Mobile Health Information System
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Final Project Report

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John M. Lloyd Foundation
Henry E. Niles Foundation
and Qualcomm, Inc.

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The Mobile Health Information System (MHIS) project is a collaborative undertaking of the following institutions:

Eastern Cape Department of Health (Government/Implementing partner)

AED-SATELLIFE (Lead implementing agency)

Henry E. Niles Foundation (Donor)

Qualcomm Wireless Reach (Donor/Implementing partner)

John M. Lloyd Foundation (Donor)

MTN - South Africa (Cellular provider)

Nelson Mandela Metropolitan University (Project evaluation)

South Africa Partners (Implementing partner)
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Abstract

The goal of the Mobile Health Information System (MHIS) project was to improve patient care by providing nurses at three urban hospitals in Port Elizabeth, South Africa with clinical information at the point of care. Fifty nurses at three hospitals of the Port Elizabeth Hospital Complex were trained to access treatment guidelines, essential drug information, protocols, a medical calculator, and other actionable evidence-based content employing an electronic system using a combination of mobile computing devices and the existing wireless telecommunications network. Nurses were introduced to the productivity applications and communication functionalities of the smart phone, and learned to use SMS (short messaging system), email, and the Internet to search for information and engage in dialogue with colleagues around the world. From January 2009 to February 2010, the nurses integrated the use of the smart phone into their daily activities and consulted the information resources on the device on a regular basis to improve clinical nursing practice through enhanced management and care of patients, provision to patients of accurate information on illnesses, expansion of personal knowledge, and professional development.

Executive Summary

In addition to the burden of the HIV and AIDS epidemic, South Africa suffers an acute shortage of nurses that exacts a heavy toll on the delivery of health care in the country. In 2008, the Inter-Press Service reported that according to Health Minister Manto Tshabalala-Msimang, the shortage of nurses in South Africa numbered 40,000. As nurses from many countries in Africa migrate abroad in search of higher salaries and better working conditions, the burden of providing care to the world’s poorest populations increasingly falls on nurses rather than doctors.

The inability to access medical and health information hobbles healthcare providers in the world’s poorest countries. Unreliable and expensive, the Internet has not solved the challenge of accessing information for decision-making in these regions. Meanwhile, health workers in rich countries increasingly capitalize on the power of mobile devices to retrieve information at the point of care and improve practice.

In 2006, AED-SATELLIFE completed a pilot project funded by the John M. Lloyd Foundation to field-test a handheld computer (or Personal Digital Computer or PDA) pre-loaded with a Mobile Library of information for treating HIV-infected and AIDS patients in South Africa. The PDAs were tested at hospitals and clinics run by The Valley Trust in KwaZulu Natal and met with a strong positive response from nurses who had little or no access to current information resources (either printed or digital). The physicians in the pilot, who had access to both journals and the Internet, did not find the PDAs or the content on the PDAs useful.

AED-SATELLIFE with funding from the John M. Lloyd Foundation, the Henry E. Niles Foundation, and Qualcomm Wireless Reach, developed a collaborative public/private partnership with the Eastern Cape Department of Health (ECDOH), the Port Elizabeth Hospital Complex (PEHC), South Africa Partners (SAP), MTN (a wireless telecommunications provider), and the Department of Nursing Science at the Nelson Mandela Metropolitan University (NMMU) to build on the useful results of the Mobile HIV/AIDS Library pilot. The goal of the effort was to create a Mobile Health Information System (MHIS) that used mobile phones and wireless technology to build the capacity of health care workers in resource-poor urban health care settings to improve patient care by providing them with locally relevant clinical information at the point of care.
From January 2009 to February 2010, MHIS was implemented at three hospitals of the PEHC with fifty clinical nurses who were trained to use smart phones loaded with digitized medical guidelines, diagnostic tools, drug formularies, and other evidence-based health information. Participating nurses learned to operate the Samsung i780 smart phone, access health information stored in the device’s memory, use SMS and email, search the Internet, and use productivity applications such as calendar, contacts, and medical calculator. Ongoing, weekly training sessions were held at each hospital and technical support was provided by Information Technology (IT) staff at each hospital and by MTN.

In August 2009, an independent, formal evaluation research study was conducted by the Department of Nursing Science at the Nelson Mandela Metropolitan University in Port Elizabeth. The study was comprised of two components: (1) a self-administered questionnaire to assess the experience of the nurses in using the smart phone, and (2) a direct observation of competence in using the device.

The results of this evaluation indicated that nurses enthusiastically embraced the new mobile technology and used the information accessible on the device to update their own clinical knowledge, for diagnosis and treatment of patients, to provide accurate information to patients, to teach students, and to share information with colleagues. The study showed that nurses actively utilized email and SMS to connect with colleagues, and searched the Internet for health information. Especially among the population of older nurses (given their complete unfamiliarity with computers), the evaluation indicated the need for longer training sessions in the use of mobile devices; for all age groups, results clearly demonstrated the need for ongoing training and technical support if the potential of the technology is to be realised. The most significant findings showed that 97% of nurses found the mobile device useful as it enabled easy access to information, 89% found nursing practice was enhanced with information accessible at the point of care, and 92% cited the portability of the device as an asset. In the words of one nurse from Dora Nginza Hospital, “Having the device has opened new doors for me.”

Recommendations emerging from the evaluation study included 1) Expansion of the project to health care providers in rural areas without access to libraries and health literature; and 2) Provision of computer training in nursing education and for practicing nurses.

Project description

Background and problem statement

The disparity between the numbers of health workers in high and low income countries is stark: the Americas command 42% of the world’s health workers while sub-Saharan Africa has only 3%. In March 2008, the first Global Forum on Human Resources for Health, convened by the Global Health Worker Alliance identified “health worker migration as one of the fundamental issues to be addressed for the resolution of the health workforce crisis.” According to the World Health Organization, on average one in four doctors and one nurse in 20 trained in Africa is working in an industrialized country. At least, 29% of Ghana’s physicians are working abroad as well as 34% of nurses from Zimbabwe. Increasingly, the burden of providing care to the world’s poorest populations falls on nurses rather than doctors. South Africa is experiencing an acute shortage of nurses that is exacting a heavy toll on the delivery of health care in the country. In 2008, the Inter-Press Service reported that according to Health Minister Manto Tshabalala-Msimang, the shortage of nurses in South Africa was acute and looming at 40,000. Nurses from many countries in sub-Saharan Africa are migrating abroad in search of higher salaries and better working conditions. Those who remain face enormous workloads, while meager resources for the public health system translate into poor pay, lack of current health information, unsafe work environments, and inadequate opportunities for professional career development and advancement.
Countless people die unnecessarily in resource-constrained countries as health care providers rely on outdated, inaccurate, and unreliable information to care for patients. Due to poor communications infrastructure and prohibitively high cost, doctors, nurses, and public health workers in Africa, Asia, and Latin America do not have recourse to the fundamental health information required for good practice and sound decision-making. Increasingly in industrialized countries, health workers capitalize on the power of information and communications technology to access diagnostic and treatment information at the point of care. Numerous studies in the medical literature have demonstrated the usefulness of computers to access the Internet for information for decision-making. In recent years, studies have also shown that mobile devices are valuable tools for making information accessible at the point of care; their portability, small size, and computing power are attractive features for busy health workers who need ready and easy access to information.

AED-SATELLIFE’s experience in using mobile technology for health

The AED-SATELLIFE Center for Health Information and Technology is a recognized leader in developing and deploying information and communication technologies to support development within the health sector. It has developed several mobile computing systems for data collection and transmission and has managed projects involving the use of ICT for health that support routine health facility reporting and continuing provider education. AED-SATELLIFE has supported projects using mobile technology in 30 countries.

