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MALARIA CONTROL PROGRAM

Terms of reference: A review of the malaria laboratory system was to be done by Dr Fabiana Alves and Dr Lorrin Pang to review the malaria information system. Both reviews could have simply described the current activities and how to improve them. However without a careful evaluation of national goals and intermediate objectives, our recommendations for changes to either the laboratory or information system would have been merely technical – of little real value. Thus, while this report will describe the present system, more importantly it will continually stress clear goals of a malaria program. From our site visits (during this and previous trips) and discussions with program staff at all levels, there seems to be general agreement that the goals described below are not only important but feasible under the Global Fund initiative. With this understood we then make specific laboratory and information system recommendations to support what we consider essential activities through which the proposed goals can be achieved.

GOALS:
- Reduce malaria 50% by 2008 (Global Fund)
- No (or rapid control of) falciparum malaria outbreaks
- Reduce risk of development of *P. falciparum* and *P. vivax* drug resistance
- Determine laboratory and information systems appropriate to different types of malaria situations (degrees of transmission; degrees of human migration).
- Construct a program which will be: simple, sustainable, flexible and efficient

COUNTRY MALARIA SITUATION / CONTROL ACTIVITIES: The National Malaria Program produces reports which reflect transmission (ILP, IPA, etc) which is very detailed with respect to geographical distribution (municipal level). However we do have some concerns regarding the validity of the data. The majority (~ 80%) of malaria case detection is based on passive detection with villagers reporting to malaria health volunteers - Col Vol (Colaborador Voluntário). It is not clear if treatment seeking behavior by villagers is similar in different locals. This factor will be very important as dengue epidemics merge with malarious areas and villagers change their Col Vol seeking behavior depending on what they think is the cause of their fever. Once patients do arrive to Col Vols there is a standardized way that they are clinically diagnosed, slides taken and treatment prescribed. Malaria slides are often of poor quality (thick smear, identification, storage and staining problems), may have longs delays in reading, with their quality control re-reading not done blindly. Feedback to

Col Vol usually takes more than 1 month but in some special cases results can be returned in a few days. Quality control is performed at Regional level and Central level (both unblindly), however feedback of quality control results do not lead to training/improvement of microscopists. The staining materials, equipment (including microscopes) and training are inadequate. Thus the validity of laboratory results (malaria smears) is questionable and might make rigorous comparisons between regions and over time difficult. In light of these concerns the data as a whole probably does reflects general trends both geographically and over time.

To summarize the malaria regions of highest priority are on the Atlantic side of the country including Colón, Atlántida, Yoro, Olancho. The area of Trujillo (Dept of Colón) is being developed as a tourist/business region and has been targeted for malaria control. In general, over the last few years there has been a 40% reduction in malaria. The species ratio is about 3:100, Pf to Pv. From the dengue program we have reports of rising dengue rates (several fold in some municipalities) in the past few years including the malaria endemic areas. There seems to be a feeling that clinically, dengue is distinguished from malaria by the presence of say, rash, retro-orbital pain, etc. While this may be possible for classical dengue, it is not clear what proportion of dengue cases do not have such symptoms but only fever. Conversely we do not know how many true malaria cases do not report to Col Vol if patients think they have dengue.

Mosquitia has not been designated a priority area of the Global Fund project. This region borders with the Nicaragua and there is a reported falciparum malaria epidemic in the past year across the border in an area of Nicaragua called “Bluefield”. Mosquitia is a remote swampy region with a relatively low population. Transportation in the area is difficult and principal activities in the area are fishing, logging and trans-border trading. Historically Mosquitia has had a higher incidence of malaria, especially falciparum.

INFRASTRUCTURE:

Information described below was collected from site visits to Guaimaca (CESAMO, TSA [Técnico de Salud Ambiental], Col Vol, Pharmacy), Central Lab, Secretary of Health (Departamento de Estadistica) and the Malaria National Program.

