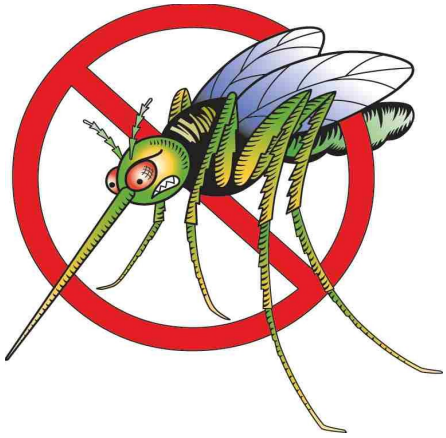
TRANSPARENCY AND ACCOUNTABILITY NETWORK



IMMC

INTEGRATED MOSQUITO AND MALARIA CONTROL

A comprehensive integrated mosquito and malaria control program to reduce the incidence of malaria, and other insect spread diseases.

BUSINESS PLAN

DATA AND MANAGEMENT INFORMATION

July 2006

DRAFT – FOR DISCUSSION ONLY

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INTEGRATED MOSQUITO AND MALARIA CONTROL CONTEXT

THIS DOCUMENT IS PART OF A SERIES THAT INCLUDES THE FOLLOWING:

EXECUTIVE SUMMARY – INTERNATIONAL PERSPECTIVE

EXECUTIVE SUMMARY – LIBERIA

BUSINESS PLAN – INTEGRATED MOSQUITO AND MALARIA CONTROL
COMPRISING:
A ... BP for IMMC – INTRODUCTION SECTION
B ... BP for IMMC – THE MALARIA CRISIS
C ... BP for IMMC – HISTORY OF SUCCESSES
D ... BP for IMMC – MOSQUITOES AND MALARIA
E ... BP FOR IMMC – THE IMMC STRATEGY
F ... BP for IMMC – PORTFOLIO OF IMMC INTERVENTIONS
G ... BP for IMMC – DATA AND MANAGEMENT INFORMATION

IMMC – ORGANIZATION AND MANAGEMENT
(An Excel workbook/spreadsheet)

IMMC – REFERENCES, CONTACTS, ETC.
(An Excel workbook/spreadsheet)

SIMULATION MODEL
(An Excel workbook/spreadsheet)

IMMC – BEHAVIOR OF COSTS
(An Excel workbook/spreadsheet)

IMMC – FINANCIAL PROJECTIONS – MACRO OVERVIEW
(An Excel workbook/spreadsheet)
IMMC – FINANCIAL PROJECTIONS – COUNTRY VERSION
(An Excel workbook/spreadsheet)
IMMC – FINANCIAL PROJECTIONS – DISTRICT VERSION
(An Excel workbook/spreadsheet)

SLIDE PRESENTATIONS
Components of IMMC (21 slides)
History of Malaria Eradication (24 slides)
Economics of Malaria (17 slides)
Organization of IMMC (24 slides)

Introduction to Data and Management Information for the IMMC environment at all levels

Management Information

Management information is the least amount of information that enables good decisions to be made reliably. This is quite different from an academic view of information which seems to be that more and more is better and better. This is also quite different from much of the relief and development sector (RDS) work where the gathering of information is an end in itself. Management information has only one purpose: to help decision makers make good decisions and to hold people accountable for performance.

The IMMC Program will make extensive use of management information for decision making and control. Management information has characteristics that are different from simple accounting or economic data; it is information that is the most suited to optimizing the decisions that need to be made for day to day operations and the long term.

In general management information “nests” from large strategic information down to more and more detail until every important aspect of performance is understood.

In the specific context of malaria and an IMMC program, information can start at a global level, and “drill down” will end up providing operating information at a specific location in a community. It is all the same information set, but different views of the data, and different ways of aggregating the data.

A good management information system is frequently an aggregation of small transactons summarized in a logical manner that is useful for decision making ... but it can also be externally aggregated information that is then supported in various ways by detailed subsets of information with more or less congruency between the different information sets. Whatever the source of information in a management information system, it must be clear and it must be correct so that decisions can be made are reliably.

An important process in management information system administration is the “reconciliation” of different datasets so that they are in conformity and as correct as possible.

It is better to have information from multiple sources, internal and external, than a single source with no way of validating its correctness. Different views and perspectives of the data can help understand how change can be improved.

The management information framework facilitates breaking down the big numbers for the world into regions and into countries ... and then to areas within the country and eventually to communities. But it should also be possible in some datasets to go further and understand the individual location and transactions (data collection) that originated in these locations. There may be a lot of data, but the data are not complex ... merely high volume and needing to be administered professionally. Modern information and communications technology (ICT) makes this easier to accomplish today than in years past, and there is no excuse of second rate management information.

Management Information
Community Detail to Global Aggregates

Global Aggregates

There are many examples of frequently quoted global aggregate information such as “The number of malaria cases in Africa is more than 400 million a year”. This may be interesting as a “number” to satisfy a journalist, but it is not very useful in management terms.

A number like this has more management value when it is compared to some prior year number computed on the same basis. Then we can conclude whether things are getting better or getting worse.

Country level data

Country level data are perhaps a little more useful in management terms than global aggregates. Country level data can be expressed in per capita terms and then compared across countries to see how the metric varies from country to country.

