THE PRIMARY INITIATIVE:
ADDRESSING MATERNAL AND INFANT HEALTH

The Road to a National Health Data Infrastructure (HDI) : Applying technology innovation in Nigeria

AUTHORS

Deborah Theobold
Executive Director
Vecna Cares Charitable Trust
+1 (617) 674 8246

Okey Okuzu
Founder/CEO
InStrat Global Health Solutions
+1 (862) 596 3548

CONTRIBUTOR

Kyle Moss
Program Manager
Qualcomm Wireless Reach

This document discusses the critical imperatives for the development and sustainment of a Health Data Infrastructure as an important component of a high functioning health system. The authors discuss CliniPAK as a possible platform for HDI and studies on applications of CliniPAK.

MAY 2015

CONTENTS

THE PRIMARY INITIATIVE: EXECUTIVE SUMMARY

Despite its position as Africa's largest economy and an emerging business destination, Nigeria continues to suffer one of the highest maternal and infant mortality rates in the world: approximately 530[1] maternal deaths per 100,000 live births versus 9 per 100,000 in developed countries. In fact, Nigeria lags its regional and global peers across the entire health care sector indices.

Traditional interventions towards solving this dire situation are being deployed including human resource capacity building; increased physical infrastructure with more clinics; wider distribution of pharmaceuticals, etc. However, a more optimal approach is to complement and direct the above interventions with better data and validated information to make them even more effective. Available wireless technologies and mobile phones, tablets, and other wireless devices present distinct opportunities to facilitate delivery channels for that data and information.

Our recent work experience has shown that with i) access and availability of information and ii) enforcement of protocols we can improve the quality of care and attendant outcomes and save lives. Health conditions can be better diagnosed and treated; program managers and policy makers can better deploy resources; and decision support tools can better direct health workers on what to do, alleviating the skill gap in many of the health facilities.

Information to support and quantify health system improvements must be captured at the primary care level – the front line of the struggle to reduce the mortality rates – where policy and provision meet the actual delivery of health care services. Patient centered documentation of the daily activities of indi-

vidual health providers at the primary care level reveals significant trends for human resource management, critical medicine needs and distribution trends, clinical protocol evaluation, patient treatment compliance, and longitudinal patient outcomes. Ideally, this information is captured through tools that support and are a part of the everyday operations of the clinic while adding value to the provider's workday. In addition, these facility-based tools must connect primary care clinics to a larger health information network to report the burden and needs for that area and receive policy updates and feedback on clinic performance.

A connected health information infrastructure transforms discrete investments in program-based solutions into a coordinated and integrated information exchange across programs, facilities, and patients for better health delivery, access, and outcomes and simplifies provider data capture requirements on the front line.

An always on and always connected health information infrastructure enabled by wireless networks transforms discrete investments in program-based solutions into a coordinated and integrated information exchange across programs, facilities, and patients for better health delivery, access, and outcomes and simplifies provider data capture requirements on the front line.

Like physical infrastructure within a region, health information infrastructure begins by meeting an operational demand; it expands and evolves with the recognition of its value to meet many more needs. A government may partner with interested stakeholders and invest in roads that connect a city to outlying villages in order to facilitate bringing goods or resources to a processing

[1] http://data.worldbank.org/indicator/SH.STA. MMRT

plant or market. Although the original return on investment is clear and valid in and of itself, the dividends and value soon increase as the now public road supports transportation, commerce, and exchange in ways unplanned, unforeseen yet hoped for in its inception.

In the same way, an information infrastructure is established to connect outlying clinics to resources, supplies, policy, and supervision in support of, for example, maternal and child health. Within that clinic, electronic devices and wireless connectivity are established and workers trained so that care activities and services are documented and shared across data networks for exchange within a larger health repository. Health delivery operations, programs, research, and policy information needs are fed from the repository without creating a "new road" to the health facility each time. Soon, all activities within the clinic, not just Maternal and Child Health (MCH), are documented electronically and exchanged via the infrastructure.

In addition, with bidirectional information flow from the data center to the outlying clinics, a feedback loop is completed that informs primary care, improves data quality, and alerts front line health workers of new threats, clinical protocols, and management best practices.

Within the clinic there is opportunity for better management of resources such as people, medicines, and supplies to help providers and staff do more with what is available. These resources are linked with protocols and decision support tools to assist providers at the point-of-care with the knowledge to treat on site with available resources, or the visibility to refer to a site better suited for care.

A connected care infrastructure means that care given at a referral site or elsewhere in the community is attributed to a patient record and comes back to the primary care level to strengthen the primary care relationship, the foundation of the public health system.

FUNDAMENTAL CONCEPTS

Current Low to Middle Income Country (LMIC) technology interventions do not adequately address the MoH recognized need for the execution of an eHealth policy through the establishment of a Healthcare Delivery Infrastructure (HDI). A synergistic relationship between facility-based computers, community-based mobile devices, and regional/national servers will provide a strong and scalable infrastructure for health care administration. The innovation of the proposed HDI is distinguished by the following characteristics:

- A **longitudinal clinical record** for each patient is the basis of the HDI. Each encounter creates a new visit in the patient's record. Key aspects of each visit are categorized and stored for reporting and analysis.

