculture (2). Population density ranges from 5 per square kilometre in lowland areas to 120 per square kilometre in the highlands. Large population movements since 1991 have occurred with permanent resettlement of refugees, settlement of demobilized soldiers in lowland areas of economic development, and seasonal migrations from highlands to lowlands for labour on large scale agricultural development projects.

Tigray’s agriculture is based on plough cultivation of mainly cereal crops and until recently depended almost entirely on rainfall. The main rainy season is from May to September, with most rains falling in June and July. In south-eastern Tigray additional rains fall during January and February, providing sufficient moisture for a second harvest. Mean annual temperature is 18° C.

SOCIO-POLITICAL SETTING

During the Ethiopian Civil War from 1974 to 1991, government services in Tigray were gradually suspended as the region became the stronghold of the Tigray People’s Liberation Front (TPLF). In the place of formal government services, the TPLF established village and district level government based on direct participation of communities. Working towards the goals of self-reliance and community participation in social and economic development, elected committees from village to regional level planned, financed, and implemented programmes for farmland allocation, water and soil conservation, and construction. At the end of the civil war in 1991, a strong social system was in place with agricultural agents, natural resources development agents, members of the militia, local judges, and locally elected community leaders serving the community without incentive in cash or kind. In addition, periodic mass mobilization for construction of roads, dams, and schools meant that a large proportion of community members were engaged in community development activities (3).

As part of community-based development efforts during the Civil War, Social Affairs Committees were formed to implement activities in health, education, and broad social affairs. A primary health care system was established in which communities helped to plan for health through health committees, community health workers (CHWs) and traditional birth attendants (TBAs). Through community financing, 88 health stations were built during the civil war years. Overall, 3000 villagers elected by their communities received
30 days health training and began work as CHWs and TBAs. However, during the transitional period at the end of the war in 1991, many community-based health personnel became inactive when supportive supervision was interrupted (3).

Following the end of the civil war, the transitional government began rebuilding infrastructure, and resources were directed to major development programmes in all sectors. By mid-1995 democratic elections had been held at district, regional, and federal levels. In 1995 the Tigray Regional Government gave priority to increasing agricultural productivity through a major water resources development project involving construction of microdams and irrigation systems. Improving access to primary education and health services also remain regional government priorities. Though gains have been made, significant challenges for development remain.

HEALTH SERVICES INFRASTRUCTURE

Since 1991, upgrading of general health services has begun through rehabilitation and construction of health facilities, training and deployment of health personnel, and expansion of maternal and child health and immunization services. The increase in number of institutions was a step to improving access of the rural population to health care (Figure 1): from 1995 to 1998 the population living within 10 kilometres of a health institution increased from 35% to 46% (4). However, as seen in Map 1 (appendix), which shows catchment areas of health institutions overlaid on population census blocks, a significant proportion of the population still lives beyond catchment areas of even peripheral health institutions. Although the 1998 Tigray Region Health Sector Development Programme allocates resources for further expansion of peripheral health services, achieving target population coverage for health institutions will take several years (target coverage: health post 1:5000; health centre 1:25,000; district hospital 1:250,000, regional hospital 1:5,000,000).

Currently, the region’s 65 doctors (1:54,300 people) are assigned to administrative posts or to clinical work in 7 hospitals and 20 health centres/zonal clinics. The 157 health clinics (the peripheral health institutions) are staffed by nurses (diploma graduates with 2.5-3 year training) and health assistants (personnel with one year health training). About 10% of health clinics have laboratory diagnostic facilities; all clinics have a limited number of essential drugs.

The Health Bureau has recognized that a significant proportion of the rural population remains without easy access to the general health services, and that strengthening community-based preventive and treatment services will remain a crucial intervention for improving the health of the population. In addition, as in other sectors, further development in the health sector will continue to depend in part on volunteer participation of communities.

Health professional to population ratio has improved but number of health professionals remains relatively low.
Fig. 1. Number of health institutions
Tigray Region, Ethiopia

<table>
<thead>
<tr>
<th>Year</th>
<th>Hospital Population Ratio</th>
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<tbody>
<tr>
<td>1981/82</td>
<td>1.37,765</td>
</tr>
<tr>
<td>1982/83</td>
<td>12.334</td>
</tr>
<tr>
<td>1983/84</td>
<td>12.1,928</td>
</tr>
</tbody>
</table>

Gregorian calendar year
Almost 75 percent of Tigray Region is malarious, and about 56 percent of the population lives in malarious areas. Malaria transmission is seasonal and depends on both altitude and rainfall. Transmission varies widely with the complex topography, which ranges from high altitude plateaux and mountainous terrain, to deeply incised river valleys and canyons, to low altitude semi-arid plains or fertile valleys. Transmission usually occurs at altitudes below 2000 metres. At higher altitudes, temperature declines to levels too low to support development and survival of the parasite in the mosquito vector.

*Anopheles gambiae* s.l., the major malaria vector, breeds in small sun exposed pools mainly produced during the rains. Development of the malaria parasite within the vector, and vector longevity depend on both temperature and relative humidity. Conditions conducive to both vector and extrinsic parasite development occur from September through November, following the main rains of June and July (Figure 2). This period is the major transmission season. In southern Tigray a second transmission season occurs March through April, following the short rains of January and February.

**Fig. 2. Temperature, rainfall, and relative humidity 1996-1998**

*Elala Station, Mekelle, Tigray Region, Ethiopia*

Source: Institute of Agricultural Research, Mekelle
As in the rest of Ethiopia, malaria is unstable in Tigray. Transmission ranges from hypoendemic to mesoendemic (5), with crude parasite rates in cross sectional surveys ranging from 3-10% during high transmission months, and from 0-3% during low transmission months (6-9). Spleen rates in children 2 to 10 years range from 15% to 18% (10,11). The unstable nature of malaria makes the region prone to outbreaks, and malaria is a major public health problem. In western Tigray, a malaria epidemic in 1987 was responsible for 142,317 cases and 349 deaths. In 1990 in an epidemic in northern Tigray, 16,456 cases and 246 deaths were reported. In 1991 an outbreak in southern Tigray effected 198 localities with a population of 172,139 and 523 deaths were recorded (12).

In most areas of Tigray the population is non-immune and even low level parasitaemia is associated with clinical illness. The non-immune status of the population means that prevalence of malaria infection and clinical illness is similar in all age groups (Figure 3). Prevalence of infection tends to be higher in males, possibly because herding and farming (crop surveillance) require outdoor work during mosquito biting times (Table 1).

---

**Fig. 3. Age-Specific Parasite Rates, Cross Sectional Surveys**

**Humera area (700m), 1995-1996 GC**

**Tigray Region, Ethiopia**

Parasite rate (all forms, all species)
Table 1.  Sex-specific parasite rates, Tigray Region, Ethiopia

<table>
<thead>
<tr>
<th>Survey</th>
<th>sex-specific parasite rate (all forms, all species)</th>
</tr>
</thead>
<tbody>
<tr>
<td>date, site, ages tested</td>
<td>transmission season</td>
</tr>
<tr>
<td>4/1995¹, 41 villages near microdams, all ages</td>
<td>low</td>
</tr>
<tr>
<td>9/1995², 3 Humera villages, all ages</td>
<td>high</td>
</tr>
<tr>
<td>10/1995³, 3 Adi Daero villages near microdams, all ages</td>
<td>high</td>
</tr>
<tr>
<td>6/1997⁴, 2 Humera area villages, all ages</td>
<td>low</td>
</tr>
</tbody>
</table>

¹ Reference 8.  
² Reference 6.  
³ Reference 9.  
⁴ Reference 7.

*Plasmodium falciparum* accounts for 60-70% of infections, and *P. vivax* for the remainder. Infection by species varies seasonally, with percent of infections due to *P. vivax* increasing in the hot and drier months from January to May (Figure 4).

The seasonal increase in proportion of *P. vivax* is due in large part to marked seasonal decrease in *P. falciparum* infection when enabling conditions for continued transmission are absent, and probable relapses of *P. vivax* (Figure 5). In most years, the seasonal variation in *P. vivax* infection is much less than that of *P. falciparum*. 
Fig 4. Variation in Parasite Formula by Month, 10 Malaria Sector Laboratories
Tigray Region, Ethiopia

Fig. 5 Slide Positivity Rate and Blood Films by Species, 10 Malaria Sector Laboratories
Tigray Region, Ethiopia
In 1992, following a year of large population movements and malaria outbreaks, a decision was made to strengthen malaria control in Tigray. The Tigray Regional Government and the National Organization for the Control of Malaria and Other Vector Borne Diseases, in collaboration with the World Health Organization and with financial assistance from the Italian government, designed a Community-Based Malaria Control Programme, building on the strengths of community-based health care developed during the civil war.

OBJECTIVES AND APPROACHES

The primary objectives of the Community-Based Programme are to reduce malaria morbidity and mortality. The primary approaches are early diagnosis and treatment of malaria at village level by community health workers, improved availability of chloroquine prophylaxis for pregnant women and involvement of community members in disease prevention through environmental management. In 1996 an impregnated bednet initiative through community financing schemes was begun in western Tigray as additional activity within the community-based programme. Training of district health staff on malaria control, and training of health professionals from the general health services on clinical management of malaria are also important programme activities.

PROGRAMME SET-UP

Malaria control in Tigray 1948-1992

The control of malaria in Ethiopia in general and in the Tigray Region in particular has a history of more than four decades. Until 1992, the National Malaria Control Programme operated in Tigray as a vertical programme through one zone office and nine sector offices. Major control strategies from 1948 through 1991 included selective indoor residual spraying, and diagnosis and treatment at health institutions and malaria sector laboratories. These control strategies were suspended in Tigray during the latter years of the civil war and only reintroduced in Tigray in 1991.
Process of integration with local government and general health services

A first step in programme development was planning lines of responsibility and communication between the local government, the general health services, and the regional department for the Control of Malaria and Other Vector Borne Diseases. At the end of the Civil War in Tigray, local government was organized under committees that decided policy and oversaw activities in the regional bureaux. The Social Affairs Committee at the regional level oversaw activities in health, education, and other broad social services. Lines of responsibility and communication reached the locality (tabia) level (unit of 3-5 villages), where governing units were composed of representatives from 3-5 villages (kushets). The Health Bureau organized and implemented activities in consonance with polices set by the regional Social Affairs Committee. In theory the Health Bureau’s lines of responsibility and communication reached from district (wereda) clinics to the locality (tabia) level. However, most CHWs and TBAs were not supervised regularly by Health Department staff and many were not active. The lines of communication between CHWs and locality governments (baito) were stronger than those with district (wereda) clinics. While communications within the general health services ended at the clinics (below the district level), the existing Malaria Control programme did not reach the district (but only 9 sectors for the whole region) and had few formal ties with the general health services.

When the programme was being planned in 1991, Tigray Region was divided into 81 weredas (districts with average population of 40,000), 1136 tabias (localities of 3-5 villages with population range 2-5,000), and 3516 kushets (villages). Since general health services was then limited to only 76 clinics, most of the rural population had very limited access to care, including diagnosis and treatment of malaria. Establishing clinics and training health staff to serve in each tabia was not feasible, as Ethiopia was and still is one of the poorest countries in the world. On this basis, it was envisaged that trained CHWs could serve as a bridge from the wereda to the community and could work to extend malaria diagnosis and treatment services to the tabia level.

It was clear that for the Community-Based Programme to be effective functional integration was needed between the Malaria Control Office, the general health services, and the local government. The reasons were clear. The Malaria Programme did not have offices at the district (wereda) level, and did not have the financial capability to provide transportation services to deliver supplies, collect reports, and supervise CHWs. Neither the Malaria Programme nor the general health services had the capacity for community level education or mobilization for environmental management for vector control. With functional integration, the district (wereda) clinics could be the link between malaria sector offices and CHWs, and local government officials who regularly visited weredas and tabias could act as couriers for reports and messages, could mobilize communities for education and environmental management, and could participate in assessment of programme activities.

The rationale behind the Community-Based Programme, and the system for its administration were discussed in detail in a series of meetings at various levels. This step in the planning process took many months. After a consensus was reached that the plan was feasible, final approval was given by the local government. Figure 6 shows the lines of responsibility and communication that defined the functional integration of the Community-Based Programme from 1992 to 1994.
Figure 6.
Communication flow for Malaria Control before integration

**Local Government**

Regional Social Affairs Committee

**Malaria Control Coordination**

Malaria Control Office

**General Health Services**

Regional Health Bureau

Zonal Social Affairs Committee

Zonal Health Department

Hospital

Health Centre

District Social Affairs Committee

District Clinic

Tabia Baito

Community Health Worker

Village Representative
Figure 7
Communication flow for Malaria control after integration

Regional Social Sector

Tigray Health Bureau

Malaria Control Prevention Health Finance

Zonal Social Sector

Zonal Health Departments Malaria Division

Wereda Social Sector

Wereda Health Services (Malaria Teams)

Wereda Clinics

Tabia Baito

Health Posts & Community Health Workers

Kushet Representative

Leader of 20-40 households
Figure 7 shows the actual integration of malaria control into the general health services. The official process of integration was step wise and occurred in three phases. In 1993, following adoption of a policy of decentralization by the Transitional Government of Ethiopia, the Tigray Health Bureau assumed responsibility for malaria control activities in Tigray. Since then, malaria control has been organized in the Regional Health Bureau by the Department for the Control of Malaria and Other Vector Borne Diseases, with four zone offices, twenty district units, and a total of 103 technical personnel. In the second phase, the Tigray Regional Government supported further decentralization and integration of malaria control activities into the general health services by approving the establishment of malaria control units in 26/36 district (wereda) health offices, the most peripheral administrative units. The establishment of the 20 current district malaria units is a major accomplishment in the ongoing decentralization process. After further training of malaria technicians in 1999, all 26 priority districts (weredas) will have at least 2 trained malaria staff per district (wereda) health office. In the remaining 10 districts (weredas) where malaria is not a major public health problem, district (wereda) health office staff will be trained in malaria control. In the third phase, actual integration is occurring with relocation of malaria sector laboratories to health institutions, integration of malaria sector offices into wereda (district) health offices, transfer of malaria vehicles into the general health services pool, integration of malaria stores into general health services stores, and integration of financial management into the general health services financial structure.

During the early years of functional integration, once responsibilities and lines of communication had been agreed on in 1992, notification of the details of programme activities and responsibilities were passed through the wereda social affairs committees to the 681 localities (tabias) that were in malarious areas and thus sites for programme implementation. When responsibilities at the locality (tabia) level were clear, training of CHWs began.

Selection of CHWs

CHWs are trained volunteers who are responsible for general health and malaria activities in a locality (tabia) of about 2500 people (3). At the time of programme implementation, the election of CHWs was preceded by meetings of malaria control personnel, Health Bureau personnel, and local government leaders to discuss CHW responsibilities, criteria for CHW selection, and the process for CHW election. CHWs were then elected during community gatherings by villagers on the basis of willingness to serve the community, good conduct and relationships in the village, ability to read and write, and permanent residence in the village.