For all practical purposes data at the country level is an aggregation of information and of rather limited practical management use. The country level metrics are a result, with rather little link to the activities and interventions that produced the results.

District level data

District level data (a practical division of the country's data, rather than a political or administrative division of the country) are getting closer to being useful management information. At this level it starts to be possible to relate the costs of an intervention with the results that are being achieved, and to do it in ways that have some hope of giving meaningful information for decision makers. But even at a district level, the external variables are still too many and complex for the costs and results to be meaningful without further detail.

Community level data

Community level data is the level where really meaningful management data starts to have meaning and to be valuable. Modern spatial information systems now make it possible for very precise geographic information to be attached to data, and for that to be used in a meaningful way for analysis and planning. At the detail level in the community it is possible to get very precise information about mosquitoes, their breeding grounds, their flight patterns, their resting places and where they bite people ... and from this it is possible to plan IMMC interventions that can reduce the vector rapidly and to keep the mosquito population from being rapidly re-established.

Household level and localized data

Household level and localized data are about individual places, individual people and IMMC interventions that reach the ultimate location in a practical form. These are the base “transactions” that need to get recorded and to be part of an information system that aggregates to deliver management information for

decision making.

Aggregation (Roll-up) and Drill Down

A good management information system for IMMC has an ability to aggregate the detail level (household and localized data) so that there is good information about the community, about the district and about the country. The mindset is that this is “accounting” and not a statistical survey. The goal is to have the ability to link the costs and results in a meaningful way so that decisions can be made about changes or about replicating success.

More data, but easier to compile

An IMMC information system as envisioned has more data being collected, but it is easier to compile and it is easier to process into useful information.

Time intervals, level of aggregation and decision making

The time intervals for data collection are often daily, though sometimes weekly. The impact of interventions can be noted almost immediately at the household level and localized data level. There may still be strong information indicators at the community level for community wide interventions, but it will average out as the information aggregates further. Decision making has to be at a level where the information is still vital and not merely an aggegate average results with little or no decision making value.

Management Information
Data Architecture / Meta Data

Transactions

A transaction based system using the relational model makes the process of acquiring data and administering the data relatively simple and efficient.

The concepts used in the accounting profession for financial transactions can be expanded to include a lot of information that relates to other aspects of IMMC. The concept of a “balance sheet account” and a “profit and loss account” in accounting can be expanded.

This facilitates the recording of durable long lasting information, such as houses, people, water points, prevalence of malaria, population of mosquitoes, etc which are ongoing and have the characteristics of balance sheet assets in transaction records that are processed like balance sheet accounts.

The various interventions have costs, and produce changes ... just like a profit and loss account.

And at various time intervals, it is possible to process the transactions so that the results can be compared with the costs ... just like a periodic financial statement. In the corporate financial statement the analyst looks for progress in sales, profits and cash flow. In the IMMC setting the analyst looks for progress in the reduction in the prevalence of malaria relative to the cost of the interventions.

Executive Information System

An executive information system can be built on top of the transactions so that key people can easily get at the information they need without having to process too many transactions each time the query is required. Key people have the flexibility to design information queries that can be routinely performed whenever needed.

The over-riding goal is to make progress in reducing the prevalence of malaria at the least possible cost.

In the IMMC setting we are also thinking of least cost in the broader context of not only the direct costs of carrying out the IMMC interventions, but also the rather difficult cost to estimate of undesirable side effects. There are some of these already identified including (1) the build up of resistance in the mosquitoes; (2) the build up of resistance in the parasite; (3) the reduction in immunity of adults after reduced exposure to childhood malaria; and, (4) damage to the environment caused by IMMC interventions.

Some of the details needed for transacton information

The detail transactions should be easy to identify geographically. This is GPS data that should be part of the transaction record. In turn this identifies community, district and country.

The detail transaction should be identified as to date and time. This information should have clarity regarding the time of the transaction and the time of the

recording of the transaction. There also needs to be data and time relating to subsequent changing (correcting) of the transaction data.

The detail transaction needs to be identified in terms of “what it is” and a unit of measure identified.

The detail transaction needs to have some numerical information attached to it.

The detail transaction needs to have some note or explanatory information attached to it, if that is helpful.

Behavior of Costs
Measurement of Performance

Integrated mosquito and malaria control (IMMC) is thought to be the most cost effective way of reducing the negative impact of malaria on society. This exercise has been done to understand the cost and value implications of modern IMMC interventions, and to start a process to improve management of IMMC so that the best results are achieved at least cost.

The present work is an interim product and a work-in process. It is being shared as a work-in-progress to encourage dialog about cost and value and the underlying interrelationship with science and technology.

Management information

Management Information is the smallest amount of information that allows good decisions to be made with almost 100% reliability. Good management information usually has both accounting and operational elements. It answers the questions of “How much?” in terms of dollar cost, “How many?” in terms of the outputs, “When?” to put time around the work, “Why?” in terms of justifying whether the cost is justified relative to the value that will be created, and “How?” in terms of selecting the best way. Good management information is timely and used within a feedback framework to facilitate decision making for continuous improvement.