- A **facility database** of patient records connects to a remote server for data synchronization and aggregation. Data from mobile phones, etc. are added to appropriate patient records for continuity of care. Data backups are located on-site via external hard drives and in the cloud via cell data networks.

- Both **standard and ad hoc reporting** tools are supported locally and in the cloud, producing all standard MoH reports and generating program reports/data without burdening clinicians in order to perform high level analysis of outbreaks, shortages and other conditions.

- **Open standards and services oriented architecture (SOA)** facilitate communication with external systems and adoption of future health care   technology innovations with minimal integration cost.

The Primary Initiative approach is characterized by the following innovations:

- Self-contained, scalable, pop-up IT units for rapid deployment to primary care health facilities;

- Point-of-care data capture to a patient record by front line health service providers using right-fit tools;

- Standardized clinical workflows with embedded clinical decision support for use by all levels of health care workers;

- Inventory tracking and management protocols embedded in point-of-care   service documentation tools;

- Clinician profiles, authorization and audit trail during system use;

- Local database synchronization with central server for continuity of care;

- A reliable metric of a quality data baseline, the Data Confidence Index;

- Access to a data capture platform and longitudinal patient and public health data on a centralized server for authorized programs;

- Patient centric and population/location based reporting, trending and surveillance.

ICT INTEROPERABILITY

The integrated Health Data Infrastructure (HDI) is designed to support any data capture environment and interface preference, with a focus on the integration and interoperability of technology tools and reporting platforms.

In addition, it is important to note that the use of mobile broadband technologies is key to enabling the gathering and dissemination of information that reporting platforms deliver. Using mobile devices and connectivity, health care providers and administrators around the world are able to access the latest professional development tools, adapt to address a sudden acute health crisis, enable remote monitoring of chronic diseases, improve efficiencies in public health systems, and extend the reach of doctors and frontline health workers.

When looking specifically at maternal and infant care, there are a number of ways mobile technologies can improve care and aid in reducing mortality. Mobile is the conduit for strengthen training of medical workers by providing access to accurate and current information regarding health conditions and treatment as well the latest ideas on treating particular health issues.

Our goal is to leverage mobile broadband technologies to connect the health care ecosystem of existing global health technologies and programs to strengthen the health care system.

The concept diagram below illustrates the interoperability architecture that facilitates the incorporation of innovative and powerful front-line data capture technologies, links them to a consolidated, patient centered clinical database and facilitates health data exchange in various aggregated, de-identified and structured formats for consumption, analysis and use by authorized stakeholders. Our projects are building out and validating each piece of this diagram with the intent to demonstrate the viability of a continuous, feedback driven data system that is operationally validated for data completeness, accuracy and quality. By doing so, data confidence will be increased for operational action and research, and interventions can be measured for impact with known data quality.
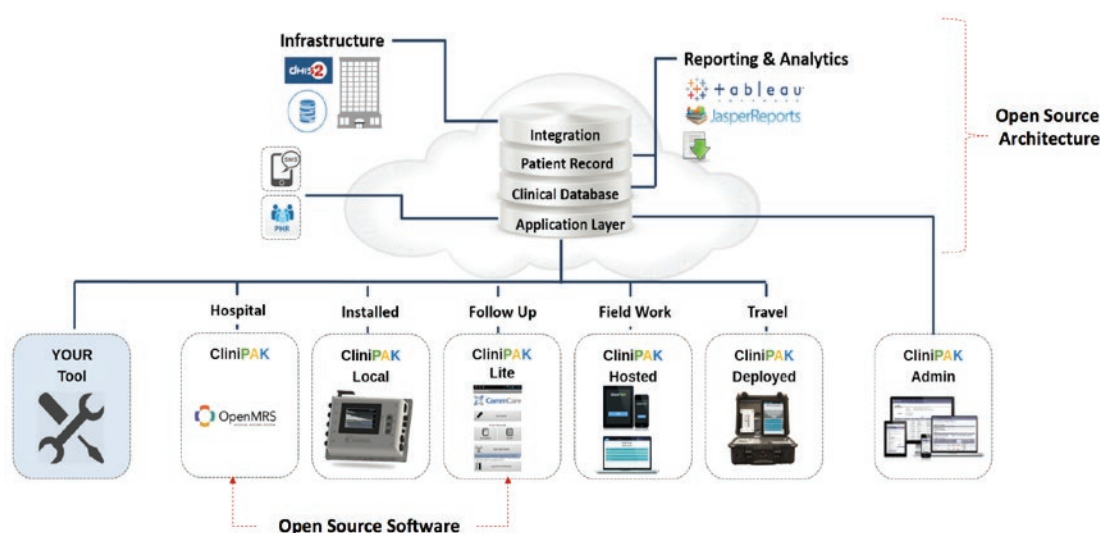
The table below illustrates the selection of the right technology combination across a range of different use cases and settings. New categories for environmental evaluation are quickly added along the left hand bar such as diagnostic capabilities, human resource constraints, and pharmacy/lab considerations and the top bar expands by use cases as we add areas of service. The solution combinations reflect the incorporation of exciting new technologies working together seamlessly to bring the best care possible to every, and any location around the world.