AED-SATELLIFE created the Uganda Health Information Network (UHIN) project that reaches over 600 health workers in 174 health centers serving over 1 million people. A two-way communication system for the delivery of continuing provider development and the collection and transmission of public health data (HMIS and disease surveillance), UHIN has built technical capacity among Ministry of Health personnel to operate and maintain the network in the five rural districts. Using their mobile devices, a wireless access point, and the wireless telecommunications network, nurses, physicians and other health personnel access regular broadcasts of relevant health information on diseases and conditions commonly seen in rural hospital and health centers. The mobile devices also contain a static library of treatment guidelines published by the Ugandan Ministry of Health, a medical calculator, a medical dictionary, and other reference texts. UHIN also includes a component for routine data collection using the PDAs and electronic versions of forms developed by the Ministry of Health. Launched in 2003, the UHIN project remains active and the Ministry of Health of Uganda is keen to expand the technology nationwide.

At the request of the government, a similar project was implemented in Mozambique. In collaboration with the Mozambican Ministry of Health (MISAU), the Ministry of Science and Technology, and local stakeholders, AED-SATELLIFE has established a wireless communication network integrating low-cost handheld computers, the existing GSM/GPRS network, and wireless access points in five districts in rural Mozambique for data collection.

AED-SATELLIFE has developed, tested, and implemented a digital surveillance and reporting platform, called GATHERdata™, to enable health systems to collect and report data using cell phones, mobile computers, and the Internet. GATHERdata™ facilitates easy creation of reporting instruments giving national health systems and NGO's the affordable tools they need to enhance decision making, disease surveillance, and program monitoring and evaluation. GATHERdata™ is designed to be adaptable to other international development activities including environmental, education, human rights, and other initiatives.

AED-SATELLIFE’s experiences from these projects indicate that when health care providers are able to access relevant health information on mobile computing devices their ability to provide better patient care is enhanced. For example, in 2004 in Uganda, an independent study conducted by Makerere University on the impact of UHIN concluded that access to health information through handheld computers had improved the health workers’ management of common conditions and diseases: they made quicker and more accurate
diagnoses; diagnosed more complicated cases, which would normally have been referred to a higher level health facility; referred continually to the PDA for choice of drugs; kept informed about new or alternative drugs and their side effects; selected appropriate treatment options; and provided valuable information to patients regarding drug administration, preventive measures, and alternative treatment options.

In an effort to support nurses and doctors caring for HIV and AIDS patients in South Africa, AED-SATELLIFE undertook a pilot project in 2006 to build the capacity of clinical nurses and doctors in resource-poor urban healthcare settings to use a mobile device to access health information. AED-SATELLIFE field-tested the Mobile HIV & AIDS Library, a handheld computer pre-loaded with essential information for treating HIV-infected and AIDS patients in South Africa. The PDAs were tested at hospitals and clinics run by The Valley Trust in KwaZulu Natal and met with a strong positive response from nurses who had little or no access to current information resources (either printed or digital) or to reference materials. The physicians in the pilot, who had access to both journals and the Internet, did not find the PDAs and/or content on the PDAs useful. Based on evidence from the field test in KwaZulu Natal, AED-SATELLIFE chose to focus on clinical nurses as a target audience during the next phase of Mobile Library development.

**Project Partners**

Based on discussions with South Africa Partners, a non-profit organization that had implemented several projects in South Africa, the decision was made to focus on the Port Elizabeth Hospital Complex in the Eastern Cape, South Africa as the target site for the MHIS pilot project. From March 2007 – March 2008, the MHIS project made several advances towards its goal of deploying smart phones and wireless networks for putting clinical information and diagnostic tools into the hands of nurses at the point-of-care. Over the course of the year, AED-SATELLIFE identified and established relationships with several partners in the Eastern Cape. Qualcomm Wireless Reach, in addition to being a funder listed in the following section, was also a partner in the project.

The **Eastern Cape Department of Health (ECDoH)** is responsible for the provision of “promotive, preventive, curative and rehabilitative health services” throughout the province. To reach its goal of delivering accessible, comprehensive, and integrated services in the Province of the Eastern Cape emphasizing the Primary Health Care approach, the ECDoH has developed a strategic plan which includes numerous objectives aimed at continuing education of clinical staff and building the capacity of health sector management to use information for decision-making.

The **Port Elizabeth Health Complex (PEHC)** was established in 2001 through the merger of three formerly racially segregated hospitals that together serve a population of 1.4 million people in the Port Elizabeth metropolitan area:

- **Dora Nginza Hospital**, Sponder Road, Zwide
- **Livingstone Hospital**, Standford Road, Korsten
- **Port Elizabeth Provincial Hospital**, Buckingham Road, Mount Croix

The Department of Nursing Science within the Faculty of Health Sciences of **Nelson Mandela Metropolitan University (NMMU)** offers a four-year Nursing Degree Program developing skilled, knowledgeable, and independent Registered Nurse Practitioners. Candidates who successfully complete the program can register with the South African Nursing Council as a Nurse (General, Community, and Psychiatric) and Midwife. The department also offers Masters, Doctoral, and continuing professional development programmes.

The Faculty of Health Sciences and the Department of Nursing Science staff contributed to the development of a needs assessment instrument and supervised graduate nursing students from the department in gathering this data and assisted in the evaluation of survey results. The Department also conducted the final evaluation of the
training provided to the nurses and their use of the smartphones to access health information at the point of care.

**South Africa Partners (SA Partners)** is a non-profit organization that connects people in the United States with their counterparts in South Africa to share the skills, talent, and resources required to build the New South Africa. Focusing on health, education, and economic development, SA Partners works with community organizations, government departments, and academic institutions in each country to develop mutually beneficial partnerships that address social, political, and economic needs in a manner that strengthens communities, builds institutional capacity, and fosters local leadership.

SA Partners has established the Partnerships for Healthy Communities Program focused on efforts to strengthen the health care infrastructure in the Province of the Eastern Cape. Specific areas of work thus far have focused on public health sector concerns as diverse as hospital management; pharmacy system development; women's health, including domestic violence; HIV/AIDS and STD control; clinical and epidemiologic research capacity development; and NGO capacity development.

In July 2008, AED-SATELLIFE entered into a contract with South Africa Partners to help with logistics and facilitate the ground activities in Port Elizabeth. SA Partners staff provided logistical support for the needs assessment, initial training in January 2009, refresher training in August and October 2009, the weekly training sessions at each of the three hospitals, follow up and resolution of technical issues with MTN, and the provision of weekly reports to AED-SATELLIFE regarding the weekly training sessions.

**MTN - South Africa** is part of the MTN Group Limited, a leading provider of communication services, offering cellular network access and business solutions. Launched in 1994, the MTN Group is a multinational telecommunications group, operating in 21 countries in Africa and the Middle East, and is listed in South Africa on the Johannesburg Stock Exchange. MTN believes that through access to communication comes economic empowerment. MTN has provided preferential pricing on equipment and telecommunications services in support of the development and deployment of the Mobile Health Information System.

The project purchased smart phones and airtime packages from MTN for each of the 50 nurses. Technical support was provided by MTN via a support phone number that nurses could call as well as staff attendance at the weekly training meetings at each of the three hospitals, whenever possible.

**AED-SATELLIFE Center for Health Information and Technology** is recognized as a leader in developing Information and Communications tools that work in low-resource environments to support the exchange of critical information. AED-SATELLIFE has significant experience in using mobile computing technologies to extend the reach of information delivery and data collection. Having deployed over 5,000 mobile devices throughout the world for multiple projects, AED-SATELLIFE has gained both deep understanding of the information challenges the health sector faces and unparalleled knowledge of the solutions. AED-SATELLIFE was responsible for all project activities during the start up and implementation phases.