Cost behavior and measurement of performance is a critical component of management information. The purpose for understanding cost behavior and measuring performance is to make it possible for better decisions to be made. High performance is achieved when durable value substantially exceeds the expenditures used to achieve the results. Low costs do not necessarily give good performance, but rather a good relationship between expenditure and related results.

Data collection, data analysis and feedback into operational decisions

An operation can only be efficient if there is practical timely data collection, data analysis and feedback into operational decisions. The model of analysis described in the charts suggests the tremendous importance of understanding costs and at the same time understanding what is accomplished as a result of operational expenditures both in mosquito control and malaria parasite control.

It is very clear that the interaction between cost and entomology and medical science is complex, but though it is complex, it is also powerful. The type of data collection and the type of analysis and decision making will be critical determinants of success. Cost and value information is needed as weall as data of a scientific nature in order to get optimum performance.

Cost and value model for IMMC

A preliminary cost and value model for IMMC has been developed. It is contained in two Excel spreadsheets. The following are brief descriptions of the two sets of information contained in the spreadsheets.

Behavior of Costs
Variability in Costs of Different Interventions

SET 1

The first set of charts sets the stage by showing some of the variability in costs between some of the key components of the program.

Introduction

What does management information need to do? Two charts show the relationship between costs and value on a per month basis, and on a cumulative basis. The key point is that short term value may be lower than cost per month, but that long term value needs to be more than cumulative cost. These are not simple relationships and the management information needs to be based on a combination of accounting, entomological and medical information.

Chart 1

The variability in costs is demonstrated in Chart 1. The chart shows the variability in cost between different approaches to mosquito control. It also shows how the impression of cost changes depending on how the cost is expressed ... for example: by acre or by hour. The chart also shows the many cost elements that make up the total cost.

The chart shows information about cost, but it does not relate cost to output or value, and cannot in this form be used as a metric for performance.

Charts 2A to 2C – The cost of various control interventions

This series of charts show the various elements of cost for a specific malaria control intevention expressed per area and per time.

The charts show the total cost as well as the various elements of cost:

- Chemical cost
- Equipment cost
- Labor cost
- Fuel cost
- Admin costs that vary with time
- Admin costs that vary with area

Chart 2A – The cost of aerial spraying – ULV (Dibrom)

ULV (ultra low volume) spraying is a relatively new technological innovation that enables the spreading of a very very fine spray. The droplets are around 50 microns, and so small that they are small even relative to a mosquito. These droplets hardly reach the ground, and remain mainly in the air.

Chemicals are the biggest element of cost both per acre and per hour. This is because aerial spraying is very efficient and a lot of area is covered in one hour. This is also a strong indicator of potential good cost effectiveness because it is the chemicals that are the cause of results.

The second biggest element of cost is the admin cost that varies per acre. This is a critical cost and important to manage. There is a need for data and analysis so that the

use of aerial ULV is based on good science and the operations are planned to get the best results at the least cost.

Chart 2B – The cost of aerial spraying – Larvaciding
Larvaciding is a valuable technique for the control of the mosquito population, but is very costly per acre, primarily because the bio-chemical agent is very expensive. However, as part of an integrated program, the use of aerial spraying of larvacide agents can be very cost effective and key to sustaining a low mosquito population at low cost. The effectiveness of larvaciding depends more on the data and decision making than on the component of cost.

Chart 2C – The cost of ground spraying – Mechanized ULV (Pyrethrom)
The cost of ground spraying is lower per hour than aerial spraying, but much more expensive per acre. Furthermore, there are practical issues relative to ground access that add to the difficulties of doing ground spraying efficiently. There are situations where ground spraying is an important component in the integrated program, but its use is generally more expensive than aerial application.

Charts 3A and 3B – The variability of cost

The variability of cost is a key parameter in implementing a cost effective and high performance program. All costs do not vary in the same way, and cost and performance optimization requires different approaches to the different components of the program.

Chart 3A – Per hour cost variability
Per hour, the cost of aerial ULV is very high and ground (mechanized) ULV is very low. However, in terms of mosquito control, the per hour cost is of small importance.

Larvaciding is much more costly than aerial ULV operations because (1) the biochemical agents are very expensive; and (2) the agents require slow and careful and costly aerial procedures. In the right places, larvaciding is an efficient way of controlling the mosquito population and can be a valuable procedure even though it is expensive.

Chart 3B – Per acre cost variability
Per acre, the cost of aerial ULV (Dibrom) is around half the cost of ground ULV, assuming that ground ULV is practical. In many cases ground access is not possible using mechanized techniques and only hand held equipment can be used. In these cases, aerial ULV is far and away the most cost effective.

The per acre cost of larvaciding is high. It needs, therefore, to be used in the right place and at the right time. For this good entomological data are essential.

Charts 4A to 4C – The variability of cost

The variability of cost is depends on may factors. The rate of utilization is one key parameter.

Chart 4A – Relationship between population density and per capita cost of mosquito eradication
The cost per acre is a very useful intermediate cost parameter, but the cost relative to the population is even more valuable. As the population density goes up, the cost per capita goes down.

This is a simple relationship, but there are complex issues that must be addressed in practice. Most real geographic areas have a mix of low density empty space and high density built up areas, and the best practice depends on how mosquitoes behave under these circumstances.