1. Village Level

Village Care Providers: Patients with fever or other malaria symptoms go to designated village malaria volunteers (Col Vol) where a clinical diagnosis is made (principally based on fever or fever history), visits are documented (E-1 forms), presumptive treatment of chloroquine (3 days)+ primaquine (5 or 14 days depending on the area) is given and slides are taken. Patients sometimes wait up to 3 days with malaria symptoms before visiting Col Vols. Col Vol services are provided free of charge and they receive no compensation or incentives for their work. The distribution of Col Vols is variable from 1 Col Vol per 50 to 1500 inhabitants. 80-90% of patients

go to Col Vol while others can go to more centralized health centers, private clinics and pharmacies.

Col Vols are only responsible for malaria activities and the vast majority are women residents of the villages. The women seldom make home visits to patients' homes and are reluctant to leave their homes to deliver the malaria smears to microscopists for staining and reading. Col Vols are visited irregularly by the Area TSA or ASA (see below). In some areas they are the ones responsible for delivering slides to the closest US (Unidad de Salud) and returning results. Col Vols are given smear results usually ~30 days after smears are taken and patients are told of their results usually only if they return to the Col Vol for their follow-up visit.

Environmental Volunteers: In each village there are volunteers responsible for vector control, mainly breeding site reduction, treatment (*Bacillus sphericus*) and monitoring. Their activities are independent of where malaria patients (clinical and smear confirmed) live. These volunteers are responsible for vector control beyond that of malaria (for example, dengue). The Environmental Volunteers are supervised by the Area TSA.

2. Municipal Level

At the municipal level the TSA (Técnico de Salud Ambiental) is responsible for a wide variety of public health functions, only one of which is malaria. Their malaria tasks include the support (provide materials and training) and supervision of Col Vols. They will also see that slides are delivered from Col Vols to microscopists and that results are returned to Col Vols. They compile the data collected by Col Vols (and Health Centers) then generate and analyze reports. Their reports are then forwarded to area and regional offices. The ratio of TSA to population is about 1: tens of thousands.

At the municipal level microscopists will stain and read smears from the Col Vols and Health Centers. The maximum number of slides read by a microscopist (exclusively working on malaria) will be about 50/day. The maximum number of malaria slides read by a lab technician (not dedicated to malaria examinations) will be about 30/day. Smear results are given to the TSA and microscopists/lab technicians are supposed to send slides weekly (all positives and 10% of negatives) for quality control (QC), however this is not always the case. At Regional levels slides are not read blindly since the results of the first reader are labeled on the slides themselves. To get a general idea of the quantity of smears for a malaria endemic region - Colón - the number of smears taken for the years 2001, 2002, and 2003 was 32140, 52271, 30906, respectively. The ILP for the respective years were 30.9%, 14.2% and 15%. The number of malaria cases diagnosed was 9940, 7404 and 4635 respectively. For these years the Colon population was approximately 230,000.

3. Regional Level

A visit was scheduled but the Comayagua Office was closed (holiday). No site visit. The regional offices are responsible for the first review of quality control of slides (10% negatives and all positives) from the local microscopists. They are also responsible to "consolidate" data by municipality and send to Central Level.

4. Central Level

Central Lab: The central laboratory is ultimately responsible for materials, equipment and training of all peripheral malaria laboratories, and a second QC. Presently their effort focuses on microscopy but in the future may include other forms of diagnostics (rapid test assays). For the purpose of QC the central laboratory receives 10% of negative slides from the Regional level (1% of all collected slides) and all positive slides. Slides are read for QC purposes unblinded. Sometimes slides are not always sent and negative slides may not be chosen at random/representative (of time, place, or staining quality). Usually the best quality slides are sent. Slides' staining quality, labeling and storage are poor, making the activity of revision difficult.

There are 126 microscopists in the country who can read malaria slides of which 35 are dedicated to only malaria, 26 are hospital based, 6 (of the 35) are dedicated to regional QC and 5 QC at central level. 5 more regional microscopists will be contracted by the Global Fund, all in Colón. There are other lab technicians at the US who, besides the malaria diagnosis, are responsible for all other lab exams (stools, urine, hematology, other diagnosis, etc). Only 25 of the 126 microscopists are in the Global Fund target region.

