Mobiles for malaria

From improved management information flows to parasite diagnosis, the mobile phone is becoming a valuable tool in the fight against malaria. Professor William Brieger reports

Communications is an essential function in the delivery of public health services. Information must to be shared; ideas need to be disseminated; and health workers and clients desire encouraging messages. In recent years as access to mobile phones continues to expand, greater use is being made of mobiles to improve public health services in Africa generally and malaria programmes specifically.

This month we are sharing various experiences in using mobile phones for malaria programmes. Some information comes from news reports, while others come from well-designed research studies. A number of issues such as cost and coverage still need to be resolved before cell phone communications can be taken to scale, but the fact that people around the continent are trying to improve services through use of mobile is an encouraging sign of 21st Century health progress.

One name for this kind of progress is 'leapfrogging.' Neil Versel described the 'hundreds of millions of people who never had access to land lines' leapfrogging or jumping over beginning or intermediate technology in their access to mobile phones.[1] This jump in turn has enabled large populations who 'never before had access to even the most basic medical care now are moving to the forefront of mobile health.'

In examining the potential for mobile technology in 21st century healthcare in Africa, Zurovac and colleagues[2] first address the health communications gap – the barriers that inhibit free flow of health information among health service managers, health service providers, and health consumers (see Figure 1). They propose six major areas of malaria control in which deficiencies are apparent and text messaging interventions could be beneficial as follows:

- Disease and treatment effectiveness surveillance.
- Monitoring of the availability of health commodities.
- Pharmaco-vigilance and post-marketing surveillance of the safety and quality of antimalarial drugs.
- Health worker adherence to guidelines.
- Patient adherence to medication regimens, and post-treatment review.

Zurovac et al noted the paucity of peer-reviewed research studies to test these various options, and there is no attempt here to replicate or expand on that area of their work. Instead we are sharing both small-scale study reports and informal reports of mHealth already in use in an attempt to improve the quality of malaria services in Africa. Hopefully this will stimulate some of the more academically minded readers to design intervention trials and will inspire practitioners to make better use of the mobile resources they already have at hand.

Surveillance, monitoring and evaluation

Health systems require timely and accurate data to make decisions about resource provision and allocation. mHealth provides a tool to achieve stronger Health Management Information Systems (HMIS). This can be achieved directly with cell phones or through modems attached to computers. While text messaging can strengthen the flow of data toward the centre, it may not ultimately improve services unless there is feedback.

The potential for mobile phones in monitoring and surveillance is two-fold. First the devices provide an opportunity for better transmission of routine HMIS. Secondly they can be used to alert programme managers to outbreaks in malaria epidemic prone areas.

As noted above, not many organised operational research studies have tested cell phone use in real healthcare settings. Fortunately there are a few in the area of monitoring and reporting of malaria data. One study team set up a SMS-based reporting system to improve timeliness of malaria data in over 140 clinics in two remote districts in Uganda.[3]

The Ugandan clinics reported RDT positivity rates of 48% in Kabale and 71% in Gulu, with more than 85% of health facilities reporting weekly. What was quite interesting about this study was the reporting of cost data. The set-up cost was $100/health facility, and local technician support cost $400 per month, yielding a cost of $0.53/week/clinic. All of this was done 'without monetary incentives or additional supervision.'

The Uganda Health Information Network is another group that has maintained information on costs of routine data transfer through mobile networks. UHIN conducted as assessment in 2004–2005 that showed 'the network delivered a 24% saving per unit of spending over the traditional manual data collection and transmission approaches.'[4]

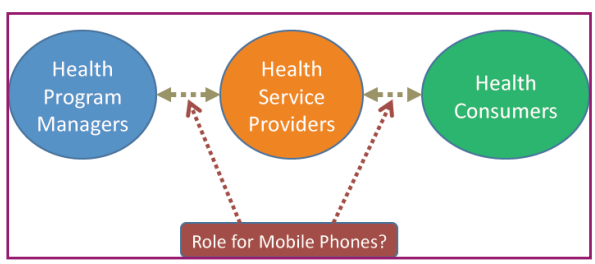

Figure 1 The health communications gap

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Another important mobile device is the modem which transmits health information using the same telephone company airwaves. We have observed medical records staff at clinics in Rwanda, for example, linking their laptops to mobile modems and transmitting monthly spread sheets to regional and national databases.Field visits to health districts in Burkina Faso earlier this year made us aware of how mHealth could potentially aid in the notification of diseases.[5] A new feature of district data collection is weekly reporting of notifiable diseases including severe malaria. Each person in charge of a community health centre has a cell phone and calls the District Monitoring and Evaluation Officer with his or her data. They do not text. These reports are then filed through the Regional to the national HMIS levels. Not infrequently, health workers need to ride their motorcycles several kilometers from their station to get good cell phone reception.