Responsibilities of CHWs

The main malaria related activities of CHWs include:

1) diagnosis of uncomplicated malaria based on clinical signs and symptoms (main criterion being fever or history of fever, with other signs and symptoms being sweating, shivering, loss of appetite, vomiting, headache, joint pain);
2) treatment with chloroquine according to age;
3) detection and referral of severe cases (persistent vomiting, inability to eat, drink, walk, sit, or speak, difficulty with urination or respiration, yellow skin or eyes, disturbed consciousness to any degree, and mucosal bleeding), and
4) referral of still sick patients (persistent symptoms despite 3 doses of chloroquine).
Additional activities include provision of weekly chloroquine chemoprophylaxis (300 mg base) to pregnant women, health education on transmission of malaria, the importance of early diagnosis and treatment of febrile illness, and the need and safety of chloroquine prophylaxis during pregnancy. On a weekly basis during the transmission season, as part of the sanitation programme organized by the Social Affairs Committee of the local government, community members are mobilized for environmental management activities for vector control under the coordination of the CHW. On average, malaria trained CHWs are expected to spend 2 hours per day on malaria-related activities.

**Supervision**

During the first years of the programme, malaria staff undertook direct and indirect supervision of CHWs on a regular basis. CHWs were observed during routine activities, and community members were interviewed about CHW performance and problems. The intent was to ensure proper diagnosis and treatment of clinical cases, to provide technical advice about environmental management for vector control, to support the volunteer work of the CHWs, and to gauge community acceptance of programme activities.

Progressively as CHW activities were well established, and during the period of integration of malaria in the general health services and decentralization to the zone level, visits at village level for supervision became rare. However, malaria staff assigned to districts visit villages for assessment of the malaria situation, particularly when CHWs report unusual transmission of febrile illness.

**Monitoring and evaluation**

Monitoring and evaluation of CHW activities take place mainly at district (woreda) clinics and at local government meetings. Clinic meetings are scheduled on a market day during the last week of each month and are attended by all community health workers in the clinic catchment area, by the health professional (nurse or health assistant) in charge of the clinic, by malaria staff, and by representatives from the Social Affairs Committee. During the meetings, there is discussion on activities and problems identified by CHWs, and CHWs collect chloroquine, reporting forms, and stationary supplies and submit their reports.

During regular monthly locality (tabia) meetings attended by villagers and their elected community officials, health issues are discussed, including CHW services in the community, drug delivery, and participation of the community in environmental management activities.

Second-level evaluation by malaria staff occurs at the district (woreda) level where CHW data are compiled, and at zones. Trends in number of treated patients, drug consumption, chemoprophylaxis coverage and community participation for vector control are reviewed. Third-level evaluation is based on computer analysis of data from CHW reports, review of supervision reports, and review of health institution data. CHW performance is assessed by review of trends in numbers of treated patients, reported versus expected drug consumption, and frequency and completeness of reports. Treatment by sex and age group is monitored as is utilization of chemoprophylaxis by pregnant women. Trends in number of patients treated in health institutions are monitored at both zone and regional level. Operational research activities are designed at the regional level to answer specific questions related to programme implementation and periodic programme review.
Two formal evaluations (gemgams) of health sector performance are held every year and address the community-based component of the malaria control programme as well as traditional control activities. Meetings at wereda, zone, and regional levels are attended by government officials and representatives from all regional bureaux.

Information system

Choice of indicators and sources of data

Choice of indicators followed WHO guidelines for evaluation of malaria control programmes (13), taking into account the availability and quality of data routinely collected by the health services, CHW workload, and the capacity for data management within the regional control programme.

Routine sources of data include weekly CHW activity reports, wereda malaria activity reports, and health institution reports. Additional information necessary for programme evaluation has been collected through surveys including focus group discussions, knowledge-attitude-practice surveys, studies on malaria diagnostic performance, willingness-to-pay studies, and repeated mortality surveys.

Indicators include:

- process indicators for training, reporting
  - number of CHWs trained
  - number of tabias in malarious areas with trained CHWs
  - CHW to population ratios
  - proportion of CHWs submitting weekly reports once, twice, three, or four times monthly

- outcome indicators for case management, malaria prevention
  - age and sex distribution of CHW treated patients
  - observed versus expected CHW drug consumption according to age distribution of patients
  - proportion of pregnant women taking weekly prophylaxis at least once monthly
  - number of community members participating in environmental management activities
  - number of bednets distributed and re-impregnated yearly
  - proportion of population living in houses with at least one impregnated net
  - cost recovery for purchasing bednets and insecticide for impregnation

- impact indicators for morbidity and mortality
  - number of patients treated by CHWs
  - number of malaria out-patients treated at health institutions
  - proportion of institution out-patients treated for malaria
  - slide positive rate at malaria sector laboratories
  - number of malaria in-patients
  - proportion of total admissions for malaria
  - number of malaria in-patient deaths
  - in-patient malaria proportionate mortality
  - malaria case fatality rate among in-patients
  - death rate in under 5 children in rural communities

Of these, a limited number of indicators are used for routine monitoring of programme implementation.
Information flow and periodicity of data collection

During monthly meeting, CHWs submit to district clinics reports of numbers of treated patients and amount of chloroquine dispensed on a monthly basis, together with reports of chemoprophylaxis. Health institution and CHW data are compiled and reviewed monthly by malaria staff at district level and then sent to zonal and regional offices for further review. Review is followed by feedback to zonal and district health offices. Mortality surveys are carried out every 2 years.

With timely submission of data, transfer of information from the village to the region and back requires about 2 months. CHWs may submit reports to clinics weekly but reports are transferred to district offices monthly. District compilation of CHW and health institution reports may take two weeks to one month, depending on field assignment of malaria staff during the transmission season. Zones submit reports to the region within the first two weeks of each month. Entry and analysis of data at the regional level takes about two weeks.

ACTIVITIES AND OUTCOMES

CHW training and description of CHWs

The first round of malaria training of CHWs was carried out in 1992 (250 CHWs) and 1993 (431 CHWs). A seven day malaria training course was given by malaria staff at the district level. Each CHW was given a guidebook for reference and a pictorial diagram with age-specific chloroquine regimens for display at the treatment site. Chloroquine is the first line drug for uncomplicated malaria in Ethiopia, and dosage follows national guidelines (Table 2). Most CHWs trained for malaria work subsequently received general health training in a two month course coordinated by the Regional Health Bureau.

Table 2. Chloroquine treatment dosage by age

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Age in years</th>
<th>Dosage in mg base</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Day 1</td>
</tr>
<tr>
<td>Chloroquine syrup</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(80mg base/5 ml)</td>
<td>&lt; 1 year</td>
<td>80mg</td>
</tr>
<tr>
<td></td>
<td>1-3 years</td>
<td>160mg</td>
</tr>
<tr>
<td></td>
<td>4-5 years</td>
<td>240mg</td>
</tr>
<tr>
<td>Chloroquine tablet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(150mg base/tablet)</td>
<td>6-7 years</td>
<td>300mg</td>
</tr>
<tr>
<td></td>
<td>8-9 years</td>
<td>300mg</td>
</tr>
<tr>
<td></td>
<td>10-12 years</td>
<td>450mg</td>
</tr>
<tr>
<td></td>
<td>12+ years</td>
<td>600mg</td>
</tr>
</tbody>
</table>
Of the original 681 volunteers chosen by their communities for malaria training, 98% were male, 98% married, and 99% farmers with a mean age of 36 (±7) years, and a median education level of 2.6 years. Factors contributing to the low numbers of female CHWs included high rate of female illiteracy (93% in 1994 (2)), heavy female household responsibilities, and cultural norms. 89% of CHWs provide services from their homes, 10% from health posts constructed by community members as sites for CHW activities. After completion of training in 1993, CHWs served a rural population of 1,682,319 (CHW/population ratio approximately 1:2500). The large majority of CHWs live within one hour’s walk of villagers resident in their catchment areas (3).

Each year additional CHWs have been trained for malaria work to cover new settlements of returnees and demobilized personnel, to expand coverage to the village level in high transmission areas, and to replace CHWs who have quit working because of illness, death, marriage, migration, salaried employment, decision to stop volunteering, or dismissal by the community. On average, less than 3% of CHWs are replaced yearly. Since 1994, the number of CHW has gradually increased from 681 to 735. CHWs now serve 2,327 villages with a rural population of almost 1.74 million.

CHW treatment activities

**Number of cases treated**

The number of patients treated by CHWs varies depending on catchment population, season, geographic location and pattern of rainfall and temperature. On average CHWs treat 26-41 patients monthly during the high transmission season and 14-20 patients monthly during the low transmission season (Tables 3,4). However, the range is very wide (0-771 patients/month/CHW). In 1996 and 1997, mean monthly high season case load in areas of relatively low transmission risk ranged from 4 to 8 (Hauzien, Mekelle), in moderate transmission risk areas from 19 to 37 (Tembien, Adua, Axum), and in high transmission risk areas from 24 to 100 (Humera, Sheraro, EndaSelassie, Mohoni, Alamata).

As seen in Figure 8, a large number of cases of clinical malaria are diagnosed and treated by CHWs in a temporal pattern that coincides with the malaria transmission season. From 1994 to 1997, CHWs treated a mean of 489,378 patients yearly (range 434,770-549,407); a mean of 61,761 monthly (range 55,614-65,618) during the major transmission season September through November, and a mean of 30,894 monthly (range 23,000-43,208) during the low transmission season months (January, February, May, June, July).
The Community-Based Malaria Control Programme in Tigray, northern Ethiopia - A Review of Programme Set-up, Activities, Outcomes, and Impact

3 - The Control Programme

Table 3. CHW treatment case load by sector, high transmission months 1996-1998, Tigray Region, Ethiopia

<table>
<thead>
<tr>
<th>Sector no. CHWs</th>
<th>Clinical malaria patients treated monthly per CHW</th>
<th>1996 GC</th>
<th>1997 GC</th>
<th>1998 GC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (range)</td>
<td>Sep</td>
<td>Oct</td>
<td>Nov</td>
</tr>
<tr>
<td>Alamata 15</td>
<td></td>
<td>68 (15-300)</td>
<td>99 (0-102)</td>
<td>38 (1-195)</td>
</tr>
<tr>
<td>Mekelle 80</td>
<td></td>
<td>30 (0-159)</td>
<td>32 (0-96)</td>
<td>20 (0-74)</td>
</tr>
<tr>
<td>Haizien 121</td>
<td></td>
<td>8 (0-86)</td>
<td>6 (0-41)</td>
<td>5 (0-50)</td>
</tr>
<tr>
<td>Tembien 63</td>
<td></td>
<td>4 (0-45)</td>
<td>3 (0-15)</td>
<td>4 (0-16)</td>
</tr>
<tr>
<td>Adua 113</td>
<td></td>
<td>22 (0-130)</td>
<td>22 (0-105)</td>
<td>25 (0-125)</td>
</tr>
<tr>
<td>Axum 61</td>
<td></td>
<td>24 (1-120)</td>
<td>33 (1-155)</td>
<td>37 (2-190)</td>
</tr>
<tr>
<td>EndaSellesie 140</td>
<td></td>
<td>19 (3-102)</td>
<td>22 (3-88)</td>
<td>26 (2-127)</td>
</tr>
<tr>
<td>Sheraro 41</td>
<td></td>
<td>38 (0-120)</td>
<td>32 (0-135)</td>
<td>37 (0-235)</td>
</tr>
<tr>
<td>Humera 63</td>
<td></td>
<td>91 (0-355)</td>
<td>100 (0-268)</td>
<td>93 (0-244)</td>
</tr>
<tr>
<td>ALL SECTORS 727</td>
<td></td>
<td>43 (0-207)</td>
<td>32 (0-180)</td>
<td>24 (0-60)</td>
</tr>
</tbody>
</table>

* data not reported
Table 4.  **CHW treatment case load by sector, low transmission months 1996-1998, Tigray Region, Ethiopia**

<table>
<thead>
<tr>
<th>Sector no. CHWs</th>
<th>1996 GC</th>
<th>1997 GC</th>
<th>1998 GC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>May</td>
<td>Jun</td>
<td>Jul</td>
</tr>
<tr>
<td>Alamata 15</td>
<td>15 (0.40)</td>
<td>27 (0.90)</td>
<td>45 (0.167)</td>
</tr>
<tr>
<td>Mohoni 30</td>
<td>10 (0.39)</td>
<td>15 (0.59)</td>
<td>17 (0.85)</td>
</tr>
<tr>
<td>Mekele 80</td>
<td>5 (0.42)</td>
<td>8 (0.51)</td>
<td>6 (0.41)</td>
</tr>
<tr>
<td>Hauzen 121</td>
<td>2 (0.15)</td>
<td>3 (0.15)</td>
<td>3 (0.15)</td>
</tr>
<tr>
<td>Temben 63</td>
<td>17 (0.15)</td>
<td>16 (0.92)</td>
<td>19 (0.108)</td>
</tr>
<tr>
<td>Adua 113</td>
<td>18 (0.90)</td>
<td>20 (0.89)</td>
<td>20 (0.80)</td>
</tr>
<tr>
<td>Axum 61</td>
<td>14 (0.61)</td>
<td>17 (0.52)</td>
<td>15 (2.48)</td>
</tr>
<tr>
<td>EndaSelassie 140</td>
<td>26 (0.15)</td>
<td>29 (0.135)</td>
<td>28 (0.138)</td>
</tr>
<tr>
<td>Sheraro 41</td>
<td>45 (0.120)</td>
<td>43 (0.146)</td>
<td>53 (0.210)</td>
</tr>
<tr>
<td>Humera 63</td>
<td>9 (0.45)</td>
<td>14 (0.45)</td>
<td>21 (0.109)</td>
</tr>
<tr>
<td><strong>ALL SECTORS</strong></td>
<td><strong>727</strong></td>
<td><strong>18 (0.148)</strong></td>
<td><strong>19 (0.210)</strong></td>
</tr>
</tbody>
</table>

* data not reported
Fig. 8. CHW-Treated Malaria Patients
Tigray Region, Ethiopia

Fig. 9. Number of Malaria Patients by Treatment Site
Tigray Region, Ethiopia
The number of febrile patients receiving treatment for malaria has increased greatly since the Community-Based Programme was implemented, as is apparent when comparing total yearly number of malaria cases treated at different health care levels (Figure 9). Since mid-1993, 65%-71% of patients treated each year in Tigray for malaria are treated by CHWs (Figure 10). The percent of malaria cases treated by CHWs has remained relatively constant over the last five years. Increase in coverage is a major outcome measure of programme success; other community-based malaria control programme have not been able to achieve a large and sustained increase in number of febrile patients treated (14).

Fig.10. Percent of Total Treated Malaria Patients by Treatment Site
Tigray Region, Ethiopia
Pattern of treatment by age and sex

In addition to total numbers treated, age and sex distribution of patients is monitored for several reasons. First, national and regional policies call for improvement in status of women and children, thus age and sex disaggregated data are necessary to assess progress. Second, although in areas of unstable malaria such as Tigray all age groups are vulnerable to malaria illness because of low level immunity, young children may suffer disproportionately. Plagued with other and frequent illnesses, children infected with malaria will not only suffer illness and possible death but may also be further compromised in growth and development. Women of child bearing age are vulnerable to malaria in pregnancy because of decreased immune responses, and may be more vulnerable to adverse effects of malaria because of existing baseline anaemia from frequent child bearing. Biological vulnerability in these groups may be compounded by social vulnerability if access to health care favours adults and/or males, as has been documented in other areas of Ethiopia (15).