Information system (of the Central Laboratory): A system introduced by the Walter Reed Institute, PHLIS, is being used. This system is rather cumbersome (DOS based) and it is hard to enter new variables and make modifications so that risk factor analysis based on slide results can be done. The system itself is not compatible with other popular programs (EPIinfo, Access, Excel, etc) except through Dbase conversions. The data entered for the QC program are the total slides collected (by the Col Vols), initial microscopist results, revision at Regional level and the Central Laboratory's QC results. The information is stratified by each microscopist/US.

QC information goes back to the Regional level, which is supposed to inform the microscopist. However, no action is taken regardless of microscopist accuracy and no criteria for actions are set. Again, QC reviews at both the Regional and Central level are not done blindly. Of the slides which were neg by the microscopist, 0-10% are really positive (false negatives). On the one hand, it is questionable to have 0% disagreement between the readers (probably influenced by the unblind QC). On the other hand 10% false negatives (true malaria cases) may be unacceptable for a municipal program. If for example the ILP is 9% a false negative rate of 10% (with 91% of the slides read by the primary microscopist as negative), the real ILP will be double that of the observed. Again, data generated don't seem to be reliable.

One should always consider the value of false positives and false negatives results from the point of view of both the patients and the program. Since currently all patients are given full treatment presumptively (based on symptoms alone), the value of slides at all (accurate or not) would be of little concern to patients unless it might stimulate compliance with long term primaquine compliance. From the program point of view accurate readings are a useful epidemiologic tool to monitor malaria transmission and modify strategies (for example, to develop rapid contact tracing to reduce transmission or reinforce compliance for those with positive smears).

Secretaria de Salud (Departamento de Estadistica): The unit receives data from doctor or nurse consultations from hospitals – both suspected and laboratory confirmed cases. These data represent about 30% of the total number of malaria cases in country. We don't know if the National Malaria Program readily accesses this data and if so which reports include this data. For example, does the reported IPA incorporate this data? We also observed inconsistency regarding species identification. This "Trans" program had cases of *P. malariae* reported, while the National Control Program never had malariae cases reported.

National Malaria Program: The National Malaria Program serves as the country's authority ultimately responsible for policy decisions and execution. This unit serves as a reference agency for evaluation and training. In order to set policy in a timely and meaningful manner, feedback is needed in the form of data collection and analysis. In addition activities are coordinated with other national programs (e.g. dengue, tuberculosis, etc) and outside agencies (Global Fund, National University).

As part of the Global Fund initiative the National Malaria Program prioritized the municipalities with the most malaria (accounting for 80% of total cases). On this basis there were 58 malaria municipalities selected (of which 44 were designated as high priority) of the 298 municipalities in Honduras. During the past two years each of the priority municipalities have produced a plan of action which included village maps (croquis), census, mosquito breeding sites and identification of vivax and falciparum malaria "houses" where cases have occurred. For all of the priority villages the next objective (Global Fund project) is to recruit more Col Vols (1/200 inhabitants), train them, insure that they have adequate materials, and improve microscopy. There will be an effort to improve community education, recruit more volunteers for environmental sanitation and improve supervision of peripheral staff by the regional and central units. This effort is part of the plan to reduce malaria by 50% in the next few years. The plan will start to be implemented in the next few months.

In terms of information systems, there is no good 'communication'/interface among the 3 Central units.

RECOMMENDATIONS:

Once the following goals and activities are agreed upon, a hierarchy of authority/responsibility has to be established. There is a need for supervision and a demand for integrated, high quality work at all levels.

Lab

- Create a reference manual of standard operating procedures (SOPs) for slide labeling, preparation, reading and storage. Create SOP manual for microscope preventive maintenance. Create a manual for microscopist training and quality control evaluations.

- Microscopists should send slides regularly (weekly) to Regional QC Office: 10% of negative slides and 100% of positive slides. Negative slides should be chosen at random.

- Keep QC at regional/dept level. Stop doing two revisions (the QC at the central level is unnecessary, unless there are questions about the quality of the regional reviewers themselves). Define criteria of acceptable error (X% false positive and Y% false negative – see below) and set a time when this criteria will be reached or set increments of improvement each year. Laboratory staff at the Central level would be responsible for different tasks: laboratory evaluation, material maintenance (microscope and disposable material), microscopist evaluation (see below), training and refreshing courses. If necessary (to review Regional microscopists) Central staff could receive slides for QC only one time per year from the different municipalities.