Botswana provides a good example of timely notification of outbreaks. Botswana is on the front-line of countries targeting malaria elimination among South African Development Community members. The disease is rare, often imported in the south and epidemic in areas in the north east and north. A group of partners including the Ministry of Health, Hewlett Packard, Positive Innovation for the Next Generation (PING), Clinton Health Access Initiative (CHAI), and the mobile network provider MASCOM, conducted a mobile disease response pilot programme starting in 2011.[6]

In the first year of the Botswana trial, over 1000 malaria notifications were reported from Chobe Region. The data transmission time reduced from 3–4 weeks to just minutes. When plotted on a map, these data points suggested over 80 potential outbreak sites.

Mobile phones can provide valuable data in tracking potential malaria outbreaks in low incidence areas even without SMS transmission of specific malaria data. A study in Zanzibar, which is near to eliminating the disease, looked at anonymous cell phone usage data. They determined travel by Zanzibari cell phone owners to the mainland where the disease is still highly endemic and used mathematical modeling to determine the potential for such trips to transfer the disease back to the island. While most travel was relatively short term and low risk, the potential for identifying the few trips that could account for most of the risk for imported malaria was demonstrated.[7]

Also on Zanzibar the US President's Malaria Initiative has been supporting a public–private partnership between Selcom wireless, (a Tanzanian information technology company), the Zanzibar Malaria Control Program (ZMCP), PMI, and Research Triangle Institute. A customised text messaging application is being used in 52 clinics to report positive malaria cases. When the number of weekly laboratory confirmed malaria cases exceeds the average number of cases from the previous 3-month period a response is initiated. Surveillance teams visit the health centre, educate the community, and even do community treatment of all suspected malaria/fever cases.[8]

Monitoring the efficacy of malaria medicines is another important mHealth surveillance activity. The Mobile Authentication Service (MAS), a mobile phone enabled technology is currently doing more than prevent the faking popular drugs in Nigeria.[9] MAS 'enables the consumer to authenticate the originality of the drug in his/her hand at the point of purchase. A scratch card is attached to the inner pack of the drug. By simply scratching the panel a unique of numbers can be seen. The consumer sends these numbers to a short code 38353, instantly he/she receives an SMS confirming the authenticity or otherwise.'

Researchers at the Dodowa Health Research Center outside Accra, Ghana, used mobile technology to follow up on patients at rural health centres from the third day after treatment to learn their experiences with the medicine and any new symptoms. Of over 4000 patients, 64% were reached by phone with calls lasting less than 4 minutes.[10] They demonstrated that clinical monitoring through mobile phones is fairly feasible in rural areas of Africa.

mHealth is not just a surveillance and reporting tool for health centre staff and researchers. In Cambodia Village malaria workers can 'now report in real time all malaria cases in their villages to the Malaria Information and Alert System in Phnom Penh with a simple text message, including the patient's name, age, location, and type of parasite.'[11]

Monitoring commodities and implementation

Funding has increased dramatically for malaria control programmes over the past 10 years, so the amount of malaria medicines and other commodities brought in to a country may be adequate, but somehow these do not always wind up in the right place at the right time. Mobile technology can help track and order commodities to save lives.

Ghana: some clinics have a satellite link for sending HMIS data

According to *Healthcare Global* Magazine, the programme *SMS for Life* is predicated on the fact that, 'In many African countries where malaria is widespread, a lack of infrastructure and computer technology means managing the distribution of anti-malarial medication is incredibly difficult, so although ACT drugs are available, a poorly managed supply chain means mortality rates are still high.'[12]

In Tanzania, for example, SMS has proved to be a valuable two-way tool. On a weekly basis a 'simple text message is sent out to the 5000 health facilities in Tanzania, prompting them to send back a stock number against the five different ACT variants and injectable quinine.' In the pilot phase of this programme, stock-outs were reduced by 70%, as reported in *Healthcare Global*.