	Individual Clinic or Community/ Field Work	Multiple Clinics or Care Stations: Connected	Multiple Missions or Care Stations: Stand Alone	Patient Health Access and Outreach	Provider Remote Access and Outreach
Internet Connectivity	Poor or intermittent	Good - excellent	Intermediate, not robust	Variable, access to SMS	Variable, access to SMS
Power	Poor or centralized	Poor to Good	Centralized	N/A	N/A
Local Data Sharing	Limited need, independent device users on the ground	Necessary data sharing among stations and providers onsite	Necessary	Print care summary	Review cases and sign off on treatments
Remote Data Sharing	Non-real time, no critical dependencies	Real-time access and contribution to patient record	Option for standalone and synchronization with Clinical Database	Share health data electronically with providers and alerts	Access to previous visits and patient messages
SOLUTION	CliniPAK Lite application on tablets connecting intermittently with Clinical Database	CliniPAK: Hosted accessed via 3G tablets with real time connection to Clinical Database	CliniPAK: Local	Clinical Communicator and SMS	CliniPAK Administration Module and Clinical Communicator

INVESTMENT AT THE PRIMARY CARE LEVEL

Governments and development partners historically shy away from implementing health information solutions that extend beyond individual programs or immediate data capture needs. For example, with over 26,000 clinics scattered across urban and rural areas of Nigeria, it is an understandably daunting proposition to purchase and place electronic equipment at all front line primary care facilities to digitally document all health services. Until now, point-of-care infrastructure limitations of power, connectivity and electronics set up and maintenance have been show stoppers with limitations on human technical resources and equipment budget among other barriers. In addition, individualized programs do not have the mandate, expertise or funding to institute, integrate and maintain a health information infrastructure that allows individual program investments to benefit a greater development effort. The result is distinct data capture demands for various programs such as malaria, TB and HIV surveillance on top of Ministry of Health mandatory reporting all contributing to the ever growing burden of the front line health worker and none contributing to a substantive and consolidated patient record.

OVERCOMING PHYSICAL BARRIERS

The initial physical barriers of power and internet connectivity are mitigated through the use of the CliniPAK hardware, a low profile server and database with power management, charging and wireless capability - both local and internet - combined into a single, easy to use, environmentally sealed box.

CliniPAK Hardware consolidates IT electronics and networking into one convenient, no-fuss package for local data capture and sharing without specialized IT support on the ground. The CliniPAK includes a portable, robust server for use with 110/240 AC, 12V DC and solar power; and a self-launching local wireless information sharing hub. And, when connected via ethernet or USB modem on a cell data network with our cloud-based Clinical Database, CliniPAK can connect to other CliniPAKs in the next village or around the world to close the care continuum information loop. Both hardware and software components have been designed with an emphasis on ease of use and sustainability.
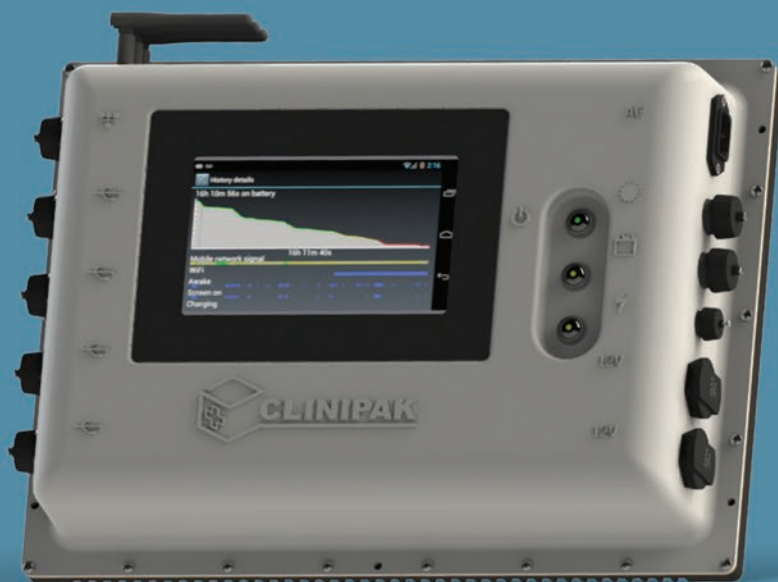
Placing this extremely low maintenance and low cost device at each facility provides the platform for health service documentation, digital reporting and information exchange with other CliniPAKs and data on the network. Little or no training or experience is required to install or use the CliniPAK. While CliniPAK overcomes physical infrastructure barriers for many primary care facilities, alternative data capture methods must also still be supported such as tablet based survey data capture at smaller dispensaries and in the community.

Using ubiquitous connectivity methods such as 3G, each facility at each level of care serves as a data entry point to a regional/national health information exchange. CliniPAK units use available data sharing options (SMS, email, mobile broadband and the internet) to upload and download information from the central server. The server is synchronized with local clinics and other decision makers as needed whenever connectivity is available.

