

Research Paper & Strategic Briefing

Health Information Systems in Developing Countries

A Landscape Analysis



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VITAL WAVE
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Executive Summary

The regions, nations, and communities that comprise the developing world face a wide variety of health-related challenges, and the health systems that address those challenges are struggling with limited resources and capability. Health leaders must therefore focus on maximizing the value of scarce resources and finding ways to make health systems operate as efficiently as possible. Having reliable data on the performance of different parts of the health system is the only way to devise, execute, and measure health interventions. Successful strengthening of health systems will require relevant, timely, and accurate information on the performance of the health system itself. The goal of a health information system (HIS) is to provide that information.

This document considers several aspects of health information systems for developing countries. First, it looks at the threats to health and the challenges facing health care systems in the developing world. Next, it surveys the landscape of efforts to specify and create successful HIS at the national level. Then it examines three case studies in depth and finally reviews the important challenges and opportunities associated with creating an effective HIS.

Research methods

The Vital Wave Consulting team employed three principal research techniques to create a comprehensive overview of the HIS landscape. Initially, the team conducted an extensive analysis of secondary literature on health information and interviews with experts in Health Information Systems. Next, the research team conducted a thorough review of secondary sources for 19 countries, including literature reviews and interviews to capture a basic picture of HIS initiatives in each country. Finally, primary research was undertaken in three countries with notable HIS initiatives: Brazil, India and Zambia. Site visits to these countries provided first-hand information on three initiatives of special significance. Though it is an upper-middle income country, Brazil is nonetheless included in this report because it exemplifies certain important characteristics of more advanced HIS development occurring in a developing country and can be a reference point for countries in Africa and Asia

Health Care Trends shaping national health information systems today

There has been substantial activity and innovation in the implementation of HIS in the last three decades, encompassing both successes and failures. Since the requirements of a successful HIS depend on the health system it serves, it is worth looking at the trends shaping health care in the developing world. These trends will impose increasing demands on health care systems and will potentially impact health information systems by presenting new data sources and opportunities for policy formulation.

- The role of private-sector health care will continue to increase in the developing world, requiring health information systems that are informed by private practitioners, facilities, and insurers.
- Economic development will change the profile of disease challenges, in which chronic conditions increase in importance even while infectious diseases remain a threat. This will dictate the need for additional health indicators and these indicators will need to be incorporated into HIS. Pandemic risks will link developed and developing countries, necessitating disease surveillance systems that accurately track outbreaks and transmit this

information internationally. This data may allow HIS to not only report on “current” health status, but also potential threats and vulnerabilities in the health care system.

- Globalization will continue to drain skilled medical and IT talent away from health systems serving the poor, necessitating health information systems that enable community-based health care workers to perform more advanced point of care services and which are sustainable in extremely low resource environments.
- Urbanization will draw talent and resources away from rural environments where a disproportionate number of the poor still live. Currently, most HIS only incorporate data collected at facilities, which leaves the needs of the rural poor, who often cannot get to a facility, under-represented in current HIS. The data collected by community-based health care workers operating in rural settings, if communicated to an HIS, will allow rural health needs to be more clearly understood.

‘First generation’ HIS

Though there is considerable diversity in HIS throughout the developing world, these systems typically share several key common traits:

- They function in the public sector and often only capture data from interactions with the public health system.
- There is significant fragmentation and duplication in data collection, because governments, donors and implementing partners have little incentive to collaborate on data collection, data sharing, or leveraging common infrastructure.
- The health information system is not used by those providing or managing health services at the local level, as these individuals are often presumed to not need health information of this nature.
- Data collection is a significant burden on those collecting the data and detracts from time spent delivering services.
- Various independent systems are seldom integrated, which impedes the ability to share data, increase the efficiency of operations or enhance the sophistication of analysis and decision making.

‘First generation’ HIS have demonstrated significant impact in improving patient health outcomes and increasing the efficiency of health systems. Improvements have been documented in:

- Increased follow-up rates on anti-retroviral drug campaigns
- Sharp reduction in emergency evacuation times and costs
- Dramatic shortening in TB diagnose time
- Improved clinical efficiency and laboratory revenues

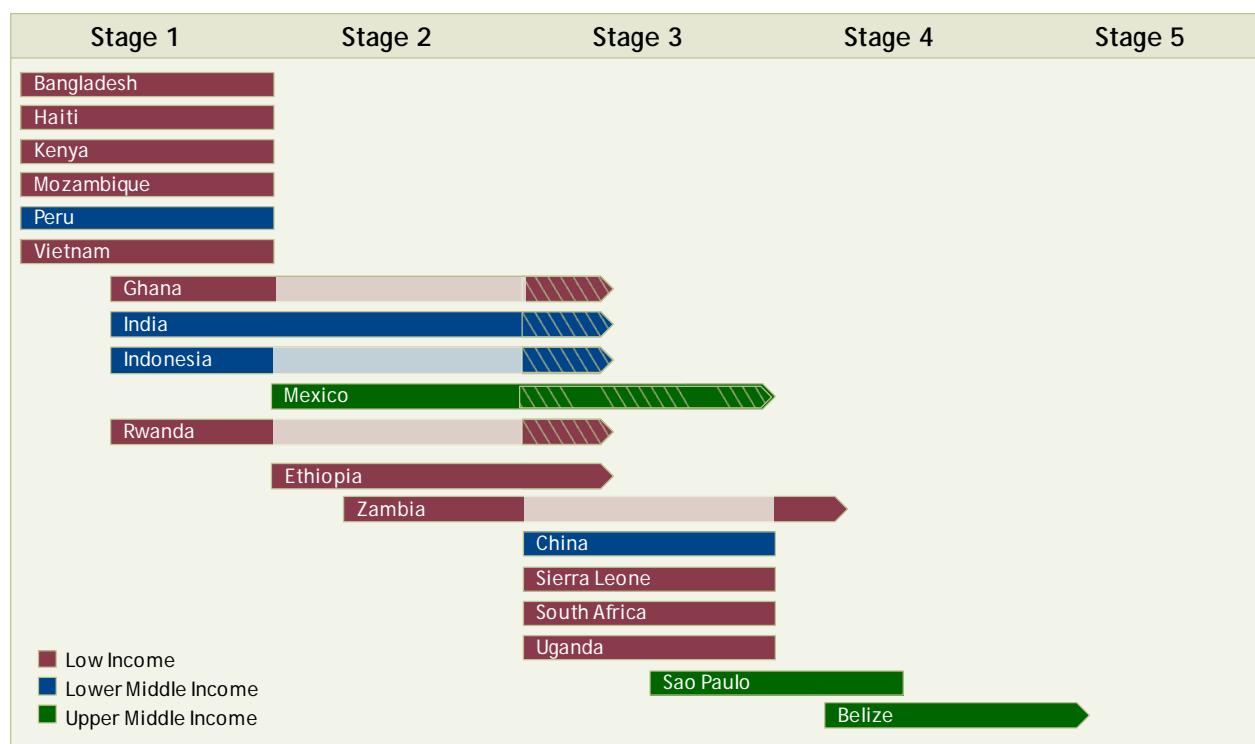
Note: Citations for these studies are in main text of the report

Organizations such as the Health Metrics Network have developed frameworks for what a successful HIS might look like, in which data from many sources is drawn into a central data warehouse, where thorough analysis takes place and actions are taken on the basis of that analysis. This framework fills several key gaps, but does not currently address:

- The problem of data quality and so long as the burdens and incentives surrounding data collection are not addressed, data quality will remain poor.
- The impact of health activity in the private sector as a source of data.
- Important data sources such as stand-alone disease surveillance systems, logistics management systems and emergency response systems.

Movement toward a 'second generation' HIS in developing countries

An analysis of the health information landscape suggests that countries are moving from the established paper-based implementations of district health information to the “second generation” HIS, where health encounter data is used to not only inform policy but to improve care at the point of service. The table below provides a categorization of health information systems today in five stages, as countries move toward systems of greater scope, scale, and sophistication. The categorization captures in a general way the characteristic features of national-level programs to collect health information. HIS stages are based on five dimensions: data flow and collection, data utilization and integration, resources and capacity, scope, and scale. The categorization depicts the evolving sophistication of these systems, the quality of decision making that these systems can support, and the capabilities required to sustain them.



Stage 1 is characterized by the usage of conventional paper-based systems for collecting district health indicators. The second Stage is characterized by as optimization of paper systems through simplifying indicators and reducing duplication. The third Stage is identified by a migration of traditional district health information systems to electronic storage and reporting. The fourth stage is characterized by the

introduction of operational IT systems as a source of data for HIS. The fifth Stage represents the achievement of an end state of a fully comprehensive and integrated national HIS.

It is important to note, however, that progress among these stages implies not just improvements in technology, but also a commitment to the use of health system information in evidence-based management decision making. This in turn requires effective leadership and comprehensive training at all levels of the health system.

Several important trends are evident among “second generation” HIS in which health encounter data is used to not only inform policy but to improve care at the point of service. These trends include:

- Better information management tools at the local level.
- Data capture through routine business operations.
- Identification of the minimum essential data sets.
- Growth of specialized technology and providers.
- Mobile devices become a key enabler for HIS.
- Early experience yields enthusiasm and skepticism around HIS.

Case studies illustrate different approaches for different goals

Country HIS case studies were organized around three main factors: Income Level, Scale and Scope. Scale refers to the size of the population covered by the HIS implementation while scope refers to the amount of data and services incorporated into the HIS.