Figure 11 shows distribution of CHW-patients by age group. The general pattern in age distribution has been similar since programme implementation: people 15 years and older account for more than two thirds of those treated each month, while children under 15 years are treated less frequently than would be expected given their proportion in the population, assuming uniform malaria risk across age groups.

Fig.11. Age Distribution of CHW-Treated Patients
Tigray Region, Ethiopia

Similarly, females are treated less frequently than expected, given population distribution, and consistently are less than 40% of CHW treated patients (Figure 12). Children under 10 years are treated only about 45% as often as would be expected, given population numbers, assuming that all age groups are equally vulnerable to malaria infection and illness (Figure 13).
Fig. 12. Sex Distribution of CHW-Treated Patients
Tigray Region, Ethiopia

Fig. 13. Age Distribution of CHW-Treated Patients Compared to Age Distribution in Population
Tigray Region, Ethiopia
While female children are treated about as often as male children, women are treated only about 70% as often as expected (Figure 14).

Overall, highest treatment coverage is in the adult male group. However, it should be recalled that community blood surveys in Tigray have shown trends in higher infection rates in males as compared to females (Table 1 above).

Investigation into the reason for relative under utilization of services by women and children has been undertaken through focus group discussions and found to be related to work responsibilities of women, time constraints, and cultural norms (16). Details of the discussions, and results of a pilot project to increase coverage of women and children are reported in the Special Initiatives section below.
CHW performance

Malaria diagnosis

The efficacy of early clinical diagnosis and treatment of malaria will depend not only on ensuring access to treatment services, but also on the proportion of febrile cases due to malaria, and on the usefulness of fever in predicting malaria illness. Because of wide variation in transmission in Tigray by season and location, CHW diagnostic performance has been studied in the high, low and transition seasons, in areas of both high and moderate risk of transmission. Malaria diagnostic performances of health professionals at peripheral health facilities and referral institutions has also been assessed during the same periods and in the same areas, in order to compare CHW performance with capacity of the general health services.

Methods

In 1995-1996, a study was undertaken to determine 1) the proportion of febrile patients seeking treatment who had malaria infection documented by blood film, 2) how this proportion varied by transmission risk area, by transmission season, and health care level, and 3) how diagnostic performance of CHWs compared to that of institution-based health professionals (17).

Twenty villages with CHWs were randomly chosen as study sites after wereda (district) stratification into high and moderate transmission risk areas (based on predominant altitude and rainfall). The ten clinics selected were the first level referral health institutions for the CHW villages and the four hospitals selected were the referral institutions for the clinics. 5,466 consecutive patients reporting with fever or history of fever over the previous three days and seen by CHWs or health professionals at first level (clinic) and third level (hospital) institutions had blood films taken and then were evaluated in the routine manner. Diagnosis made by health workers was later compared to blood film results. Confirmed malaria was defined by the presence of asexual parasitaemia. Only hospital-based professionals had access to microscopy for diagnosis: malaria diagnosis of CHWs and clinic staff was based on clinical signs and symptoms, while health professionals had the option of ordering a blood film to confirm a clinical impression. The results of routine hospital microscopy in malaria patients recruited in the study was not recorded.

Results

Out of patients presenting with fever, 88% were diagnosed as malaria on a clinical basis by CHWs and clinic staff, while only 43% were considered malaria by hospital staff. Of these, malaria was confirmed only in a minor proportion by microscopy. The prevalence of parasitaemia among febrile patients (slide positive rate) varied widely according to health care level, age group, area and transmission season. The highest prevalence for all age groups combined was found in high risk areas during the high transmission season: 24% at CHW sites, 49% at clinics, and 31% at hospitals.

Sensitivity of malaria diagnosis (the percent of patients with asexual parasitaemia who had an initial malaria diagnosis) was similarly high at CHW sites and clinics (93%-96%) but lower at hospitals (79%). In contrast specificity (the percent of patients without malaria parasitaemia who had an initial diagnosis of non-malaria illness) was low at CHW sites and clinics (13%-16%) but relatively high at hospitals (62%) (Figure 15).
Fig. 15. Sensitivity and Specificity of Malaria Diagnosis by Site in patients with history of fever the past 3 days
Tigray Region, Northern Ethiopia

Positive predictive value of a malaria diagnosis (the percent of patients considered as malaria cases who had confirmed asexual parasitaemia) was very close to prevalence of parasitaemia at CHW sites and clinics but was 1.4 to 2 times higher than prevalence at hospitals (Figures 16, 17). Positive predictive values were higher at all sites for the under 15 year age group. Negative predictive values of an initial non-malaria diagnosis (the percent of initial non-malaria diagnosis patients who had no asexual parasites on blood film examination) were high at all sites.

Fig. 16. Malaria diagnosis in patients with fever history past 3 days
Patients less than 15 years old
Tigray Region, Ethiopia
Fig. 17. Malaria diagnosis in patients with fever history past 3 days
Patients 15 years and older
Tigray Region, Ethiopia

Assessment

The sensitivity and specificity of malaria diagnosis by CHWs was similar to that of health assistants at clinics. From the patterns of persistently low specificity recorded at clinics and CHW sites, it seems clear that without microscopy, overall diagnostic performance does not differ significantly according to level of training. When judged by positive predictive values, overall performance was best at clinics, because of a higher prevalence of infection in patients presenting with febrile illness.

The low prevalence of infection in febrile patients presenting to hospitals was probably the result of 1) wide catchment areas which included areas of low transmission risk, and 2) preferential utilization of other institutions in the same towns (sector laboratories or health centres) where access is easier (shorter waiting times, no referral paper required, and/or free diagnosis and treatment). The reason for higher prevalence of infection in febrile patients at clinics as compared to CHW sites may be due in part to a difference in age distribution of patients, since a higher percentage of patients at clinics was under 15 years. Families may prefer to take children to clinics because of availability of injections or chloroquine syrup. The difference in age-specific infection rates in this study was much greater than those found in community blood surveys in similar areas during the same year (9). These differences may well reflect different patterns in utilization of health services when ill. Adults may seek care for illnesses of lesser intensity, while children may be brought for care only when more seriously ill.

CHWs and clinic workers missed fewer true malaria patients than health professionals at hospitals. However, the percent of patients diagnosed with malaria who actually had no infection (false positives) was higher at CHW sites and clinics than at hospitals. Positive predictive values in Tigray are similar to those demonstrated in primary health care settings in other areas of Africa.
Conclusions

In an area such as Tigray where malaria infection can result in serious illness and death in all age groups, and where uncontrolled transmission in a non-immune population can lead to epidemics, identifying and treating early all patients with infection is important. Thus high sensitivity in diagnosis is desirable and a major criterium for judging diagnostic performance. In this regard, CHW performance was good and equal to that of health professionals at clinics.

When judged by positive predictive values, this diagnostic approach was better in children than in adults at all sites, reflecting a higher prevalence of infection in younger age groups. Also, diagnostic performance as judged by this criterium was best at clinics, mainly because of higher attendance by children. Since diagnostic performance of CHWs and clinic professionals was similar at similar prevalence of infection, under routine conditions, improved specificity in diagnosis may require access to microscopy or other diagnostic tools, not just more intensive clinical training.

The low positive predictive values of a malaria diagnosis in adults in the context of the large number of adults treated by CHWs means that the false positive treatment rate in the community-based programme is high. Studies on new diagnostic criteria using a syndrome approach are under way to determine if a symptom complex is a better predictor of malaria infection than fever history alone, especially in adults, and thus a way to improve diagnostic performance of CHWs and clinic professionals.

Drug distribution

In theory CHWs should supervise each dose of treatment given, and record amount dispensed daily. In practice, it has proven impractical to ask sick patients who walk up to one hour from other villages to return for 2 consecutive days for subsequent doses. Most CHWs treat daily under supervision only patients who live nearby in the same village. CHWs give the first dose of treatment under observation to patients living farther away, then give the remaining tablets with instructions for second and third day dose.

Studies of compliance with treatment regimen have not been done. However, drug distribution is monitored regularly. For the past 4 years, 4.3 to 5.4 million chloroquine tablets and 480-925 litres of chloroquine syrup have been dispensed yearly. Drug distribution is assessed by comparing observed (reported) amount of drug dispensed to expected amount, given reported age distribution of treated patients.

Calculations of expected amounts assume use of syrup for children under 5 years, and tablets for older children and adults. In fact, there has been a shortage of chloroquine syrup in Ethiopia in the past 4 years and at no time has CHW supply been adequate to treat all children (Figure 18). In practice, syrup is reserved for the youngest age group, while 2-4 year old children are treated with tablets.

Because young children as well as adults are treated with tablets, observed distribution of tablets should exceed expected distribution by a small amount, if all CHWs are dispensing correct doses and if all patients receive a complete treatment dose. This pattern is generally seen when assessed monthly. Given the relatively small number of under 5 children treated by CHWs, observed to expected ratios are expected to be close to 1. As seen in Table 5, ratios range from .996 to 1.01, suggesting that most malaria patients are being given a full dose of treatment.
Fig. 18. Chloroquine Syrup Distribution by CHWs
Tigray Region, Ethiopia

![Graph showing distribution of chloroquine syrup dispensed by CHWs over a period from 1992 to 2008.]

Expected = \( (\# \leq 1 \text{yr} \times 0.015) + \\
(\#1-3 \text{yr} \times 0.025) + (\#4 \text{yr} \times 0.03) \) liter
80 mg base chloroquine/5ml

Table 5. Observed chloroquine tablet distribution by CHWs compared to expected distribution given reported age distribution of treated patients, Tigray Region, Ethiopia

1 tablet = 150 mg base chloroquine

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</thead>
<tbody>
<tr>
<td>Observed</td>
<td>723,960</td>
<td>2,582,704</td>
<td>3,611,977</td>
<td>3,842,365</td>
<td>4,763,372</td>
<td>4,482,159</td>
<td>4,940,302</td>
</tr>
<tr>
<td>Expected(^1)</td>
<td>709,221</td>
<td>2,636,234</td>
<td>3,631,899</td>
<td>3,844,795</td>
<td>4,700,403</td>
<td>4,499,548</td>
<td>4,939,871</td>
</tr>
<tr>
<td>Observed: expected ratio</td>
<td>1.02</td>
<td>.979</td>
<td>.995</td>
<td>.999</td>
<td>1.01</td>
<td>.996</td>
<td>1.00</td>
</tr>
</tbody>
</table>

\(^1\) Expected distribution = \( (\text{no.} \geq 5 \text{yr} \times 3) + (\text{no.} 6 \text{yr} - 3.5) + (\text{no.} 8 - 9 \text{yr} \times 5) + (\text{no.} 10 - 12 \text{yr} \times 7.5) + (\text{no.} 13 + \text{yr} \times 10) \) tablets.
Reporting

Close attention was given to establishing a CHW reporting system at the start of programme. The intent was twofold: to monitor CHW activity and to establish a community-based surveillance system. While review of monthly reports could serve well enough to monitor CHW activity, review of weekly treatment trends was seen as a means for early detection of outbreaks and thus prevention of epidemics. Weekly reporting was deemed feasible, since villagers almost always attend weekly markets, and could leave reports at drop points during market days.

Pattern of weekly CHW reporting is seen in Figure 19. The relatively low level of weekly reporting 1993-1994 was partly related to the reporting system and not CHW activity: CHWs reporting zero patients (because no sick persons came for evaluation), and CHWs not reporting (because they had not worked) had been put in the same category of "no report" when data were compiled at the wereda level. Following correction of the problem, the reporting pattern remained about the same for 3 1/2 years, until 5/1998: overall, about 90% of CHWs reported at least once monthly and about 60% four times monthly. During ploughing and planting months (May/June) frequency of weekly reporting tended to decrease. CHWs who remain in the fields for long hours may not be available for consultation, and villagers who are also very busy may not take time to seek care unless very ill. The decrease in reporting frequency after 4/1998 was directly related to the beginning of the border disputes with Eritrea, when a number of CHWs volunteered for military service. Although training of replacements was done, some villages remained without CHWs for several months.

CHWs who do not report for three consecutive months are defined as inactive. Most inactive CHWs are identified quickly, before 3 months have elapsed, at monthly clinic meetings of CHWs and monthly tabia baiot (governing units of a locality of 3-5 villages) meetings. Temporary absence from the villages, death, illness, migration, regular employment in a salaried job, and decision to stop volunteering are reported quickly to the tabia baiot, replacements are elected, and the sector is notified that training is needed. When replacement training takes place within one to two months, no significant change in pattern in overall reporting is seen on regional review. Overall, only about 5% of CHWs have been identified as not reporting for 3 consecutive months at the regional level. Even in these cases, the inactive status of the CHWs has usually already been identified at the community and wereda level, but replacement training may not have taken place because of lack of funds or scheduling problems. The CHWs recruited to replace drop-outs usually receive within 6 months an informal on-the-job training by malaria staff; the subsequent formal training (45 days course with 7-10 days on malaria) is carried out by the health services training department during regularly scheduled sessions.

CHW chemoprophylaxis activities

In a detailed analysis of pregnancy related activity by 89 CHWs in Mekelle sector during the nine month period January through September 1993, a mean of 80% of CHWs submitted 4 weekly reports per month detailing treatment activities, but only 16% submitted one or more monthly reports of pregnancy related activity. Analysis of the few reports received revealed 1) that the numbers of registered pregnant women per village were much smaller than expected and 2) that use of chloroquine prophylaxis by registered pregnant women was rare (18).

All CHWs from the time of programme implementation have reported the reluctance of pregnant women to take prophylaxis. This pattern of low use of prophylaxis is found throughout Tigray and has persisted.
Investigation into reasons for prophylaxis under-utilization was undertaken through focus group discussions and the same barriers to use of CHW-treatment services in women and children were reported as barriers to use of prophylactic services. In addition, it is generally believed that chloroquine use in pregnancy causes abortion. Further discussion of these issues and of the results of pilot projects to increase prophylactic coverage are reported in the Special Initiatives section below.

CHW and environmental management

Environmental management for vector control is undertaken during the transmission season as part of regular sanitation activities organized by tabia committees (baitos). The quantity, quality, and effectiveness of environmental activities are difficult to measure. Although CHW report forms have a section for reporting environmental management activities, few reports are made. Instead, the kushet (village) and tabia officials who are directly responsible for sanitation activities report regularly to wereda offices the size of breeding sites drained, filled, and cleared, and the number of community participants (Table 6). Overall, the number of participants in environmental management has increased, as has source reduction. These increases have followed notifications to wereda offices and announcements in newspapers and by radio about the likelihood of vector breeding associated with rainfall, and the need for community mobilization for vector control.
Assessment of the adequacy of environmental activities for vector control by such numbers alone is difficult, as the extent of needed activity varies widely by location. In addition, mobilization is for general sanitation as well as vector control, and activities may have more than one purpose. For example, vegetation clearing is done to eliminate snake habitats as well as to eliminate resting sites for mosquitoes. In some areas, participation in environmental sanitation is compensated by food for work, but such compensation is not regular or widespread. CHWs do report that agricultural responsibilities and the time required for treatment activities limit the time available for environmental work.