USER APPROPRIATE DATA CAPTURE TOOLS

DATA IN

A fundamental and important shift in the HDI is the change in record keeping from registers to records. Currently, public health reports are generated primarily from Ministry of Health registries, which preclude effective longitudinal patient tracking, inhibit cross-disease reporting, and are prone to human error. In addition, data aggregation from Ministry of Health outpatient registers is labor intensive, requiring the physical movement of staff and documents over an inadequate travel infrastructure. Travel and time constraints often leave the government and international community unable to gauge the true state of health care in many rural areas.

Quality of care can be hugely impacted by incomplete records at the point-of-care . It is difficult to retrieve medical histories from patient registers, and patients often misplace or forget their outpatient card, leading to a reduction in the quality of care. These inefficiencies can also affect the referral process, as many patients arrive at higher level facilities without their outpatient cards, negating the significance of previous medical decisions.
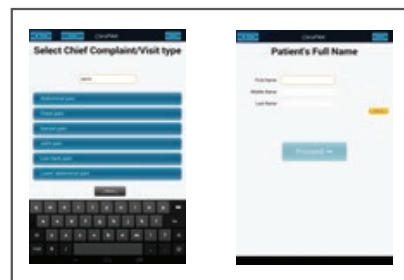
Capturing data occurs on multiple data capture tools, but the information is integrated into a single patient record locally or in the cloud. The HDI is configured to ensure that patient records are consolidated and accessible irrespective of the capture tool that is employed. Open API's and a collaborative approach connects mHealth tools to a larger information infrastructure.

CliniPAK Software is a streamlined electronic medical record, data capture and reporting system including patient registration and demographics, vitals capture, diagnosis, treatment, case review and administrative task support, lab order management, pharmacy distribution and inventory control, and patient flow management. Installed locally on CliniPAK Hardware, CliniPAK offers both workflow and forms-based data capture at the point of care and real time access to patient records and reporting tools. Patients benefit from longitudinal records that allow for efficient healthcare provider interactions. Providers find that CliniPAK's flexible configurations and easy adoption facilitate the best outcomes for their patient populations. Real time data capture allows up-to-date accurate reporting that reduces the undue burden of paper forms and manual tabulation on healthcare workers today.

CliniPAK Lite is the ideal software for data capture in the community and resource limited infrastructure facilities. The tablet and cell phone application, based on the open source CommCare platform, allows you to use existing surveys, create and use custom data surveys, or choose from Vecna Cares' standard health modules for patient identification, history, triage and more. Information is transmitted via cell network or wifi to a local CliniPAK unit or the centrally hosted Clinical Database where it is added to a patient record or creates a new one.

CLINICAL DECISION SUPPORT

CliniPAK modular workflows allow the insertion of Clinical Decision Support (CDS) tools for access by the care provider without leaving the application experience. Users may seamlessly enter a decision support module that will leverage patient information and guide provider action at critical care moments. We work closely with providers of tools and content to develop and integrate clinical decision support software into the data entry workflows.

ESSENTIAL MEDICINE TRACKING

The intake and use of disposables (prescriptions, mosquito nets, and disposable medical equipment) are monitored at multiple levels of the health care framework through the use of a stock module. Upon receiving a delivery of disposables, the district health management team or clinician inputs the amounts and types of received items, with the option for future expansion to Radio Frequency Identification (RFID) or barcode input. An automated inventory process then tracks inventory used by each clinician and facility. Automatic surveillance can alert local administrators of imminent stock-outs and reserves can be found elsewhere by digitally checking the stock of surrounding locations.

The **Pharmacy and Inventory Management and Reporting Tool** creates greater efficiencies for dispensaries, safer, more standardized dispensing to patients, and strengthens the supply chain integrity by managing the supply and demand of medications.

The pharmaceutical software has the capability of tracking prescriptions and dispensing at the patient level particularly with respect to product recalls or adverse events. From an administration perspective it supports healthcare workers in knowing what products they have available for dispensing. Synchronization of data can be run over multiple clinics and attribute each pharmacy action to the clinic where it occurred. Through the administration module, users can view a real time listing of all pharmacy activity and current stock. The tool can be run independently of other CliniPAK solutions or as part of a suite of tools.

SETTING A HEALTH DATA BASELINE (DENOMINATOR)

National, state and local health policy, annual operational performance goals and critical resource allocation decisions are made based on data collected at the most fundamental levels of the health care system. The degree to which this data is accurate and complete is the degree to which all other health administration decisions work to improve the quality of care delivered. This fact has been repeatedly recognized and articulated by authorities at all levels of the Nigerian health care system.

Current disease specific programs and interventions have shown great promise, but commonly generate incompatible data sets. With data traveling through multiple, parallel channels, it is often not until the highest levels that advanced reporting and research is possible. Without efficient data sharing capabilities between disease programs, high level MoH offices are charged with the nearly impossible task of collecting, aggregating, and analyzing copious amounts of non-standardized data.

Clinical Database, hosted securely in the cloud, connects all data capture interfaces and feeds business intelligence tools for reporting across patient demographics, specialty services provided, location of events and event type, to name a few. The data model manages patient and visit linked data within a structured framework for ease of reporting and integration while also accommodating dynamic survey responses.