Chart 4B – Relationship between the use of the aircraft and the hourly operating cost of the aircraft

The capital cost of an aircraft is high, but, with proper use and maintenance, lasts a long time. The hourly cost of use is relatively low as long as the plane is used for a high proportion of the total time.

Chart 4Bi shows the cost variability as use goes from very low to some 500 hours a year, and Chart 4Bii shows the continuing reduction in hourly cost as the use increases to 1,000 hours per year.

Chart 4C – Relationship between the pilot's flying hours and the hourly pilot cost

If the pilot is paid by the month, the cost per hour of flying drops as the number of hours flying increases. If the flying time is low, the per hour cost can be very high.

Charts 5A – Cost per 1,000 of population

This set will eventually document how much it costs to have an effective intervention using the various techniques that are available, and the combination of techniques. They will also provide a way of presenting the effectiveness of interventions in having an impact on the people and the society.

Chart 5A – Cost per 1,000 population

This chart shows the wide divergence in apparent cost for four different interventions: Interior residual spraying (IRS) with DDT (IRS/DDT), aerial ULV spraying, insecticide treated bednets (ITN) and IRS using non DDT compounds. The chart shows the cost, and adjusts this base cost to reflect the notion of effectiveness in contributing to a durable solution.

The critical importance of getting good data and good metrics about effectiveness needs to be stressed. Getting the data and doing the analysis needs to be an integral and well structured part of the program and should include not only the scientific data but also data about costs and the results being achieved and the socio-economic value of the results.

Measurement of Performance
Variability in Costs of Different Interventions

SET 2

The second set of charts starts to describe the dynamic of an integrated mosquito and malaria control program, and then starts to link this dynamic with the cost components.

Charts 7A and 7B – Mosquito population dynamics

These charts are a first attempt to describe the relationship ... the cause and effect ... of mosquito and malaria control interventions.

Chart 7A – Mosquito population dynamics

This chart describes the impact of a high frequency aerial ULV spraying intervention on the mosquito population. There is a rapid drop in population as the ULV takes effect, but a rapid rebuild of the population takes place rapidly.

With repeated interventions, the mosquito population declines over time until it reaches a low level. Data can be compiled to show the actual experience in any specific situation.

Chart 7B – Mosquito population dynamics

This chart describes the impact of a lower frequency of aerial ULV spraying intervention on the mosquito population. In this case there is a rapid drop in population as the ULV takes effect, with population building back again it reaches again a high stable level.

Though there are multiple interventions, they are rather widely spaced in time, and the mosquito population does not trend down but continues to return to a high stable level. This is a situation where the mosquito population can become resistant to the interventions.

Charts 9A to 9D – Mosquito / malaria dynamics

The goal is not simply to reduce the mosquito population, nor to treat more malaria patients, but to reduce the negative impact of malaria on society in a durable manner. There is a complex interaction between mosquitoes and malaria which can result in a major reduction in illness and death from malaria and is thus a key determinant of cost effectiveness and performance.

Chart 9A – Mosquito / malaria dynamics

In this chart the blue line represents untreated malaria, and the green line represents a reduction in malaria arising from some medical treatments.

The maroon line represents the reduction in the mosquito population as a result of a high level of mosquito control intervention.

Chart 9B – Mosquito / malaria dynamics

This is similar to the previous chart with the addition of a further red line that represents the level of reinfection taking place in the human community.

Because the mosquito population is significantly reduced, the rate of reinfection drops. This is a critical measure for a durable success.

Chart 9C – Mosquito / malaria dynamics
In this case there is no mosquito control intervention, the mosquito population stays the same, and even though malaria prevalence can be reduced by heavy intervention in treatment, the reinfection index is high, and a long term durable reduction in the negative impact of malaria on society is impossible.

Chart 9D – Mosquito / malaria dynamics
Comparison of the reinfection index between the case WITH mosquito control and the case WITHOUT mosquito control suggests that durable progress will be achieved with a combination of mosquito control AND malaria treatment including initiatives to minimize reinfection through life-style changes such as insecticide treated bednets (ITN) and interior residual spraying (IRS).

Charts 10A to 10C – Cost and value

The relationship between cost and value is the critical factor in measuring the preformance of an integrated mosquito and malaria control program. The absolute cost of interventions is not important on its own.

Chart 10A – Value of lives saved
The value of lives saved is a critical concept. This chart looks at this considering how much value is associated with lives saved at various values per life saved from a low of $100 to a high of $10,000. These numbers are small in relation to the value that US juries place on lost life in civil suits such as medical malpractice which often get multi-million dollar valuations.

Chart 10B – Cum cost versus cum value with IMMC
This chart which reflects a simple model for five years shows how an effective IMMC has a high cost in the early stages, but delivers a very much higher value over time.

Chart 10C – Cum cost versus cum value without IMMC
This chart shows how very much lower cost program can be implemented, but without much long term impact, and essential a lower cost that still exceeds by far the value being derived from the expenditures.

Chart 10D – Period cost versus value with IMMC
This chart shows how costs exceed value for the initial periods, but how value subsequently exceeds cost.

The chart also shows how in the long term the value drops, but so also is cost lower for a sustainable situation.

Chart 10E – Period cost versus value without IMMC
In contrast this chart shows costs exceeding value both for the initial periods and ongoing into the future.