**Table 6. Yearly environmental management activity, Tigray Region, Ethiopia**

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</thead>
<tbody>
<tr>
<td>Filled, m²</td>
<td>*</td>
<td>333</td>
<td>25,122</td>
<td>*</td>
<td>32,730</td>
<td>4,580</td>
<td>461,288</td>
</tr>
<tr>
<td>Drained and cleared, m²</td>
<td>66</td>
<td>784</td>
<td>6,327</td>
<td>*</td>
<td>449,070</td>
<td>387,574</td>
<td>1,554,119</td>
</tr>
<tr>
<td>Population participating</td>
<td>60</td>
<td>14,128</td>
<td>81,781</td>
<td>65,707</td>
<td>80,468</td>
<td>127,819</td>
<td>366,365</td>
</tr>
</tbody>
</table>

* data not reported

**Other training activities**

In addition to CHW training, technical and professional training has been undertaken to ensure proper functioning of the Community-Based Programme within the context of the general health services. With increasing decentralization, many professionals in zone, woreda, and district offices given responsibilities for first level management of malaria control activities had little experience in or formal training for such work. Four zone chiefs, 10 sector chiefs and 8 supervisors are now trained as trainers of CHW trainers, in supervision of CHW activities, and in a basic epidemiological approach to malaria control. Thirty-two vector biology technicians have been trained as CHW trainers, in CHW supervision, in data compilation and interpretation, and in bednet re-impregnation techniques. In addition, malaria technicians have received refresher training in vector biology and control. Thirty-seven clinic based health professionals in priority areas received training in epidemic preparedness in 1996. Twenty-one health institution-based laboratory technicians received refresher training in malaria microscopy in 1995.
Effect of training on management of severe malaria

In 1995 WHO sponsored a training of trainers course in management of severe and complicated malaria at the national level, and provided funds for training of health professionals at regional levels. Initiatives for ensuring subsequent training at the periphery were the responsibility of regions. In Tigray, as a means of motivating trained physicians to further train colleagues at peripheral institutions, physicians were invited to participate in a study to evaluate case management before and after training. 16 physician trainers from 12 of the 16 institutions with in-patients trained staff in their institutions and reviewed charts of 400 consecutive hospitalized malaria patients, one month before and one month after training.

Charts were reviewed for completeness of information important for optimal case management. Although information was recorded more frequently after training, essential information still missing after training included temperature, blood pressure, weight, blood film results, and haemoglobin. 81% of patients received parenteral treatment initially, and 80% received quinine as initial drug, with no difference in relation to training. When standard weights (by age and sex) were assigned for missing values, estimated median initial parenteral quinine dose increased significantly after training from 10 to 17 mg/kg (p < 0.0001); median maintenance dose did not change (9 versus 10 mg/kg, p = 0.24). Median hospital stay was 4 days, and malaria case fatality was 7.8%, with no difference by study period. Significant system constraints to optimal management were documented and included shortages of sulfadoxine/pyrimethamine tablets, quinine tablets, and 50% dextrose. In addition, the three hospitals in the most malarious areas had no capacity to measure haemoglobin, and no capacity to transfuse blood (19).

In summary, training was followed by improved case management mainly in use of a loading dose of quinine. However, even after training information important for optimal case management was often not recorded, suggesting a persistent need for improvement in clinical practice. In addition, shortages of drugs and laboratory supplies/equipment interfered with optimal management of patients.
SPECIAL INITIATIVES

Investigation of relative under-utilization of CHW services by females and children

Focus group discussions

Reasons for relative under-utilization of CHW-treatment services by females and children and of prophylaxis by pregnant women were investigated in 1994. Focus group discussions were held with 5 groups: 1) pregnant women, 2) women with children under 5 years, 3) men with pregnant wives, 4) men with children under 5 years, and 5) CHWs, TBAs, and elected community officials.

The main information collected was as follows.

1) The heavy work load of women leaves them little time to attend to their own and their young children’s health needs.
2) Distance to the CHW village, when combined with work responsibilities, proves a significant barrier to care.
3) Children under 5 years are “tied to the mother’s breast” and thus subject to the same factors influencing women’s use of services.
4) Chloroquine syrup is perceived as better treatment for young children than chloroquine tablets but CHW syrup supply is usually exhausted by the first week each month.
5) Pregnant women do not take chloroquine prophylaxis because of a widespread belief that chloroquine tablets cause abortion. Chloroquine is sometimes taken at 2-3 times normal dose by pregnant women in attempt to induce abortion.
6) There is a general lack of knowledge about safety of chloroquine in pregnancy and the importance of early diagnosis and treatment of febrile illness in young children.

Additional factors influencing care seeking behaviour mentioned by discussants were 1) male dominance in decision making, 2) female habit of not expressing needs, and 3) possible perception of sexual disloyalty when a woman seeks care from a male CHW.

The main recommendation offered by group discussants as means to improve the Community-Based Programme were: 1) more CHWs should be trained in order to improve women’s access to care, 2) chloroquine syrup supply should improve, and 3) community education should intensify (16).
Fig. 20. Under 5 year patients: Mohoni TBAs, Mohoni CHWs, Maichew CHWs
Tigray Region, Ethiopia

1994 census:
<5yr = 16.8%

Fig. 21. Female patients: Mohoni TBAs, Mohoni CHWs, Maichew CHWs
Tigray Region, Ethiopia

1994 census:
females = 49.2%
Fig. 22. Under 5 year patients: Humera CHWs
Tigray Region, Ethiopia

In contrast, in Humera, village-level male CHWs treated the same percentage of females as had tabia-based CHWs in prior years. On the contrary, a higher proportion of children was treated in 1998 (Figures 22, 23).

Fig. 23. Female patients: Humera CHWs
Tigray Region, Ethiopia
Pilot project to extend coverage through female versus male CHWs and village-level CHWs

Following the focus group discussions, a pilot study was implemented in Tigray’s two most malarious areas (Mohoni, Humera) to determine if better access to services and possibly care by a female health worker resulted in better coverage of females and young children. In Mohoni wereda 10 traditional birth attendants (TBAs) were trained to give malaria treatment and prophylaxis. In Adebay village, Humera, 6 TBAs were trained to give malaria prophylaxis only, because they were too busy with deliveries to assume treatment responsibilities as well. In Humera area, training of male CHWs was extended to the kuschet (village) level. Here, instead of being responsible for covering 2-5 widely scattered villages as was the case previously, after training, Humera CHWs like Mohoni TBAs were responsible for malaria activities only in their own villages.

Five of the 16 TBAs were illiterate. Both pictorial report forms and regular report forms were tested. Illiterate TBAs preferred the regular report forms and asked husbands or children for help in recording information.

Treatment coverage

Reporting performance was excellent throughout the follow-up period. During the first 2 years, in Mohoni TBAs treated a higher proportion of children under 5 years and females than did than 30 male CHWs: the proportion of children under 5 years treated by TBA and male CHW were 14% and 7%, respectively while the proportion of women treated were 44% and 39% (Figures 20, 21). From 1997 through 1998, the differences between TBAs and males CHWs in this area progressively disappeared. The change coincided with the implementation of another pilot study in the Mohoni area, in which mothers were trained for home treatment of malaria and then followed for one year. Wide treatment coverage of females and children in the home was attained in this study and impact is currently being analyzed (Gebreyesus Kidane, personal communication). It is reasonable to assume that the decrease in target group coverage by female TBAs was due to early diagnosis and treatment by mothers in the home.

Prophylaxis coverage

During the two year pilot period in both Mohoni and Humera, TBAs registered monthly more pregnant women than did the male CHWs in their sectors. In addition, in both areas a larger proportion of those registered by TBAs than those registered by male CHWs took prophylaxis at least once monthly (in Mohoni, TBA monthly mean 17%, CHW monthly mean 0%; in Humera, TBA monthly mean 74%, CHW monthly mean 69%). The large difference in percent taking prophylaxis by area is probably a reflection of clustering of houses into large villages in Humera, coordinated education efforts of communities in Humera by tabias, and collaboration in Humera with clinic nurses, who referred all antenatal attenders to TBAs for prophylaxis. Two years after the pilot project was implemented, TBAs remain more successful than male CHWs in Humera in prophylaxis coverage, although coverage has slowly declined, especially in low transmission season months.

Conclusions from pilot study of coverage by TBAs

TBAs are more effective than male CHWs in providing treatment service to women and young children and prophylaxis services to pregnant women in their communities. It should be noted that training of female health workers will not alone solve the problem of low chemoprophylaxis coverage in pregnancy. Despite
better coverage achieved by TBAs, a large proportion of pregnant women still refuse to take prophylaxis. Continuing education at the community level of both women and their families will be necessary to change beliefs and finally behaviour. Though reporting remains a potential difficulty for illiterate women, especially when following pregnant women, with the help of family members and with close supervision this has not proven a major obstacle to effective work.

Because of the better coverage attained by female CHWs, consideration was given to recruiting and training TBAs to work at the village level as a means of improving coverage in the Community-Based Programme. Changes were not made, however, for several reasons. First, the Health Bureau decided to upgrade the level of community-based birth attendants by training women with at least sixth grade education. Because few village women are educated to this level, in practice the policy requires rural assignments of newly trained TBAs (TTBAs). The effectiveness of this approach needs more evaluation. Second, good coverage was seen during routine monitoring of the pilot home treatment project, and a decision was made to await the analysis of project impact on morbidity and mortality. If results are good, training women as health care providers at village level may prove a better way to extend coverage.

Education messages about early diagnosis and treatment and malaria chemoprophylaxis in pregnancy have been given regularly in the past 4 years during the high transmission season in an attempt to increase knowledge and influence care seeking behaviour of women and young children. More effective activity is needed in this area.

Intensification of community-based control in the Humera area

Humera, an area of great agricultural potential in western Tigray, is also the Region’s most malarious area. Challenges to malaria control include geographic isolation, intense seasonal malaria transmission, and a diverse population including indigenous farmers, resettled returnees from Sudan (in Adebay, Rawian, Mai Kadra villages), settled demobilized personnel (Dansha Project villages), and large numbers of seasonal agricultural labourers. CHW were trained to provide services in Humera in 1993, but malaria remained a major public health problem, accounting for 31%-47% of admissions and 5%-46% of deaths at Humera Hospital during the high transmission months 1993-1995. In 1994, death rates in under 5 children were 3.4 times higher than in other areas of Tigray. (See mortality survey discussion below.)

Providing migrant labourers with access to early diagnosis and treatment

The vulnerability of highland migrant labourers to malaria during migration to the lowlands for agricultural work has been a problem of increasing magnitude since 1991, as more large scale agricultural investors move into the Humera area. Most agricultural sites are located two or more hours walk from even peripheral health units.

Labourers often sleep in fields and/or work at night, and are thus at high risk of infection. In 1996 the Department proposed regulations for the protection of migrant labour health in accordance with the existing Labour Proclamation Act (20). A series of meetings were convened with regional, zonal, and wereda government officials, with representatives from the Bureaus of Health, Agriculture, and Social Affairs, and with investors to discuss the problem and proposed solutions.
As a result of the meetings, Humera area investors voluntarily agreed to designate at each site one person to work as a CHW, to treat migrant labourers with clinical malaria. In May 1996 and 1997, 97 investors registered with the Humera wereda administration; the 51 providing information about employees hired a total of about 9500 agricultural workers yearly during each harvest season. A person is sent by each registered investor to the malaria control sector office for training each year before the main transmission season. Investors purchase chloroquine at cost and charge workers cost price for treatment. Records of numbers of treated labourers are reviewed monthly by malaria personnel. In 1996, 97 workers were trained in the clinical diagnosis and treatment of malaria. A similar number provided treatment at agricultural sites in 1997, and then there was a dramatic drop in 1998 related to a significant decrease in commercial farming in the area following the start of the war with Eritrea.

**Insecticide-treated bednet initiative**

Establishment of communities of returnees and demobilized personnel in the Humera area began in 1993/1994 when the health services infrastructure in the area was weak. CHWs were trained to work in all settlement areas but malaria morbidity remained high. (See mortality section below.) Because both returnees and demobilized villagers had used bednets previously (in Sudan and in the armed forces respectively) the feasibility of introducing treated bednets as a strategy for intensified control was investigated.

**KAP survey**

In September 1995 a malaria knowledge, attitude and practice survey was done in returnee communities. Malaria knowledge was high and practice of preventive and curative measures was appropriate (6). Almost all interviewees (n=294) recognized malaria as an important problem, and the great majority knew that malaria was transmitted by mosquitoes, and that untreated malaria could be fatal. 98% knew that malaria could be treated with modern medicines and 86% of persons with febrile illness the previous 2 weeks had sought medical evaluation. 96% reported at least one correct way to prevent malaria; 93% knew that DDT house spraying could prevent malaria and 99% reported their houses had been sprayed during the year. 84% of households had a member participate in environmental management activities during the preceding month.

Knowledge about and attitude toward bednet use were good. 70% knew that bednet use could prevent malaria and 100% stated that bednets would be used if available. 24% of households currently used locally made bednets purchased at a mean cost of 32(+20) birr (USD 4.40).