**Project Funders**

The project funders included:

**John M. Lloyd Foundation:** The John M. Lloyd Foundation supports novel, entrepreneurial projects that have a high likelihood of affecting social change with regard to HIV/AIDS. Giving preference to organizations and projects that advocate for evidence-based policies, those that mobilize awareness and support for AIDS programs, and those that employ innovation to battle the HIV/AIDS pandemic, the Foundation works to expand access to HIV/AIDS health care and treatment, and to ensure access to accurate
The Lloyd Foundation supported the development of the first HIV and AIDS Mobile Library and its pilot test, and has contributed to support the needs assessment phase of the Mobile Health Information System (MHIS) intervention in Port Elizabeth.

The mission of the Henry E. Niles Foundation is to help in the nurturing and uplifting of people in need. The Foundation strives to support humanitarian efforts that strengthen education, fight economic hardships through self-help opportunities, and enhance public health and sanitation on a global basis. The Niles Foundation supported this project through a generous grant.

QUALCOMM Wireless Reach: Qualcomm believes access to advanced wireless voice and data services improves people’s lives. Qualcomm’s Wireless ReachTM initiative supports programs and solutions that bring the benefits of connectivity to underserved communities globally. By working with partners, Wireless Reach projects create new ways for people to communicate, learn, access health care, sustain the environment and reach global markets.

**Goal and Objectives of MHIS**

The goal of the project at the Port Elizabeth Hospital Complex was to build the capacity of health care workers in resource-poor urban health care settings to improve patient care by providing them with locally relevant clinical information at the point of care. To achieve this goal, AED-SATELLIFE set the following objectives:

- Design and develop a system for converting clinical health information resources to format suitable for viewing on mobile devices;
- Build the capacity of clinical nurses to use mobile devices to access clinical information;
- Support clinical nurses in their use of health information accessed on the mobile device; and
- Build the capacity of local organizations to incorporate information technology in their health care initiatives.

**Implementation Strategy**

To create and sustain MHIS, the implementation strategy identified a broad set of major activities, defined the roles and responsibilities of the key players, and laid out the technology, content, and on-going support needs for the effort. Activities included:

- Creation of a private-public collaboration (for enhancing sustainability);
- Enhancing stakeholder participation (building consensus, stakeholders meeting, target audience and sites, technology, MOU);
- Identification of clinical content (information needs assessment of nurses, local content from SADOH and ECDoH addressing local needs; meeting additional information needs);
- Training (initial, refresher, on-going);
- Progressive capacity building (nurses, hospital IT teams, three-tier user support, district IT); and
- Fostering local ownership and sustainability.

**Key Project Activities**

**Collaboration of Public/Private partners**

It was clear from the outset that the success of MHIS would depend upon the creation of a collaborative effort among public and private sector partners. Since MHIS rested on the creation of an electronic system, it was necessary to engage private sector technology partners such as Qualcomm Wireless Reach and MTN who could play key roles in the project. Working in the public sector of the South African health system and to ensure the sustainability of MHIS required the active involvement of governmental agencies such as the Port
Elizabeth Hospital Complex at the district level and the Eastern Cape Department of Health at the provincial level. The contribution of resources from the Nelson Mandela Metropolitan University was also a crucial element in furthering the research and publication aims of an information and communication technology project. Project coordination at the local level was vital; South Africa Partners as a non-governmental organization with staff in Port Elizabeth provided the additional support for the smooth day-to-day operations and functioning of the project. By February 2010 when the project was formally concluded, with approval from the ECDOH, MHIS was embedded and operating in a sustainable manner within the PEHC.

Enhancing stakeholder participation

On May 8, 2008 a meeting was held in Port Elizabeth among representatives of multiple stakeholders to develop consensus on key elements of the project. Organizations represented included: the Eastern Cape Department of Health, the Port Elizabeth Hospital Complex, the Department of Nursing of the Faculty of Health Sciences at Nelson Mandela Metropolitan University, South Africa Partners, Qualcomm Wireless Reach, and AED-SATELLIFE. The meeting’s agenda included overviews of nursing education in the Eastern Cape, the technology infrastructure of the Eastern Cape health sector, Qualcomm’s Wireless Reach initiative, and the proposed Mobile Health Information System that would introduce mobile technology for information access among nurses. Participants had the opportunity to use mobile computing devices similar to the ones proposed for the project. Discussion focused on the specifics of which clinics would be involved in the implementation phase and the conducting a survey on the information needs of nurses. PEHC representatives suggested that the labor unions at the three hospitals comprising the hospital complex should be consulted on the proposed project. Due to management changes at PEHC, there was a delay in moving the project forward. However, the CEO of PEHC in September 2008 called for a meeting among union representatives and PEHC administrators and supervisors. After the second meeting, the CEO announced that the project could move forward.

Selection of project sites

Based on feedback from the stakeholder meetings, the decision was made to deploy the MHIS at the three hospitals of the Port Elizabeth Hospital Complex, namely Dora Nginza, Provincial and Livingston Hospitals. Fifty nurses would be selected by senior nursing management from a wide range of clinics and departments, reflecting the comprehensive care environment of the PEHC. These included Antenatal, ARV, Cardiac, Casualty, Chronic Illness, Emergency, Gynecology, Hematology, Maternity, Medical, Neurosurgery, Nursing Management, Occupational Health, Oncology, Outpatient, Orthopedics, Pediatrics, Surgical, Thoracic and Plastics, Training, and Urology.

Memorandum of Understanding (MOU)

Following the stakeholders meeting, an MOU between ECDOH, PEHC, South Africa Partners, Nelson Mandela Metropolitan University, Qualcomm Wireless Reach, MTN and AED was drafted and submitted to the PEHC. The MOU, outlining the roles and responsibilities of the partners, was fully executed by the partners in August 2009. The MOU is included as Attachment-A.

Submission of Proof of Concept

The AED-SATELLIFE/MHIS Project Manager met with representatives of the ECDOH to acquaint them with the goals and objectives of the project and was requested to submit a formal Proof of Concept document to the provincial government. After a formal presentation to the ECDOH/Executive Management Team, the Proof of Concept was signed and fully executed by the ECDOH giving final approval for MHIS. A copy of the signed Proof of Concept is included as Attachment-B.

Selection of phones and airtime for project

The private sector partners were able to lend their experience and expertise in making decisions about the technology that would be used in the project. With the aid and advice of staff at Qualcomm Wireless Reach
and MTN, the CDMA-enabled Samsung i780 was identified as the smart phone which the project would deploy.

**Content**

The development of a Mobile Library of documents that nurses could use to improve their nursing practice was a central component of the MHIS project. To ensure that the selection of health topics was driven by the needs of the nurses, an information needs assessment was conducted prior to the deployment of the project. Content selection was based on the outcomes of the needs assessment. AED-SATELLIFE’s experience in Uganda indicated that once introduced to an easily accessible source of practical information on the mobile device, health care providers would ask for additional and expanded knowledge resources. Therefore, project partners developed a methodology employing electronic means to support the on-going information needs of the nurses which relied on the user support systems that the project successfully implemented at each of the hospitals.

**Needs Assessment**

The Department of Nursing at NMMU conducted a needs assessment in October 2008 to (1) investigate whether access to clinical information at the point of care was readily available, and (2) identify the types of information that registered nurses at PEHC considered necessary on a daily basis to enhance service delivery. A combination of simple random and proportionate sampling was used to determine the sample size of 250 nurses from the 757 registered nurses employed by PEHC at the time of the assessment. A structured, self-administered questionnaire was used to gather the necessary data from the respondents.