The goals of the infrastructure, therefore, are operational, not programmatic. The investment success metrics focus on data confidence and provide a quantifiable Data Confidence Index for the data collected. For any data set across time, location or cohort, consumers of the data (i.e. policy makers and researchers) will know the quality and limitations in order to compare clinical intervention data for more reliable and informative results.

The Data Confidence Index is based on achieving progressive levels of (1) consistent use in capturing all health services rendered at the clinic, (2) completeness of data elements within services and finally, (3) quality of data elements captured.

By focusing on establishing operational IT metrics, we deliver a clinical repository of validated data with known limitations and known confidence indicators for each cohort and time frame selected. When data confidence is high, program data requirements are more easily met.

The process for this begins with Best Practice standard operating procedures for site preparation and deployment. Following deployment, operational metrics such as visits recorded per day and of which type are transmitted for a weekly dashboard review of system performance and user adoption. The second level is accuracy of use. Data captured within the visit are reviewed for completeness and accuracy. The third level evaluates if the system is being used meaningfully. A critical feature of data validation effort is the Feedback Loop with front line health workers. Dashboards and benchmarks shared with clinic providers allow them to compare their metrics with other clinics and discuss barriers to adoption and accuracy which often results in system improvements and an increase in user motivation. Insights are revealed regarding delivery of care and practicality of work in the clinic environment that informs clinical as well as operational attitudes, methods, barriers and opportunities.

Tools are necessary to manage and support a distributed network of remote clinics with efficiency and minimal resources. The durability of the CliniPAK reduces service calls, however scheduled and unscheduled visits and support calls are actively tracked and managed to identify system faults and respond to risks across the network.

Vecna Cares has developed valuable tools to achieve this quality data baseline as listed below:

- Standard Operating Procedures for clinic acceptance and user adoption

- Validated resource plans and budget for technology implementations and support

- Data monitoring and validation dashboards

- Front line feedback support model for data and behavioral validation

- Salesforce tracking of site activity including visits, support phone calls, hardware performance, and site leadership. Support documentation is made easy on our field staff through standardized digital surveys completed for both scheduled and on call support. This valuable record informs future release and support strategies, mobile device selection and hardware improvements, and staff turnover and re-training needs.

REPORTING FOR PROGRAMS, POLICY AND RESEARCH

DATA OUT

The HDI offers a range of reporting options for both clinical and operational metrics, these include Jasper Reports, Tableau and Revolution Analytics. The reporting technology is integrated with the local CliniPAK software and the cloud-based clinical database, providing the users, program managers and administrators with direct access to information.

All CliniPAK data collection tools feed a secure, patient-centered Clinical Database so views and reports are comprehensive and complete. CliniPAK allows providers to quickly cross-reference comorbidities across patients and populations for better understanding of health burdens and resource demands. Users can view and share standard reports for Ministries of Health and export custom data sets saving large amounts of time and labor while preserving patient privacy. Three export options (excel, csv, and pdf) allow for hard copy and/or digital storage locally.

In addition, the Reporting module acts as a web services layer to export information to other data consumers such as DHIS2[2]. We are currently forging this automated interface in Nigeria.

SAVING ONE MILLION LIVES[3] SOLUTION EXAMPLE

An illustration of the application of CliniPAK as the core of HDI is shown below with an alignment around the 6 Pillars of Nigeria's Saving One Million Lives Initiative.
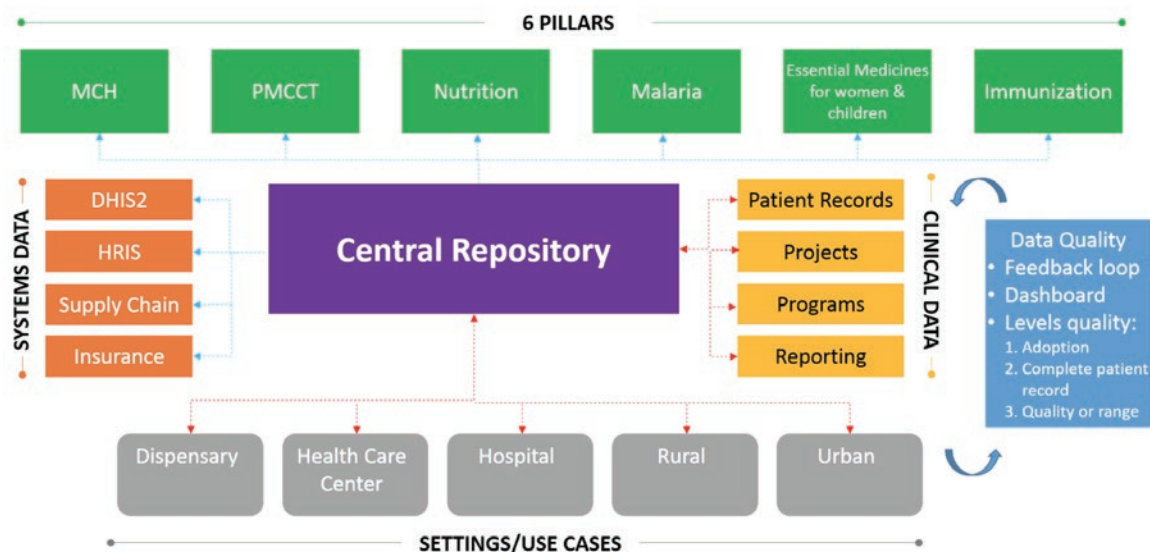
[2] DHIS 2 is the preferred health management information system in 47 countries and 23 organizations across four continents. DHIS 2 helps governments and health organizations to manage their operations more effectively, monitor processes and improve communication