**Bednet affordability and willingness to buy survey**

Based on the high level of malaria knowledge and appropriate action taken to prevent and treat malaria in the community, additional studies were undertaken to assess the feasibility of community financing of a bednet initiative (20). The anticipated cost of a bednet initiative was considerable: purchase costs of bednets and insecticide abroad, transport costs to Ethiopia and Humera, impregnation training costs, community education costs, and operational costs for supervision and monitoring. Though training and operational costs could be met by the National Malaria Control Programme, net/insecticide purchase and transport costs would need to be met by the community if the initiative were to be sustained. Such costs have been shown to be the major capital and recurrent costs of bednet projects in other countries. Thus determining the feasibility of community financing was essential before implementing the project.
Table 7.  Bednet coverage in the pilot Humera area in 1997, at the end of the

<table>
<thead>
<tr>
<th></th>
<th>Dansha 1</th>
<th>Rawian</th>
<th>Adebay 2</th>
<th>Mai Kadra 1</th>
<th>Total</th>
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<tbody>
<tr>
<td><strong>Population,</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>10,562</td>
<td>5,969</td>
<td>9,320</td>
<td>6,571</td>
<td>32,422</td>
</tr>
<tr>
<td>Number in houses with nets</td>
<td>7,673</td>
<td>4,999</td>
<td>7,064</td>
<td>5,049</td>
<td>24,785</td>
</tr>
<tr>
<td>Percent in houses with nets</td>
<td>73%</td>
<td>84%</td>
<td>76%</td>
<td>77%</td>
<td>76%</td>
</tr>
<tr>
<td><strong>Households,</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4,126</td>
<td>1,619</td>
<td>2,524</td>
<td>2,125</td>
<td>10,404</td>
</tr>
<tr>
<td>Number with at least 1 net</td>
<td>3,315</td>
<td>1,425</td>
<td>1,756</td>
<td>1,615</td>
<td>8,111</td>
</tr>
<tr>
<td>Percent with at least 1 net</td>
<td>80%</td>
<td>88%</td>
<td>69%</td>
<td>75%</td>
<td>78%</td>
</tr>
<tr>
<td><strong>New nets distributed,</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total per house with net, mean (±SD)</td>
<td>3.826</td>
<td>2.241</td>
<td>3.297</td>
<td>2.353</td>
<td>11,717</td>
</tr>
<tr>
<td>Beds in houses with nets,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total per house, mean (±SD)</td>
<td>4.562</td>
<td>3.405</td>
<td>4.515</td>
<td>3.396</td>
<td>15,477</td>
</tr>
<tr>
<td></td>
<td>1.4 (±0.6)</td>
<td>2.4 (±1.1)</td>
<td>2.2 (±0.9)</td>
<td>2.1 (±1.0)</td>
<td>1.9 (±1.0)</td>
</tr>
</tbody>
</table>

1  Includes 6 villages of farmers, excludes administrative village
2  Includes Sur Construction Camp (100 workers)
3  Includes Mai Kadra settlement, Bereket kushet, and WeldeAb agricultural scheme (25 workers)
4  By taba report: Dansha, Rawian; by house-to-house census: Adebay, Mai Kadra

Bednet affordability and community willingness to buy bednets were assessed in Rawian (n=100), the resettlement community with highest malaria prevalence. 54% of households had no secure source of regular monthly cash income, including salary, wage, sale of agricultural products, trading, or government/non-governmental organization stipend. In households reporting cash income, source was sale of farm products, small scale trading, wage for daily labour, or stipend from UNHCR or Red Cross. Overall, mean monthly income was 119 (+86) Ethiopian birr (approximately USD 19.00). 90% of households reported a seasonal variation in cash availability with more cash available from July through December.

In all households, those interviewed said bednets would be used if available, and 61% of interviewees reported that they would be willing to purchase bednets if provided by the government at a “balanced” cost. An additional 22% stated that they would try to purchase nets if they were offered at a time when cash was available. When asked about affordability, the mean amount a family could spend for one bednet was 13 (+9) birr (USD 1.80). 17% stated they were too poor to buy nets.

Implementation in pilot areas

On the basis of these findings, community financing of the bednet initiative was deemed feasible if partial payments were made over several months at the time of highest cash availability. Based on the cost of importing nets and insecticide, the price for one new impregnated net was set at 40 Ethiopian birr (approximately USD 5.50), and the cost of re-impregnation was set at 5 birr (approximately USD 0.70). A system for establishing and managing revolving funds for sustaining the bednet initiative was developed (7).
Meetings were convened at regional and district levels to discuss the issue of community financing of a preventive public health initiative, as such financing had not previously been tried in Tigray. After a consensus was reached that such financing would be subject to the approval of the communities themselves, community meetings were held in two pilot areas, Dansha and Rawian villages, before the transmission season in 1996. Communities voted to accept responsibility for financing and managing the initiative, agreed that partial payments would be made regularly, then elected bednet committees to open community bank accounts in Humera and to manage collected monies.

Community leaders mobilized teams for bednet impregnation, which was done under department staff supervision to ensure the correct target dose of insecticide. Leaders registered households buying nets, then subsequently organized collection and deposit of monthly payments. Financial reports were sent regularly to district and zone administration offices. Based on the widespread acceptance and community contribution to the initiative in the first season, the initiative was extended in 1997 to two other resettlement areas, Adebay and Mai Kadra villages.

Coverage

By the end of the second year of the project, 11,717 nets had been distributed to 8,111 households with a total population of 24,785. Overall 78% of households in pilot villages had at least one bednet (Table 7). Coverage in Adebay and Mai Kadra was less than in other villages because both villages had a large number of temporary/seasonal residents. By vote of the bednet committees in these areas, temporary households (mainly seasonal agricultural workers) could receive nets only if full purchase price were paid at the time of collection. During the high transmission season in 1996, early morning observation in randomly selected households (n=120) showed that net use was widespread, nets were in good condition, and water soluble markings were still present on 93% of nets inspected.
As seen in Figure 24, first year re-impregnation rates were higher in Dansha and Rawian (1997 re-impregnation) than first year rates in Adebay and Mai Kadra (1998 re-impregnation), in large part because of war related upheaval: in 1998 re-impregnation rates were also low in Dansha and Rawian. However, the problem with re-impregnation cannot be ascribed only to the war. In 1997, first year re-impregnation rates were only 65% in Dansha and Rawian, in spite of intense persuasion of communities by malaria staff and local leaders who went house to house to unite bednets and convince villagers to bring them for dipping. Financial considerations may have played a part in Dansha but should not have been a significant factor in Rawian, as the money deposited in the community bednet fund in 1996 had earned sufficient interest to cover the cost of the 1997 re-impregnation, and communities were told they would probably not need to pay. The reasons for poor participation are being investigated. It may be that villagers who did not bring their nets for dipping are not convinced of the importance of insecticide, since many used non-impregnated nets for years when living in the Sudan.

Trends in infection rate

Parasitology surveys of all members of randomly selected households were undertaken before and after net distribution in pilot areas. Overall, results show decrease in crude parasite rates (Table 8). However, interpretation of the decrease is complicated by lack of data during high transmission season the year of initial distribution in 3 villages, a change in climactic conditions in 1997, and increased spray coverage in Rawian after net distribution. Thus the contribution of bednets to decreased infection rates cannot be determined.
### Table 8.
**Crude parasite rates before and after bednet distribution**  
**Humera pilot area, Tigray Region, Ethiopia**

<table>
<thead>
<tr>
<th>VILLAGE</th>
<th>CRUDE PARASITE RATE (number tested)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High season</td>
<td>low season</td>
<td>low season</td>
<td>high season</td>
<td>low season</td>
<td>low season</td>
</tr>
<tr>
<td>DANSHA¹</td>
<td>-</td>
<td>2.5 (570)</td>
<td>NET DISTRIBUTION</td>
<td>6.9 (406)</td>
<td>2.2 (691)</td>
<td>RE IMPREGNATION</td>
</tr>
<tr>
<td>RAWIAN²</td>
<td>14.1 (356)</td>
<td>4.0 (620)</td>
<td>NET DISTRIBUTION</td>
<td>7.4 (541)</td>
<td>1.7 (417)</td>
<td>RE IMPREGNATION</td>
</tr>
<tr>
<td>ADEBAY³</td>
<td>7.6 (463)</td>
<td>-</td>
<td>NET DISTRIBUTION</td>
<td>-</td>
<td>1.3 (452)</td>
<td>NET DISTRIBUTION</td>
</tr>
<tr>
<td>MAI KADRA¹</td>
<td>8.8 (171)</td>
<td>-</td>
<td>NET DISTRIBUTION</td>
<td>-</td>
<td>0.2 (445)</td>
<td>NET DISTRIBUTION</td>
</tr>
<tr>
<td>TOTAL</td>
<td>10.1 (990)</td>
<td>3.3 (1210)</td>
<td>7.2 (947)</td>
<td>1.4 (2005)</td>
<td>5.5 (1930)</td>
<td></td>
</tr>
</tbody>
</table>

¹ sprayed June/July 1995-1997  

### Trends in mortality.

Returnee villages (Adebay, Rawian, and Mai Kadra) were chosen to monitor mortality since access to CHWs and clinics did not change during the intervention period. In contrast, in Dansha CHWs were first trained in 1997, and there was a significant upgrading of health institutions during the pilot period and for these reasons it was not included in the mortality surveys. Repeated mortality surveys to estimate the overall death rate in under 5 children were carried out in the bednet project areas. Because most people in Tigray die at home, community-based mortality surveys are a better source of mortality data than health institutions. Because young children are less mobile than adults, death rates in young children reflect community conditions better than death rates in adults. Because it is not possible to identify malaria deaths at the community level in Tigray (21), overall death rate in under 5 children was the major indicator chosen to measure impact in the bednet project areas.

Figure 25 shows death rates in bednet villages compared with death rates in villages within the same large geographic area, in Mezega wereda (district), where community-based control activities are also carried out, but where bednets have not been distributed. A clear downward trend in death rates is seen in both areas. However, the decrease in rates from 1995/96 to 1997/98 was significant in Humera bednet villages.
(45% reduction in death rate between years, p=0.02) but not in Mezega (33% reduction in death rate, p=0.09). Without detailed comparative information about all aspects of development, meteorological conditions, and malaria prevalence, it is not possible to definitely claim with certainty what is responsible for this difference. However, it is reasonable to conclude that bednets played a role since a large proportion of households in Humera bednet villages had impregnated bednets from 1996-1997 (Table 7 above).

Fig. 25. Death rates in under 5 children
3 Humera Bednet Villages and 9 Mezega Non-Bednet Villages

Cost recovery

By January 1999, of the USD 72,115 cost to the programme of purchasing nets and insecticide, USD 41,764 (58%) had been collected and deposited in community bank accounts (Figure 26). Cost recovery differs significantly by village for several reasons.

1) Payments have been made for two years in Dansha and Rawian, but only one year in Adebay and Mai Kadra.
2) In Dansha, which was administered until 1997 by the Department of Defence, administrative and temporary workers rented nets for 10 birr/year while farmers paid full price in one year.
3) Crop harvest was better and disposable income higher in 1996 than in 1997, thus first year payments (1996) in Dansha and Rawian were higher than first year payments (1997) in Adebay and Mai Kadra.
4) Finally, great social upheaval followed occupation of areas of northern Tigray by the Eritrea army in May 1998; most villagers saved because of uncertainty about relocation evacuation and donated to the war effort.
Sustainability issues

Good acceptance of bednets and proper use has been documented in areas were the majority of people have used nets before, and where people sleep on beds. In addition, a significant financial contribution by the community has been made to meet the cost of the initiative. The intent is that communities will use the banked community-based funds to purchase replacement nets. However, whether bednets will have the desired impact of lowering morbidity and mortality will depend on the degree of participation in re-impregnation. Focus group discussions will be held before the 1999 transmission season with community members and local government officials to further investigate the reasons for non-participation, and to re-plan the approach to re-impregnation. Until higher rates of re-impregnation have been documented in pilot areas, the bednet initiative will not be extended to other areas of Tigray where similar problems are anticipated, and where introduction of nets may be more problematic because people have not used bednets and do not sleep on beds.

Effect of water resources development on vector borne diseases

Tigray’s agriculture has traditionally depended almost entirely on the availability of rainfall, and because of this agricultural production has been erratic. In an effort to address the problems of recurrent drought, famine, and food insecurity, in 1994 the Transitional Government of Ethiopia gave priority to the implementation of a major rural development programme called “Sustainable Agriculture and Environmental Rehabilitation in Tigray (SAERT)”. The principal objectives of SAERT are to change the agrarian system of Tigray to one geared to widespread irrigation, to minimize dependence on rain-fed systems, and to gradually attain self-sufficiency in food production. A major strategy is water resources development through construction of microdams and irrigation systems.
In many tropical and sub-tropical countries including Ethiopia, water resource development projects have induced environmental changes that favour increased transmission of water related diseases, including malaria and schistosomiasis, both already major public health problems in Tigray. In 1995 a malacological, entomological, and parasitological survey was undertaken at the 41 existing microdams in Tigray, to provide the epidemiological basis for planning the health component of the SAERT water resources development project.

Methods and Results

The study took place during the low malaria transmission season in 1995 (23). At each dam site the village nearest the dam (within thirty minutes walk) was selected, ten households were randomly chosen, and all family members were examined for malaria and intestinal parasites. The overall study sample was 2271 people, of all age groups. P. falciparum infection was documented in four villages (at 19% of microdams); prevalence was 1.2% (range 0-20% by village). Larvae of Anopheles gambiae s.l. were found at one microdam. Infection with intestinal schistosomiasis was documented in 20 villages (at 49% of microdams), and one third of those infected had moderate to heavy infections. Biomphalaria species, the intermediate host snails of S. mansoni, were found at 16 microdams (39%), and snails infected by mammalian cercariae were found in one locality. Infections with soil transmitted nematodes was common: hookworm infection was present in subjects form more that two-thirds of villages, and Ascaris lumbricoides and Trichuris trichiura were present in people from almost half the study villages.

Assessment

The widespread distribution of schistosomiasis and the presence of malaria infection during the dry season confirmed that microdams create favourable conditions for the transmission of these parasitic diseases. Because of the importance of incorporating health safeguards in the construction and operation of microdams and irrigation systems in order to prevent or reduce these diseases, a request was made to WHO to help develop guidelines for water resource development projects. In 1996 WHO produced a plan of action for health assessment and incorporation of health safeguards into the planning, design and operation of water resource development projects (24). The plan was distributed to the regional government bureaux involved in water resources development projects, including SAERT, and the Bureaux of Agriculture, Planning, and Health, but unfortunately it was not implemented due to the lack of funds.

The microdam study provided the basis for a subsequent collaborative study by the Malaria Department of the Tigray Health Bureau and Mekelle University College, funded by TDR/WHO through SAREC. The Impact of Land Use Change From Rainfed to Irrigation Agriculture on Socioeconomic Status and the Incidence of Malaria and Schistosomiasis. The study determined malaria incidence in almost 7000 children under 10 years, in four paired survey cycles in 1997. Half of the children lived in villages within one half hour walk of microdams (the flight range of the malaria mosquito vector), and the other half in villages at the same altitude 8-10 kilometres from dams. During the survey period, a seven-fold incidence of malaria was documented in children living near dams (Figure 27). No infection was documented in children living at villages near 2 dams at altitudes > 2000 metres (25).

In 1998 bednets were introduced on a credit basis in villages below 2000 metres and within a 4 kilometre radius of dams. Monitoring is continuing to see if net use will decrease malaria incidence in near dam villages to control area village levels. The importance of this assessment lies in the fact that control without bednets would require several spray rounds per year (depending on insecticide used) since malaria transmission risk is increased throughout the year. Although nets would need to be impregnated twice yearly, operations for re-impregnation are simpler and less costly than for spraying. However, even should bednets prove effective in this research setting, the key to success will lie in community participation in re-impregnation, and in financing.
Application of GIS to visualize coverage

In 1997, in collaboration with the WHO/UNICEF Health Map programme, the Malaria Control Programme introduced geographic information system (GIS) technologies as a means of analysing epidemiological data within a spatial context (26). One component of the malaria GIS project has been to spatially analyze malaria distribution and to monitor the coverage of community-based control activities in relation to the population at risk, taking into account health services coverage and accessibility.

The first step is establishing the GIS was development of a geo-referenced database of population settlements containing information on the location and name of community health worker sites, population data, and information on the location and type of health services. Databases containing the geographic co-ordinates of schools and health institutions were obtained through UNDP/EUE from a World Bank sponsored school mapping project. Population data for 1997 at census block level were also obtained from the same source.