The Needs Assessment revealed that the four most common topics that the respondents indicated interest in gaining access to were Extreme Multiple Drug Resistant Tuberculosis (TB) (76%), HIV/AIDS (73%), Multiple Drug Resistant TB (72%) and Anti-Retroviral Drugs (ARVs) (71%). Respondents indicated strongest interest in gaining access to information on TB (60%), Prevention of Mother to Child Transmission of HIV/AIDS (53%) and Non-Communicable Diseases such chronic diseases of lifestyle (52%). Respondents also indicated a keen interest in information on STIs (43%), Malaria (43%) and Public Health Legislation (40%). Other topics in which respondents indicated an interest included accessing information on included laboratory services (39.7%), disease surveillance (38%), research abstracts on topical subjects in health (38.2%), immunizable diseases (37%), diarrheal diseases (34%), maternal health issues (34%) and family planning (30%).

The results of the Needs Assessment formed the basis for the initial selection of relevant clinical content for the mobile device to assist the nurses in improving their nursing practice. The Needs Assessment is included as Attachment-C.

**Developing an Electronic Knowledge-base and Mobile Library**

AED-SATELLIFE’s experience in its mobile health project in Uganda showed that health care providers found local content which addressed commonly seen conditions to be most useful. Building on this learning, the initial PEHC Mobile Library was comprised of two local documents: the South African Standard Treatment Guidelines and Essential Drug List for Primary Care and the Eastern Cape Diseases and Conditions Directory. Compiled by the South African Department of Health, the comprehensive national treatment guidelines sets forth the standard of care for a wide range of commonly seen conditions in South Africa, including those topics that the nurses identified in the needs assessment. The Eastern Cape Diseases and Conditions Directory is more locally based and covers 10 common conditions, each presented in 2-3 pages of easily accessible language. These documents as well as a medical calculator were downloaded from their respective web sites on the Internet and loaded on to all 50 smart phones for the initial training.
In conjunction with this project, AED-SATELLIFE designed, developed, and tested an automated content conversion application and content management system, called GUIDE™, to facilitate the process of converting very lengthy paper-based and online documents including complex graphs, tables, and illustrations to a format suitable for viewing on the small display of a smart phone. For the PEHC Mobile Library, the Standard Treatment Guidelines and Essential Drug List for Primary Care and the Eastern Cape Diseases and Conditions Directory documents were converted using GUIDE™, with sub-sections hyperlinked for easy navigation and browsing of content.

**Meeting additional information needs**

Ongoing feedback from the nurses has contributed to the identification of new topics based on their particular informational needs. Within two weeks of the deployment of the MHIS at PEHC, the AED team began to receive - and respond to - requests from the nurses using the system for supplemental information resources on topics specific to their clinical areas. Over the course of 2009, the nurses continued to send their requests for information on a wide range of clinical topics. While the Hospital Level Guidelines outlined diagnostic and treatment information in a bulleted format, the supplemental information provided more explanatory narratives. Nurses were particularly interested in outbreak and treatment information on H1N1 and Rift Valley outbreaks in South Africa and nurse migration issues in Africa. Pertinent health information was selected primarily from the South African Department of Health web site, ECDOH web site resources, and other credible institutions such as the WHO, CDC, and the NIH.

As the nurses’ ability to use email, open file attachments, and save files on to the embedded memory card improved, AED-SATELLIFE located the requested information and transmitted the files to the IT staff at each of the three hospitals for electronic distribution to the nurses. A major accomplishment has been the compilation of all the information resources provided in response to nurses’ requests into one consolidated, comprehensive mobile library of documents with an easily navigable Table of Contents launched from an icon on the main screen of the smart phone. The nurses’ smart phones currently hold several thousand pages of clinical content.

**MHIS Table of Contents**

1. Guidelines
   - a.) Hospital Level (adults)
   - b.) Primary Health Care
   - c.) National ARV Guidelines
   - d.) National PMTCT Guidelines
   - e.) National Guidelines on Cervical Cancer Screening
   - f.) Eastern Cape Diseases and Conditions Directory

2. HIV/AIDS
   - a.) ART Associated Adverse Events
   - b.) Opportunistic Infections
   - c.) Cryptococcal Meningitis
   - d.) Deep Vein Thrombosis
   - e.) Lactic Acidosis
   - f.) Skin Disorders
   - g.) WHO Staging System for HIV Infection in Children
   - h.) WHO Staging System for HIV Infection in for Adults

3. HIV/AIDS and Paediatric Care
   - a.) Challenges of Paediatric HIV Care and Treatment in South Africa
   - b.) Clinical Manifestations of Advanced Paediatric HIV

4. Diabetes
5. Trauma
   a.) Head Injuries
   b.) Crush Syndrome

6. Tuberculosis
   a.) XDR-TB in South Africa
   b.) MDR and XDR-TB Facts

7. Swine Flu
   a.) Interim Case Management of Influenza
   b.) Swine Flu (2009 H1N1 Flu) in South Africa

8. Other Conditions
   a.) Birth Defects
   b.) Human Papillomaviruses and Cancer
   c.) Malaria Nursing Care
   d.) Sciatica
   e.) Spinal Stenosis

The Mobile Health Information System Library
Sample Content on the Smart Phone

Donors                                           Table of Contents

Eastern Cape Disease Directory                   Standard Treatment Guidelines
A medical calculator with formulae and scores was also made available on the smart phone for the calculation of dosages of drugs. In addition to this suite of medical reference materials, the PEHC nurses had access to other health information within their hospital settings and resources developed by AED-SATELLIFE such as their HealthNet News-Nursing e-newsletter. PEHC Nurses are also able to take part in email-based discussion groups offered by AED-SATELLIFE to all the readers of HealthNet News.

**Training**

From the successful implementation of numerous information technology projects, AED-SATELLIFE has learned the pivotal importance of investing resources in training health care providers to use the technology. Therefore, in planning the deployment of the MHIS, the project built in time for initial training, refresher training sessions, and regular, on-going training to ensure that nurses introduced to new technology in the form of a mobile device for information and communication purposes were made fully comfortable with its use.

*Initial training:* Project partners deployed new smart phones, the Samsung i780 (Windows OS) to 50 clinical nurses at PEHC participating in the pilot project. The Medical Superintendants and Nurse Matrons of each of the three hospitals identified 50 nurses to participate in the project from the clinics identified at the stakeholders meeting in May 2008.

The following table provides the number of users at each of the three hospitals.

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Number of users (nurses) using MHIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dora Nginza Hospital</td>
<td>21</td>
</tr>
<tr>
<td>Provincial Hospital</td>
<td>9</td>
</tr>
<tr>
<td>Livingston Hospital</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>50 nurses</strong></td>
</tr>
</tbody>
</table>

During January 19 through 22, 2009, the selected nurses participated in two-day training sessions on the use of the mobile device which concluded with each nurse leaving in possession of a mobile computing device loaded with clinical health content chosen to aid them in caring for their patients at the point of care. All training sessions were held at the Eastern Cape Department of Health offices in Port Elizabeth. The venue and projection equipment were provided as an in-kind contribution to the project. Personnel from South Africa Partners provided logistical support.
AED-SATELLIFE staff designed and developed the curriculum and presentation materials to train the nurses to use the mobile device and its features in support of their daily work activities and in using the clinical content and medical calculator provided. Nurses were provided with notebooks and pens, but no other training materials were distributed as a decision had been made to provide the User’s Guide electronically and to keep the training focused on accessing information on the smart phone. The hands-on and highly interactive training sessions were designed to intersperse instructional modules related to using the smart phone with those related to accessing content. Two staff from South Africa Partners were also present to assist the two trainers in working one-on-one with the nurses. MTN staff attended a morning session of the training and assisted the trainers by working with the nurses to configure their smart phones for email accounts through MTN. All of the nurses had at least basic familiarity with using cell phones, but very few had any experience using computers. They were extremely enthusiastic learners.

