

Crossing the digital divide: the contribution of information technology to the professional performance of malaria researchers in Africa

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Abstract

Background: The US National Library of Medicine supports the Multilateral Initiative on Malaria (MIM) through the design, implementation, and operation of the Multilateral Initiative on Malaria Communications Network (MIMCom.) MIMCom makes possible enhanced access to the Internet and to medical literature.

Objectives: The main objectives of the present study were to examine the use of MIMCom supported information technology (IT) by scientists, students, and administrative personnel to facilitate communication, retrieve information, obtain documents, write proposals, and prepare papers for publication; and to determine the contribution of this intervention to their professional performance.

Methods: The authors analyzed the contribution of enhanced Internet connectivity and access to electronic information resources to the performance of malaria research staff and their institutes through a cross-sectional questionnaire survey of 181 respondents at 14 health research centers in Africa. Separate reviews of bandwidth usage, requests for document delivery, and publications in peer reviewed journals support the data of the survey.

Results: The MIMCom network makes a positive contribution to the performance of malaria researchers and support staff at the sites reviewed by improving e-mail exchange, access to published literature, and research proposal development and submission. Implications of these findings are discussed.

Conclusion: By providing full access to the Internet and the resources of the WorldWide Web, MIMCom has been shown to be invaluable to malaria researchers and their institutes in Africa. This access has increased visibility of scientists in their respective institutions and provided opportunities for stronger engagement with the international scientific community.

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Introduction

The emergence of the Internet constitutes a new and attractive channel for accessing the latest in scientific research. This is especially true for Africa where research information is often scarce and incomplete^{1,2,3&4}. The Internet offers researchers and students immediate access to a wide variety of research publications^{3&4}.

Communication using Internet technologies is expanding the range and flexibility of intervention and teaching options available in the health sciences⁵. Advantages of Internet communication include convenience, flexibility, interactivity, and automated processing. The information technology evolution is creating new opportunities for the delivery of research information and education materials. Innovative and thoughtful applications of this new technology can increase the consistency, reliability, and quality of information shared.

However, access to the benefits of information technology has been difficult for researchers in much of sub-Saharan Africa due to limited telecommunications infrastructure. For example, in 1997, the U.S. National Library of Medicine made MEDLINE®, its premier database of the world's medical literature, available free

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to the networked world through PubMed® which has over 15 million records for biomedical articles. For scientists with access to the WorldWide Web (WWW), this service made it possible to search MEDLINE, read abstracts, and carry out research⁶. However, for researchers in developing countries, especially those in Africa, Internet access is often very limited, or nonexistent, and expensive.

From its creation in 1997, the Multilateral Initiative on Malaria Communications Network (MIMCom) started reversing this state of affairs and has provided an ideal application for PubMed to be used by researchers in underserved areas of Africa. MIMCom was conceived by African malaria researchers and has been designed, implemented and overseen by the U.S. National Library of Medicine (NLM) in collaboration with partners in Africa, US, and UK⁶. The mandate for improved communications came from the African scientists: “Access to e-mail and the Internet will promote rapid communication between investigators working at different sites as well as access to online literature and data

available to scientists outside Africa. Subsequent development of electronic networks would promote the use of common databases which will facilitate research efforts at multiple sites across the continent.”⁶.

MIMCom has grown as a research network, the first of its kind in Africa, from two sites in one country to 19 sites in 12 countries. MIMCom also comprises a website, training programs, monitoring and evaluation activities, document delivery service, and support of specific malaria research agendas.

Study setting

Table 1 shows sites and funding partners that make up the MIMCom network. Each site is represented in one or more of the data sources reviewed for this article. The research sites include rural and urban environments and represent large and small institutions in East and West Africa. Some sites are well-funded by agencies in the US and UK; others rely more on local resources with small amounts of funding from outside sources; still others fall in between. The participants in this study comprise a broad array of malaria research specialties as well as technical, applied, and support staff.