The second step was to integrate the results of the health facility and the community-based malaria surveillance system into the GIS. These data were matched by name to the village and school based databases and linked to their geographic co-ordinates. The geographic co-ordinates of approximately 40% of community health worker sites and 90% of the health facilities were identified from these sources. These data were then standardised and integrated into a standard GIS software package, ArcView.

As a support for planning, the GIS has been used to assess the adequacy of health services coverage and the coverage of the community health worker programme. Map 1 (appendix) shows catchment areas of health institutions overlaid on population census blocks. It is apparent from this map that a significant proportion of the population lives beyond the catchment areas of even peripheral health institutions.
Map 2 (appendix) shows the results of the health facility based malaria surveillance system, with data points showing number of out-patients treated at health institutions in 1996 mapped proportionally in size. The system allows for immediate visualisation of the number of malaria cases treated at the health facility level and permits a dynamic querying of the data. By clicking on any one clinic, one can assess the seasonal trends in malaria reporting by month and year. At the bottom left, the 1995-1996 seasonal variation in number of malaria patients in Kafra Clinic, Humera area, is shown.

Map 3 (appendix) shows an assessment of community-based coverage which was done by plotting the number of cases treated by community health workers on the maps and then overlaying the health facilities. Next, a radius of 5 km (a buffer) was calculated using the GIS to represent the theoretical catchment area of the health clinic. Roads were also displayed. As can be inferred from Map 3, most of the malaria cases are located beyond a 5 km catchment area of the existing health services. In this area where mapping of community health worker sites is almost completed, the comparison between number of malaria out-patients treated at different levels of the health care system and the catchment areas of the respective health facilities, shows that a significant proportion of patients are treated beyond the reach of the health facilities and that are not accessible by road.

Malaria technical core group at regional level

Significant changes in programme management have occurred with integration of the formerly vertical programme into the general health services and with decentralization of responsibility from the region to zonal and district levels (Figure 6,7 above). Currently the programme is run by a regional and four zonal teams of professionals including 4 biologists, 3 graduates with public health degrees, and 2 physicians. The 3 senior biologists (Department and Division heads) each has more than 12 years of experience in malaria control. Through separate funding, training grants have allowed 2 biologists and 1 physician to receive masters training (in epidemiology (current), applied medical entomology (completed), applied medical parasitology (completed). The Programme manager is completing a PhD in Public Health (in a sandwich programme that allows him to continue working in his current position). Data from the Tigray malaria control programme have been used to support the graduate research work of the team. Beginning in 1999, additional training of zonal team members began when one zone chief went for short course training in epidemiology (support from separate source).

Financial Input and expenditure

The Programme is supported by the volunteer work of community members, and by funds from the Regional Government and WHO, through a contribution of the Italian Government. The annual Malaria Control Department budget (approximately USD 569,000 every year) covers all department staff salaries, insecticide purchase, operational cost for insecticide spraying, and other recurrent costs including drugs used by CHWs.

A total of USD 800,000 has been received through WHO for Programme activities, 300,000 in 1994 and 500,000 in 1996. Of the total, 79,200 (9.9%) was retained by WHO for administrative expenses, 601,000 (75%) was used for purchase abroad of supplies and equipment and for cost of consultation, and 120,000 (15%) was transferred to Tigray for local expenses.
Items purchased abroad included 42 motorcycles, 9 pickups, spare parts and motorcycle helmets, 3 computers and printers, 13,000 bednets, 150 litres of permethrin insecticide, one shipment of emergency drugs (quinine and fansidar), basic medical supplies and equipment for Humera Hospital, and training manuals. Local funds were used for training, per-diem for supervision, local supplies, operational costs for monitoring and evaluation, stationary (including CHW reports pads), and for community education activities (including poster production and radio broadcasts).

For the past 2 years, the great majority of recurrent programme costs have been covered by the Department budget. The cost recovered for bednets initially was promising but it is not clear that the initiative can be sustained by community financing. (See above under Special Initiatives.) The work of CHWs, which is key to programme success, remains uncompensated financially. Discussion of this issue at all levels is perennial. Schemes for revolving drug funds have been discussed, with a component of collected money for CHWs. However, since free chloroquine has been a means of ensuring equity in access to care at the periphery, such schemes have not yet been tried in the community-based programme. The Regional Health Sector Development Programme Programmes further development of peripheral health services through construction of health posts (1:5000 population) staffed by paid “front line” (primary) health workers. CHWs may be recruited for these positions and receive extended training as the community-based activities are gradually incorporated into the formal structure of the health services. In the meantime, benefits to CHWs include free medical care for the family, participation in decision-making in local government as members of local health committees, and good status in the community.
4 - CHALLENGES OF MEASUREMENT AND ASSESSMENT OF IMPACT

Evaluation of the impact of the Community-Based Malaria Control Programme is a complex undertaking for a number of reasons.

1) The programme was implemented when concurrent significant investment in development began, immediately following a period of prolonged war-related destruction and stagnation.
2) The community-based control programme was implemented together with traditional approaches to malaria control such as indoor residual spraying.
3) Programme activities must be evaluated as "uncontrolled" interventions because coverage is region wide; historical data that would be helpful for comparison are not available because of civil war-related disruption.
4) Primary health care interventions were implemented concurrently, most importantly maternal and child health initiatives such as expanded immunization.
5) Significant upgrading and expansion of health institutions occurred concurrently, including deployment of trained professionals to first and second level institutions.
6) Malaria transmission increased over time in areas with water resources development projects.
7) Permanent and seasonal migration to lowland areas of high malaria transmission increased, demanding expansion of control activities.
9) Chloroquine resistance has reached a high level in Ethiopia and in Tigray.
10) After 7 years of peace, war has broken out, and Tigray is again the major site of conflict and population displacement.

Thus challenges for programme evaluation have been not only to identify valid and reliable indicators of morbidity and mortality, and survey methods to collect good quality data, but also to assess the potential influence of all of these factors on programme effectiveness.

Limitations of indicators

In a practical guide to information systems for evaluating malaria control published by WHO, 22 outcome indicators and 7 impact indicators are discussed, most based on health institution data (13). The difficulties in using health institution data in Tigray are many: 1) data are incomplete before 1992 because of the civil war; 2) access of the rural populations to health institutions is limited (< 50%), and data may not be representative of disease patterns in the community; 3) mortality data from hospitals deaths are not reported by age or sex; 4) most out-patient data are from clinics and based on clinical diagnosis only; and 5) use of sentinel institutions is problematic since transmission is variable and focal.
Because of problems and limited representativeness of hospital death data, community-based mortality surveys are a better way to collect information about death in children. Because lay reporting of causes of death is unreliable and verbal autopsy methods for malaria have limited feasibility and low predictive value (22), the overall death rate in under 5 children was selected to monitor programme impact. However, although death rates are related to programme activities and anticipated outcomes, change in rates cannot be attributed only to programme interventions.

Since activities are heterogeneous there are several indicators selected for programme monitoring (see information system, above) and, as a consequence, data management is a major undertaking. For successful control, surveillance and monitoring must be decentralized to the zone and wereda (district) levels, where decision making takes place. The current major obstacle to decentralized surveillance and monitoring is staff time allocation for compilation of the large number of CHWs reports and quality control of health-institution data. At present, this work is done by the malaria personnel, mainly at regional level, and control operations often interfere with timely analysis of data particularly during the transmission season. In spite of the difficulties, given the need to better characterize malaria epidemiology in the region, collection of information should continue and analysis be done at the regional level, until proper resource allocation will be available at zonal and district levels.

Assigning to clinic personnel the responsibility for compiling reports from a few sentinel CHW sites would strengthen the surveillance and epidemic early warning systems. A minimum number of indicators should be used at district level and should include:

- **CHW data:** weekly/monthly total treated cases at sentinel CHW sites
- **Sector laboratory data:** weekly/monthly number of slides examined, slide positive rate, percent infection by species
- **In patient data:**
  - monthly total/malaria admissions
  - monthly total/malaria deaths

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**Validation of data**

**Health institutions**

Early in the programme health institution data were collected from reports compiled by zonal health departments and sent to the statistics office of the Tigray Region Health Bureau. On review, large variations in patient numbers could not be explained by local knowledge of health services utilization. In addition, most data were reported quarterly, so monitoring of monthly trends was impossible. In an attempt to pinpoint problems with data quality, to ensure data of sufficient reliability to serve as indicators, and to evaluate the feasibility of collection the timely information necessary for early warning of epidemics, parallel collection of institution data by malaria staff began from wereda and zone health statistics offices.

Problems documented during collection of health institution data by malaria staff included compilation of total figures without indication of number of missing reports, no correction of compiled data after arrival of late reports, no missing-report notification to institutions, and inclusion of obvious errors without request for re-submission of data. After a tedious process of verification of questionable reports and collection of missing reports, comparison between passive and active collection of data showed trends to be smoother.
with Malaria Department figures. The verified data were then judged to be of sufficient reliability for analysis of impact (Figures 28-31). Recollection of health centre and hospital data is complete. Since clinic data have

Fig.28. Admissions to Tigray Hospitals and Health Centres
Comparison by source of data compilation

Fig.29. Deaths at Tigray Hospitals and Health Centres
Comparison by source of data compilation
been verified only from mid-1995 through 1998, clinic trends are reported using Planning Department (statistics office) data.

**Fig.30. Out-patients, Tigray Hospitals and Health Centres**

Comparison by source of data compilation

![Graph showing number of patients (thousands) for Total out-patients and Malaria out-patients from 1991/92 to 1997/98.](image)

- Malaria Control Dept
- Planning Dept

**Fig.31. Out-patients, Tigray Clinics**

Comparison by source of data compilation

![Graph showing number of patients (thousands) for Total out-patients and Malaria out-patients from 1991/92 to 1997/98.](image)

- Malaria Control Dept
- Planning Dept
Validation of data has not been done systematically at the health institution level. However, the following weakness in the existing health information system should be noted. Patient diagnosis at hospital and health centre out-patient departments is often registered in the out-patient book after history and physical exam, before and before review of diagnostic tests, and thus may be preliminary rather than final diagnosis. Regarding in-patient data, criteria for recording cause of death may vary especially when multiple cases are reported. These problems, and problems with data compilation at district and zone levels, are being addressed by the Planning Department of the Health Bureau.

CHW data

The well established CHW reporting system produces a regular source of community-based information about clinical malaria. Validation of data at the village level has not been done. Validation of data compiled at the wereda level has been done by unscheduled review of CHW weekly reports, independent compilation at the regional level, and comparison of wereda and regional figures.

Laboratory data

The national cross check system for ensuring quality of parasitological diagnosis at sector laboratories gradually ended after 1994 with decentralization when all but 4 of the national malaria staff were eventually reassigned to regions. A formal cross check system has not yet been established in Tigray region. However, all survey slides are routinely cross checked (positives and a 10% random sample of negatives) and results entered into a computerized data base that allows for analysis of error rates over time and by individual microscopists. Cross check results for 17,000 slides read by 7 of the 10 sector microscopists have been entered, with overall error rates 1995-1997 ranging from 2.3% false positive rate, to 2.9% species misidentification rate, to 4.2% false negative rate. Rates from the previous countrywide cross check system are not available for comparison. Tigray rates are higher than the few published error rates from research studies, however, remain within acceptable range for routine working conditions in a control programme. There has been no cross check of health institution-based microscopist readings.

Impact of control programme activities on malaria morbidity

In Tigray, malaria is unstable, meaning that transmission changes in the same place from month to month, and year to year. The population is non-immune and develops clinical illness with malaria infection. In such a setting, while trends in patient numbers may well reflect trends in transmission, they don't necessarily reflect trends in programme effectiveness since early diagnosis and treatment with effective antimalarial drugs alone will not decrease incidence of malaria.

Trend in numbers of CHW-treated malaria patients

Since the programme started there has been in general a gradual increase in number of patients treated by CHWs (Figures 8, 9 above). Seasonal variation show an increase higher in high transmission months, smaller in low transmission months, with a gradual increase in numbers treated in the transmission period between high and low treatment months.
Trend in number of malaria patients treated at health institutions

The first three years following programme implementation, a decrease in both total number of malaria patients and percent of total malaria out-patients seen at clinics, hospitals, and health centres was seen in association with increased numbers treated by CHWs (Figures 32, 33). Since mid-1995, although the percent of total malaria cases seen at institutions has remained about the same, the number of malaria cases treated at institutions has increased. The increase has occurred in association with an increase in number of reporting health institutions, especially clinics and health posts (Figure 1 above). In addition, although total number of hospitals did not increase, two new larger hospitals were built to replace small old hospitals in Humera and EndaSelassie, both high transmission areas. During the same period, there was extensive refresher training of health professionals, assignment of the graduates of the first four classes from the newly established regional Nursing School, and extension of laboratory capacity by improvement of equipment and supplies, all factors with potential for improving malaria diagnostic capacity.

A similar increase in number of patients seen at sector laboratories and in slide positive rate began mid-1995 when a new sector laboratory was opened in Axum, new sub-sector laboratories were opened in Humera (Dansha, Rawian, Adebay) and when the Mohoni Sector Laboratory was relocated from Maichew town (high altitude, low risk of transmission) to Mohoni town (low altitude, high risk of transmission) (Figure 34). In 1997 a new sector laboratory was opened in Tanqua Aborgele, a high risk area. In 1998, 26 vector biology technicians were trained in microscopy as well as in vector biology, and assigned to high priority weredas. These technicians collect slides from villages in their catchment areas during active case detection during outbreak investigations and forward them to nearby malaria sector laboratories for reading.

Fig.32. Yearly Out-Patients, Clinics
Tigray Region, Ethiopia

Data collected by Planning Department

<table>
<thead>
<tr>
<th>Gregorian Calendar Year</th>
<th>Number of new patients (thousands)</th>
<th>Percent malaria patients</th>
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</thead>
<tbody>
<tr>
<td>1991/1992</td>
<td>19.7</td>
<td>27.6</td>
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<td>1992/1993</td>
<td>24.8</td>
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<tr>
<td>1993/1994</td>
<td>25</td>
<td>25.2</td>
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<td>1994/1995</td>
<td>25.8</td>
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<td>1995/1996</td>
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<td>1996/1997</td>
<td>25.2</td>
<td>25.2</td>
</tr>
<tr>
<td>1997/1998</td>
<td>27.6</td>
<td>27.6</td>
</tr>
</tbody>
</table>

□ Total □ Malaria ★ Percent malaria
Fig. 33. Yearly Out-Patients, Hospitals and Health Centres
Tigray Region, Ethiopia

Fig. 34. Number of Patients and Slide Positivity Rate, Malaria Sector Laboratories
1991-94 = 9 labs, 1995-98 = 10 labs and 3 sub labs
Tigray Region, Ethiopia
In addition to increased coverage due to expansion and upgrading of health institutions, and assignment of trained personnel with better diagnostic skills, the increase in institution-treated malaria cases is also related to the same factors that contributed to increase in CHW treated malaria patients: water resources development, population movements for resettlement or seasonal labour, war-related population displacement, and chloroquine resistance.