In addition to training on accessing the aforementioned content, the trainers also presented modules on the use of the calendar, contacts, and email applications to support the nurses’ daily work. Although the nurses’ smart phones were disabled for making most telephone calls, calls to the PEHC Technical Support Call Center, the IT staff at each hospital, and technical support at MTN were allowed. These phone numbers were entered into the Contacts on each smart phone. Nurses were instructed to proactively seek out support.

**Ongoing Support:** After the initial training in January 2009, two staff members from South Africa Partners continued to visit the nurses at work every few weeks to answer questions, collect feedback, and encourage the nurses to use the smart phones daily in their work. A questionnaire and spreadsheet were developed to aid in identifying additional clinical topics and recording this information. The major initial challenge reported related to the nurses’ inability to access Internet and email. MTN was contacted and offered technical support via phone and in person at the hospitals. The lack of Internet access did not interfere with the nurses’ ability to access the clinical content resident on the device.

**Refresher training:** To ensure that the Mobile Library was meeting the needs of the intended users and to encourage users’ long-term engagement with the information tool, project staff reached out to clinical nurses by scheduling periodic training sessions to refresh users’ understanding of the breadth of the library’s functionality and periodically introduce new and/or updated information resources.

During March 16-20, 2009, an AED-SATELLIFE staff member returned to Port Elizabeth and held follow-up one-on-one meetings with each of the nurses. During these sessions additional clinical content was downloaded to each nurse’s smart phone. Nurses at each of the hospitals continued to meet regularly with the PEHC IT staff located in their hospitals. The involvement of the IT staff has helped to solidify the hospital complex’s commitment to the project and has added to the project’s future sustainability.

From August 5-7, 2009, two AED-SATELLIFE staff returned to Port Elizabeth and conducted refresher training sessions for the nurses and IT staff at each of the three hospitals. The review emphasized specific features on the phones, namely, using email, reading new content, and entering information into different applications. MiniSD cards for expanded memory storage were installed in the smart phones and several new features were introduced at this time. To support the dissemination of local health content by PEHC staff via email, the nurses were trained to open, read, and save email file attachments to the memory cards. They learned to create new folders on the expansion cards so that they could classify and store additional content for easy retrieval. Nurses also learned to access the consolidated library of documents on the Home page so that they could browse all the information. Similar to the training in January 2009, there were extensive hands-on exercises together with instructor-led activities. Training handouts were prepared and provided to the nurses and IT staff in hard copy.

**Progressive building of capacity**
To enhance the long-term sustainability of the project, systems were developed to support the capacity of nurses to use the mobile devices to access health information when the project was concluded. The project focused its attention on gradually building capacity at several levels: nurses, IT staff at the hospitals, and the district IT Manager.

IT staff from the three hospitals were trained in January 2009 to use the smart phones to access the mobile library. During the refresher training provided by AED-SATELLIFE in August 2009, IT staff were actively engaged in working with the nurses, identifying problems, and developing a greater familiarity with all the applications that the nurses were using on a daily basis. To further consolidate the involvement of the IT staff, Qualcomm Wireless Reach generously donated Samsung i780 phones with airtime for 24 months for each person. Since the phones were similar to those of the nurses, the IT staff could more easily understand and/or replicate the problems being experienced by the nurses, thus enabling them to address nurses’ concerns in a timely fashion.

Three-tier model of user support
Realizing the need to institutionalize technical and training support within the hospitals, the pilot project formulated a three-tier user-support model.

Tier-1: The first line of user support was peer-to-peer where more competent users supported their colleagues in troubleshooting problems and/or teaching them how to use certain functionalities on the smart phone. To facilitate this peer-to-peer support mechanism, the nurses met every week to share experiences and address technical issues. Project staff and IT personnel usually attended these short meetings. This approach proved to be effective. Most of the nurses progressed to a level where they needed very little external support.

Tier-2: The second line of user support was provided by the IT staff at each of the three hospitals. Any issue that could not be resolved through Tier-1 was addressed by hospital IT staff.

Tier-3: Project technical staff and/or cellular service providers were involved if problem(s) could not be addressed through Tier-1 and Tier-2 support mechanisms.

After the initial training in January 2009, nurses experienced a continuing lack of connectivity to the Internet and email services through the cellular network. MTN worked closely with AED-SATELLIFE in providing on-going, daily technical support to the nurses and IT staff.

The District IT Manager at PEHC played a key role in facilitating and coordinating activities for MHIS. As the project evolved, the IT Manager gradually assumed more decision-making authority for various local activities, formulated policy, and resolved problems. The IT Manager often acted as a liaison between AED-SATELLIFE and the PEHC CEO to follow-through on issues. Over the course of the project, active engagement of the PEHC CEO, the IT Manager, and the IT staff at each of the three hospitals generated a sense of local ownership, investment of resources, and sustainability for the MHIS project.

Final Evaluation Study of MHIS
The full report of the research evaluation study is included as Attachment-D.

The Nursing Sciences Department of NMMU conducted the final evaluation study of MHIS. The principal objectives of the evaluation study were to assess:

- The usefulness of the training provided to the nurses on using the mobile device;
- The ability of the nurses to use the mobile device to access information;
- The usefulness of the information provided on the mobile device; and
- The use of the information on mobile device to improve clinical nursing practice.
A quantitative, descriptive, and contextual survey using a self-administered questionnaire was conducted among the 50 registered nurses who received training and a mobile computing device to use at the PEHC. This component of the final evaluation was conducted by a graduate student in the Nursing Sciences Department of NMMU under the supervision of a faculty member. A wide range of questions were posed related to the adequacy of the training to use the mobile device, use of the device to access relevant health information, the usefulness of the clinical information, and the application of the information in practice at the point of care.

In addition to self-reporting data, an objective observational evaluation was conducted with a sample of randomly selected nurses. This component was conducted by a faculty member of the Nursing Sciences Department of NMMU. The direct observation exercises aimed to assess the nurse's competence in performing a set of exercises on the Samsung i780 phone.

Based on the results of the evaluation, recommendations were provided on whether the project could be rolled out elsewhere in the Eastern Cape. The results of the evaluation were also expected to provide useful information to ECDOH policy makers on the benefits of the use of a mobile library by nurses to improve patient care.

**Summary of the results**

**A. Self-administered questionnaire:** The response rate for this evaluation research study was 82%. 45 questionnaires were distributed by the researcher and a fieldworker to nurses at the three hospitals comprising the PEHC; 37 questionnaires were completed and returned.

**Biographical data on nurses**

This section of the questionnaire provided demographic information on the nurses participating in the project.

Of the thirty seven (37) respondents, thirty six (36) were female and one (1) male, an accurate reflection of the nursing sex profile in South Africa.

**Basic computer training**

The majority, 73% (27), of nurses were between the ages of 45-49 years, 18% (7) were less than 44 years, and 3% (1) was 60 years or older, a reflection of seniority and years of clinical nursing experience.

68% of the respondents indicated that they had no training in basic computer applications such as MS Word, Excel, PowerPoint, etc. Only 2 nurses had received computer training as a part of their basic nursing qualifications.

Nurses worked in many different wards reflecting the comprehensive care environment of the PEHC: Outpatient, Medical, Surgical, Pediatrics, Gynecology, Obstetrics, and Casualty.

That the majority of the nurses were older and without any prior computer experience was a significant factor for the project. Their lack of confidence in the use of the mobile device after their initial training was evident and projected a steep learning curve. Project staff were aware that systems needed to put into place to provide additional training and on-going support if the nurses were to successfully use the smart phones in their daily work.
Usefulness of training to use a mobile device
This section of the questionnaire elicited the views of the respondents regarding the training received and the time allocated for training.