Table 1: MIMCom partnerships

| Site | Local Partners | International Funding Partners |
|----------|--|---|
| Cameroon | The Biotechnology Centre, Faculty of Medicine and Biomedical Sciences University of Yaounde 1(Yaounde) | US National Library of Medicine (NLM) US National Institute of Allergy and Infectious Diseases/ National Institutes of Health (NIAID/NIH) |
| Gabon | Medical Research Unit, Albert Schweitzer Hospital (Lambarene) | US National Library of Medicine (NLM); US National Institute of Allergy and Infectious Diseases/ National Institutes of Health (NIAID/NIH) |
| Ghana | Noguchi Memorial Institute (Accra); Navrongo Health Research Center (Navrongo) | US National Library of Medicine (NLM); US National Institute of Allergy and Infectious Diseases/ National Institutes of Health (NIAID/NIH); Naval Institute of Medical Research (NIMR); US Agency for International Development (USAID) |
| Kenya | Kenyan Medical Research Institute (KEMRI)(Nairobi); KEMRI/ Wellcome Trust (Kilifi); KEMRI /CDC(Kisian); International Center of Insect Physiology and Ecology (Mbita); Findlay Tea Plantation/ US Army Medical Research Unit (Kericho) | US National Library of Medicine (NLM) US Walter Reed Army Institute of Research (WRAIR); US Centers for Disease Control (CDC); US National Library of Medicine (NLM) Wellcome Trust (UK); US National Library of Medicine (NLM) US Centers for Disease Control (CDC); US National Library of Medicine (NLM); US National Institute of Allergy and Infectious Diseases/ National Institutes of Health (NIAID/NIH) |
| Mali | Malaria Research and Training Center, Faculte de Medecine (Bamako) | US National Library of Medicine (NLM); US National Institute of Allergy and Infectious Diseases/ National Institutes of Health (NIAID/NIH) (Initial support for a microwave connection which led to installation of an independent VSAT system) |
| Malawi | College of Medicine/Pediatric Malaria Project/ Wellcome Trust | US National Library of Medicine (NLM); UK Wellcome Trust; US National Institute of Allergy and Infectious Diseases/ National Institutes of Health (NIAID/NIH) |
| Tanzania | National Institute for Medical Research (NIMR); Amani Medical Research Center; Ifakara Health Research and Development Center | US National Library of Medicine (NLM) US National Institutes of Health (NIH)/Office of the Director |
| Uganda | Makerere University/Mulago Hospital; Ugandan Viral Research Institute (UVRI) | US National Library of Medicine(NLM); US National Institute of Allergy and Infectious Diseases/ National Institutes of Health (NIAID/NIH) US Centers for Disease Control (CDC) |

MIMCom uses a variety of technologies to connect each site to the Internet, depending on the services available locally. If there is no local Internet Service Provider to address the need, then a very small aperture terminal (VSAT) which communicates with a geostationary satellite is installed as part of a shared bandwidth service designed and implemented by NLM working with Redwing Satellite Solutions in the UK. This network is closed and private, meaning that only the sites on the system (participating malaria research sites in Africa) are using it and there is no contention from outside users.

Objectives

The purpose of the present study was to:

- (a) Examine the use of MIMCom supported information technology (IT) by scientists, students, and administrative personnel to facilitate communication, retrieve information, obtain documents, write proposals, and prepare papers for publication.
- (b) To determine the contribution of this IT intervention to their professional performance.

Methods

Informed consent was sought for all participants in the study. The information from the respondents has been treated with confidentiality. The tracking of Internet use did not include user specific details. Two different approaches were used in this study:

- a) A cross sectional survey of MIMCom users
- b) A retrospective review of publications, use of bandwidth, and full text document requests

Data collection

The main data sources include: responses to an electronic questionnaire from users at sites participating in MIMCom; records of individual requests for reprints of journal articles through a document delivery service offered on the MIMCom website; publication information as provided by site directors; and summary statistics of bandwidth usage at the MIMCom sites. The details of each of these data source are provided below:

- a) An electronic questionnaire with 181 (51%) of 354 MIMCom users at participating sites.