Three countries – *India*, *Brazil*, and *Zambia* – were chosen for site visits to collect in-depth information about major initiatives that represented distinct sets of goals and challenges at different levels of income, scale and scope.

The table below outlines the differences between the case study countries.

Case Study	Region	Income Level	Scale	Scope
India	Asia	Lower middle	National, rural focus	Core health and disease indicators
Brazil (Sao Paulo)	Latin America	Upper middle	Citywide, urban	Resource allocation, EMR-based
Zambia	Sub-Saharan Africa	Low	National, urban and rural	EMR-based

As demonstrated in the three tables below, Brazil, India, and Zambia each approach HIS in a distinct fashion.

In *India*, a nationwide initiative of the National Rural Health Mission to introduce a Health Management Information System (HMIS) has been developed with the aim of improving the quality of health data in India and understanding the effectiveness and impact of recently-launched programs. The HMIS deployment is taking place on a massive scale, involving thousands of health facilities and

hundreds of thousands of health workers, and its success or failure will likely have a far-reaching impact on HIS development in India for years to come.

Brazil, though an upper-middle-income country, represents some of the greatest income disparity in the developing world, with about 31% of the population earning under \$1¹ per day. The HIS studied, called SIGA Saúde, is a large-scale, advanced HIS explicitly designed to manage resources in a public health system serving a very large population of urban poor. With many features of an Enterprise Resource Management system, SIGA Saúde offered the chance to understand the potential of a complex, operational system that generates indicator data from routine business operations, while at the same time using system data to improve specific aspects of health-system performance.

Zambia was selected because it houses three significant health information management efforts: the European Union-supported HMIS project, SmartCare, and ZEPRS. SmartCare was of particular interest because it represented a significant, nationwide initiative to improve patient health outcomes by providing frontline health care providers with relevant, timely patient information, which is housed in electronic medical records. Furthermore, this effort was taking place alongside and national efforts to reform the basic health information system, offering an opportunity to understand the challenges faced by countries coping with multiple HIS initiatives.

Sao Paulo, Brazil

Featured HIS Initiative:
SIGA Saúde

Sponsors/Partners: Sao Paulo City Department of Health

Key System Attributes:
Enterprise Resource Planning-like system with electronic medical records to manage resource allocation and patient flow

Scale: Regional, managing 20 million health encounters per year at 702 health facilities

Scope: Comprehensive resource management and recording essential health encounter data

India

Featured HIS Initiative:
Health Management Information System for the National Rural Health Mission (NRHM)

Sponsors/Partners: NRHM, National Informatics Centre, National Health Systems Resource Centre, state governments

Key System Attributes:
Web-based system that collects health indicators for monitoring and evaluation of NRHM programs

Scale: Initial focus on 18 poor, rural states followed by nationwide deployment

Scope: Reproductive and child health and infectious diseases, in line with Millennium Development Goals (MDGs) 4, 5, and 6

Zambia

Featured HIS Initiative:
SmartCare Electronic Health Record System

Sponsors/Partners: Ministry of Health of Zambia, US President's Emergency Plan for AIDS Relief (PEPFAR), US Centers for Disease Control and Prevention (CDC)

Key System Attributes:
Distributed database system providing a portable patient health record to each patient

Scale: 400 health facilities, with 250,000 patients registered

Scope: Health records for ante-natal care and HIV treatment modules, with family planning, outpatient, lab, pharmacy and under age 5 modules added in 2009

Looking forward

The report concludes with a set of next steps and recommendations for governments and organizations to follow to support effective health information management in the developing world. Although the field of health informatics is relatively new in the developing world and it is still experimenting with implementation models that can produce results, HIS remain critical to strengthening health systems in developing countries. Good information on the performance of the health system and the effectiveness of specific interventions is required to put extremely scarce resources to the best use. There are significant risks inherent in large-scale IT investments in HIS for developing countries because of the nascent state of local capability in these countries. It is important, therefore, to focus on strategies and initiatives that can establish solid foundations upon which to build increasingly sophisticated HIS over time. Accordingly, while not ignoring the crucial role of information technology, these conclusions emphasizes steps that will improve the quality and consistency of data reported by existing HIS without presupposing an advance commitment to high-risk IT investments.

Next Steps:

- Drive consensus adoption of a minimum set of essential indicators
- Determine the common, essential information needs across countries

Additional Recommendations:

- Enhance HIS success rates by supporting initiatives that have high-level sponsorship and occur in the context of wider health-system reform
- Support in setting clear priorities for reform
- Define HIS needs and goals
- Streamline data collection
- Develop HIS to support user decision-making
- Plan for project operations and maintenance at project outset
- Invest in adapted technology
- Develop commercial markets
- Increase project accountability by changing the structure of provider contracts
- Invest in increasing the attractiveness of the HIS technology and services market

Introduction

The regions, nations, and communities that comprise the developing world face a wide variety of health-related challenges. The afflictions of water-borne illness and nutritional deficiency affect low-income communities all over the world. Vaccine-preventable diseases needlessly claim millions of lives each year, as do infectious diseases such as malaria, tuberculosis, and HIV/AIDS. Thus, the challenge of improving health outcomes in developing countries will remain, even as incomes and living standards slowly improve.

Not only are the health challenges facing developing countries great, the health systems that address those challenges are struggling with limited resources and capability. The need to find ways to strengthen health systems overall is therefore urgent. Whereas stronger health systems may come as a result of bolstering resources, and additional resources may be necessary, there will never truly be adequate resources. Under that premise, there must be a focus on maximizing the value of very scarce resources and finding ways to make health systems operate as efficiently as possible. Having reliable data on the performance of the health system and its constituent parts is the only way to devise, execute, and measure interventions. Successful strengthening of health systems will therefore require relevant, timely, and accurate information on the performance of the health system itself. The goal of a health information system is to provide that information.

The concept of an HIS can often be confusing because the term is sometimes applied to specialized systems (for example, a disease surveillance system for tuberculosis or a patient registration system for a hospital). In addition, the term applies to nationwide data collection efforts, that report on population health status such as the conventional health district reporting, which is common in developing countries. This paper focuses upon efforts to create national health information systems that integrate a broad range of critical health-related data, ultimately covering an entire national population and that can be used at all levels of the health system to support improved service delivery and health outcomes.

As understood here, a HIS is not primarily about technology. Whereas technology can enhance the efficiency and effectiveness of information systems, collection and use of reliable data does not necessarily require sophisticated technology. Even simple, paper-based systems can be effective if well conceived. In sum, it is important to recognize the role that technology can play, while keeping in mind that the performance of an information system and the quality of decisions it supports are seldom a matter of technology alone.

A multi-faceted research approach was used to create this report, starting with a comprehensive review of secondary literature on HIS and health-related IT initiatives in developing countries, followed by extensive interviews with experts in the health informatics field and rounded out with in-country research – in three extremely diverse developing countries: India, Brazil and Zambia.

This document considers several aspects of health information systems for developing countries. First, it looks at the threats to health and the challenges facing health care systems in the developing world. Next, it surveys the landscape of efforts to specify and create successful HIS at the national level. Then it examines three case studies in depth and finally reviews the important challenges and opportunities associated with creating an effective HIS.

Research Methods

To create a comprehensive scan of the HIS landscape, three principal research techniques were employed. Initially, the Vital Wave Consulting team conducted an extensive analysis of secondary literature on health information and interviews with experts in health information systems. The experts interviewed were system vendors and implementers, in-country information technology (IT) officials, and academic subject-matter experts. Next, the research team conducted an extensive review of secondary sources for 19 countries, including literature reviews and interviews to capture a basic picture of HIS initiatives in each country. Finally, primary research was undertaken in three of these countries through country site visits, which provided first-hand information on three initiatives of special significance.

Secondary research countries

Countries included in secondary research were chosen to represent a cross-section of low-income countries that are distributed across major geographies and that have a variety of demographic profiles. Also included were several large, emerging, lower and upper middle-income countries with large populations of very poor citizens who are dependent upon public health systems. The following geographies and countries were studied:

1. **Asia**, including Bangladesh, China, India, Indonesia, and Vietnam;
2. **Sub-Saharan Africa**, including Ethiopia, Ghana, Kenya, Mozambique, Rwanda, Sierra Leone, South Africa, Uganda, and Zambia; and
3. **Latin America and the Caribbean**, including Belize, Brazil, Haiti, Mexico, and Peru.

Primary research countries

Three countries – **India**, **Brazil**, and **Zambia** – were chosen for site visits to collect in-depth information about three major initiatives that represented distinct sets of goals and challenges. Each case study offered a chance to understand major issues at different stages of HIS development and, as demonstrated in the table below, is unique in its geographic placement and income level.

Case Study	Region	Income Level	Scale	Scope
India	Asia	Lower middle	National, rural focus	Core health and disease indicators
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hundreds of thousands of health workers, and its success or failure will likely have a far-reaching impact on HIS development in India for years to come.

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Terminology

Discussions of health informatics, or health information systems, are often enhanced by a common understanding of terminology. In the interest of clarity, this document adheres to the following definitions.

Architecture, also referred to as **enterprise architecture**, refers to the organizing logic for business processes, data, applications and IT infrastructure reflecting the integration and standardization requirements of the health system's operating model.

Data architecture describes the data structures used by an organization and/or its applications. There are descriptions of data in storage and data in motion; descriptions of data stores, data groups, and data items; and mappings of those data artifacts to data qualities, applications, and locations, for example. Essential to realizing the target state, data architecture describes how data is processed, stored, and utilized in a given system. It provides criteria for data processing operations that make it possible to design data flows and also control the flow of data in the system.