81% of the respondents were satisfied with the two days of training. Given the volume of content that needed to be covered in learning to use the mobile device, this result provided useful feedback for structuring future training sessions.

On a scale of very good to very poor, 84% viewed the training received to be very good and good while 16% found it to be average. No respondent found the training to be poor or very poor. This finding indicated that the format, interactive methodology, hands-on exercises, and content of the sessions were satisfactory.

Usefulness of training to use a mobile device

On a scale of inadequate to extremely adequate, 95% of the respondents indicated that the information provided at the training sessions were either adequate, very adequate or extremely adequate. However, almost equal numbers of respondents indicated they found the information provided at the training to be both easy (19) and difficult (18). The latter findings could be attributed to the fact that many of the nurses had no computer training during their nursing studies. While the information presented a challenge to the nurses, they were eager to learn and persevered in developing new skills.

Degree of difficulty with information provided at training
After the initial training, the confidence level of the majority (22) of the respondents ranged from not confident to slightly confident when using the mobile computing device while thirteen (13) indicated they were not confident. 73% of the respondents indicated the need for more training while 24% did not require additional training. These findings were not surprising given the lack of any prior computer experience and the introduction to a brand new technology. Nurses also reported that the training session facilitated bonding and fostered nurses helping each other when problems were experienced in operating the mobile computing devices. They were also satisfied with the trainers and their commitment to empowering them in the use of the new technology.

Demystifying the use of computer technology, especially for nurses who were mainly women without access to computers, was a challenge facing the project. The nurses’ satisfaction with the initial training was encouraging even though there was a clear need for additional training to realize the potential of the new technology tool.

**Use of the mobile device to access information**

This section of the questionnaire elicited data on the nurses’ experience in using the various programs and features on the mobile device to access information.

Overall, 81% of the respondents found it easy to extremely easy to retrieve information from the mobile computing device while 19% experienced difficulty.

**Ease of locating information on the mobile device**

Specifically, 72% (27) found the Essential Drug List easily, 81% (30) the Eastern Cape Disease Directory, 70% (26) the Standard Treatment Guidelines. Almost 30% (11) of the respondents indicated they found the medical calculator the most difficult to use while 38% (14) found it easy. Reasons given for the difficulties accessing the variety of content on the device were: lack of computer literacy, lack of time to practice, and lack of understanding of procedures.
46% of the respondents considered technical problems to be the major issue in retrieving information. Initially, many of the mobile devices were not correctly setup for email messaging but this issue was eventually resolved. The MTN server was frequently inaccessible for searching the Internet or for sending email messages.

Applications used most frequently were: 57% (21) used Internet Explorer to search the Internet, 43% (16) used short messages service (SMS), and 32% (12) used electronic mail.

Nurses also reported the following: 57% (21) found the device to be user friendly, information easily accessible, and a time saver; 11% (4) viewed the smart phone as a communication device that enabled sharing of information with nurses on a national and international level; 8% (3) found the introduction to computers useful; 8% (3) used the information to train students; and 8% (3) used the information for health education with patients and members of the community.

**Usefulness of the information provided on the mobile device**

This section of the questionnaire was comprised of questions related to finding out the usefulness of the various types of content and programs on the smart phone.

Respondents found the following information and programs on the mobile device most useful: 87% (32) Eastern Cape Disease Directory, 73% (27) Standard Treatment Guidelines, 54% (20) Essential Drug List, 35% (13) SMS, 30% (11) e-mail, and 24% (9) Calendar. In response to the question on information that was lacking on the device, only a few nurses found a gap on Trauma and Gynecology.

**Most useful content and programs on the mobile device**

57% (21) of the respondents indicated that they very frequently accessed information at home, 46% (17) while on duty in the ward but not with a patient, 43% (16) occasionally at the point of care but not in view of the patient, and 32% (12) while on break.

35% (13) of the respondents indicated they spent more than 10 minutes but less than 30 minutes researching clinical questions, 30% (11) spent more than 5 minutes but less than 10 minutes, and 27% (10) spent more than 30 minutes on average per session. This finding highlighted the value of the mobile library as an educational and reference tool that nurses could easily consult when relevant information was needed.

During most working days, clinical information on the device was accessed occasionally by 43% (16) of the
nurses, frequently by 27% (10), and less than 5 times each week by 24% (9).

**Time spent researching clinical questions**

89% (33) of the respondents indicated that they consulted the smart phone for clinical information with varying frequency most days away from work. This was a significant finding that highlighted that the portability of the mobile device enabled nurses to use the reference material when away from the hospital work setting.

**Using the Mobile Library away from work**

These findings on the usefulness of the information addressed a major objective of the pilot project which was to create a health library on the mobile device that nurses could refer to at any time in caring for patients. The power and potential of the smart phone as a mobile computing device was also evident as it provided an opportunity for the nurses to further their clinical knowledge even outside of the work environment. Portability and an ample storage capacity for a large library of documents were factors that increased the usefulness of the mobile technology tool for the nurses.

**Use of information to improve clinical nursing practice**

This section of the questionnaire was comprised of questions related to the nurses’ application of the information accessed on the mobile device in their daily nursing practice.
89% (33) of the respondents indicated that nursing practice was enhanced by making information accessible at the point of care.

Respondents reported that access to health information at the point of care enhanced their clinical nursing practice. 89% (33) of nurses reported that they were able to update their knowledge on management and treatment of various conditions, 70% (26) reported that they provided relevant, up-to-date information to patients, 68% (25) reported that they provided the correct information to patients, 68% (25) reported that they empowered patients with knowledge of their diagnosis and treatment, and 68% (25) reported that they enhanced their own knowledge so that side effects of drugs were recognised.

**Enhanced clinical nursing practice using the Mobile Library**

When asked about sharing information on the device, 89% (33) mainly shared with other nurses, 51% (19) with junior staff, 32% (12) with doctors, and 24% (9) with hospital administrators.

These findings were significant as they addressed the major goal of the pilot project and indicated that nursing practice could be improved by providing relevant health information in an appropriate and suitable technology. Not only were nurses able to provide better care for their patients but they were also able to support their own professional development with a readily accessible library of accurate and reliable information.

**Overall experience using the mobile device**

When asked about their overall experience of using the smart phone, 92% (34) of the respondents said it was helpful to carry the mobile device around, 84% (31) found the content easy to read, 57% (21) wanted to print the information from the device, and 11% (4) preferred to read content on paper.

100% (37) of the respondents indicated they would continue using the mobile computing device upon completion of the project. 92% (34) of the nurses indicated that they would be willing to purchase their own mobile device if they did not already own one. Doctors, other nurses, and patients viewed the mobile devices favourably when used by the nurses in the project. Some wanted to own such a device, be included in the project, and were impressed by the information on the device.
The self-administered questionnaire relied on the subjective experiences of the nurses; it was necessary to employ a more objective assessment of the nurses’ proficiency in the use of the mobile device. The direct observation exercises aimed to assess the nurse's proficiency in performing a set of exercises on the mobile device. Related to the use of various programs and features on the smart phone as well as ease of navigating the pre-loaded health content, the exercises were based on procedures with which the nurses had familiarity and regularly practiced during their weekly training sessions at each of the hospitals.

The researcher used an interview-guide approach together with a structured direct observation checklist comprised of a set of practical exercises with specific commands that needed to be performed. The participants were required to follow the commands and perform the exercises under the direct observation of the researcher and fieldworkers. The information obtained in this step enabled the researcher to establish whether the respondents were competent in using the various programs on the mobile computing device. A total of 25 respondents participated in this step and structured direct observation sheets were fully completed for each participant by the observers.