A hard copy of the questionnaire was pre-tested at the Mbita Point Research and Training Centre of the International Centre for Insect Physiology and Ecology (ICIPE) in Western Kenya. The form was divided in four sections: Personal Data, E-mail Use, Internet Use and Enhanced Connectivity. This

evaluation activity started in August 2002 and was closed in February 2003. The respondents were from sites in Cameroon, Gabon, Ghana, Kenya, Malawi, Tanzania, and Uganda. All respondents had access to enhanced connectivity via MIMCom for a minimum of six months prior to the study. Their professional categories included biomedical scientists, students, and support staff.

- b) Records of 625 full text document requests via the MIMCom website. Requests were received automatically by the Medical Library at the University of Zimbabwe and, when necessary, forwarded by the University of Zimbabwe to the U.S. National Library of Medicine for fulfillment. Records include address, name of the scientist and name of the institution originating the request, name of article requested and journal in which it appeared, and how the request was satisfied.

- c) Lists of all publications between March 1999 and March 2003 from 9 sites participating in MIMCom. These lists covered the period before and after enhanced connectivity. This data was obtained from site directors and included the publications for which the main authors (first or last author) are from the sites.

- d) MIMCom summary statistics on bandwidth use and the type of websites frequently accessed for 8 of the MIMCom sites connected to the Internet via the shared bandwidth satellite service. Data on daily average use came from Webalizer and Sawmill which tracked traffic to various websites.

Data analysis

Analysis focused on use of e-mail and the resources of the WorldWide Web and covered a variety of professional categories – biomedical, statistical, socio-economic, and administrative.

Results

The main findings of this study are presented in four broad categories: 1) characteristics of the online questionnaire respondents; 2) communication and access to information; 3) use of MIMCom services; 4) professional performance.

1. Characteristics of the respondents of the on-line questionnaire

Slightly more than half (59.7%) of the 181 respondents who took part in the online questionnaire were qualified scientists; a quarter (21.5%) were support staff. A smaller proportion (18.8%) of the respondents comprised PhD and MSc students. Two thirds (65.2%) of the respondents were male scientists. Table 2 shows the background characteristics of the 181 respondents to the online questionnaire.