Data warehouse is a repository of an organization's electronically stored data. In addition to data storage, the means to retrieve and analyze data, to extract, transform and load data, and to manage the data dictionary are essential components of a data warehousing system. Operational systems contrast from data warehouses in that operational systems perform day-to-day transaction processing.

A **developing country** has a Gross National Income per capita of less than or equal to \$11,455 according to World Bank's country classification scheme. The World Bank

categorizes countries according to Gross National Income per capita (2007). Developing countries are broken down into the following categories:

- ***Low income country:*** a low income country's GNI per capita is \$935 or less.
- ***Lower-middle income country:*** a lower-middle income country's GNI per capita is between \$936 and \$3,705.
- ***Upper-middle income country:*** an upper-middle income country's GNI per capita is between \$3,706 and \$11,455.

A ***health information system (HIS)*** refers to any organized effort to systematically collect, maintain and disseminate data relevant to the performance of a health system or any of its component parts. As such, any health system has potentially many health applications functioning within it.

A ***health system*** is the complete universe of all activities that serve to maintain or improve the health and longevity of a population in a specific geography.

Indicators are aggregate or compiled statistics derived from data pertaining to interactions, events, or occurrences in the health system.

Health care delivery, or care delivery organization (CDO) refers to the core medical system and its adjuncts, such as pharmacies, clinical laboratories, and their respective supply chains.

Metadata is definitional data that provides information about or documentation of other data managed within an application or environment. Metadata may include descriptive information about the context, quality and condition, or characteristics of the data it describes.

Microdata refers to data relating to an individual which is not, however, uniquely identified to a particular person. The record of a clinic visit that does not otherwise identify the patient is an example of microdata.

Personal health records (PHR) are transaction-level data on health-related events and indicators pertaining to a single, identifiable individual. PHR includes – and is often used interchangeably with – electronic medical records, patient health records, and other similar terms.

A ***population*** is any universe of things, events, or occurrences on which data are collected.

Note on currency: Unless otherwise specified, all data and findings in this report are presented in real US dollars.

Landscape Overview

Decentralization and the Importance of Health Information Systems

With its declaration that “primary health care is essential health care” and its call for “urgent and effective national and international action to develop and implement primary health care throughout the world and particularly in developing countries,”² the Alma-Ata conference in 1978 set a course leading to the development of the health information systems most commonly seen in developing countries today. The focus on primary care encouraged decentralization and the creation of health districts administering publicly-funded health services within a geographic area of moderate size. Concern for monitoring the performance of the health care system gave rise to paper-based data collection systems intended to provide comprehensive data on the performance of the country’s public health system and its disease burden.

In the past decade, there has been tremendous activity and innovation in the development of health information systems, spurred in large part by technological advances, and the interest these advances have generated in the health sector. Progress has been made in designing systems that meet the needs of patients and health workers. IT implementations have demonstrated initial successes in improving patient outcomes, particularly around HIV patient case management, and have increased the efficiency of health services delivery as well, by improving the speed of laboratory testing, the evacuation of patients in emergency settings, or the expected cost of tuberculosis treatment. Yet significant shortcomings remain.

This section will offer a closer look at the promise and challenges of health information systems. It will provide an overview of today’s health information landscape and describe the health information trends that are shaping health systems. This section will also provide a view of emerging patterns in the way that health information is evolving in the developing world.

Trends Shaping the Idea of a National Health Information System

Any effort to create a health information system of national scale will necessarily involve a significant commitment of time and resources, and is accompanied by inevitable risks. So it is worth pausing to consider just what is meant by HIS in this context, the purposes it must serve, and the conditions under which it must operate. These considerations suggest that a single national health information system is difficult to create.

The Health Metrics Network (HMN),³ hosted by the World Health Organization, was organized to spearhead an international effort to strengthen HIS in developing countries.

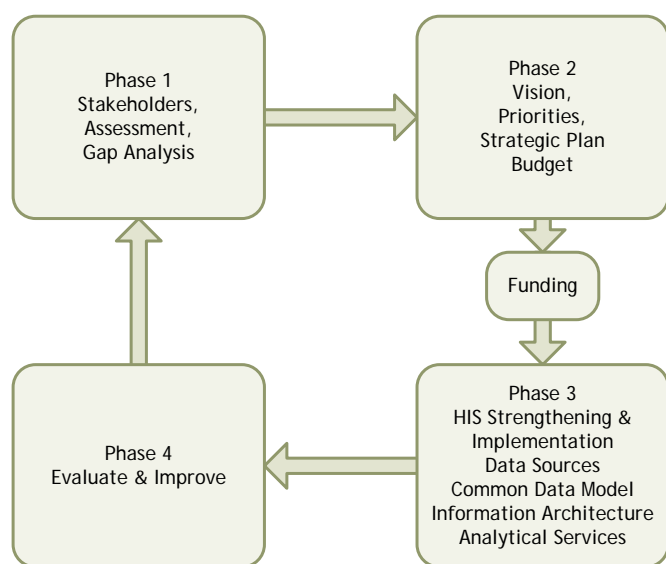


Figure 1 - HMN Process

HMN has developed a set of tools for the comprehensive assessment of a country's HIS, resulting in a multi-faceted picture of the strengths and weaknesses of all critical elements, including data sources and collection, as well as capacity for analysis and use of information for policy making and administration. It was planned that participating countries would follow the process illustrated in Figure 1.

In the words of HMN, the goal of a national health information system is to allow decision makers to “identify problems and needs, track progress, evaluate the impact of interventions and make evidence-based decisions on health policy, programme design and resource allocation.”⁴ This goal is ambitious, as the potential users of health information include “those delivering care and those responsible

for managing and planning health programs both within countries (health and finance ministries) and outside (donors, development banks and technical support agencies).”⁵ The scope of the goals involved and the size and diversity of the intended audience suggest that an effective national HIS therefore entails:

- The collection of a very wide range of data from multiple sources and jurisdictions
- A data repository that is available to a diverse audience of users
- Functionality and business logic to perform the needed synthesis and analysis to turn raw data into meaningful information usable for management and policy decision-making.

This is to be accomplished in the context of health systems that, beyond widespread poverty and weak public institutions, are shaped by larger trends in disease, technology, and social development. These trends will reshape health concerns and present new opportunities for addressing long-standing challenges, but will also demand more from national HIS.

- **The role of private-sector health care will continue to increase in the developing world.** Longitudinal data on health expenditure in developing countries is scarce, but does suggest that private sector health expenditure is increasing as a share of total health expenditure.⁶ The omission of private health data from HIS, therefore, will become more significant as private sector participation in the health sector increases. Public health systems will need to be structured to be able to engage with their private sector counterparts,⁷ and information technology can play an important role in facilitating this process.

Second, in countries where private health expenditure represents a large share of income in poor households, HIS that cover only public health services may under-report information on these households. There may be a specific role for insurers, public or private, to play an

important part in shaping HIS as they form an important link within the private health care system, and they have a strong vested interest in obtaining accurate data on health system performance to support actuarial calculations underpinning the finances of all insurance. Moreover, because they reimburse private providers, these insurers, public or private, are uniquely positioned to require data on services rendered as a condition of payment. In Ghana there is a World Bank project to create a nationwide integrated ICT solution for the National Health Insurance Scheme to enhance financial management and resource utilization. Unlike the typical district health information system, when complete this system will collect data from both public and private sector facilities.⁸ The intersection of the health system and insurance systems that fund it will be an essential nexus that drives data collection from the private sector.

- **Economic development will change the profile of disease challenges.** With a few notable exceptions, the relationship between development and disease is typically positioned as a two-way street: disease inhibits development, and poverty creates conditions that make people more vulnerable to disease. As populations grow wealthier, their disease profile changes. Today, major communicable diseases such as malaria, TB, HIV, cholera, and diarrheal diseases are a main focus of attention in developing countries. Progress against these diseases will surely boost economic development, but that improvement will eventually be accompanied by increased incidence of chronic diseases, such as India is experiencing today in urban areas.^{9,10} This shift in focus toward longitudinal health management will change the demands on primary care in the health system and create demand for systems of effective monitoring and continuous care of individual patients over extended periods of time. This too will change the way that HIS must function, requiring flexibility in design in order to accommodate the appearance of new disease threats, while still addressing infectious diseases.
- **Pandemic risks will link developed and developing countries.** In late 2002 and early 2003 much of the world was startled to discover that a new viral disease, Severe Acute Respiratory Syndrome (SARS), had infected more than 8000 people in several months and rapidly spread across wide areas of the globe. Globalization has increased the ease and speed with which serious communicable diseases can become pandemic, and detecting and managing people with diseases like SARS, avian flu or Extremely Drug Resistant TB (XDR-TB) becomes a global, not a local, concern. Developing countries are committed to strengthening their surveillance systems in conformance with the WHO Global Health Regulations. In response to SARS, China developed its web-based real-time disease surveillance system and other countries such as Mexico and Peru have similar disease surveillance systems. The urgency of effective surveillance and incident response will compel the development and collection of indicators for surveillance systems.
- **Developments in medical technology enhance treatment but require improved infrastructure for distribution.** Powerful new drugs and vaccines will offer the prospect of cure for many common diseases, but these products will require much better supply chains to avoid very expensive losses due to spoilage or expiration. Vaccines and drugs that require cold-chain storage and delivery can pose special problems in the developing world, where transportation infrastructures are often inadequate and shortages of equipment such as syringes are common. Future treatments will increasingly involve combinatorial drug cocktails that require sophisticated administration and monitoring over lengthy periods of time. In many cases, such as with HIV, improperly administering treatments can lead to very undesirable

results (increased drug resistance, dangerous side effects, wasted doses of expensive medications, etc.). Monitoring the performance of the supply chain will be increasingly essential to the success of disease programs. HIS will need reliable indicators on the basis of which to correct bottlenecks and misallocation. Because of the difficulty of keeping manual inventories especially in large facilities, operational software systems that handle real-time data will become more and more necessary.