**Results of the direct observation exercises**

The documents in the mobile library were organized in one location on the device and accessible via a Table of Contents page that could be easily launched from an icon on the main screen of the smart phone. Documents were hyperlinked from the Table of Contents page for easy navigation and location of specific information.

The following exercises were posed to the participants, their performance observed, and recorded on a monitoring checklist:

1. **Launching the Table of Contents page**
2. **Locating specific health content on the phone**
3. **Locating the Storage Card on the phone**
4. **Using Messaging features**

**1. Launching the table of contents page**

68% (17) of the participants could competently launch the Table of Contents page from the icon on the main screen while 32% (8) appeared to be unsure.

**2. Locating specific health content on the phone**

- **Locating the recipe for a home-made oral rehydration solution**

The majority, 68% (17), of the participants could competently locate the recipe for the home-made oral rehydration solution to treat diarrhea in the Eastern Cape Disease Directory document on the mobile library, 20% (5) appeared to be unsure, and 12% (3) were not yet competent.
Locating the local wound care treatment for diabetic foot ulcers

44% (11) of the participants were able to competently locate the local wound care treatment for diabetic foot ulcers in the South African Hospital Level (Adult) Standard Treatment Guidelines document, 44% (11) appeared to be unsure, and the remaining 12% (3) were not yet competent.

Identifying the document that is most frequently used on the phone

The majority, 88% (22) of the participants could competently and quickly locate the document that they identified as the one they used most frequently; 12% (3) were not sure.

3. Navigating to the Storage Card on the phone

64% (16) of the participants could competently locate the Storage Card, 20% (5) appeared to be unsure, and 6% (2) were not able to complete the exercise.

4. Using Messaging features

96% (24) of the participants could competently check for new e-mails, open messages, create and send a new e-mail message, and then close the messaging application. Only one (1) participant appeared to be unsure of how to perform these tasks.

Summary of direct observation exercises

Conclusions of the Evaluation

The overall results of the evaluation of the pilot project indicated that nurses at the PEHC enthusiastically embraced the new mobile technology, found the training to be adequate, made regular reference to the health information on the device, and used the information to improve their nursing practice. The nurses integrated the use of the smart phone into their daily activities and consulted the clinical information on the device on a regular basis as they cared for patients. The nurses were positive about their use of the new communication tools on the mobile device such as email and SMS to connect with colleagues both within South Africa and internationally, and searching the Internet for health information. The introduction to the mobile device as an information and communication tool has sparked a genuine desire for more knowledge, for connection and networking with other nurses in email-based discussion groups, and has generated a pattern of knowledge-
seeking behavior and life-long learning. Given the fact that the majority of nurses in the project were aged 40-59 years of age and had completed single diplomas in nursing, the use of the mobile device as a tool for professional development and continuing education in a wide range of topics was a significant finding. The evaluation results clearly demonstrate that with the introduction of any new and unfamiliar technology, the need for refresher training and ongoing, regularly scheduled technical support is critical if the power and potential of the technology is to be realised. The evaluation results support the recommendation that funders and partners in the project and policy makers at the Department of Health should consider the expansion of mobile technology use by nurses to improve patient care in the Eastern Cape.
Testimonials of Nurses

The nurses at the three hospitals of PEHC routinely used the Mobile Library and reported that the information helped them to improve patient care. This was their first experience of having access to relevant clinical information at the point-of-care on a mobile device to inform the diagnosis, treatment, and care of patients. Similarly, for most it was their introduction to using email messaging for communication with peers and to searching the Internet for information. The Mobile Health Information System generated a novel process of knowledge-seeking behavior, self education, and learning; improved patient education; enhanced sharing of information with other; supported student education; and improved clinical practice.

We are including the following excerpts from testimonials of the nurses at the PEHC. The full testimonials are provided as Attachment-E.
Lessons Learned

Important lessons were learned and solutions noted over the course of the project.

- Developing local ownership and sustainability for MHIS
  Building a collaborative relationship with the ECDOH and PEHC was crucial to the success of the MHIS
project. Periodic meetings in person and regular communications via phone and email with the IT Manager of the ECDOH and the CEO and IT Manager at PEHC were vital in building and consolidating a mutual relationship of trust with AED-SATELLIFE as the implementing partner of MHIS. More importantly, these communications helped to convey a better understanding of the vision, priorities, and current initiatives in e-health in the Eastern Cape in relation to the objectives of MHIS. As the project progressed and responsibility for various project activities was assumed at a local level, an emerging sense of ownership and sustainability of MHIS was fostered and embedded at both the district and provincial level.

- **Designating a coordinator with leadership authority at MTN**
  Project staff as well as MTN could not have envisioned the high level of technical support that would be needed by the nurses. MTN staff sought to resolve technical problems diligently and even attended weekly training meetings with nurses to offer assistance, thus contributing to the positive outcomes of the project. However, identifying a coordinator with decision-making authority at MTN would have helped in dealing with the institutional and user-related issues that arose during the course of the project.

- **Reporting from the field regularly**
  Developing a formal system for field staff to report on activities on a regular basis was important as it maintained the smooth operation of the project, kept the implementing partner closely informed, and provided an opportunity to address problems in a timely fashion. Regular, on-going visits by local partner staff to the nurses in the hospitals monitored and supported the use of the mobile devices, captured requests for additional information on topics of interest, and identified issues and concerns early for resolution.

- **Institutionalizing a model of user support**
  While the initial 2 days of training in using the mobile device to access health information appeared to be satisfactory to the nurses, it was evident that additional support would be necessary given the high level of inexperience with computers. The three-tier support model (peer-to-peer, IT staff, and MTN technical assistance as a last resort) developed and institutionalized by August 2009 has proved to be most successful and is currently in operation. Engagement of the IT staff at each of the three hospitals in providing technical and training support in the use of the mobile device played a critical role in the development of the nurses’ competence to access health information and improve nursing practice.

- **Using mobile technology to access information improved health care practice and patient care**
  The majority of nurses had no computer training during or after completing their nursing qualifications. Intensive training comprised of the two days of initial training and periodic refresher trainings in the use of the mobile device to access health information and the subsequent three-tier model of user support institutionalized in each of the hospitals created a supportive and enabling environment so that the nurses could feel confident and comfortable in the use of the new technology. While the nurses have made a considerable investment of time in learning to use the mobile device and consulting it on a daily basis, the knowledge gained from the mobile library has improved their clinical nursing practice and led to better care for their patients. The MHIS project has demonstrated that nurses without computer training can learn to use a new technology in a relatively short time and benefit from the potential offered by ICTs.

**Post-Pilot Use of MHIS**

**Continuity of use**
AED-SATELLIFE has ensured that the fifty nurses and the IT support staff at PEHC were adequately trained to use and troubleshoot the devices before the conclusion of this pilot. The nurses are able to continue using the Mobile Library after the conclusion of the pilot with no or little assistance from the DoH.
Under a service agreement with MTN, the project has established voice and data services for the nurses using the smart phones provided by the project. The period of performance of the service contract is 24 months, and it will be valid for at least 11 months after the conclusion of the pilot in February 2010 (pre-paid for the entire term of the contract). This arrangement will enable the DoH to make financial allocations following due process as the pilot is concluded successfully and the DoH decides to continue funding the activities of the pilot.

**Mainstreaming roles to PEHC/ECDOH**

**Management:** In the post-pilot period, responsibility for day-to-day operations will be assumed by the PEHC. The district level IT Manager will ensure that the weekly practice meetings for the nurses continue, manage and address issues, problems, and concerns that arise over the use of the mobile devices, request advice and support from AED-SATELLIFE if necessary, and report on project progress to the CEO of PEHC and the IT Manager at ECDOH. The management systems put into place during the pilot were operating successfully and can be supervised locally.