Table 2: Questionnaire respondent characteristics

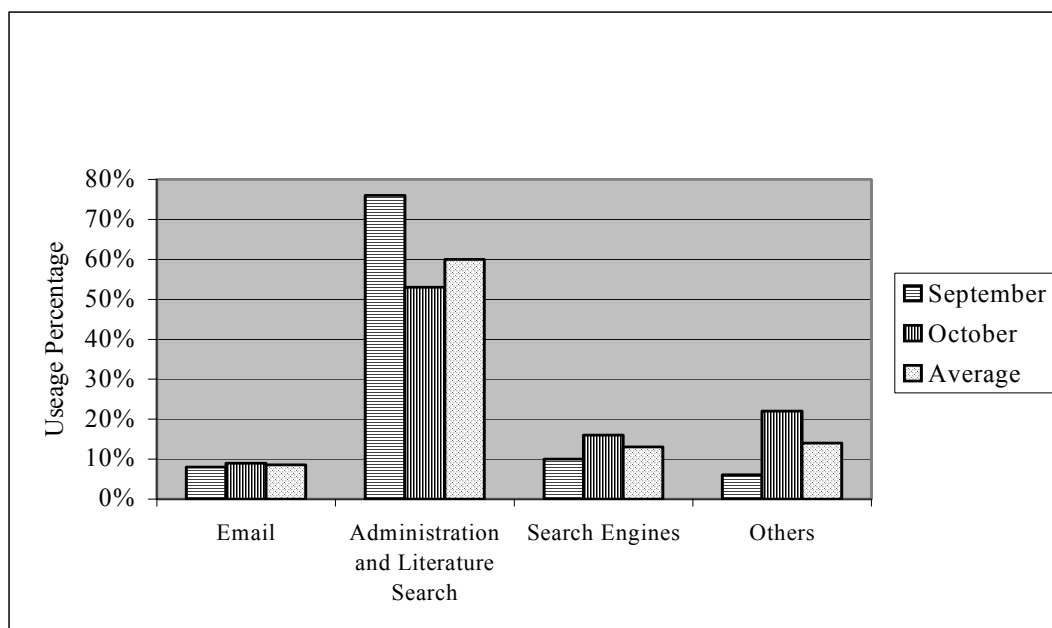
| | Scientists (N=108) | Students (N=34) | Support staff (N=39) | All (N=181) |
|---|-----------------------|--------------------|-------------------------|----------------|
| Male | 40.9 (74) | 11.0% (20) | 13.3% (24) | 65.2% (118) |
| Female | 18.8% (34) | 7.7% (14) | 8.3% (15) | 34.8% (63) |
| Biomedical | 44.7% (81) | 17.2% (31) | 10.5% (19) | 72.4% (131) |
| Statistics/IT/Social Science/Support | 15% (27) | 1.6% (3) | 11% (20) | 27.6% (50) |

2. Improved communication and access to information

The data on bandwidth use, gathered by MIMCom's central technical staff, came from the sites connected to the Internet by the VSAT system. According to this data, usage falls into four main categories: 1) Internet based e-mail services such as Hotmail and Yahoo; 2) acquisition of software through Symantec network and updates of computer operating systems, mainly from Microsoft Windows; 3) in-

formation search on professional sites. Those most frequently accessed include: the U.S. National Library of Medicine's NCBI/PubMed; Health Internetwork (HINARI), a World Health Organization program to supply full text articles free of charge to developing countries; and 4) a wide variety of other uses, including access to news organization sites such as CNN and BBC. Figure 1 summarizes the main four categories of monthly bandwidth use for September and October of 2003.

Figure 1: Monthly network usage by Bandwidth in October and September 2003



3. Use of MIMCom network services

Table 3 summarizes the distribution of responses regarding the use of MIMCom facilities from the 181 respondents to the online questionnaire. The main uses of the network are: to obtain literature

158 (87%); access to information data bases 140 (77%); and search for training and grant opportunities 119 (66%). Table 3 also shows some of the less developed uses of MIMCom Network. These include: teleconferencing (2.2%), online presentation (4.4%), and

attendance of online courses (14.4%).