- **Globalization will continue to drain skilled talent away from health systems serving the poor.** Doctors and nurses in developing countries are not just drawn to cities, but are increasingly attracted to Europe or North America, where positions in medicine as well as average non-medical wages are significantly higher than in the developing world. Analysis of physicians in the US, the UK, Canada and Australia shows that 23-28% of physicians in those countries are international medical graduates, and 40-75% of international physicians come from low income countries.¹¹ As the author suggests, the analysis likely understates the magnitude of the “brain drain” because not all physicians immigrating to the countries studied succeed in obtaining their medical qualification, and not all physicians emigrating from low income countries go to the four countries above. The medical “brain drain” will drive investment in technologies that enable non-physician health care workers such as nurses, midwives, community health care workers, etc. to perform more advanced functions. It may encourage the implementation of HIS or related systems and infrastructure further down the health system hierarchy to reach these lower-level health workers and enable them to compile and transfer data. It will also reinforce the demand for HIS systems that are simpler and more intuitive to use and learn, because the less time it takes to train someone to use and become proficient with the HIS, the sooner they become productive. Mobile devices will play an important role in this process. A similar “brain drain” pattern exists for IT personnel in the developing world that likely affects the availability of IT resources for HIS projects. Initiatives that increase private sector participation and wages in health informatics in the developing world have the opportunity to slow this trend, in much the same way that the growth of business models such as business process outsourcing (BPO) and call centers has enabled IT professionals in developing countries to gain world-class experience on challenging projects without leaving home.

Several trends will reshape health concerns and present new opportunities for addressing long standing challenges, but will also demand more from national HIS. These include:

- The role of private-sector health care will continue to increase in the developing world.
- Economic development will change the profile of disease challenges.
- Pandemic risks will link developed and developing countries.
- Developments in medical technology enhance treatment but require improved infrastructure for distribution.
- Globalization will continue to drain skilled talent away from health systems serving the poor.

Reconsidering the Definition of HIS

The trends discussed above, as well as the environments in which specific HIS have evolved, have given way to health information systems different from theoretical descriptions of HIS. This subsection will describe this “first generation” health information system, or today’s health information

system, drawing from field research, expert interviews, and review of health informatics literature. It will describe the impact and common challenges associated with “first generation” systems, laying the groundwork for the “second generation” system described in the next sub-section.

Characterization of first generation HIS

First generation HIS share a set of common characteristics, readily observable in the HIS assessments supported by the Health Metrics Network. First generation HIS are typically anchored within public health systems. In the years following Alma Ata, a general pattern of data collection has evolved in such systems. Activities at health facilities are recorded in written log books or registers. At regular intervals these are tallied by health workers and summary reports of compiled indicators are forwarded to the next higher administrative level of the system where they are recompiled and passed on again, repeating the process until, in theory, a final country-wide compilation is available for use in setting policy.

The data in such systems flows upward to the central Ministry of Health (MoH) and donors, but typically not downwards (or horizontally) to the health care provider. Many “first generation” HIS have been built by a single agency, group, or program, always with their specific needs in mind. As such, many systems may proliferate within a single country, and the systems tend to be siloed from one another. They often reflect the information needs of a specific donor or program rather than those of the users themselves. They also are generally designed to address a particular *disease* or *condition*, and are therefore limited in scope. First generation HIS are frequently smaller in scale, as well.



Picture 1: The dozen-plus registries that nurse midwives in India maintain

Observed shortcomings of first generation HIS

These systems have a number of common traits:

- **They function in the public sector** and often only capture data from interactions with the public health system or with specific surveillance and monitoring programs operated by donors in conjunction with the public health system. However, this is beginning to change, as evidenced by HIS coverage of private clinics in Zambia and private providers' integration into the Sao Paulo HIS scheduling system. In India, the government is able to collect health statistics from private health care providers with varying degrees of quality.¹²

- **There is significant fragmentation and duplication in data collection,** because governments, donors and implementing partners have little incentive to collaborate with others on data collection, to share data, or to leverage existing systems. For example, early response to the HIV epidemic in Zambia drove the creation of at least five patient data management programs, because stringent data management is critical to effective HIV patient care, and several actors provided HIV patient care by the mid-2000s. In many cases, health workers must complete separate forms containing the same information for delivery to different agencies who do not share data among themselves. National ministries of health are seldom in a position to resist the demands of donors who fund large health care programs, and moreover the incremental cost of collecting additional data is largely invisible to the donor, so there is little disincentive to adding additional indicators that accumulate over time into very large workloads for local health workers. Notwithstanding common pledges to work toward harmonization, such as the Paris Declaration on Aid Effectiveness (so-called “Paris 21”), this remains a very significant challenge for HIS in developing countries.
- **The health information system is not used by those providing or managing health services at the local level,** as these individuals are often presumed to not need health information of this nature. The data collected is determined by users far removed from the actual delivery of health services, and seldom has relevance to improving those services. Donors require indicators for purposes of program evaluation and not necessarily the improvement of service delivery. Data flows in one direction, from those at the bottom doing the collecting to those further up the chain of command. Health care providers do not have access to information beyond their health facility, and as such are unable to compare their performance to that of similar health facilities.
- **Data collection is a significant burden on those collecting the data.** These individuals often have limited means and little incentive to collect complete or accurate data. In some instances there are perverse incentives to exaggerate indicators to satisfy so-called “pay for performance” arrangements where funding is tied to improvement in specified indicators.¹³ In India, it is reported that health workers spend four to five hours per week completing numerous forms with information from as many as 13 different registries, several of which frequently require identical pieces of information. In Zambia, the data collection burden significantly reduces the time that health care providers have to spend on improving the quality of patient care. One head nurse said that if she and her team did not have to spend so much time on reporting (five days per month), she could use her quarterly site report to discuss with other nurses how to improve care.¹⁴
- **Various independent systems are seldom integrated,** which impedes the ability to leverage data from multiple sources to increase the efficiency of operations or the sophistication of analysis and decision making. In Brazil and in many developing countries, decentralization has enabled the development of region-level or municipality-level health information systems that are tailored to each area’s specific health information needs. Despite requests from the regions, the national government has yet to step in to develop common standards that would allow these systems to interoperate.¹⁵

Impact of 'first generation' HIS on patient health outcomes

Despite the shortcomings of first generation HIS, some of these systems have – perhaps surprisingly, given their constraints – demonstrated significant impact in improving patient health outcomes and increasing the efficiency of health systems. Many anti-retroviral drug campaigns suffer from high rates of patients being lost to follow-up.¹⁶ Electronic patient registry systems such as OpenMRS or CDC's SmartCare and CIDRZ programs in Zambia, can help mitigate this problem.¹⁷ The EHAS system in use in the Amazon region of Peru reduced mean evacuation time of emergency cases by 40%.¹⁸ An economic evaluation of this system demonstrated a significant cost savings, mostly due to more efficient use of services.¹⁹ An email-based consulting service in Cambodia was very well-received by its users, and was associated with a significant drop in mean duration of patient chief complaint.²⁰

IT systems have been successfully used in the developing world in pharmacy and laboratory management, as well. Programs such as the one described by Fraser et al. to support laboratory diagnosis of TB-positive sputum samples can decrease the detection time for new cases, from a mean of more than a month to six days.²¹ A system in use in Turkey dramatically reduced sample turnaround time, thereby improving clinical efficiency and simultaneously increasing laboratory revenue.²² The PIH-EMR system deployed in Lima, Peru, accurately predicted anti-TB drug usage by a subset of patients. Had its model been used to order prescriptions, there would have been a 30% savings.²³

First generation HIS have demonstrated significant impact in improving patient health outcomes and increasing the efficiency of health systems. Improvements have been documented in:

- Increased follow-up rates on anti-retroviral drug campaigns
- Sharp reduction in emergency evacuation times and costs
- Dramatic shortening in TB diagnose time
- Improved clinical efficiency and laboratory revenues

The same first generation HIS systems also share a number of common traits or constraints:

- Anchored in the public sector
- Significant fragmentation and duplication in data collection
- Not generally used by those providing or managing health services at the local level
- Data collection is a significant burden on those collecting the data
- Independent systems are seldom integrated

The need for a new concept of HIS

The promise and the shortcomings of current systems raise the question of what a successful HIS might look like. While there are a number of variations, there is a clear pattern to many of these conceptions, illustrated in the following diagram.