[3] The Saving One Million Lives (SOML) Initiative is a program instituted to focus on outcomes, through strengthening the execution and delivery of Nigeria's existing health services by setting clear, ambitious targets for real impact; and a simple, yet laser-focused system of performance management to achieve them to save one million lives by 2015.

HDI BENEFIT ANALYSIS

Patient

The introduction of the HDI will positively impact the patient through increased access to medical resources and expertise through clinical decision support at the dispensary level. In addition, tele-referral and tele-medicine greatly reduces the financial and time cost to patients, requiring them to travel to higher facilities only when necessary.

Community

At the community level, mobile data capture results in the enrollment of more patients into the public health system, allowing for more complete and standardized data. Simple decision support capabilities improve the quality of care given by CHWs. Information collected regarding home-based care tracks the work habits and decisions made by CHWs to direct training. The seamless integration between community health and dispensary level programs creates a continuity of care. The introduction of CliniPAK also aids in the process of community education while mobile literacy and public health education programs available on each CliniPAK facilitates job marketability and public health awareness.

Dispensary/Health Center

Most MoH regulated primary care and health data capture takes place at the dispensary/health center level, making placement of CliniPAKs in these facilities especially important. Standardized workflows ensure complete data reporting from each facility, and help to ensure the implementation of consistent treatment and International management of Childhood Illnesses(IMCI) diagnostic protocols. Longitudinal patient records, combined with standardized clinical protocols allow for better patient management, more consistent care, and better transparency into treatment efficacy. Auto-

mated, wireless reporting mechanisms allow clinicians to focus on patient treatment, rather than on compiling monthly reports from a cumbersome paper-based system. Inventory tracking systems and automatic alerts facilitate proper resource management on the clinic level and help curb stock-outs.

In addition, the dissemination of health information not only empowers local dispensaries, but provides opportunities for local clinicians to learn from distant physicians over time. It also influences patient management, as fewer patients will need to travel to district or provincial hospitals.

District/Local Government Agency (LGA)

The burden of data management at the district level will be greatly reduced as a result of the implementation of an HDI. Public health officers need not travel to smaller facilities as often, saving both time and transportation costs. In addition, data collected from a specific disease program is easily and anonymously cross-referenced against other programs, allowing for more advanced and accurate surveillance mechanisms. Pharmacy tracking at the district level is automated and allows local officials to identify which facilities require more resources, and at what point in the supply chain accountability needs to be addressed.

Human resource and decision tracking at the dispensary/health center level provides district officials with an accurate account of the number of hours worked by each clinician, and a tool to identify clinicians that may need more training or guidance. The tele-referral tool helps ease the burden of overcrowding at district hospitals, as physicians have the opportunity to treat patients remotely. Thus, physicians at large district hospitals spend time attending to only those patients that require specialized assistance or advanced diagnostics.

Disease surveillance and epidemiology become simultaneously easier and more thorough as a result of the implementation of the HDI. Automated reporting compiles, generates, and delivers standardized reports to the District MoH. Future features, such as automatic surveillance systems, will alert officials to possible outbreaks. Real-time data, as opposed to monthly reports, can be displayed as graphs, maps, and reports to enable decision making as soon as the need arises.

Accountability

Inefficiencies of the paper record system can lead to high levels of resource mismanagement. Incomplete inventory reports sometimes lead to massive money expenditure in the form of mis-allocated drugs. Also, due to the low-income nature of many under-served populations, there is a growing incentive for clinicians and health workers to use facility resources for their own purposes, leading to a decrease in quality of care. There have been claims that fees collected from pa-

tients are sometimes kept for personal use, staffing is over reported to augment salaries, unauthorized leave is taken, and drugs from the pharmacy are either sold privately or at increased prices. In addition, long queues at inpatient clinics can be skipped by offering money to clinicians. There are currently few institutionalized methods to curb these trends, as pharmacy stocks are not carefully monitored, fees are not faithfully tallied, and official patient queues are either not kept or marked in pencil. An advanced wireless technological solution that links each clinical action to the identity of the clinician on duty and tracks the distribution and use of prescription drugs will reduce the opportunity for such misuses of resources.

CLINIPAK PILOTS

NIGERIA: MATERNAL CHILD HEALTH AND PRIMARY CARE

CliniPAK has been deployed in Nigeria since September 2013; under a consortium funded by Qualcomm® Wireless Reach™, the National Primary Healthcare Development Agency (NPHCDA) and SURE P Maternal Health Program jointly implemented CliniPAKs with the aim of reducing maternal and child mortality rates in Nigeria through access to better data. Consortium member Etisalat provided wireless connectivity for the project while Evidence for Action (MamaYe) provided analytic support. Vecna Cares provided technical direction and development support while InStrat provded implementation and training support and oversight.