- Conduct **all** QC examinations **blindly**, at Regional and Central levels.
- Central Lab will only receive QC 2 X 2 table for each microscopist. For example:

		Gold Standard (Regional reviewer)	
		+	-
Slides	+	100	10
(microscopist)	-	30	70

The positive Predictive Value (PPV), above example 100/110, and the Negative Predictive Value (NPV), above example 70/100, will be calculated and reported for each microscopist. For QC the qualitative agreement (positive/negative and species identification) is more important than quantitative agreement (parasitemia level).

The PPV and NPV, or the false positive and false negative rates performed by each microscopist should be compared to the criteria set for acceptable errors. In the table example above, this microscopist had 10/110 false positive results= 9%; and 30/100 false negative results= 30%. A 30% false negative result would probably be unacceptable.

The Central Lab can indicate and schedule a training/refreshing course for those microscopists who don't meet the acceptable criteria. These microscopists should be followed-up closely until readings are accurate.

The 2 x 2 table example above chooses the number of positive slides (all) and the number of negative slides (10%). Because these proportions are somewhat arbitrary, only the PPV and the NPV for the slide readers will be meaningful. The true sensitivity and specificity are determined from values within each column BUT ONLY IF the ratio of positive to negative slides truly represents the population of ALL slides. In this case they are not representative. The ratio is about 10 times too large since only a 10% sample of the negative slides is taken. Thus, for the above example, 100/130 is NOT an estimate of the sensitivity and 70/80 is NOT an estimate of the specificity.

Species differentiation is very important – it means different follow-up field activities.

- Create a reference set of well stained slides – 100 each of PF, PV and negative (30 mixed) smears to use as a QC tool to test microscopists. The current method used cannot distinguish if errors are the fault of the reader or the poor quality of the slide. The number of slides sent to each microscopist will be about 20 (of all types) for each evaluation. For disputed cases consider using dipsticks as the gold standard. Start with regional microscopists (the ones responsible for QC) to make sure they can be 'gold standards for QC.

- Make sure to provide good working conditions at Local level: microscopes, supplies, staining material, forms, etc. A set of 10 microscopes can be available at Central level on a rotational basis to replace temporarily microscopes from Local labs, which are to be fixed.

- Create system of slide labeling to distinguish initial slides from treatment failures/ follow-up.

- Create system of Blinding, ex. a form to be filled out by the microscopist and sent with the slides for QC (results cannot be written directly on the slide). This form cannot be given to the Regional reviewer, but kept with his/her Supervisor to compare results and forwarded to Central lab.

- Secretaria de Salud (Departamento de Estadistica) system must be somehow coordinated with the Programa Nacional de Malaria system, to join and yet avoid duplication of cases.

- Coordinate software programs – Foxpro, PHLIS, Excel, EpiInfo. We do recommend EpiInfo. This is essential if databases are to be joined and modified so that rapid analysis and assessment of field situations can be conducted.

- Determine different surveillance system for different epidemiological settings:

High transmission – take samples from all febrile cases and monitor results as described above.

Low transmission or none – below X%/year make a slide on every 'y' cases with fever; or on all febrile cases if: one suspects an outbreak with malaria, patients have proven risk factors (migration, occupational etc), patients are at high risk of malaria complications (pregnant women, young children, etc).

- Patient form (current M-I) should include information about:
  - Patient disposition (whether Col Vol referred patient to home, took malaria slide, health clinic or hospital)
  - Places visited 15 days prior to **onset of fever** (tracking site of exposure)
  - Prior treatment before Col Vol visit (Yes/No, which drug and where – pharmacy, self-treatment, etc).
  - M-I form does not need information on:

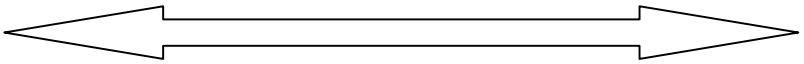
  'Positivo por grupo de edad', 'Produccion mensual mes', 'tiempo toma/diagnostico/inicio tratamiento' – these will be obtained by the informatics system with data already recorded in the form.