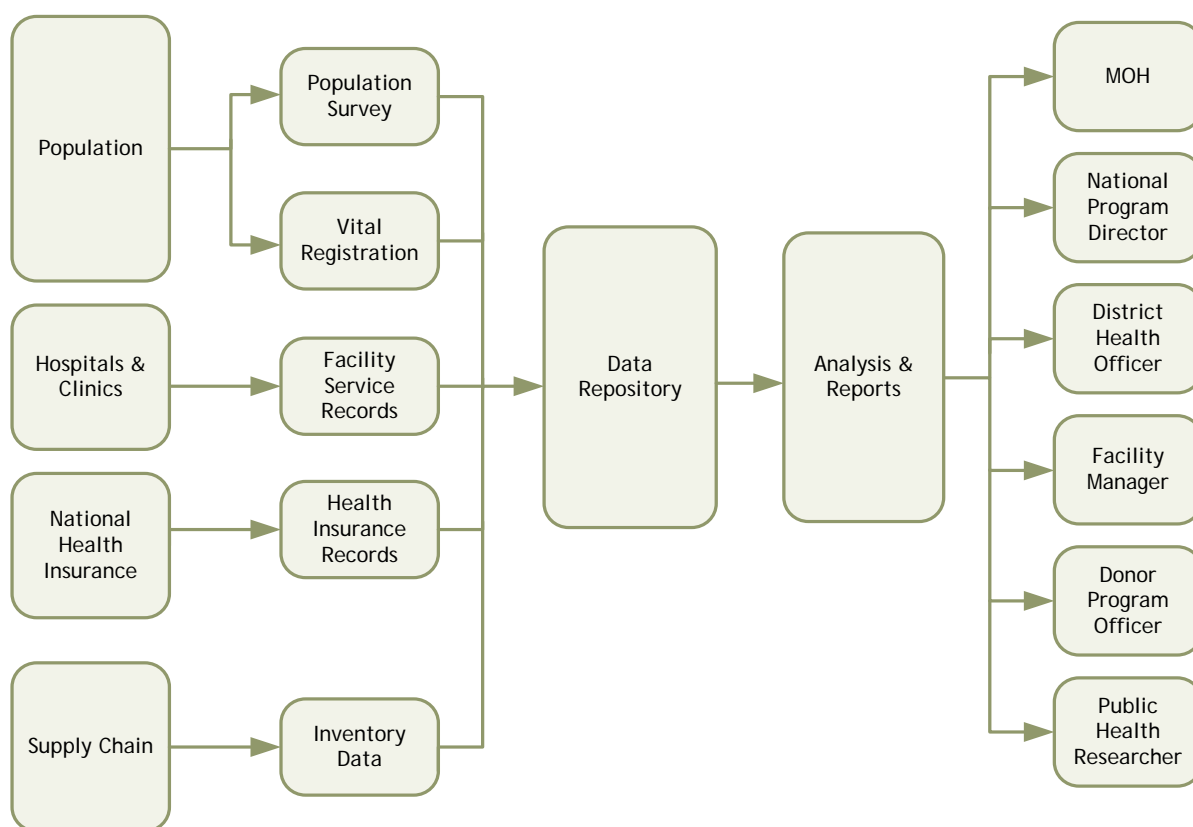


Figure 2 - Typical Vision of HIS

This conception recognizes the importance of bringing together data from different sources to enable much more effective analytics. Inspired by models applied in modern business corporations, it does not necessarily require the merger of all information systems (“data sources”). However, it presumes the ability to map data sets from disparate sources into a single repository where analysis can be performed seamlessly across all of them.

Leaving aside the technical challenges and resource requirements of creating a successful data warehouse, from the viewpoint of a national health system this conception has several important limitations.

- The problem of data quality is not directly addressed.** So long as the burdens and incentives surrounding data collection are not addressed, data quality will remain poor and aggregating it in a data warehouse will not thereby improve it. Technology can help improve data quality, but data quality is not primarily a technological problem. Investment in sophisticated electronic storage is of limited value if poor data quality is largely a function of the burden of existing data collection processes and the lack of incentives for accurate reporting. Sao Paulo’s SIGA Saúde system addresses the question of data quality by capturing data in “real time” as part of routine patient scheduling and care. The SIGA Saúde system saves health care professionals time in data entry, creating a strong natural incentive to report data correctly.

- **The impact of health-related activity in the private sector is overlooked** and is neglected as a source of data relevant to setting policy for the health system as a whole. This view of HIS is still focused on the public sector, that part of the health system that is most visible and amenable to data collection. Systems that cover private providers, such as Zambia's SmartCare electronic health record system, will be able to gather data on individuals in lower income strata. Such systems will also be able to monitor the quality of privately provided care, improving care where needed.
- **This conception often omits important potential data sources** such as disease surveillance and response systems, or environmental data such as water or air quality data, which are particularly important in an age of fast-moving epidemics.

In many discussions about serving the needs of a national population via HIS there is a tendency to focus on technology (the data warehouse). Technology has a role to play, but the benefits of an information system are only incidentally dependent on technology. It can manage information efficiently but cannot decide on the right information to collect or the right use of that information once collected. This approach to HIS continues to view the information system primarily as a means of collecting and storing data for the benefit of administrators, analysts, funders, and others while the needs of those actively providing health services are neglected. People in the health system are viewed as data providers, not as information consumers or active managers of their respective roles and activities. So while they might well benefit indirectly from the results of data analysis conducted elsewhere, the possibility that the HIS should directly enable more effective and efficient delivery at the point of service is largely overlooked.

Movement Toward a National HIS in Developing Countries

In response to the health challenges they face, many developing countries have launched reforms of their health systems and as part of those reforms they have undertaken to expand and improve their HIS. Analysis of the health information landscape suggests that countries are moving from the established paper-based system of district health information to the “second generation” HIS, where health encounter data is used to not only inform policy but to improve care at the point of service. This sub-section provides a categorization of health information systems today in five stages, as countries move toward systems of greater scope, scale, and sophistication. Care should be applied in judging the quality of a system by its level of sophistication, however, system quality is highly dependent on factors such as system design, stakeholder buy-in, proper budgeting, and implementation.

Table 1 depicts the evolving sophistication of HIS systems, the quality of decision making that these systems can support, and the capabilities required to sustain them. It is based on a survey of secondary literature on 16 developing countries²⁴ and primary research on three: India, Brazil, and Zambia (case studies are in the following section of this report). The categorization captures in a general way the characteristic features of national-level programs to collect health information. It is important to bear in mind that any country will have many independent programs to collect and use health-related information. These programs may be simple and paper-based, or may be high-functioning and technologically advanced, as are many disease surveillance and monitoring systems for diseases such as TB or HIV. Accordingly, the grouping below is not based on the range, or the total number, or the type of individual data collection efforts. It is instead a view of some typical characteristics that differentiate national efforts to move toward the creation of a fully integrated comprehensive HIS.

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Data Flow and Collection	<ul style="list-style-type: none"> Data collection is based on manual tallies from activity registers Multiple redundant forms Data collection is external to routine operations, time consuming 	<ul style="list-style-type: none"> Data collection is based on manual tallies from activity registers Focus on using existing systems to collect an optimized and smaller set of data with a view to increasing data quality, relevance. Collection burden reduced, more rapid availability possible 	<ul style="list-style-type: none"> Data collection is based on manual tallies from activity registers District data collection converted to electronic storage and reporting No change to basic process of compiled reports passed up institutional chain. 	<ul style="list-style-type: none"> Data captured in course of routine transactions rather than collected. No manual tabulation from registers. Heavy reliance on electronic data storage (some paper-based data collection may remain) Operational systems (e.g., patient scheduling, lab management, pharmaceutical modules) as data source 	<ul style="list-style-type: none"> Data captured electronically from routine business ops (clinical and administrative) Integration of data from multiple information systems at all levels of health system Data collection provides decision support for clinicians
Data Utilization and Integration	<ul style="list-style-type: none"> Disorganized and ineffective district reporting Data quality poor, long delays in reporting No integration of separate information systems Peer data from other facilities or geographies rarely available 	<ul style="list-style-type: none"> District data collection normalized, simplified More rapid data availability Improved management decisions possible with quality data No integration with other information systems 	<ul style="list-style-type: none"> Formal electronic communication, storage and automated reporting of collected data Increased analytics Aggregated data not tied to individual electronic medical records Data from other facilities and geographies can be obtained for peer comparison 	<ul style="list-style-type: none"> Enabled individual IDs, EMR, appointment, scheduling and reminders, facility operations capabilities (lab, pharmacy, etc.) Systematic business process analysis required Access to information from all levels of service delivery network possible and encouraged Public health data not integrated Complex reporting 	<ul style="list-style-type: none"> Full Personal Health Record for all individuals Complex reporting Evidence-based decision making and data-driven management Integrates all significant health-related data from all component systems Explicit national policies on data standards and interoperability
Resources and Capacity	<ul style="list-style-type: none"> Little or no computer literacy at local level Capacity for data analysis limited, confined to central MoH 	<ul style="list-style-type: none"> Little or no computer literacy at local level Basic capacity for data analysis at local levels M&E capacity at central level 	<ul style="list-style-type: none"> Limited computer literacy required for data entry at local level Increased analytical capabilities 	<ul style="list-style-type: none"> Moderate to significant computer literacy required for larger number of users Substantial technical skills required on ongoing basis Often local push for national adoption, but no sustained national commitment or funding 	<ul style="list-style-type: none"> Managers at all levels strongly inclined to using data to support decision making Strong culture of data-driven management Strong consistent leadership and support. National commitment to ongoing funding
Scope	Scope: Modest - captures only district indicators	Same as Stage 1	Same as Stage 1	Greatly expanded with inclusion of patient-level data from health system transactions (EMR), and resource data (personnel, medical supplies)	Maximized, with Stage 4 data integrated with public health data
Scale	Can be country-wide depending on compliance and follow-through (which is often spotty)	Same as Stage 1	Projects often begin with one or two districts, but aim for nationwide deployment	Sub-national because of increased resource and capability requirements	National, entire population included

Table 1 - National HIS Efforts in Developing Countries

Stage 1

represents countries that still rely on unreformed district health information systems of the type described in Table 1. These are paper-based systems that are a highly fragmented and burdensome to health workers tasked with data collection. Peru is an example of this stage. While it possesses

several successful small-scale HIS initiatives, it does not have a high-functioning health data collection or analysis scheme operating on a nationwide basis. The majority of low-income, developing countries reviewed for this study belong in this category, as do lower-middle income countries such as Peru and Indonesia.