Novartis, a major supplier of ACTs, reported the Tanzanian SMS for Life effort reduced stock-outs from 79% to less than 26% in the three districts.[13] Similar efforts are underway in Ghana.

The SMS system tested in Kabale and Gulu Districts described above, was also used to report on stock-outs of artemisinin-based combination therapy (ACT) drugs.[3] Stock-outs were 54% in Kabale and 54% in Gulu. The group concluded that, 'With the development of specific capacity to manage stock data at district level, the availability of timely data offers potential to address commodity distribution problems and reduce stock-outs.' More importantly, the authors addressed the practical issue of feedback – hoping that improved data collection would not be just a newer technological one-way street:

Maintaining the observed high compliance may depend on demonstration of a clear improvement in the quality of the support health workers receive as a result of their reports, such as improved stock delivery, in addition to the feedback reports.

The USAID DELIVER Project is working with ministries of health in many African countries to strengthen supply chain management in the public sector.[14] DELIVER has introduced EpiSurveyor as an end-use verification mobile technology tool in several countries. EpiSurveyor has replaced paper based reporting and enables quarterly analysis of stock use and case management for malaria. The data once transmitted through mobile phones provides actional information to address stock needs and gaps. In Ghana, for example, EpiSurveyor has been used to create an early warning system for stock-outs of essential medicine.

The Mozambique Health Information Network (MHIN) uses mobile phones not only for reporting data but also for managing malaria commodity stocks.[15] The network receives data for monitoring drug usage and stocks, which is used for ordering medicines. Wireless access points have been developed and a Linux server has been located in Maputo at the Ministry of Health. The Mozambique effort demonstrates the importance of developing and sustaining the information technology infrastructure needed to make mHealth function beyond a few pilot districts.

Mobile technologies are not only programmed to focus on malaria medicines. In Tanzania, mobile technology 'allows for quick communication about stock levels and use of nets by the community.'[16] When people exchange vouchers for insecticide-treated nets at local retailers, the retailer then sends a text message back to a Canadian organization, MEDA so new supplies can be estimated and shipped in a timely manner.

Kenya: data entering for Jhpiego

Akwa Ibom State, Nigeria: a nurse keeps her cell phone close in case she needs to call for more supplies

Health worker capacity building

mHealth provides opportunities for health workers to gain new capabilities as well as reinforce the knowledge, attitudes, and skills they have previously acquired. In short mHealth contributes to both continuing education and supervisory processes.

The title of a new article published on the *Public Library of Science* (PLoS) network, sums up perfectly why we need mHealth work health worker education – 'Even if You Know Everything You Can Forget'.[17] This qualitative study looked at the opinions of health workers who participated in regular SMS reminders about correct malaria case management procedures. The researchers found that the respondents had, 'high acceptance of all components of the intervention, with the active delivery of information in an on the job setting, the ready availability of new and stored text messages and the perception of being kept "up to date" as important factors influencing practice.'

According to the Uganda Health Information Network

(established in 2003), Uganda 'has one of the highest burdens of disease in the world but also some of the best cellular telephone coverage in Africa.'[4] This situation provides both a stimulus and a means for tackling the malaria problem in new ways. UHIN reports that… *Continuing Medical Education (CME) targeted to doctors, senior nurses, and senior clinical officers ('tier-1'), and to community health workers ('tier-2') is regularly broadcast though the UHIN. Both tiers of health workers receive content three times a week via PDA pertaining to diagnosis, treatment, and prevention of major health problems such as diarrhoea, pneumonia, malaria, HIV/AIDS, and tuberculosis. In addition health workers receive daily news from mainstream media on a daily basis through the network*.