- If data from private laboratories (confirmed cases) and pharmacies (confirmed and presumptive cases) cannot easily be collected, let us not focus on this activity. Therefore our target reduction of 50% will be based on the national program data which understandably may represent only 70% of the total cases.

During the system evaluation and discussions it was clear that improving diagnosis and treatment would be of major importance to reach the goals stated in the beginning of this report. Specifically, only with a rapid and accurate diagnosis will quick and effective control measures be possible, resulting in reduced transmission, the principal goal of the Global Fund. A result of rapid diagnosis and reduced transmission through timely intervention will be better detection and control of outbreaks. In addition, rapid and accurate diagnosis will allow withholding anti-malaria drugs until laboratory confirmation. This will restrict the use of anti-malarial drugs, reducing drug costs and minimizing the chance of developing drug resistant malaria. In the next section we describe a stepwise strategy for achieving rapid diagnosis and the consequent malaria control activities.

STEPS - The following table lists factors which favor treatment before diagnosis and those which favor diagnosis before treatment. The malaria program should look at the current status of each village and what has to be done to move towards diagnosis prior to treatment. When transmission is decreased and Diagnosis is improved the trend should be from left to right. However if unexpected events occur (for example, introduction of falciparum malaria) the strategy can move back to the left.

Figure 1.

Treatment before diagnosis	**Diagnosis before treatment**
	
Delayed diagnosis	Rapid diagnosis (3-5 days)
High ILP	Low ILP (lots of other febrile illness)
Low probability of Resistance	High probability of Resistance
Lots of *P. falciparum*	Low *P. falciparum*
Safe, inexpensive, effective drugs	Toxic, expensive drugs

The following steps can be done in selected, pilot areas before expanding to all malaria endemic areas of Honduras. **Community participation** is essential for the success of any malaria program, and even more important when a change in policy (Dx before treatment) is undertaken. Therefore community education and input (feedback) is of utmost importance. Anytime there is a strategy change (see steps outlined below) there has to be education and community agreement.

1st step

– Make a rapid diagnosis. Have microscopic diagnosis available for patients in 2-3 days depending on each village/setting. Once a patient comes to the Col Vol, make a clinical diagnosis of malaria, continue to give presumptive treatment with cloriquine+primaquine for 3 days, make a good quality slide, have the slide delivered to the closest US (unidad de salud), the slides will be stained, read and results returned to the Col Vol in 2-3 days.

In order to do this the community needs to organize themselves. For example, if the community has 3 or 4 Col Vols, they can coordinate the slide delivery and the return of the results. Each Col Vol will visit the US on a rotating basis every 3rd or 4th day. As slides are delivered, results from previous deliveries can be picked up and returned to the corresponding Col Vol for patient notification. Alternatively the community can

arrange for any responsible person to deliver the slides and pick-up results (ex. guardian, teacher, etc).

- Patient follow-up. Once the Col Vol receives the results, **only the positive patients** will be notified. We recommend that Col Vol go to the patient's house, ask about treatment compliance, give the rest of the medication (primaquine for 14 days for *P. vivax* cases), and encourage full compliance. The Col Vol should also ask about improvement of malaria symptoms since the slide was taken. Col Vols should tell their patients to return (and take a slide) anytime that they have malaria symptoms within 28 days (after the first smear). On day 28 all patients (symptoms or not) will have smear taken and a final interview for symptoms. This 28 day follow-up is to document compliance OR LACK OF COMPLIANCE, evaluate cure, and to begin a surveillance system to detect treatment failures. All follow-up slides need a special system of labeling (ex. Clave Col Vol 120, slide 90 – case was detected; follow-up slide would be Clave Col Vol 120, slide 90-**1**. For this follow-up visit the Col Vol can either use the same M-1 form or a new specific form for follow-up should be designed.

- Contact tracing. At the time of the first follow-up visit for the positive patients the Col Vol will do contact tracing as follows: Ask for fevers (or history of fevers in past 28 days) in all family members and for those who have fever, treat as a new case. Depending on Global Fund activity "Intensificacion de las Intervenciones" (Feb-March of 2005) the fever search might be expanded to neighbors. With quick response for contact tracing the transmission should be reduced.