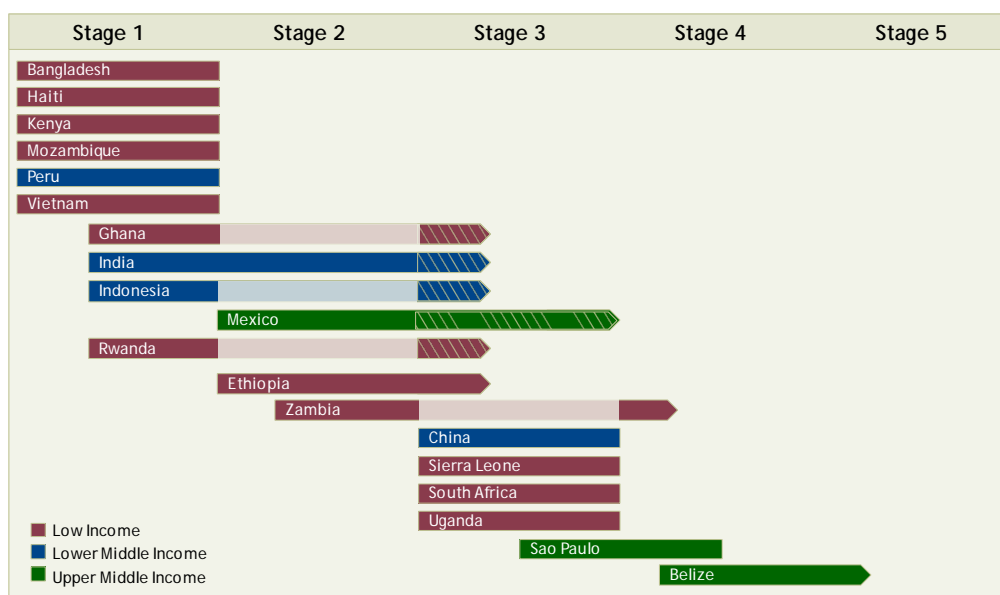


Table 2 - Countries and Progression Along HIS Stages

Stage 2 represents countries that still employ paper-based systems yet have undertaken an initiative to address data quality, accuracy and timeliness by optimizing the type and amount of data collected and reforming data collection processes. These initiatives explicitly focus on optimizing the existing paper-based district health information system without any advance commitment to electronic technology. Ethiopia is one such country in this group. In 2006, Ethiopia completed a full review and revision of HMIS indicators and forms with notable results. Health posts that once collected indicators based on an average of 353 varied data elements, now collect a uniform 50 standard data points. Health centers that were collecting indicators based on an average of 401 data elements are now collecting a standard 150 data points, uniformly adopted throughout the country.

Though technology is not involved at this stage of development, the opportunities to optimize an existing paper-based system are quite significant. For perhaps the first time, there must be a strong country-level champion and a national commitment to reform. There must also be an effective process for determining a reduced set of common core indicators, and then changes in the registers and log books at all local facilities throughout the country. Lastly, donors must be aligned in support of the initiative. As reflected in Table 2, many countries neglect this important step in making the move to electronic collection and storage. Because duplicate and inconsistent data continues to be collected, avoiding this step undermines the effort to improve data quality and only postpones the time when leadership and consensus will be necessary to further progress.

Stage 3 represents the start of the electronic collection and storage of health data, to further address the issue of data collection quality, accuracy and timeliness. Initiatives in this category may start off in a few districts or states but proceed with the eventual goal of a nationwide rollout. Many initiatives result in a hybrid system where paper forms are completed at the facility level and which are subsequently entered into a computer at the district level. The NRHM HMIS project in India (subject of a detailed discussion in the case study section of this report) is a prominent current example of a concerted national effort to replace the entire paper-based district reporting system with an electronic one ultimately encompassing thousands of local health facilities. It is accompanied by an effort to increase computer literacy, but is hampered by the slow rollout of computers and connectivity to rural facilities. In certain cases, innovative mHealth projects are being used to collect data that can feed directly into the HIS. Uganda, for example, has a hybrid system of paper reporting at the lower levels and data entry into a central “databank” at the national level.²⁵ Yet the country also has several innovative mHealth projects including the Uganda Health Information Network (data collected via PDA and transmitted via wireless link). The TracNet project in Rwanda is another example mHealth. In this project, cell phones are used to collect data on HIV patients. Sierra Leone is another notable example, which is distinguished by the simultaneous effort to integrate the district reporting system with an electronic medical records system (OpenMRS).

Depending on the number of indicators as well as the software used for data entry, migration from a paper-based to an electronic system does not necessarily reduce the burden on local health workers, but it does reduce errors associated with manual aggregation of the data at higher administrative levels. Electronic systems also make reporting potentially much more flexible and efficient, because information can be analyzed at the district level as well as above. Assuming the tasks required to optimize a paper-based system are successfully completed, the challenges associated with moving to electronic storage and reporting are those related to support of the technology and system users. Computers and infrastructure are needed. Usability is critical, as many health care professionals have limited computer literacy, and ongoing technical support of both hardware and software is required. The transition to electronic data storage does however mean significant changes in the means and manner of reporting. An important challenge, therefore, is the choice of reporting tools and the design of reports. This however, presupposes a commitment to evidence-based decision making that empowers health workers. In India, as the case study below further details, there is a concerted effort to provide training and encourage the use of HIS data that accompanies the deployment of the new HMIS. An additional challenge at this stage is consensus-building across relevant actors. At this stage, it is extremely important that consensus is built, to lay the groundwork for future cooperation and use of the system. The CDC-Zambia used a highly consensus-oriented approach to determining the indicators that its system would collect in 2004, by many accounts generating significant goodwill across key partners that became central to implementation.

The HIS Stages are based on five dimensions:

- Data flow and collection
- Data utilization and integration
- Resources and capacity
- Scope
- Scale

Stage 4 represents a fundamental shift in HIS strategy, and a significant escalation of required capability and resource demands. Initiatives in this category attempt to eliminate conventional data collection conducted as a separate activity independent of the actual delivery of health services. Instead,

the initiative is to derive indicators from data captured as part of routine business operations. These systems include EMR, but also pharmacy, laboratory, supply chain, human resources (HR), finance, and other applications that support any many of the activities on which health care services are dependent. These systems are in many respects similar to the enterprise-resource planning (ERP) systems used by business. They manage health care at the point of service as well as satisfying the reporting needs for higher level policy makers and donors.

Sao Paulo's SIGA Saúde system, while regional in nature, is an example of a Stage 4 HIS initiative. The SIGA Saúde system includes a unique patient identification system through its national bar-coded cards, and the deployment of EMR-based solutions in all public health facilities in Sao Paolo. Users at various levels in the health system are able to access health data and reports using the system. The system has implemented data access rights such that users are limited to see only the data that they are authorized to view.

Moving to operational systems, especially across multiple business functions and multiple facilities, introduces very significant challenges for people, process and technology. Successful software projects of this kind require clear goals, careful business process analysis, and a sense of ownership from all key stakeholders. Because most operational systems consist of multiple modules or applications that collectively must share data, the challenge of system interoperability is seriously confronted at this stage. Because of the complexity of these systems, scalability is a critical issue. While there are evident gains in efficiency and improvement in data quality, this comes at significant cost beyond the cost of building and implementing software applications. The computer literacy requirements for end users and technical support requirements for sustainability are significantly higher. For this reason these systems are more likely to succeed in urban areas. Beyond this, applications like EMR require the ability to uniquely identify individual patients, raising security and privacy concerns implicating national policy and regulatory process. Altogether, the investment required and the risks are significantly greater in the move to this stage.

Stage 5 represents a final step in the evolution of a comprehensive national HIS where all critical data sources are available and fully integrated into a system that is adaptable and sustainable over time. While no country can be said to have attained this stage, Belize can perhaps claim to be furthest along in this direction (though the small size, relative homogeneity and wealth of the country make the achievement of this level of integration much easier than most other countries considered in this survey, and all system functions are not yet fully operational). There is strong and consistent government support, stable funding, a clear and responsive policy and regulatory environment, a strong culture of evidence-based decision making to manage the health system, and a very high degree of automation. In many respects the challenge of getting to this stage, assuming the challenges associated with previous stages are met, is one of optimizing the integration of the many applications and data sources associated with the previous stage.

Note on the Stages: Countries may not fit neatly into this categorization, and progress may occur in fits and starts. Yet this classification provides a useful framework for understanding the steps that policymakers must manage as they develop their HIS, as well as the challenges associated with moving from one stage to the next.

Cross-cutting 'Second Generation' Trends

HIS has become the subject of widespread and continuing interest among the medical community, donors, and developing countries. Analysis points to several important trends across the “second generation” landscape.