### Interpretation of morbidity trends

Overall numbers of CHW-treated patients and out-patients treated at health institutions for malaria cases have gradually increased since programme implementation. Extension of coverage of early diagnosis and treatment to the periphery has been a major programme success, and is evidenced by the large increase in number of malaria patients treated since programme implementation. As mentioned above, many factors have contributed to the gradual increase in number of malaria patients treated. Changes in number of malaria patients will continue to reflect changes in treatment coverage and transmission risk.

In the absence of “control” areas without community-based interventions in Tigray, it would be interesting to compare other regional experiences in Ethiopia. In the past 3 years programme managers from Amhara, Oromia, and Southern People’s Regions have come to Tigray to learn about the community-based programme. Since 1993 in these regions only traditional were used for control but in 1997 and 1998 new community-based control initiatives including CHW early diagnosis and treatment and impregnated bednet distribution have begun.

The increase in number of treated patients from 4/92 to 7/94 occurred in conjunction with progressive training of CHWs. Since 9/94 many factors have contributed to the increase in number of treated patients (Figure 9):

1) extension of coverage by training additional CHWs for work in new and/or growing communities, and recruitment of additional CHWs in high transmission areas (Mohoni, Humera) for work at the village instead of tabia level;
2) higher utilization of CHW services following improvement in drug supply and intensification of community education by radio and at tabia meetings;
3) increase in malaria transmission following water resources development projects, such as river diversion projects, microdam and irrigation system construction, and construction of horeyu (small water impoundments for household use and watering of animals);
4) increase in population exposure to malaria risk following seasonal migration of agricultural labourers during high transmission months to large scale agricultural projects in the Humera area, and from establishment and growth of resettlement communities of returnees and demobilized soldiers in western Tigray (Adebay, Rawian, Mai Kadra, and Dansha villages);
5) climatic changes in late 1997/early 1998 due to the El Nino Southern Oscillation, including increase in rainfall, mean temperature and relative humidity, all enabling continued transmission beyond the usual 3 month season to 6 months (Figure 2,5 above), and
6) occupation of parts of Tigray by Eritrean military forces May/June 1998 with displacement of 10% of the population, with many displaced living without adequate protection in lowland areas of high transmission risk.
While the progressive increase in number of patients treated by CHWs can be explained by better utilization of CHW services, a larger population living in risk areas (because of migration, water resources development, and war-related population displacement), and in the longer duration of the 1997/98 transmission season, two additional potential factor contributing to this trend are drug and insecticide resistance.

Potential influence of chloroquine resistance

Chloroquine has been the first line drug for uncomplicated malaria for more than 30 years in Ethiopia. Resistance was first documented in southern Ethiopia in 1986 (27), and has gradually increased since. By the early 1990s high level resistance was documented in many regions including Tigray (28-30). Although most resistance studies have been done at second or third level health institutions, increasing resistance at second level institutions is an indicator for increasing resistance in the community.

Comparison of resistance trends over time is complicated by changes in protocols for studying resistance in vivo, and change in criteria for defining levels of treatment failures. Results of chloroquine sensitivity studies in Tigray are shown in Table 9. Chloroquine sensitivity (column headed “S/Late R1 or “ACR”) at health institutions was only 18% in 1993 but did not worsen through 1997 in studies with similar protocols (parasitaemia alone used to define treatment failure). With change in protocol in 1996 (clinical symptoms and parasitaemia both required for definition of treatment failure), 33% of infections were sensitive at health institutions, and from 44 to 56% were sensitive at the village level. Both village sites studied in Tigray 1998 were CHW villages in high transmission risk areas.

Because no studies were done prior to 1998 at village level, trend in development of resistance and recent contribution of chloroquine distribution to resistance cannot be assessed. However, comparison of countrywide results from recent national studies supported by WHO in 1996 and 1998 is useful. Table 10 lists results at 15 sites in general order of decreasing sensitivity to chloroquine (column headed ACR) (31). It is apparent that resistance level is high throughout Ethiopia, even though only Tigray implemented a large scale programme for early diagnosis and treatment at the community level.

Thus, while drug pressure is probably contributing to increasing drug resistance in Tigray, the overall situation in Tigray is no worse than in most other areas of Ethiopia, at either second level health institutions or at the village level (Table 11).

It is reasonable to assume that chloroquine resistance existed 7 years ago at the village level in Tigray, since resistance was high at first and second level institutions. It is also reasonable to assume that resistance levels have gradually increased since. The overall effect of increasing resistance will be to increase the number of patients treated by CHWs and at health institutions. Patients with early treatment failure are likely to go to health institutions since treatment at the village level is rightly perceived as not working. However, patients with late treatment failure who become symptomatic some weeks after treatment completion may again seek care from CHWs.
Table 9.  
**in vivo chloroquine sensitivity, Tigray Region, Ethiopia**  
25 mg base chloroquine/kg body weight over 3 days

<table>
<thead>
<tr>
<th>YEAR</th>
<th>SITE</th>
<th>AGE</th>
<th>n</th>
<th>S/LATE R1 no.(%)</th>
<th>EARLY R1,R2 no.(%)</th>
<th>R111 no.(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>Sheraro Health Centre</td>
<td>&gt;5 yr</td>
<td>57</td>
<td>10 (18)</td>
<td>15 (26)</td>
<td>32 (56)</td>
</tr>
</tbody>
</table>

**REICKMANN PROTOCOL, 7 days (29)**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>SITE</th>
<th>AGE</th>
<th>n</th>
<th>S/LATE R1 no.(%)</th>
<th>EARLY R1,R11 no.(%)</th>
<th>R111 no.(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>Rawian Mai Kadra Clinics</td>
<td>&gt;5 yr</td>
<td>79</td>
<td>30 (38)</td>
<td>10 (13)</td>
<td>39 (49)</td>
</tr>
<tr>
<td>1997</td>
<td>Alamata Sector Laboratory</td>
<td>&gt;5 yr</td>
<td>51</td>
<td>18 (36)</td>
<td>25 (49)</td>
<td>8 (16)</td>
</tr>
</tbody>
</table>

**REICKMANN PROTOCOL, MODIFIED, 14 days (30)**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>SITE</th>
<th>AGE</th>
<th>n</th>
<th>ACR no.(%)</th>
<th>LTF no.(%)</th>
<th>ETF no.(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>Selesklea Health Centre</td>
<td>&lt;5 yr</td>
<td>61</td>
<td>20 (33)</td>
<td>17 (28)</td>
<td>2 (39)</td>
</tr>
<tr>
<td>1998</td>
<td>Gueli village</td>
<td>&lt;5 yr</td>
<td>18</td>
<td>8 (44)</td>
<td>5 (28)</td>
<td>5 (28)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5+ yr</td>
<td>25</td>
<td>13 (52)</td>
<td>7 (28)</td>
<td>5 (20)</td>
</tr>
<tr>
<td>1998</td>
<td>Adis Mien Village</td>
<td>&lt;5 yr</td>
<td>16</td>
<td>9 (56)</td>
<td>4 (25)</td>
<td>3 (19)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5+ yr</td>
<td>34</td>
<td>19 (56)</td>
<td>9 (26)</td>
<td>6 (18)</td>
</tr>
</tbody>
</table>
### Table 10. 1996 in vivo chloroquine sensitivity (31), Ethiopian regional study sites 25 mg base chloroquine/kg body weight over 3 days

<table>
<thead>
<tr>
<th>SITE</th>
<th>1996 WHO PROTOCOL, 14 days</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AGE</td>
<td>n</td>
<td>ACR no. (%)</td>
<td>LTF no. (%)</td>
<td>ETF no. (%)</td>
</tr>
<tr>
<td>Bamby, Benshalagul Gumuz Region</td>
<td>&lt;5 yr</td>
<td>15</td>
<td>15 (100)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>5+ yr</td>
<td>32</td>
<td>28 (88)</td>
<td>3 (9)</td>
<td>1 (3)</td>
</tr>
<tr>
<td>Gambella, Gambella Region</td>
<td>5+ yr</td>
<td>35</td>
<td>24 (69)</td>
<td>6 (17)</td>
<td>5 (14)</td>
</tr>
<tr>
<td>Kella, Southern People's Region</td>
<td>&lt;5 yr</td>
<td>26</td>
<td>11 (42)</td>
<td>3 (12)</td>
<td>12 (46)</td>
</tr>
<tr>
<td>Anger Guten, Oromia Region</td>
<td>&lt;5 yr</td>
<td>40</td>
<td>15 (38)</td>
<td>10 (25)</td>
<td>15 (38)</td>
</tr>
<tr>
<td>SELEKLEKA, TIGRAY REGION</td>
<td>&lt;5 yr</td>
<td>57</td>
<td>20 (35)</td>
<td>16 (28)</td>
<td>21 (37)</td>
</tr>
<tr>
<td>Dire Dawa, Region 15</td>
<td>&lt;5 yr</td>
<td>47</td>
<td>15 (32)</td>
<td>15 (32)</td>
<td>17 (36)</td>
</tr>
<tr>
<td>Metehara, Oromia Region</td>
<td>&lt;5 yr</td>
<td>36</td>
<td>11 (31)</td>
<td>17 (47)</td>
<td>8 (22)</td>
</tr>
<tr>
<td>Pawli, Benshalagul Gumuz Region</td>
<td>&lt;5 yr</td>
<td>35</td>
<td>10 (29)</td>
<td>9 (26)</td>
<td>15 (43)</td>
</tr>
<tr>
<td>Zeway, Oromia Region</td>
<td>&lt;5 yr</td>
<td>48</td>
<td>11 (23)</td>
<td>16 (33)</td>
<td>21 (44)</td>
</tr>
<tr>
<td></td>
<td>5+ yr</td>
<td>56</td>
<td>16 (29)</td>
<td>15 (27)</td>
<td>25 (45)</td>
</tr>
<tr>
<td>Bahir Dar, Amhara Region</td>
<td>&lt;5 yr</td>
<td>44</td>
<td>5 (11)</td>
<td>13 (30)</td>
<td>26 (59)</td>
</tr>
<tr>
<td></td>
<td>5+ yr</td>
<td>48</td>
<td>12 (25)</td>
<td>23 (48)</td>
<td>13 (27)</td>
</tr>
<tr>
<td>Harbu, Amhara Region</td>
<td>&lt;5 yr</td>
<td>42</td>
<td>0 (0)</td>
<td>7 (17)</td>
<td>35 (83)</td>
</tr>
<tr>
<td></td>
<td>5+ yr</td>
<td>35</td>
<td>8 (23)</td>
<td>11 (31)</td>
<td>16 (46)</td>
</tr>
<tr>
<td>Tepi, Southern People's Region</td>
<td>&lt;5 yr</td>
<td>21</td>
<td>4 (19)</td>
<td>7 (33)</td>
<td>10 (48)</td>
</tr>
<tr>
<td>Aleta, Southern People's Region</td>
<td>&lt;5 yr</td>
<td>18</td>
<td>3 (17)</td>
<td>8 (44)</td>
<td>7 (14)</td>
</tr>
<tr>
<td></td>
<td>5+ yr</td>
<td>51</td>
<td>5 (10)</td>
<td>33 (65)</td>
<td>12 (24)</td>
</tr>
<tr>
<td>Sarbo, Oromia Region</td>
<td>&lt;5 yr</td>
<td>27</td>
<td>3 (11)</td>
<td>6 (30)</td>
<td>16 (59)</td>
</tr>
<tr>
<td>Chiko, Southern People's Region</td>
<td>&lt;5 yr</td>
<td>17</td>
<td>1 (6)</td>
<td>4 (23)</td>
<td>12 (71)</td>
</tr>
</tbody>
</table>
Table 11. 1998 in vivo chloroquine sensitivity (31). Ethiopian regional study sites 25 mg base chloroquine/kg body weight over 3 days

<table>
<thead>
<tr>
<th>Site</th>
<th>Age</th>
<th>n</th>
<th>ACR no.(%)</th>
<th>LTF no.(%)</th>
<th>ETF no.(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kontar Health Station, Amhara Region</td>
<td>&lt;5 yr</td>
<td>49</td>
<td>33 (67)</td>
<td>8 (16)</td>
<td>8 (16)</td>
</tr>
<tr>
<td>ADIS MIEN VILLAGE, TIGRAY REGION</td>
<td>&lt;5 yr</td>
<td>16</td>
<td>9 (56)</td>
<td>4 (25)</td>
<td>3 (19)</td>
</tr>
<tr>
<td></td>
<td>5+ yr</td>
<td>34</td>
<td>19 (56)</td>
<td>9 (26)</td>
<td>6 (18)</td>
</tr>
<tr>
<td>GUELITY VILLAGE, TIGRAY REGION</td>
<td>&lt;5 yr</td>
<td>18</td>
<td>8 (44)</td>
<td>5 (28)</td>
<td>5 (28)</td>
</tr>
<tr>
<td></td>
<td>5+ yr</td>
<td>25</td>
<td>13 (52)</td>
<td>7 (28)</td>
<td>5 (20)</td>
</tr>
<tr>
<td>Asendabo Health Station, Oromia Region</td>
<td>&lt;5 yr</td>
<td>24</td>
<td>16 (25)</td>
<td>9 (38)</td>
<td>9 (38)</td>
</tr>
</tbody>
</table>

Potential influence of effectiveness of vector control operations

In areas with unstable seasonal transmission, infection in the non-immune population results in clinical illness. In such areas, given a demographically stable population, very high early treatment coverage of the population at risk with effective antimalarial drugs, number of patients treated for malaria cannot be expected to decrease over time unless transmission is also limited by vector control. Thus trends in number of treated patients must also be assessed in the context of effective coverage by vector control operations.

Since 1991, selective residual indoor spraying and source reduction have been important strategies in the Tigray regional malaria control programme. DDT has been used in Ethiopia for more than 30 years. In theory the residual effect of DDT lasts 9 months, but in practice duration of effectiveness is less because of less than complete application, varying absorption of different ceiling and wall materials, and replastering. Thus spraying is done every 6 months in areas with two periods of yearly rainfall, and once early in areas with one rainfall period.

Spray localities are selected by stratification criteria including altitude, rainfall, and previous pattern of transmission. Since 1992, a twice yearly review of localities stratification has been undertaken to improve the efficiency and effectiveness of spray operations. Areas at low risk of transmission are removed from the spray operation and second round spraying is limited to areas with significant precipitation during the short rains. Thus coverage changes over time. (Figure 35).

In 1994, DDT susceptibility testing began. As a result of high level resistance in focal areas, insecticide was changed to malathion in southern Tigray (Alamata/Mohoni) in 1995 and in central Tigray (Tembien) in 1998. An analysis to determine if there was a relation between spray coverage and effectiveness and increase in malaria patients is not feasible. However, it is possible that increasing resistance may have contributed to the increase in number of patients treated yearly by CHWs. Finally, the 3 month prolongation of the 1997/1998 transmission period occurred at a time of probable waning effectiveness of residual indoor insecticide.
Fig. 35. Residual Insecticide Spraying
Tigray Region, Ethiopia

Impact of the programme on severe malaria morbidity and mortality

Since malaria death results from severe and complicated malaria, reduction in the incidence of severe and complicated malaria can be used as a proxy for a reduction in mortality due to malaria. In Tigray, because of limited number of beds, only severely ill patients are admitted to hospital. A patient admitted with malaria thus has severe malaria by definition. Figure 36 shows yearly admissions to hospitals and health centres.