Endnote

Management information
Management information is the least amount of information that allows decision makers to make good decisions reliably, and for all concerned to be held accountable for performance. The value of management information arises when good decisions deliver good results.

Ongoing development
The charts and other sets of data are continuing to be developed so that they are a better representation of the IMMC process. The goal is to build information and a dynamic simulation model that very well reflects the costs and the behavior of mosquitoes (entomology) and the costs and behavior of treating the malaria parasite (medical science).

This model can then be used to help define the important parameters of the program and what is needed to get the best possible results. This is management information in action and not merely an academic exercise. It is an initial attempt to define the management information needed to manage IMMC in the best possible way.

Need for cooperation
There is need for cooperation. The information about costs and performance that is presently available easily is inadequate for effective management of the resources being used for mosquito and malaria control. Getting key operational data and the essential scientific information to measure results is critical and a valuable though costly component of the program.

AN ORGANIZATION SPECIFICALLY STRUCTURED FOR IMMC ALL LINKED BY COMMON MANAGEMENT INFORMATION

The IMMC Organization has a management information component that includes: (1) data collection and analysis; and, (2) feedback. planning and decision making.

The organization needed to have success in a large scale integrated mosquito and malaria control (IMMC) intervention has a geographic component and a functional component. By optimizing organization along these two lines, it is possible to have excellence at a reasonable cost. A common use of timely, relevant and reliable management information enables a complex organization to be efficient without an expensive and time consuming coordinating function. The organization to implement decisions includes the following units: (1) a global international unit; (2) a series of country units; (3) one or more regional units, mainly to optimize aerial operations and logistics; (4) district units; and, (5) community activities.

International organization

The international IMMC organization has a planning and coordination role, and a responsibility for the overall management information framework. The international management group has a functional responsibility to ensure that all the IMMC interventions are best practice and effective. The international organization makes it possible for the IMMC group to have access to world class expertise without having an excessively high cost to be allocated to the local community interventions. The international organization has the primary responsibility for the strategy to finance the needed interventions in cooperation with all of the stakeholders.

Regional organization

Some of the IMMC interventions, specifically aerial operations and logistics are more efficient on a scale that is larger than needed for a single country intervention. Accordingly aerial operations and logistics are organized as regional units that operate to serve several country operations.

Country program

An IMMC country program has overall responsibility for the activities and effectiveness of the IMMC program in the country. There are many activities that the country program has to be responsible for including: (1) all the relations with government and the cooperation with government in the establishment and implementation of public policy with respect to mosquitoes and malaria. This includes having permission to operate from government and local authorities where required and the joint planning of interventions to achieve success; (2) setting up a data collection and analysis capability at the country level, including cooperating with government and private entities that already make use of some of the needed data; and, (3) setting up to undertake the physical operations including mobilizing and maintaining equipment, running a coordinating office, recruiting and training staff, and all of the other things needed for the smooth running of an efficient organization. At the country level, the country organization

has a big responsibility to ensure that the financing strategy facilitates effective use of IMMC interventions.

District program

The district programs are responsible for the detail planning of interventions that are needed in a district, based on detailed information about the geography and the physical setting, detailed information about entomology and detailed information about the malaria prevalence and malaria case management. The district programs also recruit, train and supervise the staff needed to implement district IMMC interventions, and arrange for the required equipment to be deployed into the district. The district identifies the need for aerial interventions and logistical support in conjunction with the country office. The district office in cooperation with the country office also serves as the mentor and developer of community level activities.

Community program

Several communities can be in a single district. The district office is responsible for helping community groups understand how malaria can be alleviated by controlling mosquitoes, and how mosquitoes can be controlled using IMMC interventions, including interventions that only require effort on the part of the local community, such as cleaning up potential mosquito breeding sites, and helping to provide information to manage the IMMC interventions and measure results.

Management information and coordination

The goal is simple ... to have the most reduction in malaria prevalence for the least possible cost, and for this to be sustainable.

The data and the analysis to make the best possible decisions is not quick and easy, nor is the goal of least cost malaria prevalence reduction going to be achieved by purely academic analysis of the scientific data. There is a need for reliable and timely management information that is clear and easy to understand. It must help to make the best possible decisions and it must measure the results being achieved. The stakeholders need to know what works and what does not, and how much it is costing to reduce malaria prevalence under different operating situations.

Collecting data and the interpretation and analysis of the data

The starting point for the IMMC program is to collect and organize existing data so that it is easier to understand and to have a baseline and starting point. A lot of data are already available, and these data should be supplemented and updated as needed. There are several sets of data that are needed: (1) entomological data concerning the mosquito population and its breeding locations; (2) geographical or spatial information about the community ... population, buildings, water, etc; (3) medical information about malaria in the community and how cases are being treated (if at all); (4) the actual IMMC interventions that have taken place and where; and, (5) updates of all the information so that results can be compared to activities.

The collection of data and its organization so that it is easily available for analysis and planning can be done now using a combination of low cost local data

collectors and the low cost and power of modern information and communications technology (ICT). The IMMC program pulls together a lot of data that have been collected in the past, as well as current data to provide a starting point for planning. The IMMC process then continues data collection, analysis and planning to ensure that IMMC interventions are as effective as they can be and low cost.