- **Better information management tools at the local level.** Greater emphasis on improved primary care implies effective management of local health services by those who staff them and administer them. This in turn implies that data on the performance of local facilities and programs should be available to and used by local personnel. Yet data collected at the local level is not used there, nor do many HIS save health care professionals time or help them to do their jobs more effectively. In response, developing countries of all income levels have launched programs that now explicitly focus on making health information available to practitioners at the local level and encouraging its use to support patient care decisions, provide outreach, or manage resources. Examples of these programs include The Baobab Health Partnership in Malawi, the ZEPRS program in Zambia, the NRHM Health Management Information System in India, and the SIGA Saúde in Brazil, each of which provides more effective support to system end-users.
- **Data capture through routine business operations.** In developing countries today, most health data is collected manually as a separate administrative task external to the routine activity of providing health-related services. This increases the data collection burden by requiring that data be recorded on paper or entered into the IT system more than once. Though still a small trend, an increasing number of HIS are identifying how to use “real time” data capture for EMR and patient-flow systems, or for resource management, as in Sao Paulo or Belize.
- **Identification of minimum essential data sets.** Growing criticism of the poor quality of data collected is stimulating efforts to establish minimum core sets of indicators tracked to reduce the burden of data collection and enhance comparability.²⁶ In South Africa, the EQUITY project, a collaboration between USAID and the National Department of Health, led an effort to reduce the number and frequency of indicators collected by health workers, thereby relieving a burden on workers and boosting the number of districts reporting each month.²⁷ As noted above, a similar effort has been made in Ethiopia achieving dramatic reductions in the number of indicators and general standardization across the country.
- **Growth of specialized technology and providers.** Two software applications, DHIS²⁸ and OpenMRS,²⁹ have been in existence for almost a decade, are backed by active open source development teams and have now been deployed in numerous sites across the developing world. Specialized non-profit groups such as Baobab Health Partnership³⁰ and Inveneo³¹ are developing specialized expertise in designing information technologies adapted to the most severely resource constrained environments of developed countries. At least one company, Voxiva Inc., now markets specialized solutions for health information applications for developing countries, employing a subscription-based business model. As service-oriented architectures develop, allowing deployment of complex web-based applications, larger companies will join this trend. IBM is participating in a project in India to provide electronic medical records throughout the country to any health care facility on a subscription basis without the need to host or maintain any application locally.³² While the emergence of this

technical capacity does lead to valuable innovations, it can also have the negative effect of encouraging premature resort to technological solutions, before other people and process issues are addressed.

■ **Mobile devices become a key enabler for HIS.** In

less than two decades, mobile phone networks have expanded to cover the vast majority of the world's population, and penetration has been exceptionally fast in developing countries with limited legacy wire-based systems. In the same time, mobile devices have transformed from being large bulky units offering nothing more than analog voice communication to more slender and powerful computing platforms. As mobile networks continue to extend their reach, demand remains high and the markets have room to grow, mobile phones will be a key enabler for health systems to reach their goal of providing health care for all. Mobile phones will enable health care delivery end-to-end, from rural village to urban center, populating a HIS with more complete data and providing a richer view of the health of the entire population than health information systems have today. Mobile phones may encourage more use of health care services because a rural farmer can seek care using the phone instead of losing a day's income to travel in to town to see a doctor. If they are able to see more patients and deliver better care through mobile technologies, health workers may feel more empowered and more receptive to using more HIS technologies. The rapid evolution of mobile devices has inspired a wide variety of mHealth applications³³ and attracted widespread attention. In Uganda, the Uganda Health Information Network allows workers to collect and transmit information with wireless-enabled PDAs to local access points, where it is then relayed to the central health database. Other applications range from drug adherence monitoring to simple decision support systems that facilitate screening of patients by counselors to make more efficient use of doctors' and nurses' time as well as gain access to specialists in cities and developed countries. For instance, ClickDiagnostics offers a mobile telemedicine solution that equips a health worker with a mobile camera phone to capture an image of a patient's symptoms. They transmit it via the mobile network to remote doctors who make the diagnosis, with the data going into a central database.³⁴ With solutions such as this, it is now conceivable that the rural poor can receive better quality care. It should be noted that in developing countries, a common mode of access to a mobile phone is through a shared phone, whether it is a phone shared amongst family members or as part of a village phone program, so mobile solutions need to ensure data privacy and security.

Several important trends are evident across the "second generation" HIS landscape. These include:

- Better information management tools at the local level
- Data capture through routine business operations
- Identification of minimum essential data sets
- Growth of specialized technology and providers
- Mobile devices become a key enabler for HIS
- Early experience yields enthusiasm and skepticism around HIS

- **Early experience yields enthusiasm and skepticism around HIS.** There is an increasing level of interest in and funding for projects to develop HIS, whether it is patient medical records or mobile health solutions. HMN was established only four years ago at the May 2005

World Health Assembly³⁵ and major foundations such as the Rockefeller Foundation, the UN Foundation and the Bill & Melinda Gates Foundation are supporting and funding eHealth and mHealth initiatives and research. Education and capacity is building. Given the scarcity of resources in developing countries, however, the opportunity cost of investments in technology solutions encourages careful consideration of the incremental benefit provided by electronic technology solutions. The early implementation experience of many HIS suggests that there is a steep learning curve associated with successfully rolling out information systems in resource-challenged environments, and many first-time electronic implementations have sacrificed quality and performance as they have attempted large-scale rollouts. However, health information management shows tremendous potential for improving patient outcomes in the developing world. The Centre for Infectious Disease Research in Zambia (CIDRZ) was one of the government's first partners in the provision of ART services in Zambia's capital, Lusaka. With the support of the US President's Emergency Plan for AIDS Relief (PEPFAR), CIDRZ began to provide support for ART services to Lusaka area clinics in 2004. After 18 months, CIDRZ evaluated the impact of its program – a combination of coaching and financial incentives to non-physician clinicians, supply chain management, facility restoration, and electronic data management – on improving the survival rate of HIV-positive patients. Analysis found that patient outcomes were good, and that electronic data management had been a major factor in allowing the scale of care required by the program – by 2006, over 39,000 patients had been enrolled in the program.³⁶ As with other health information deployments in the developing world, the CIDRZ experience suggests that health information systems hold tremendous potential for facilitating the delivery of higher-quality patient care and appropriate resource allocation. For HIS to realize this potential, however, HIS initiatives must be rigorously evaluated, and findings must be shared and utilized within the health and health informatics communities, to drive HIS design, implementation and funding decisions.

Case Studies

This section provides an understanding of the challenges and the potential benefits associated with high-performing, interoperable health information systems in the developing world, as observed in case study research in India; Sao Paulo, Brazil; and Zambia. Particular focus is given to how HIS can be structured to give frontline health care providers the information they need to provide quality care and education to their patients and to local populations. This section will also illustrate some of the themes described in the previous section of this report, the Landscape Analysis.

Overview of case study methodology

Three HIS projects were chosen as case studies: the National Rural Health Mission (NRHM) Health Management Information System (HMIS) in India; the SIGA Saúde system in Sao Paulo, Brazil; and the SmartCare electronic health record system in Zambia. These projects were chosen because they are significant efforts to improve health information management in developing countries; because they have been rolled out in countries that are markedly different, in terms of geography and income level; and because they represent three major types of HIS deployments. Case study research included extensive review of secondary literature on the health information systems, interviews with experts familiar with the system, and in-country field research.

The field research on the HIS projects was carried out between December 2008 and January 2009 in each of the three case-study countries. Field research included interviews with the Ministry of Health, project management, implementing partners, system end-users, and other health informatics experts in each country. It included visits to sites that use the HIS under study, and in some cases, visits to sites that use alternate health information systems.

The field research had three areas objectives. First, it aimed to establish the basic facts about the health information system: the reason for the system's development, the problem it was designed to solve, the system's champion and its funder(s), its objectives, its structure and implementation, and its impact, if any. Second, the field research sought to understand the factors that have helped or hindered the health information systems as they were developed or scaled. Research focused on understanding which parts of the health information "value chain," or the factors that influence the health information system, were most influential. These factors can include government policy and regulation, organizational structure and environment, or available human and financial resources. Third, the field research focused on understanding how health care providers used health information, and whether and in what ways each health information system supported pre-existing operational or decision-making processes.

Three HIS projects were chosen as case studies:

- India: National Rural Health Mission's Health Management Information System
- Brazil: SIGA Saúde system in Sao Paulo
- Zambia: SmartCare electronic health record system

Objectives of the field research:

- Establish the basic facts about the health information system
- Identify the factors that have helped or hindered the HIS as they were developed or scaled
- Understand how health care providers used health information, and whether and in what ways each HIS supported pre-existing operational or decision-making processes

This section provides a profile of each of the health information systems studied. Each profile briefly describes the reason for which the HIS was developed, what its goals and/or objectives are, how it is structured and what its primary uses are, how the system has been implemented, what its results are (if measured), and what the outstanding implementation challenges or next steps are. The chapter ends with a discussion of the major lessons from analysis of the three health information systems profiled.

Featured HIS Initiative:

Health Management Information System for the National Rural Health Mission (NRHM)

Country: India

Population: 1.1 billion

GNI per capita (2007): \$950

Acute Health Challenges:

High child and maternal mortality rates, malnutrition, infectious diseases (malaria, HIV, TB), chronic diseases

Sponsors/Partners: National Rural Health Mission, National Informatics Centre, National Health Systems Resource Centre, state governments

Key System Attributes: Web-based system that collects health indicators for monitoring and evaluation of NRHM programs

Scale: Initial focus on 18 poor, rural states followed by nationwide deployment

Scope: Reproductive and child health and infectious diseases, in line with Millennium Development Goals (MDGs) 4, 5, and 6

Introduction

India's Health Management Information System (HMIS) is just as much an effort to employ technology to improve people's health as it is a mission to convince health workers at each level of government that good data can pave the way to better health care.