**Technical and training support:** With the three-tier model of support institutionalized at each of the three PEHC hospitals and operating successfully, ongoing technical and training support is in place for the post-pilot phase of the project.

IT staff trained at each of the three PEHC hospitals during the pilot project will continue to be engaged to provide technical support based on their experience with the nurses’ use of the smart phones. Since airtime has been purchased through January 2011, technical support may also be sought from MTN as the telecommunications service provider for the project.

Nurse managers, identified during the pilot project, will continue to be responsible for convening the weekly practice meetings at each hospital; the more competent MHIS users will support their nursing peers. IT staff will continue to attend these meetings to address issues, concerns, and troubleshoot mobile device-related problems that arise.

**Meeting additional content needs:** Tracking new topics identified by the nurses, locating appropriate content, and packaging it for access will be ongoing needs for which resources need to be allocated. During the pilot phase, AED-SATELLIFE was responsible for identifying relevant health information and packaging it into a comprehensive medical library. After the pilot, relevant staff from the Eastern Cape Department of Health (ECDOH) will be in a position to select, package, and deliver additional clinical and public health content. AED-SATELLIFE will train relevant staff from ECDOH on identifying and packaging health information to a format suitable to mobile devices and transferring this content to the smart phones. This will be done using GUIDE, the tool developed by AED-SATELLIFE that allows conversion of files in PDF, text, html and Word format to html format that can be easily browsed and read on mobile devices such as the smart phones.

AED-SATELLIFE will also closely work with the IT unit of the ECDOH to develop tools and processes to enable users of the Mobile Library to download content from an ECDOH-mandated website or Intranet. In close consultation with ECDOH, AED-SATELLIFE will develop an Eastern Cape Mobile Health Information Portal to provide a password-protected website for an Administrator to manage all aspects of the Portal. Administrative rights will include the ability to add/edit/delete users from accessing the system to read and/or download documents from the system using mobile computing devices. In addition, the Administrator will have the ability to manage source documents, mobile format documents, and other content management-related tasks, as well as the document conversion processes. Users authorized by the ECDOH would access the Portal to download content. Remotely located users will access the system either through an Intranet or Internet connection with the help of mobile computing devices. On the Portal, the users would be presented
with a list of documents available for review and download to their mobile device. The Portal will run on ECDOH’s Windows-based server, accessible via Intranet and/or Internet.

**Suggested Business Model for MHIS Expansion**

*Value Proposition*

South Africans in the Eastern Cape depend upon public health care to an extraordinary degree - over ninety percent of the population relies on government provided health services. To improve the health and well-being of its most disadvantaged communities, it is incumbent upon the health service to establish a functioning public health infrastructure, particularly in areas of the country that were previously excluded from adequate access to health care. Key pathways to achieving this goal are increasing the number of health care providers through expanded clinical education programs and supporting all health care professionals through continuing medical education and professional development.

However, medical and nursing graduates working in smaller and rural health facilities are often unable to maintain and expand their professional skills due to inadequate opportunities for mentoring and continuing education, and limited access to current clinical information. This situation has long-term deleterious effects on clinical professionals’ diagnostic and therapeutic abilities, and contributes to feelings of isolation and career stagnation. Both individual patients and the community suffer as a result through delayed or unnecessary referrals to specialist clinics, unacceptable negative impact on health status, and avoidable increases in cost.

The MHIS project addresses some of these challenges by using mobile computing devices to improve healthcare providers’ access to relevant health information, treatment guidelines, Continuing Medical Education (CME), and other resources. Expansion of MHIS to rural settings will help providers deliver better healthcare to their communities and will enhance the efficiency of the health system. Nurses will receive mentoring and CME to build their skill base, and training and technical support for using simple mobile phone-based tools for planning and sending and receiving relevant public health data and information. The ability to deliver CME materials and guidelines electronically to health works will reduce printing and shipping costs, and will minimize the need for costly and time consuming residential-type training.
**Infrastructure**

The basic services, skills, partnerships, and processes required for generating the benefits described in the value proposition are the following:

**Core Capabilities**

The capabilities and competencies that are essential for MHIS are:

1. Cellular service provider for facilitating delivery of CME materials, treatment guidelines, and other resources to health workers;
2. Smart phones that will support Mobile Clinical Library storage, access to health information that is regularly sent to health workers, and email exchange;
3. A mechanism for converting content to a format suitable for the smart phones; and the ability to make such conversions as needed;
4. A server for conversion of documents into a format suitable for mobile devices; and the ability to host and maintain the server;
5. Relevant and current health information that addresses health problems of the population; and the ability to identify and select relevant information; and
6. The ability to provide continuous support to users to troubleshoot technical problems related to smart phones and provide them with the content they need.

**Partner Network**

The MHIS value proposition can be achieved through the alliance of the following partners.

The **Eastern Cape Department of Health** will be the owner of the program and the source of CME materials. The ECDOH will host and maintain the server for facilitating documents conversion to mobile format and sending the documents health workers.

**AED-SATELLIFE** will make additional developments to GUIDE and ensure that the ECDOH is capable of using and maintaining it. AED-SATELLIFE will train relevant ECDOH and health workers to use the MHIS system for content conversion and access. In addition, AED-SATELLIFE will establish free access to its
wealth of health information obtained from over 40 leading health journals.

**MTN-SA** will provide cellular services and smart phones to MHIS users. MTN will also provide technical support to users and the ECDOH and will ensure that all smart phones are functioning.

**Target Users**

Nurses, midwives, and physicians serving in primary healthcare settings will be the primary users of the Mobile Health Information System. The ECDOH will develop criteria for selection of health facilities and personnel who will be the primary target users of the MHIS. Expansion of MHIS will focus on rural health facilities whose workforce is isolated from major institutions of learning and receive little or no support from senior practitioners.

**Finances**

The major expenses required to produce the outcomes described in the value proposition are for the purchase of a server, smart phones, initial support by AED-SATELLIFE and air-time costs to support continued information access by users.

Sources of Finance:

The MHIS began as a private-public partnership. It is anticipated that the funding required for initial expansion of MHIS will be obtained through a combination of ECDOH resources and grants from foundations and donor agencies. Once the system is fully integrated with the health system and the benefits accrued from the system are visible, the ECDOH is expected to fully fund the intervention.

**Recommendations for the way forward**

The goal and objectives of MHIS were successfully accomplished over the formal period of performance of the project. Implemented in a resource-constrained setting, the MHIS pilot demonstrated that clinical nurses without any computer experience can be trained to use mobile devices and the wireless telecommunications network to access health information, thus improving nursing practice and enhancing patient care.

Among the recommendations that emerged from the evaluation study, foremost was the proposition that the scope of MHIS be enlarged to include rural health care providers without access to libraries and health literature. This finding closely correlates with the health priorities for the province and the e-health initiatives of the ECDOH. Therefore, based on our experience and feedback to the project from stakeholders, we recommend the expansion of MHIS under the aegis of the ECDOH to nurses and doctors at rural health centers to support the improvement of health care delivery in these under-resourced facilities. We believe that, just as their urban counterparts did, isolated rural health care providers can rapidly learn to use mobile devices and wireless technology and to integrate these tools into their daily practice. Both health care providers and their patients will benefit from access to a library of health information for the diagnosis, treatment, and care of patients at the point of care, continuing medical education, and on-going professional development.

Future expansion should build on the lessons learned in this project regarding stakeholder engagement, local ownership and sustainability, content, technology, training, and capacity building and should strive to replicate the collaborative public/private partnership of donors, government agencies, non-governmental organizations, and corporations that proved to be a winning combination contributing to the success of MHIS.
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