In order to make access to information as easy as possible, a large scale relational database is being established that will be web accessible for all IMMC analysts. The goal of the database is to make it possible to track performance both as a time series and across different locations, and using different sets of interventions.

A planning model is being developed so that critical variables that affect the dynamic of the mosquito and malaria can be studied with easy to understand “what if?” simulations. The model attempts to relate cost with result, on top of calculations that reflect the underlying science. The model includes costs, scale of interventions and results and helps decision making about what might work, how much it is likely to cost and what results should be expected. The model is in an early version, and has not yet been tested against a lot of field information, but initial indications are that a combination of interventions is very much more cost effective than any single intervention carried out on its own.

Data collection incorporates information flows that relate to the physical situation and spatial information for the area, entomological information about the mosquito, medical information about the human population and medical information about the malaria parasite. Data is needed to measure results and also to alert the program managers to side effects like resistance or environmental risks that need to be minimized.

Available data are also being organized and used in financial and cost analysis spreadsheets. The aim is to understand the costs and the behavior of all of the possible interventions and how these costs are related to performance in different combinations of interventions. The spreadsheets help to make cost projections for a successful IMMC program in any district or community and to understand the costs and results that can be expected based on an operational model.

One of the critical parameters that emerges from these data is that time and scale are the two very critical variables. What the operating model shows is that timing makes a big difference and fast response to changing situations is very valuable. It is also apparent that spatial information can be very valuable in helping to design interventions that improve the results and reduce costs.

Another indicator emerging from the analysis of data is that both the prevalence of malaria and the behavior of the mosquito is not evenly spread over an area, but has a broad spread of different densities. (See Dr. Donald Robert's work). This means that spatial information is very valuable and can be used to focus IMMC interventions where they will do the most good, and increase effectiveness significantly.

Collecting data

Data collection and analysis is the key to success of the total program. The science of the mosquito and the malaria parasite needs to be respected and data collected and used continuously, so that program activities produce useful results at least cost.

Existing data

The starting point for the IMMC program is to collect and organize existing data. so that it is easier to understand and to have a baseline and starting point. A lot of data are already available, and these data should be supplemented and updated as needed.

It is anticipated that there will be a lot of work required to make the various information sets that become available compatible and comparable.

Data needed

There are several sets of data that are needed:

(1) entomological data concerning the mosquito population and its breeding locations;

(2) geographical or spatial information about the community ... population, buildings, water, etc;

(3) information about the prevalence of malaria in the community

(4) medical information about malaria cases and how they are being treated (if at all);

(5) the actual IMMC interventions that have taken place and where; and,

(6) updates of all the information so that results can be compared to activities.

Collection of data

The collection of data and its organization so that it is easily available for analysis and planning can be done now using a combination of low cost local data collectors and the low cost and power of modern information and communications technology (ICT).

The IMMC program pulls together a lot of data that have been collected in the past, as well as current data to provide a starting point for planning. The IMMC process then continues data collection, analysis and planning to ensure that IMMC interventions are as effective as they can be and low cost.

Data collection incorporates information flows that relate to the physical situation and spatial information for the area, entomological information about the mosquito, medical information about the human population and medical information about the malaria parasite. Data is needed to measure results and also to alert the program managers to side effects like resistance or environmental risks that need to be minimized.

One of the challenges is to establish a global willingness to share data and make it available in an easily accessible form so that it can be used for improved management of IMMC style activities world wide. (see separate section).

Entomological data

Entomological data concerning the mosquito population and its breeding locations are needed.

Entomological surveys will be used at the start of any program to establish which breeding areas are being used by the various malaria vectors, so that the best control methods are applied.

Entomological data is not found in the library, it is found in the field and where operational and financial transactions are taking place. The best data are data that can be used to draw useful conclusions with a minimum of complex analysis and manipulation. The following images give an idea about the source of entomological data.

In the Monrovia situation, for example, entomological data are critical because the Monrovian swamps are fed by fresh ground waters in the more inland areas and by the sea closer to the Atlantic. The estuary areas present an especially complex situation as far as the breeding grounds are concerned. This will be carried out by insect trapping and identification in the affected areas. .

Spatial data

Geographical or spatial information about the community ... population, buildings, water, etc;

Prevalence of malaria in the community

Information about the prevalence of malaria in the community

Malaria cases

Medical information about malaria cases and how they are being treated (if at all);

IMMC Interventions

Actual IMMC interventions that have taken place.

updates of all the information so that results can be compared to activities.

Human population and prevalence of malaria

Available information about malaria and the human population must also be surveyed, to establish a base for programming interventions that will reduce the existence of the parasite.

Existing Liberian organizations will be asked to cooperate on this, including clinics and hospitals, schools and universities, and laboratories such as the Red Cross Blood Bank and Liberian Institute of Research.

Local teams for data collection

Teams of local staff will collect data about mosquito populations and the response of those populations to various treatment regimes. These data will be analyzed on a continuous basis, so as to feed into the spray campaign planning. Teams of local staff will also collect data concerning the prevalence of the mosquito parasite in the human population. This will be done mainly at hospitals and clinics, but it will also be done by sampling people who are not currently going to either the hospitals or clinics.