- Coordinate with Environmental Volunteers: The Col Vol should inform the Environmental Volunteers about malaria cases, so they can perform their activities of vector control.

The Global Fund project is planning to train the Col Vols in the high transmission malaria municipalities. The following topics should be covered during this training.
- Clinical/epidemiologic Diagnosis - define simple criteria for diagnosis of malaria and differential diagnosis of other endemic diseases (for example dengue).
- Making, labeling and storage of slides.
- Treatment regimens for different ages.
- Coordinate with community and other Col Vols for rapid delivery of slides and return of results.
- Filling out the M-1 form.
- Reinforce patient compliance with malaria treatment.
- Follow-up (detection of treatment failures) and contact tracing.
- Recommended activities for environmental volunteers for "malaria houses".

Obs: If the Col Vols training is under the responsibility of Municipality, the Malaria Control Program should have a system to evaluate the quality of the training and make sure they are covering at least the main topics. The Malaria National Control Program must assure consistency and quality of Col Vols training at the Municipal level.

2nd Step

Village by village ALL the following criteria must be met **before** moving to the 2nd step: *show rapid diagnosis (result returned in 2-3 days)*, Col Vol *clinical malaria diagnosis* has to be more specific to reduce the total number of slides taken (identify risk factors or symptoms which would distinguish better between malaria and non malaria illness) and yet not lose sensitivity (deny smears to those who really have malaria), ILP < X% in the past Y months (ex, ILP < 25% in the past 6 months).

To rigorously prove accuracy of clinical diagnosis one has to show simultaneously good specificity and good sensitivity in a "special" study. The "test" would be the clinical diagnosis and the gold standard would be smears. One would smear ALL cases presenting to the Col Vol regardless of symptoms. Col Vols would keep a record of who they think has malaria (based on clinical symptoms and other possible risk factors listed by the program – Col Vol can have a list of criteria as a guide) and who they think is negative (in the real situation one would take smears only on those they think have malaria, but in this study we smear all to see how many would be missed). Then all the slides are read (blindly) and we look at the sensitivity, specificity, PPV and NPV of the clinical diagnosis for this particular Col Vol (or average the Col Vols for a village).

Before such an evaluation occurs the villages and National Program can examine (retrospectively) a set of risk factors (age, migration, gender, etc) and a see which ones are associated with malaria. If a suspected risk factor has not been collected the data has to be collected in a future evaluation.

Obs: In general as specificity improves sensitivity will worsen and vice versa. However, we feel that, based on the currently used criteria, the clinical/epidemiologic malaria criteria for the Col Vol can be more specific without sacrificing sensitivity. Improving specificity will reduce the total number of slides taken and read.

Once a patient comes to the Col Vol, continue to take a smear from everybody who has fever. However, don't give malaria treatment (maybe give paracetamol) and wait for the slide result. Have everyone's slides delivered to the closest US (unidad de

salud), the slides will be stained, read and results returned to the Col Vol in 2-3 days. Positive cases should be immediately contacted and treated (complete treatment, with 14 days primaquine for *P. vivax*). Do patients' follow-up, contact tracing and coordination with Environmental Volunteer as for 1st step above.

Obs: Since patients are used to receive a treatment/resolution when they go to the Col Vol, one might consider to give paracetamol for patients presenting to the Col Vol. Paracetamol is a safe drug and will at least relieve symptoms of fever, headache and other pains, for any disease. In dengue areas 'aspirin' should be avoided.

Optional transitional step (if one doesn't want to go straight from 1st to 2nd step)

Village by village **all** the following criteria must be met **before** moving to the optional step: *show rapid diagnosis (2-3 days)*, Col Vol *clinical malaria diagnosis* has to be more accurate (identify risk factors or symptoms which would distinguish better between malaria and non malaria illness), ILP < X% in the past Y months.