Table 3: Internet use across the sites reviewed

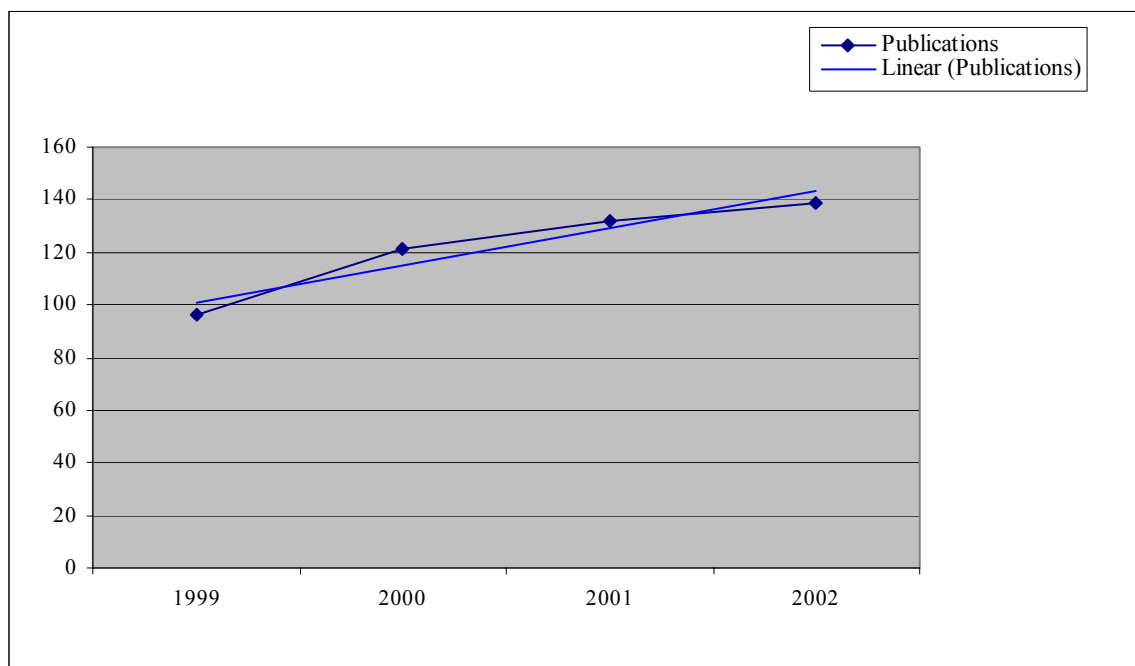
| Contact | | Search | | |
|---------------------------|-------------|----------------------------|---------------------------|-------------|
| | All (N=181) | | All (N=181) | |
| Teleconferencing | 2.2% (4) | Literature | 86.7% (157) | |
| | | Health database | 77.3% (140) | |
| | | Full text articles | 67.4% (122) | |
| Submission | All (N=181) | Subject information | 66.9 (121) | |
| | Articles | 42.5% (77) | Educational opportunities | 65.7% (119) |
| Capacity Building | Proposals | 38.7% (70) | Computer software | 42% (76) |
| | | | Donor organisations | 32% (58) |
| | | | Potential collaborators | 27.6% (50) |
| | All (N=181) | Reserach & work attributes | 16.6% (30) | |
| On-line course work | 14.4% (26) | | | |
| On-line training | 6.6 (12) | | | |
| Give on-line presentation | 4.4% (8) | | | |

4. A positive contribution to professional performance

As a proxy to indicate the contribution to professional performance, NLM asked site directors at sites participating in the MIMCom network to send the number of publications produced by researchers at their sites before and after the advent of enhanced connectivity via MIMCom. The results, drawn from 9 responding sites, are shown in Figure 2. A total of 98 peer reviewed journal articles

were published in 1999 just before most sites had an enhanced connection to the Internet compared with 138 in 2002 when all of the sites were connected to the Internet. A number of other factors may be responsible for 40% increase in the number of publications cited between 1999 and 2003. Data on websites searched on the Internet by the researchers, however, reveal a high volume of traffic to professional journals related to malaria. This indicates that access to literature has benefited scientific publications from the research sites.

Figure 2: The number of publications between 1999 - 2002



Furthermore, a review of a full text journal article delivery program in Africa supported by NLM in collaboration with the Medical Library at the University of Zimbabwe shows that there were 312 requests in 1999. This figure rose to 624 in 2002 suggesting more than 100% increase in demand of the scientific literature available. A ranked list of the 213 journals from which articles were requested shows that 10 journals were the most sought after, based on the number of requests: American Journal of Tropical Medicine and Hygiene (17%) and Infection and Immunity (17%), Journal of Medical Entomology (16%), Parasitology Today (10%), Transactions of the Royal Society of Tropical Medicine and Hygiene (10%), Annals of Tropical Medicine Parasitology (8%), Journal of Immunology (7%), Lancet (6%), Parassitologia (5%), and Journal of Infectious Diseases (5%).