Operational cost effectiveness modelling

The cost effectiveness of the Program depends on making good operational decisions on a continuing basis. This requires cost information and results information to be collected and used in an operational modelling framework. This was done as part of the initial Program design, but without very good information. Though malaria control programs have been implemented for many years, there is almost no accessible cost and management information about these programmes and what is the relationship between the costs and the results.

The cost effectiveness modelling suggests that ULV aerial spraying is the lowest cost way of reducing the mosquito population, that DDT and Interior Residual Spraying (IRS) is the lowest cost way of reducing mosquito bites inside a residence and that a prevalence level of the malaria parasite in host population blood is another critical factor for sustained success.

The cost of chemicals and salary costs are the two biggest cost elements. Larvaciding is the most expensive chemical treatment, and DDT perhaps the most cost effective. The banning of DDT by the Environmental Protection Agency in the USA in he 1970s may, in retrospect, be one of the most costly decisions ever in terms of human life and the cost effectiveness of malaria control. Salary costs will be high as long as the program needs many international staff, and other professional staff that command international scale salaries.

Transparency and accountability

The program will have excellence in accountancy as the foundation for transparency and accountability. Critical data that are used for operational decisions will be made available in a web accessible database so that progress of the Program can be easily monitored by all interested stakeholders and performance objectively assessed. Modern information technology will be used with content optimized for management and oversight purposes. Monitoring and evaluation will be done as an integrated part of the operational and management processes, so that costs can be related to results. Every month, managers and staff will provide internal management information that relates entomological and medical data with the operational activities and operational costs. This will be an ongoing process that, *inter alia*, aims to get the best results from scarce funding resources.

Monitoring and evaluation

The Program is open to independent professional monitoring and evaluation by concerned stakeholders. This external monitoring and evaluation is transparency in practice. It does not form a part of the internal Program management information system used for Program decision making and control.

Internal assessment of performance

The success of the program will be assessed internally on a continuous basis and the results will be easily accessible by stakeholders. The impact of all the operations are measured in a very timely way so that critical decisions about ongoing operations can be made based on feedback from very recent activities and their latest impact.

For the mosquito control activities, the Program managers need to know almost in real time how the population of mosquitoes is responding to various spray interventions. Mosquito population information needs to be collected from many locations, recorded in a suitable information system, and tracked to understand cause and effect, and the next decisions that need to be made. This is part entomology and part operations research or management science.

A different set of information is needed for the management of an Interior Residual Spraying (IRS) activity. An inventory of buildings is needed, together with a record of the activities undertaken in connection with the building and the impact of the interventions on the mosquitoes and the building occupants. This information needs to be at the right level of detail and easy to manage and use.

The accounting information must also be organized for use in the management information mode. This provides both information to help with decision making about Program activities, and also feedback that ensures that fund flows are fully accounted for.

Cooperation with Tr-Ac-Net

The Transparency and Accountability Network (Tr-Ac-Net) is experienced in management science and will advise as needed to facilitate the design and implementation of suitable management information systems and processes, and will also provide a web enabled database environment for the storage and analysis of this information by all stakeholders interested in the performance of the Program.

Management information, organizing for optimum performance

Organization is very important. Good performance results from management information that uses data and an appropriate analysis process, and organization that converts ideas and plans into action, and measures the results.

A planning model is being developed so that critical variables that affect the dynamic of the mosquito and malaria can be studied with easy to understand “what if?” simulations. The model attempts to relate cost with result, on top of calculations that reflect the underlying science.

Available data are being organized and used in financial and cost analysis spreadsheets. The aim is to understand the costs and the behavior of all of the possible interventions and how these costs are related to performance in different combinations of interventions. The spreadsheets help to make cost projections for a successful IMMC program in any district or community and to understand the costs and results that can be expected based on an operational model.

One of the critical parameters that emerges from these data is that time and scale are the two very critical variables. What the operating model shows is that timing makes a big difference and fast response to changing situations is very valuable. It is also apparent that spatial information can be very valuable in helping to design interventions that improve the results and reduce costs.

Spatial information

Spatial information

Spatial information is very valuable. Spatial information is needed about the physical characteristics of the area, how mosquitoes behave in the area and the prevalence of malaria in the population. It is also needed to show how various IMMC interventions have been deployed. Spatial information gives a way to relate activity to the area as a whole, and to focus effort where it has the most impact.

Satellite imagery is one of the tools we have available.

The satellite image map of Monrovia shows the unusual situation of the city. The red dot to the northwest is about 10 miles from the red dot in the southeast. This area comprises about 50,000 acres, with a clearly visible swamp in the middle of the city. Coupled with a warm, wet tropical climate, this makes Monrovia one of the world's leading cities for the incidence of malaria, which accounts for well over 50% of all disease in the city. However, with available modern technologies, there is no reason that this situation needs to continue.

Data related to spatial distribution of malaria cases may be particularly useful, because it may be possible to focus effort in ways that reduce costs and increase results significantly. The following image shows a built up area, and helps to show visually how much work needs to be done. Where there is a population of 1 million people, there are perhaps 400,000 rooms that need to be sprayed to get complete coverage, and many of these rooms are in houses that do not have easy vehicular access.

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IMMC interventions have been deployed. Spatial information gives a way to relate activity to the area as a whole, and to focus effort where it has the most impact. The following is a satellite image of Monrovia, Liberia.