Wirelessly connected tablets equipped with CliniPAK point-of-care   data capture and decision support applications have now been provided to midwives and health workers in 51 rural and urban Primary Health Centers in Ondo, Kano and Anambra States and the Federal Capital Territory. We have also equipped two specialized Mother and Child Hospitals in Akure and Ondo with CliniPAKs.
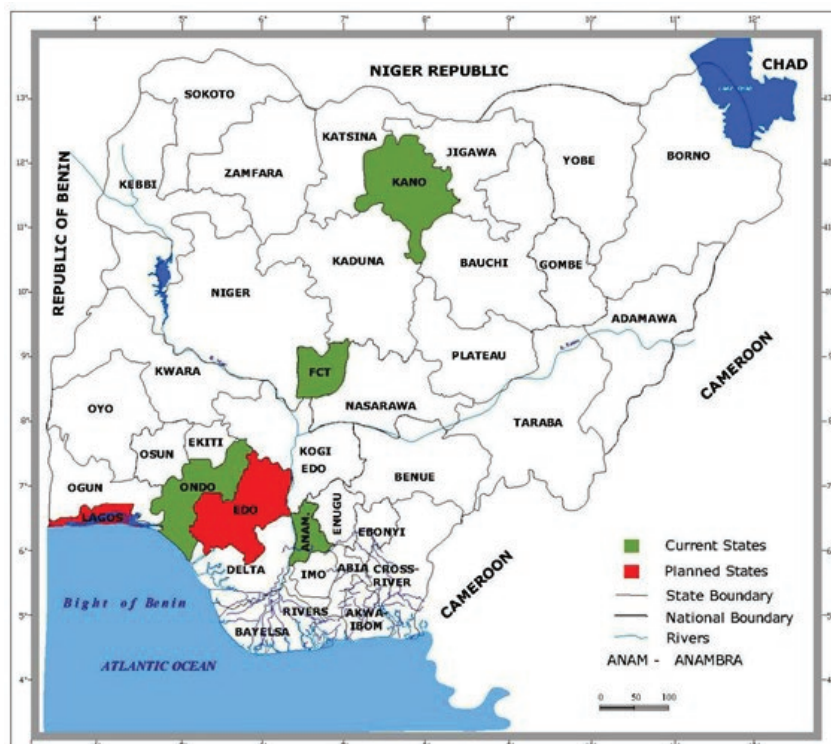
SOLUTION DESCRIPTION

The, a point-of-care   data capture and decision support tool, features 3G enabled tablets that allow health workers to capture patient health information and send the pertinent data points and information to remote servers through any of the available mobile networks. Each health worker electronically documents key patient data points, including demographics, history, complaint, diagnoses, treatment and follow up. Patient information is processed through algorithms to identify risk factors, triage patients accordingly and provide clinical decision-making support to the workers. Our systems enable immediate alerts for at-risk patients, referrals to secondary health systems, and on-demand reporting - all enabling care administrators to increase productivity and streamline the patient's clinical experience. Patient data is also available for recall on the tablet, at the point of care. The immediate availability of up-to-date medical data means clinicians and health workers are able to make informed, timely decisions that can assist in ultimately saving lives.

In situations where power supply is not available, we have provided solar chargers that have enabled the tablets be power independent.

Data Capture Categories

- Patient Level Information & Demographics
- Maternal & Child Health Workflows
  - Antenatal & Postnatal Visits
  - Birth Summaries
  - Nutrition
- Family Planning
- Immunization
- Labor & Delivery
- Mortality
- Prevention of Mother to Child Transmission (PMTCT) Sections

Reports Currently Provided

- Antenatal & Postnatal Care
- Birth Summary Sections
- Nutrition
- Family Planning
- Immunization Sections
- Labour & Delivery
- Mortality
- PMTCT Sections

Operational Data Currently Monitored

- Patient visits per day, per clinic
- Unique patient registrations per clinic
- Number of particular types of visits at each clinic including ANC 1-4

2015 Activities

Under a 2015 grant, our consortium has been funded by Qualcomm Wireless Reach to accomplish the following:

- Extend the reach of CliniPAK to at least one additional State expanding our presence in Nigeria's geo-political zones to achieve nationally representative data. Also, focus the expansion effort of CliniPAK in select local government areas (LGA) to build out mini versions of the HDI. An additional 50 facilities will be brought on line in 2015 with the continued support of Qualcomm Wireless Reach.

- Deploy CliniPAK hardware to high traffic facilities/ hospitals to enable local access to medical records and interactive CDS tools

- Extend clinical coverage to Outpatient Services to offer digital care documentation for the spectrum of health services offered by Primary Health Centers.

- Integrate CliniPAK report capabilities directly with the DHIS2 platform for automatic and real time transfer of national health metrics to DHIS2 (in progress).