Discussion

MIMCom has become a dynamic tool in the research process. For researchers, the Internet connection to colleagues and to current information has gone a long way toward addressing the distances of time and space that are part and parcel of research in remote endemic areas. Electronic communication has enabled research teams to engage in discussions with colleagues in other parts of the world and participate in real time problem-solving; coordinate research activities; store information; share information; search for literature; submit manuscripts for publication; and send research proposals to funding agencies. Electronic communication also has made possible the provision of long distance educational/training activities and improved communication between students and supervisors.

MIMCom has helped remove geographic as well as intellectual isolation - among the greatest challenges faced by researchers in the sites reviewed. Isolation for these researchers has meant not only difficulty or inconvenience but also a low sense of self-esteem when relating to colleagues in other parts of the world. As a result of links to the Internet, researchers are beginning to join the greater international scientific community online.

MIMCom was intended to be an organized channel for sharing scientific information beyond e-mail exchanges and Internet access. The Antimalarial Drug Resistance Network¹ was used as a proxy to assess the extent to which sharing of information beyond e-mail exchanges has occurred

in the study sites.

The Antimalarial Drug Resistance Network comprises scientists from Ghana, Nigeria, Mali, Tanzania, and Uganda. The network was designed to define systematically the characteristics of *Plasmodium falciparum* infections and parasites resistant to first line and alternative antimalarial drugs, including Chloroquine, Amodiaquine, Sulphadoxine / pyrimethamine (SP), Mefloquine, Halofantrine and Artesunate/SP combination.

With the collaboration of NLM/MIMCom and MIM/TDR (a funding mechanism supported by MIM partners and managed by the UNDP/World Bank/World Health Organization Special Program for Research and Training in Tropical Diseases – TDR), the Antimalarial Drug Resistance Network designed a website (Figure 4) which enables researchers to present their work to the public as well as privately share data summaries. They also have established a secure server in order to share raw data among themselves and thereby improve the flow of information on the pattern of development of antimalarial drug resistance in the region. The website and server are hosted by the U.S. National Library of Medicine.

The more general MIMCom website (www.nlm.nih.gov/mimcom) at the U.S. National Library of Medicine enables users to explore the research interests of participating sites; search major databases and medical reference resources on genomics, pharmacology, reagents, and vaccines; order full-text documents for free and access a number of journals, guides, books, and reports; learn more about how to use the Internet; participate in discussion groups; discover funding opportunities, meeting schedules, and training materials.

The MIMCom website is managed by an experienced webmaster and reference librarian and overseen by an advisory committee of African scientists. When a new entry is posted by the webmaster, an e-mail alert goes out to those who have signed up. The site is updated regularly with information from a wide variety of sources. All MIMCom users, and others who elect to participate, receive “MIMCom Malaria News Update,” a weekly e-mail alert service providing regular news to support malaria research in Africa and networking around the world.

Some of the researchers in the sites reviewed use the MIMCom facilities for information retrieval. Others, such as Antimalarial Drug Resistance Network, use what MIMCom provides in a more interactive way, asking their own questions and receiving personal answers tailored to their own specific needs. In the area of literature and scientific publications, MIMCom has become a real support for the users. They can now undertake the simple actions of carrying out online searches which were not

possible before the installation of IT. Beyond access to information, the results show that a growing proportion of researchers rely on MIMCom to carry out research and submit funding proposals, processes which would have been extremely difficult, if not impossible, only a few years ago. The results also show that MIMCom is gradually becoming a training tool for students and physicians.

Overall, MIMCom has provided researchers in the sites reviewed with four key opportunities: (1) The ability to download PDF files of journal articles making the Internet link a lifeline for many. Large files are now sent through e-mail, saving money and time. (2) The scientists in these centers are now capable of competing favorably with their colleagues in other parts of the world in proposal writing, acquisition of literature, and submission of papers for publication. (3) Users no longer waste large amounts of time looking for Internet cafés. (4) For some junior scientists, MIMCom facilities are the only means by which they can access the information they need for their training.