This is very much like the 1st step, except that a group of patients who probably are not malaria will have diagnosis before treatment. Once a patient comes to the Col Vol, continue to take a smear from everybody who has fever. **Based on new specific clinico-epidemiological criteria**, classify the patients into 2 groups: probable malaria and non malaria. For the probable malaria give presumptive treatment with cloroquine+primaquine for 3 days, and for the non malaria don't give malaria treatment (maybe give paracetamol) and wait for the slide result. Have everyone's slides delivered to the closest US (unidad de salud), the slides will be stained, read and results returned to the Col Vol in 2-3 days. When results are received, treat those **positive cases** who did not get presumptive treatment. After a certain period we should examine the smear results of those classified as "probable malaria". If the ILP for this group is too low perhaps they should not be given treatment before Dx.

Do patients' follow-up and contact tracing as above.

Special situation: In the *P. falciparum* transmission areas consider using *P. falciparum* dipstick for rapid diagnosis, especially for children < 10year old, pregnant women and/or those who meet probable malaria criteria (see optional step above). The cost of a complete treatment is approximately L 30.00. If the PF dipstick is comparable then it would be cost-effective to use the dipstick as an alternative to presumptive treatment. Alternatively if falciparum malaria is high one might consider reducing the time for return of slide results (say 24 hours).

A key person – the Col Vol. As mentioned before, the Col Vol plays an essential role in the system. In the stepwise strategy described above he/she will be requested to perform even more tasks than before and under good quality work (slides quality and timely delivery, active search for contacts, treatment compliance, case follow-up, etc). If we are requesting so much from the Col Vols we need to provide them with incentives for them to continue doing their job and to recruit new volunteers.

Incentives could be good training and regular refreshing courses, provide good equipment, supplies, facilitate transportation to the US (ex. bicycle, money for taking a bus, etc), invitation to participate in the meetings for local health personnel, etc. Also, there has to be a definition of who is going to supervise and give feedback to the Col Vols – the TSA, ASA, Promotor de Salud, Microscopist from the US? The goal is to have 1 Col Vol/200 inhabitants, which is not just a matter of numbers but also geographical distribution. Col Vols should be distributed evenly in the communities so all villagers can reach a Col Vol in a 15-20 min walk.

Information system

Within the National Malaria Program: The goal is to support all malaria control activities for the patients' benefits and for rapid epidemiologic assessment and response (if needed). Also the information system will support a timely QC evaluation. From the activities listed above (for example Figure 1) one can determine what kind of information is needed. For example:

- Graphs of the age distribution of vivax malaria in the past 6 months by gender, for each region. The age range with the highest incidence of vivax malaria might be one of the risk factors to improve clinico-epidemiologic diagnosis by the Col Vol.

- The curve over one year of the 10 microscopists with the highest false negative rate (to monitor improvement). This is one of the QC evaluations.

- For the past 6 months, the trend in ILP, the number of smears taken, the incidence of falciparum malaria and the average time from smear to return of results for the five pilot villages – to see if they are ready to move to the 2nd step strategy above.

- For the past year the percent of falciparum malaria cases which were "imported" (history of migration in the past 15 days prior to the onset of fever). This variable of "migration" is not in the M-1 form but the information to get this variable is there ('lugares que visito en los ultimos 15 dias *antes de la fiebre'*). This might be another risk factor to improve clinico-epidemiologic diagnosis by the Col Vol.

In general the information system has to be simple, flexible, user friendly and use a universally available software system (for example EPIINFO, Excel, ACCESS, etc). The Malaria National Program has to decide at what level each type of data will be entered and what level will analyze each type of data. Who in the malaria program will be designated to have ultimate authority over these decisions? All information has to be on a common database to enable joining databases and analysis at all levels, local, regional and central. All collected data should be analyzed to direct the malaria program (and change strategies if needed)…otherwise it is meaningless to collect data. Feedback of the analysis results should be given to those collecting and entering data to reinforce the value of their work.

The analysis of the situation can only be done if data is entered regularly and in a timely manner in the database. Therefore there has to be a definition of which data is entered at each level by who and in which frequency, say weekly. Only a rapid system will enable rapid responses for action in the field.
Example of personnel who could be involved in data entering and analysis:

- Local level – TSA, ASA, Promotor de Salud
- Area/Regional level – Epidemiologist of the Area or Region
- Central – Malaria National Program, Epidemiologist of the Malaria National Program, Lab Central

The Malaria Program information system has to communicate with other programs (Trans, dengue, association of pharmacists, etc) which might have information relevant to the malaria program.

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