In Kenya, a cluster-randomised controlled trial at 107 rural health facilities in 11 districts in coastal and western Kenya was undertaken to address the problem of health workers not following national malaria treatment guidelines. Health workers in the intervention group H received text messages on their personal mobile phones on malaria case-management for 6 months. At follow-up, case-management practices were assessed for children who needed treatment and a 24% improvement was seen immediately after intervention as stayed at the same level 6 months later.[18]

In Tanzania, Community Health Workers (CHWs) are responsible for 100 households in their catchment area and visit five households per day, making sure to visit each household at least once a month. A pilot SMS reminder system was set up to see how visiting and follow-up of referrals could be improved.

The Tanzanian CHWs in the SMS group automatically received an SMS message 2 days after they had reported a referral with 'CommCare,' reminding them of the follow-up visit. Daily SMS messages were sent until the follow-up was recorded. 'The reminders resulted in an 86% reduction in the average number of days a CHW's clients were overdue (9.7 to 1.4 days).'[19] This greatly reduced the number of supervisor visits needed.

Diagnosis and treatment

Several mobile tools are being proposed and developed to augment malaria diagnosis at the front line. Antigen-based rapid diagnostic tests (RDTs) for malaria have revolutionised malaria treatment at peripheral clinics and in the community. The expanded use of mobile devices does not replace RDTs but can be used to enhance accuracy and usefulness.

Transmitting RDT images can also be used to help map malaria distribution and thus, according to Mudanyali and co-researchers,[20] provide, 'realtime spatio-temporal statistics for the prevalence of various infectious diseases.' Their smart RDT reader platform running on cellphones would hopefully 'assist healthcare professionals and policy makers to track emerging epidemics worldwide and help epidemic preparedness.'

Another research team has developed a mobile phone application that they hope will also contribute to real time tracking of malaria. The group, led by Wilson To, is using a custom-made app and a tiny lens scrounged from an old CD player, to make it possible for a Windows Phone to diagnose malaria from a drop of blood.[21]

Similarly a research group at the University of California, Berkeley has been developing a small 'microscopy' attachment to a cell phone. The device, called a CellScope, "is designed to uncouple the need for a physician to be in the same place as a patient, allowing those who lack the benefits of healthcare to be properly diagnosed.' CellScope uses a slide containing a blood sample.[22] 'A ring of bright LEDs illuminates the sample, and if faint blue dots appear, the patient is positive for malaria. The image can then be transmitted to medical experts for analysis and recommendations.'[23]

The Bill and Melinda Gates Foundation is funding development of other innovative mobile technologies. One such project is 'Using an ordinary mobile phone camera with a $15 specialised lens, the system can detect malaria by imaging the eye or the skin to look for hemozoin, a pigment generated by the malaria parasite when it digests red blood cells. This pigment changes the orientation of light reflecting back from the tissue."[24] The images can be telecommunicated immediately to reference laboratories, for diagnostic confirmation by experts.

It is not certain when such devices will become cheaply and widely available. Most will have stand-alone diagnostic capabilities. The use in mapping and tracking will require additional regional and national network capacities to receive and integrate diagnostic data that are transmitted and back-up laboratory technicians and physicians on call to interpret results in special cases. Even so, this will be an especially important tool in tracking transmission in countries nearing malaria elimination.

Consumer education and follow-up

Another aspect of case management of malaria is tracking patients and learning the effect and efficacy of medicines used to treat them. A team of researchers recruited 100 volunteer consumers of malaria medications from pharmacies and other outlets in Sagamu, Nigeria, to provide feedback via a toll-free phone number over a 2-week period on their reactions to malaria medicines purchased.[25] Most volunteers called within the first few days though none called after 96 hours. This small study hints at a feasible methods for patient follow-up and should be tested on a larger scale.

Rwanda: a health centre uses a modem to send health service statistics

In Kenya 70 000 mobile device users now have access to accurate health information at the touch of an app on their cell phones. There is a symptoms menu along with links to appropriate healthcare personnel.[26]

In closing, we can see that examples of mobile technologies presented here show that mHealth is both a current practical reality as well as a subject for further research to improve the delivery of malaria services. mHealth can be both timely and cost-effective. It does require an investment in wireless and mobile infrastructure for these benefits to accrue, but it is worth the investment is health workers and malaria programme managers do not 'forget' important information, but use it to save lives.

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Nigeria: what can we do with this patient? Health centre staff can call for the help of supervisors to solve problems