As with any study evaluating the user's perception of and satisfaction with any given service,

this study has some limitations which one should take into account while interpreting these results. The sample size of researchers responding to the on-line questionnaire was small, although the number who did respond represented 51% of the users at the participating sites. As with any online survey, the sample was subject to a recruitment bias. It is not possible to know the extent to which those who did not respond to the questionnaire did so because they were not interested or because they were satisfied with the MIMCom facilities. Further, it is difficult to compare the research sites in terms of the impact of enhanced connectivity because of major differences in organization, size, and prior IT history. Some of the sites had slow e-mail before MIMCom; other sites had virtually no communication links at all. Nevertheless, this evaluation activity has been based on common experiences, and the conclusions and information provided are generally valid for all sites. The ultimate goal of an in-depth evaluation of the impact of enhanced connectivity on malaria research and its contribution to reducing malaria morbidity and mortality will be possible only after some years of enhanced connectivity and additional evaluation activities.

Figure 4

NATIONAL LIBRARY OF MEDICINE

ADRN Home Page

Contact NLM | Site Index | Search Our Web Site | NLM Home

Health Information | Library Services | Research Programs | New & Noteworthy | General Information

"We must develop a communications system so that the miraculous triumphs of modern science can be taken from the laboratory and transmitted to all in need."

-- Senator Lister Hill, 1965

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Conclusions

The purpose of the present study was to examine the use of IT by scientists, students, and administrative personnel to facilitate communication, retrieve information, obtain documents, write proposals, and prepare papers for publication.

The speed with which simple tasks now can be carried out, thus saving time, energy, and money, appears to be the most important result of enhanced connectivity at the participating sites. The new facility has, within limits, made a positive contribution to researchers' productivity and efficiency and, subsequently, to each site's research agenda. Further, enhanced connectivity and access to information have affected each site's financial bottom line through savings in areas such as transportation related to communication, telephone and facsimile transmissions, and ordering supplies and by supporting development and submission of research grant applications. Respondents to the online survey mentioned the importance of being able to communicate with donors in a timely fashion, of being able to collaborate effectively with others on proposals, and finally, to submit proposals by the appointed deadline.

Access to the Internet enables rapid communication between investigators working at different research sites as well as access to online literature and data. Subsequent development of electronic networks could promote the use of common databases to facilitate research efforts at multiple sites across the continent.

Although the access to the Internet and information which was envisioned in Dakar at the first meeting of the Multilateral Initiative on Malaria has been realized for many researchers, African scientists' full participation in the scientific community is still evolving.

Implications

To what extent does an information technology (IT) intervention, as described in this paper, translate into a change in the disease burden of malaria? Will researchers in Africa be able to use the tool in more innovative ways than their colleagues have employed it in other parts of the world? Will they use the connectivity to create collaborations among African researchers in support of common interests that they then move forward together? Next steps are burdened by models from the past which support hierarchical structures competing through the

withholding of data and information.

The challenge for African researchers involves an enormous leap of faith and a mastery of basic research skills, but the rewards could be great. The promise of IT in malaria research in Africa holds with it the key for capacity building, a leveling of the playing field in international research, and a whole new way of doing science.

This paper is just the first step in a broader discussion of critical issues addressing the obvious inequity of access to the benefits of IT. The information contained herein will provide a building block for additional studies which one day can address the question: Can an IT intervention make a difference in the morbidity and mortality of malaria? At present, these findings can be used by research sites and principal investigators in their efforts with funding organizations to make their current IT sustainable and expandable as required. The findings also can be used by consortia such as the Multilateral Initiative on Malaria as they work proactively to promote interaction among IT, research, and better health with governments in Africa (i.e., regulatory bodies, telephone company monopolies, ministries of health, and policy makers), foundations, corporations, and international aid organizations. IT is critical to widening the circle to include African researchers as part of the international scientific community.

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