CASE STUDIES:

Ebola frontline health worker education and management

In collaboration with the Ondo State Ministry of Health, InStrat, in collaboration with implementing partners and Anadach Group launched the first Pre/Post empirical evaluation of a mHealth intervention in West Africa aimed designed to improve FHW knowledge and attitude towards EVD and to establish their effectiveness as health systems strengthening tools. This effort highlights the use of tablets for instantaneous communication with facilities, training and capacity building of health workers and disease surveillance and response. This educational initiative shifted front line health worker knowledge and attitudes towards the Ebola Virus disease by statistically significant margins. This research has been submitted to the Bio Med Central (BMC) Human Resources for Health for publication.

Ondo State Disease Surveillance

InStrat was invited by the Ondo State Government to conduct the electronic disease surveillance of a mysterious illness that was discovered using our data capture tools and system. tOverall, 39 cases were line-listed with 29 dead resulting ina case fatality rate of 74.4% people in Irele LGA of Ondo State Nigeria. Our team was part of a State Ministry of health task force that included State Ministry of Health Epidemiologists and the State World Health Organization representatives.

Within 24 hours, we developed and deployed detailed electronic disease surveillance data capture tools through CliniPAK enabled mobile tablets to the local hospital in the affected area as well to Epidemiologists who interviewed families of all deceased and ill patients. Within 36 hours of initiation of the effort, based on captured data, we were able to determine that the most likely cause of the illness was "Acute Methanol Poisoning" from a local brew consumed by all the affected patients.

The impact of this quick intervention is that needless panic was averted nationally and countless lives were saved as information of the danger of this "brew" has been disseminated in the affected area as a result of data captured by our team. We are now working with the State and National officials to translate this to national policy.   The Ondo State Government declared the epidemic over on May 8th, 2015.

IMPACT OF CURRENT DEPLOYMENTS TO DATE

Impact on Patients: To date, 51 MCH clinics across four states in Nigeria are using CliniPAK. This has resulted in data of health care encounters on more than 100,000 pregnant women in Nigeria and this number increases daily. Data from these visits are aggregated for national health care   registries and collated into reference-able patient records. Using the platform on mobile devices, in this case tablets, health workers can track patients, perform outreach visits, and treat mothers and children according to recommended care schedules. The impact on these patients is significantly better care due to reference-able information captured on previous visits and conditions.

Impact on Providers: There are three main impacts we've seen thus far for providers:

1. Morale: Our experience is that when health workers and clinicians are better informed about a patient's medical history and condition, they are better able to care for that patient. The resultant improvement in the patients' health outcomes assists in improving the providers' morale.

2. Time Savings: Validated clinician time savings for data entry and report generation has been a major reason for consistent and invested CliniPAK use and sustainment in challenging working environments. Health workers are relieved of up to three days of tallying register entries for program and public health reporting, not to mention travel to the district headquarters for delivery. Clinicians are thus able to spend more time with their patients. The integration of data with the DHIS2 (National Health Data Aggregation) platform provides a comprehensive HIS solution for the reporting and analysis needs of the users at any level.

3. Capacity Strengthening: The transparency enabled by the availability of better data has highlighted gaps in health worker knowledge and health care   delivery capacity. On account of this, our counter parties in Ondo State have already begun instituting programs to retrain health workers to bridge capacity gaps.

Impact on Policymakers: The ability to track data across programs, and drill down to individual clinic or visit data with this depth and assurance of data, has never before been available to health policy makers. This allows for data driven evaluation of health burdens, interventions and allocation of resources. The following are examples of how improvements enabled by better data in Ondo State:

1. Policy makers in Ondo State are now better able to anticipate demand for services and ensure the availability of critical supplies and personnel

2. Service gaps have been highlighted and efforts are ongoing to ensure that all required services are provided at all health care   delivery points

SUMMARY AND CONCLUSIONS

An information infrastructure that connects outlying clinics to resources, supplies, policy and clinical health services supervision is a necessary imperative to building or strengthening health care   systems.

Such infrastructure featuring mobile technologies and 3G connectivity enable care activities and services to be documented and shared for clinical, program and policy decision support. Mobile health (mHealth) services can and are transforming health care and addressing disparities in access to health care services that impact patient outcomes. mHealth applications, platforms and devices are key to enabling better access to frontline health workers, medical services and to the information patients need to lead healthier lives.

The rapid penetration of mobile phones in LMICs on one hand, and the evolution of mobile devices to handle more sophisticated function have been critical enablers of The Primary Initiative. The accomplishments demonstrated in the applications of CliniPAKs to date and, more importantly, the potential for even more impact in the future rely on consistent improvement in the capabilities of those devices and increased reliability of mobile networks.

The authors of this paper are very interested in engaging public sector stakeholders and private sector partners to further explore the most effective mechanisms to implement an effective HDI. We are also very keen on identifying synergies with other systems and establishing interoperability platforms to ensure that the HDI serves as broad a purpose as possible. We are very interested in advancing the dialogue on developing and sustaining effective Health Data Infrastructure environments.

InStrat
INSTRAT GLOBAL HEALTH SOLUTIONS
instratghs.com

VECNACARES
vecnacares.org

QUALCOMM®
Wireless Reach™
qualcomm.com/wirelessreach