After implementation of community-based activities in 1992, number of malaria admissions and the malaria admission rate decreased for several years but then began steadily increasing. In the last 12 month period shown (1997/1998), malaria accounted for 25% of admissions. Trends in monthly malaria admission rates varied as expected seasonally until late 1997 and early 1998 when the usual decrease was not seen (Figure 37). Persistence in high admission rates during this time was due to the changing transmission pattern associated with El Nino, as previously discussed.
Fig. 36. Yearly Admissions, Hospitals and Health Centres
Tigray Region, Ethiopia

Fig. 37. Monthly Malaria Admission Rate, Hospitals and Health Centres
Tigray Region, Ethiopia
Fig. 38. Yearly Deaths, Hospitals and Health Centres
Tigray Region, Ethiopia

The trend in hospital-based malaria proportionate mortality is the same as the trend in malaria admission rate: an initial decrease from 1991/92 to 1993/94 and then a gradual increase through 1997/1998 (Figure 38).

Fig. 39. Mean Malaria Case Fatality
Tigray Region Health Institutions, Ethiopia

case fatality rate = (no. malaria deaths/no. malaria admissions) X 100
Case fatality rate has remained fairly stable, ranging from 4.4 to 6.8 percent (Figure 39). Although malaria admission rate was high in 1997/1998, case fatality rate for the same year was low. Possible explanations include early recognition and referral of severe malaria, appropriate case management practices, and availability of necessary supplies and medicines.

All of the factors previously discussed as contributing to change in number of malaria out-patients have potential to influence malaria admission rates. Drug resistance is a key factor. With increasing resistance, early treatment failure becomes more common, and progression to severe and complicated malaria may also have become more common.

**Trend in death rates in under 5 children in rural areas**

Since 1994, repeated mortality surveys in under 5 year children have been carried out every two years in the same 90 villages. A multistage cluster sampling technique was used to choose villages. Primary sampling units (woreda) and secondary sampling units (tabias) were chosen with probability proportional to size. Villages, the ultimate sampling unit, were chosen by lottery. Sample size necessary to document a 25% decrease in under 5 deaths was calculated using a design effect of 2. After the 1994 survey, actual design effect was calculated and found to be 2.94 and the sample size was increased accordingly in subsequent surveys (22).

During surveys, trained malaria staff interview randomly selected households with under 5 year children, and register number of deaths in under 5 children during the preceding 12 months. Because births were not registered in the 1994 survey, under five mortality rates could not be calculated, thus rates for comparison in survey are death rates in the under 5 population, defined as number of under 5 deaths/under 5 population X 1000. Characteristics of survey households are shown in Table 12.

**Table 12. Mortality survey households, Tigray Region, Ethiopia**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of survey households</td>
<td>4,660</td>
<td>6,929</td>
<td>6,916</td>
</tr>
<tr>
<td>Total household population</td>
<td>24,217</td>
<td>36,598</td>
<td>36,967</td>
</tr>
<tr>
<td>Mean number of persons per household (+1 SD)</td>
<td>5.2 ± 1.9</td>
<td>5.3 ± 1.9</td>
<td>5.4 ± 1.8</td>
</tr>
<tr>
<td>Total under 5 household population</td>
<td>7,335</td>
<td>10,567</td>
<td>10,661</td>
</tr>
<tr>
<td>Mean number of under-5 children per household (+1 SD)</td>
<td>1.6 ± 0.6</td>
<td>1.5 ± 0.6</td>
<td>1.5 ± 0.6</td>
</tr>
<tr>
<td>Total number of under-5 deaths in survey households</td>
<td>190</td>
<td>171</td>
<td>190</td>
</tr>
</tbody>
</table>
More than 90% of children who died in each survey period died at home. During each survey period, the number of children who died without receiving any medical care has remained about the same, 45% in 1994, 46% in 1996, and 52% in 1998. As seen in Figure 40, a 40% reduction in under 5 deaths was documented from 1994 to 1996. Death rate in 1998 increased 10% compared to 1996, but the change was not statistically significant.

**Fig. 40. Death Rate, Under 5 Mortality Surveys**

*Tigray Region, Ethiopia*

\[
\text{death rate} = \frac{\text{no. under 5 deaths}}{\text{under 5 population}} \times 1000
\]

Interpretation of mortality trends

When interpreting these data, several considerations must be kept in mind. First, all malarious areas are covered by community-based control activities. Without well matched "non-intervention" areas no definite claims can be made about what factors are responsible for the changes in mortality.

The serial mortality surveys carried out as part of the operational evaluation of the Community-Based Malaria Control Programme are the first large scale studies of childhood mortality in Tigray Region for many years. While mortality figures are most meaningful when viewed as trends, Tigray was not included in national studies because of the civil war, and lack of regional mortality data precludes analysis of long term mortality trends within the region. Examination of such trends in Ethiopia is instructive and helps put into perspective the Tigray figures. In many areas of Africa a secular trend with progressive decrease in under 5 mortality has been noted for the past 30 years. However, from the mid-1970s to the early 1980s Ethiopia was one of 6 countries identified in analysis of changing mortality patterns in Sub-Saharan Africa as showing persistent stagnation or an increase in mortality in children under 5, a fact ascribed to the prolonged civil war and a general lack of socio-economic development (32). For the last 15 years, reports of under 5 mortality in Ethiopia, though they vary by source, show no significant secular decrease in under 5 mortality (22) (Figure 41).
Fig. 41. Comparison of Under 5 Mortality Estimates
Ethiopia
(U5MR = no. deaths under 5 children/no. live births) x 1000

<table>
<thead>
<tr>
<th>Year</th>
<th>Data Source and Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980-1984</td>
<td>Central Statistical Authority</td>
</tr>
<tr>
<td>1986</td>
<td>Bungura Project Amhara Region</td>
</tr>
<tr>
<td>1991</td>
<td>UNICEF</td>
</tr>
<tr>
<td>1990-1993</td>
<td>USAID</td>
</tr>
<tr>
<td>1994</td>
<td>Malaria Control Tigray Region</td>
</tr>
</tbody>
</table>

Fig. 42. Measles Immunization Coverage
Tigray Region, Ethiopia

Data source: Department of Preventive Services, Tigray Health Bureau

<table>
<thead>
<tr>
<th>Year</th>
<th>Percent Coverage, Target Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991/1992</td>
<td>8</td>
</tr>
<tr>
<td>1992/1993</td>
<td>15</td>
</tr>
</tbody>
</table>

Gregorian Calendar Year
However, with the end of the civil war and with investment and gains from basic development, it is likely that childhood mortality should begin to decrease. The general infrastructure of the region improved greatly in the first four years following the end of the civil war. Factors such as improved transportation systems, improved food delivery, improved agricultural practices, improved access to safe water, and improved community education all had the potential to affect child health and probably made a contribution to the overall decrease in under 5 mortality noted from 1994 to 1996. Certainly other health interventions also contributed, such as strengthening of the general health services through deployment of more personnel, establishment of regular drug supplies, and construction of new health clinics (Figure 1 above). Interventions with potential for improving child health, especially expansion of the immunization programme, no doubt had an important impact. Of note, coverage by measles immunization increased significantly in 1995 (Figure 42). This intervention has been shown in Africa to have a major impact on under 5 mortality.

Yet it is reasonable to conclude that the community-based malaria control programme activities probably also contributed from 1994-1996 to the decrease in childhood mortality in Tigray. Early diagnosis and treatment coverage at the village level increased.

Many factors probably contributed to increase in child mortality from 1996-1998. It is not possible to determine the contribution of any factor, including malaria, to increased death rate. However, it is possible that malaria deaths may have increased and could also have contributed to increase in death rates. The population at risk increased in areas of water resources development, and communities in malarious areas grew. The transmission period in 1997 doubled because of climatic changes. Finally, with more malaria cases and with resistance to chloroquine, more severe and complicated malaria could have developed, and resulted in more deaths despite treatment.

Study of mortality in children allows health assessment of the most vulnerable age group in the population. However, analysis of age distribution of patients treated has shown that children are treated by CHWs less than expected assuming a uniform exposure, probably related to the low access of women to care. Greater impact on mortality could have been expected with improved access of children to CHW-treatment.
5 - CONCLUSIONS AND RECOMMENDATIONS

The Community-Based Malaria Control Programme in Tigray was built on a tradition of volunteer participation in community activities to control a disease of major public health importance. Continuous evaluation and operational research has allowed identification of problems, and pilot testing of alternative approaches has been successful.

A major success of the Programme is that a significant proportion of the rural population at risk for malaria is now being treated at the village level by volunteer CHWs who, despite their agricultural responsibilities, continue to carry out treatment activities on a regular basis.

Following the introduction of the Community-Based Programme a significant decrease (40%) in death rates of children under 5 was noted from 1994 to 1996 in mortality surveys covering random samples of 7,335 and 10,567 children, respectively. However the reduced levels were not maintained and a 10% mortality increase was documented in 1998, using the same survey methodology. Malaria deaths increased in 1997/1998 and this may be attributed to increased transmission and probably chloroquine resistance. Analysis of data also indicated that in spite of improved coverage, a significant portion of children under 5 do not have access to the CHWs, and all three mortality surveys showed that 45-52% children who died received no medical care.

Results of the recent drug studies have important implications for first line drug use in Tigray. Because of high levels of resistance countrywide, the National Malaria Unit, Ministry of Health, has formulated a policy for change in first line drug (30). At the peripheral level, for health posts and community health workers, the first-line treatment recommended for fever suspected as malaria is sulfadoxine-pyrimethamine to cure a potentially dangerous *Plasmodium falciparum* infection (33). At the current international prices this will not produce significant increases in the drug budget of the Community-Based Programme.

Changes in the structure Tigray's health services have been made since programme implementation. The former vertical malaria control programme has been integrated into the general health services. Significant progress has been made in decentralization to the zone level, and steady progress is being made in further extending decentralization to the district level. The Community-Based Malaria Control Programme has also been reoriented in accordance with national health development policy. The Tigray Regional Government has developed a five-year Heath Sector Development Programme (HSDP) with the objective of further improving the public health services. According to the HSDP, health delivery will be organized in 4 layers from the Primary Health Care Units, composed of a Health Center and several satellite Health Posts, to Hospitals at District, Zonal and Regional-referral levels. Characteristics of the Community-Based Programme responsible in part for its success are also essential components of the HSDP: community involvement, extension of coverage, regular drug supply, an information system based on routine reporting and operational research, and community contribution in kind and in cash to malaria control efforts. During the period of strengthening of peripheral health services according to the HSDP, community-based activities will remain an important approach to malaria control. The HSDP requires more active involvement of the general health services in malaria control. In particular, the curriculum of the health professional is being revised so
that clinicians, nurses, health assistants and environmental health officers will receive pre-service training in various aspects of malaria control. In addition, there is a need for trained and experienced teachers who will be responsible for training general health services staff.

Re-planning of the Community-Based Programme is under way to expand coverage to women and young children, to expand services in areas of population movements and water resources development, and to address drug resistance. This planning will be in consonance with the Regional HSDP. With the wealth of data now available for evaluation of the malaria situation, priority areas for further intervention can be identified:

1) Based on identified needs, service delivery at the community level should be progressively extended to cover the most vulnerable groups: children and pregnant women. To improve coverage it would be necessary to recruit and train female community health workers. The specific mechanisms (village health agents, female CHWs, traditional birth attendants, and women’s groups at village level) will depend on results of the final evaluation of the home management of malaria study and on the regional policy.

2) Implementation of the new national policy for treatment of malaria (July 1999); requires efforts and investments. Issues to be addressed include planning/estimation of drug requirements, review/improvement of the drug delivery system, training of health workers, education of communities, baseline studies of SP resistance and establishment of a specific evaluation system to ensure correct implementation of guidelines.

3) Improved quality of care should be pursued in the general health services on all aspects of disease management (strengthening laboratories in malaria microscopy, identification/follow-up of treatment failures, referral, and proper treatment of severe malaria) and management of health information systems (early detection of epidemics, malaria stratification for selective vector control and planning/allocation of resources at the district level). This will require strengthening the supply delivery system, and improving staff performance through training and supervision.

4) Extension of the insecticide-treated bednet programme should be considered after evaluation of and correction of the factors responsible for low re-impregnation rates in the pilot areas. The cost recovery system should be reviewed and consideration given to use of money in community bank accounts to cover re-impregnation and provision of nets to the poorest. Pilot areas should be extended to the high transmission areas in Mohoni and Alamata districts, and a system designed for net distribution to seasonal workers in Humera through private companies.

5) Operational research activities should focus on the following: 1) identification of practical clinical algorithms for malaria diagnosis in adults and during the low transmission season in areas where there is no microscopy; 2) practical approaches for management of severe malaria in areas where referral is difficult; 3) application of GIS for stratification of malaria, identification of epidemic-prone areas and targeting/evaluating vector control activities; 4) development of practical systems for early detection of epidemics at clinic level and a regional warning system for epidemics, and 5) development of an improved system to assess the impact of various components of the Community-Based Malaria Control Programme.

The Regional Health Bureau is struggling with a paucity of funds to meet preventive and curative health care needs for a widely dispersed, poor, predominately rural, and not easily accessible population. Progress toward meeting the primary objectives of the Programme is being made, and should continue with improved coverage of children and use of effective antimalarial drugs.
The Community-Based Malaria Control Programme was developed thanks to the commitment of the Regional Government and Health Bureau of Tigray, and the collaboration of the World Health Organization. The Italian Cooperation has provided financial support to the programme through multi-bilateral contributions to WHO in 1994, 1996 and 1999. The inputs and guidance from Regional Health Bureau, in particular from Dr Mesfin Minass, have been instrumental to the success of the programme. The programme was initially managed by Mr Tesfamariam Alemayehu, former Regional Malaria Coordinator, and then by Mr Tedros Adhanom Ghebreyesus, currently Head of the Department for the Control of Malaria and Other Vector-Borne Diseases of the Tigray Region Health Bureau. The malaria staff of the Regional Department were deeply engaged in all activities, in particular Mr Asefaw Getachew, Mr Ambachew Medhin Yohannes, Dr Hailay Desta Teklehaimanot, Dr Gebrehawariat Araya, Mr Woldegabriel Tesfay, Mr Goitom Mehari and Dr Karen Hanna Witten, who was involved in the data analysis and prepared this document during a WHO consultancy in April-May 1999. From the World Health Organization, the programme received the technical support of Dr Awash Teklehaimanot and Dr Andrea Bosman. The programme would have never been successful without the dedicated and continuous work of the volunteer community health workers, the support of staff from peripheral health facilities and malaria offices, and the serious engagement of the village communities of Tigray.
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APPENDIX

(MAPS)
Map 2 - Malaria patients treated in health facilities

Seasonal trends of malaria reporting

- Malaria Patients

Health Stations
Weredas

Number of new malaria patients reported at health facilities:
- 1 - 500
- 501 - 1000
- 1001 - 1500
- 1501 - 2000
- 2001 - 5000
- 5001 - 8000

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