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Data related to spatial distribution of malaria cases will make it possible to focus effort in places where it is most needed, and for the same cost getting much better results. The following image shows a built up area, and helps to show visually how much work needs to be done. Where there is a population of 1 million people, there are perhaps 400,000 rooms that need to be sprayed to get complete coverage, and many of these rooms are in houses that do not have easy vehicular access.

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The picture (below) of the Sinkor neighborhood shows a different set of physical conditions, and different issues for effective ground operations. Note in both cases how few of the buildings are road accessible and within range of effective mechanized ground fogging. Again, this area is suited to ULV aerial spraying.

In Darwin, Northern Territories, Australia, there is a strong focus on spatial information. Darwin is now malaria free, but any malaria case is reported and a range of control measures are immediately implemented. These include quarantining the patient, killing all mosquitoes near where the case was reported and intensive monitoring of people in the area. As a result Darwin has had no cases of local transmission of malaria since 1962. All the reported cases have been associated with visitors and travel from malaria affected areas.

The Program plans to use modern mosquito control techniques that make use of insecticides and a variety of delivery systems, depending on the terrain and local circumstances. There are several systems that may be used, including aerial spraying, ground fogging from vehicles, hand spraying in confined areas and interior residual spraying. The most efficient system for the conditions will always be employed in determining which insecticides and methods to use. Cost analysis and projections for the Program suggest that a combination of methods will be the most cost effective depending on both the physical structures and terrain and the response to interventions by both mosquitoes as the vector and the malaria parasite within the human host.

Mosquitoes have the ability to reestablish themselves very quickly. Therefore, ongoing operations are needed to kill any remaining mosquitoes and reduce the mosquito vector to insignificance, and then keep it under control at a very low level. Fast data analysis is critical, with action interventions modified to get maximum impact under rapidly changing conditions. For example: though mosquitoes are totally eliminated for a time, there is the potential for a rapid reemergence of the mosquito population because eggs that are in the environment can emerge in the future to become a new vector threat, unless they too are eliminated. The goal of the Program must be to maintain an unfavorable environment for the mosquito throughout its life cycle and in perpetuity. This is a challenge in Monrovia, where very favorable mosquito breeding grounds are everywhere, unless there is ongoing aggressive intervention.

This image is for for Monrovia, Liberia, a location suffering from endemic malaria. The population of Monrovia was around 500,000 prior to the Liberian civil war, but since the war insecurity and an influx of displaced persons has probably expanded the population to more than 1 million people. Monrovia covers an area of around 50,000 acres, some 15,000 acres of which are marshland, a perfect breeding ground for mosquitoes, and located very close to homes. On the map , the area within the yellow lines is about 50,000 acres. The dark brown represents the marshy area of about 15,000 acres.

The majority of Monrovia's population is very poor and lives in very crowded and disorganized conditions. Perhaps half the population are now living in squatter conditions, and road access is very limited.

Data collection, analysis and activity planning

The Program is based on science and technology, and uses data to determine the best mix of Program activities. Rapid changes are going to take place as a result of Program activities and the Program must respond as needed to the changes that are identified. For example, mosquito populations can rapidly reestablish from old eggs and rapid response is essential to keep a new mosquito population from reestablishing itself. Data will be collected to understand the mosquito and the impact of Program activities. Data will also be collected about malaria and the malaria parasite. The Program supports treatment initiatives so that pool of infection is reduced. All performance metrics – financial, scientific and operational are used to assess Program performance and to be accountable for resource use. The metrics are all related and make up a complete system of management information that will support full transparency and accountability. Modern information technology will be used in ways that provide for the best possible management information for decision making in the Program. Critical operational data will be made available in a web accessible database so that all interested stakeholders can easily assess Program progress and performance.

Program organization and management

The program organization and management reflects the operational situation in Liberia. Key staff associated with the Program have long experience in Liberia and other similar developing countries and are committed to a high standard of Program performance in spite of physical and logistical difficulties. The Program is planned to have efficient and effective operations not only for the short term but also for a continuing period into the future. The model of California's Mosquito Abatement Districts may be used as a template for ongoing Program management into the future. The Program will be implemented in cooperation with local organizations that can be valuable to the Program and benefit from participation, such as schools, church groups, local NGOs and youth groups. Consideration will be given to cooperating with the authorities to employ demobilized soldiers in connection with mosquito / malaria control environmental cleanup.

The program organization includes units to provide data and analysis that are scientifically based, objective, independent, professional and reliable. The

Program organization includes a unit to ensure financial and economic performance, cost effectiveness, and transparency and accountability. Guidance in the area of financial control and management information for Program decision making is being provided by the Transparency and Accountability Network. (Tr-Ac-Net).

Review of past costs of mosquito and malaria control interventions is difficult because of the incredible lack of useful cost information. An cost effectiveness model has been developed for this program based on relatively easily accessible information and it is clear that costs can be kept to a reasonable level if the program is cost optimized. The behavior of the mosquito and the malaria parasite to various interventions cannot be predicted with certainty, and it is absolutely clear that success will be achieved at minimum cost if interventions are initiated based feedback about current cost information, entomological data and malaria epidemiology information. All of this is included in the program plan.