Home to a surging population of more than one billion people spread throughout megacities and 600,000 villages, India faces health care challenges of a scale and diversity unmatched in the developing world. Although the country's economy has surged in recent years as a technology industry thrives in major Indian cities, and the central government seeks to attract foreign investment, much of the urban and rural population remains poor and without adequate access to quality health care services. The Indian government created the National Rural Health Mission (NRHM) in 2005 "with an aim to achieving the targets set by the Millennium Development Goals (MDGs) 4, 5, and 6 and making the health delivery system more responsive to the health care needs of the people of India."³⁷ The program is part of the government's broader effort to increase health care spending from 0.9% to 2-3% of GDP.

The NRHM seeks to empower communities and health workers through feedback and participatory mechanisms designed to improve the quality of health services. Recently, the agency launched initiatives to improve basic health in rural areas, with a focus on maternal and child health and infectious diseases, the most critical health issues in rural India. With the NRHM introducing several major programs, a strong monitoring and evaluation (M&E) effort is essential for tracking program performance. At the heart of the M&E effort is the

Health Management Information System (HMIS), focused on improving the collection and use of data related to core programs.

The HIS evaluated here is India's HMIS. Field research focused on Chhattisgarh state, a newly created, heavily rural state in eastern central India at the forefront in implementing the HMIS. The HMIS is designed to streamline and automate the data entry process. The system also introduced new analytical tools. The tools will allow analysis of rural health trends, specific health problems, and the performance of the programs created to address those problems. The HMIS can also provide health workers with a clearer picture of health conditions in their area as compared to other areas and enable the workers to request more resources to improve care.

India's rural health system: underfunded and overtaxed

Despite the rapid growth of its large cities, India remains a predominantly rural nation, with more than 70% of its people residing in rural areas.³⁸ The vast publicly funded rural health system serves this population, in accordance with the NRHM's commitment to be more responsive to the health needs of rural Indians. States are divided into districts, which are in turn divided into blocks. The system is organized hierarchically, with each level reporting to the level above it, and is comprised of:

- **145,000 subcenters**, staffed by Auxiliary Nurse Midwives (ANMs), who provide care primarily for women and children, and Multi-Purpose Workers (MPW), male workers who usually treat male patients and provide them with referrals. Each subcenter serves five to seven villages, or approximately 5,000-7,000 people.
- **24,000 Primary Health Centers (PHC)**, staffed by a doctor and paramedical staff, with one PHC per 30,000 people. Each PHC covers five to seven subcenters.
- **3,400 Community Health Centers (CHC)**, block-level (the administrative unit just below the district level), staffed by basic medical specialists (such as pediatricians) and nurses and containing 30 beds. Each CHC serves 100,000 people.
- **600 District Hospitals**, staffed by more advanced medical specialists (such as urologists). Each hospital serves one to two million people.

Although the NRHM aims to improve health services for India's rural population, the system is severely overextended. Many who can afford to do so seek treatment at private hospitals and clinics, which are growing rapidly and which, by some estimates, constitute 68% of all hospitals in India.³⁹

Issues with existing data collection systems

While the Ministry of Health and Family Welfare (MOHFW) in India has long collected data on health statistics from all public and many private health care facilities, it lacks a coherent strategy for integrating, synthesizing, and analyzing data to allow faster responses from the government. The reporting process focuses on a top-down imposition of data requirements and pays little attention to the need for information that can help health care workers improve patient treatment. Data quality is poor, with little institutional incentive for health care workers and functionaries to improve it. Most data entry is manual, forcing repeat data entry across as many as seven different layers of government and causing untold hours of wasted time. Data analysis is also manual, which often results in the government misunderstanding trends in health statistics. Finally, health care workers must collect up to 3,000 data points, according to divergent requirements laid down by central, state, and local governments. These problems – consistent with those observed across developing countries – point to the need for reform of the NRHM health information system.

Impetus for HMIS reform

The HMIS initiative began with the launch of the NRHM itself. As the agency unveiled a host of new programs to improve rural health, the M&E division of the NRHM, as well as at the National Informatics Centre (NIC), a key partner in the HMIS, agreed that the ineffective data collection and analysis process described above had to be improved in order to determine the effectiveness of these

new programs. Mr. Pravin Srivastava, a director at the NIC, laid the foundation for the system in 2006, though initial planning began earlier. The NRHM had four major tasks: build M&E capacity at the national, state, and regional level; rationalize data and determine the number and frequency of necessary indicators; contract with a software provider to develop a Web-based system; and build physical infrastructure to transmit and house data.

Data rationalization proved to be the most difficult task. The M&E division determined approximately 200 critical indicators by exhaustively reviewing the indicators collected by each program area and then identifying both redundancies and the minimum frequency of collection for each indicator. The final list was approved by committee and accepted by the Additional Secretary of the MOHFW. As a director of the M&E division reports, “it was a difficult and often ruthless exercise, and often acrimonious” since program heads tend to try to protect their data elements.

HMIS overview

The HMIS initiative of the NRHM, implemented in conjunction with the NIC, seeks to:

- **Improve the data collection and analysis process** by taking steps to streamline data collection, namely by identifying data points related to the NRHM’s primary goals and reducing the data points from nearly 3,000 to about 200. Frequency of collection will be reduced from monthly to quarterly, or annually, for most data points.
- **Automate the data process** by introducing a Web-based system that can be accessed at all levels of government through the deployment of computer hardware and Internet connectivity at facilities nationwide.
- **Validate data** by triangulating other data sources to verify and improve data quality. Validation will also be achieved through the introduction of dedicated data managers, as far down as the Primary Health Center (PHC) level, whom can identify and analyze data and work with providers to improve collection and quality.
- **Introduce analytical tools**, starting at the central government and trickling down, that allow health care workers and government officials to see and understand health trends and formulate an effective response.

HMIS description

The HMIS is designed to aggregate data based on health indicators compiled by rural health care workers. At the system’s core are approximately 200 indicators related to the areas of child and maternal health and infectious diseases. (India has “siloed” programs for monitoring diseases such as HIV/AIDS, malaria, tuberculosis, and leprosy.) The data are collected at the facility level and fed progressively up to block, district, state, and central government levels, where it can be analyzed and used to make decisions. Core indicators are entered digitally into the system at the block or district level and aggregated to provide a statistical snapshot of India’s health indicators at each level of the system. HMIS data quality is verified through a triangulation process, as described in the “Triangulation” box on the next page.

How the HMIS is used

Rural health care workers use the data to effect changes in policy and treatment and to allocate resources more effectively. The HMIS has two key features that enhance system usability: (1) enhanced analysis and (2) two-way information flows. Enhanced analytical features allow authorized users to view and compare the performance of different health centers and hospitals. Users are able to generate reports on different indicators for specific time periods and compare them to earlier periods, and reports can be viewed in both graphical and tabular format. The system also includes back-end, SAS-based analytical tools for higher-level users.

Two-way information flows allow health care providers at all levels to access data. The dedicated data managers funded by the NRHM at the district, block, and PHC levels will be able to access data for use in monthly meetings, where information collected in the previous month is discussed with health workers and administrators. The data will also be provided to the newly empowered gram panchayats, or village health councils, which are charged by the NRHM with developing community health action plans for their villages. Village health councils will be assisted by female Accredited Social and Health Activists (ASHA). The ASHA is a NRHM-created position that will act as a liaison between ANMs and villages to improve data collection and the response to community health needs. The gram panchayats and ASHAs will have access to HMIS-generated data related to their areas, empowering them to create stronger community health action plans. These two-way data flows are depicted in Figure 3.

While the Indian HMIS is intended to capture comprehensive data about reproductive and child health and infectious diseases, it will not cover all health encounters. Chronic diseases such as heart disease and diabetes, which are growing problems in India and China, will not be comprehensively tracked, a fact acknowledged by health officials interviewed for this study: “We are aware of the growth of chronic disease issues, but they are a greater problem in urban areas, which are not our focus,” said one NRHM official.

Triangulation: A Framework for Identifying Data Flaws and Their Sources

Poor data quality is a persistent challenge across health information systems. Data systems are typically not structured to support frontline health care professionals in their decision-making. Instead, data collection is often mandated from “the top” – a national Ministry of Health or a vertical health program. Data is infrequently, if ever, fed back down the system for health care professionals’ use in day-to-day health care decisions. As a result, the individuals who are responsible for collecting the data are not motivated to do so, and data quality often suffers.

This is clearly a problem in India, where the data collected is reported to be of poor quality. This issue is not limited to the health sector. According to one NRHM director, “There is a culture of disrespect for data in India.”

To enhance data quality in the near term, the HMIS program emphasizes data validation. NRHM officials verify data quality through an explicit data “triangulation” strategy. They use data collected from health workers and compare it to (1) information obtained from household and community surveys and (2) “concurrent evaluation” at facilities contracted by the government. This method, combined with HMIS facility-based reporting, will allow officials down to the block level to determine where data quality is poor and to take measures to improve it, such as requesting funds for additional data or medical staff.

The system is, however, designed to accommodate expansion and could eventually include such conditions as the government continues to address them. The HMIS is currently integrated with the Gujarat Hospital Management Information System (see box below). The HMIS is not yet integrated with India's Integrated Disease Surveillance Program (IDSP), the nation's main surveillance program, though the system's architects are working to develop an integration plan.

Project implementation to date

The national HMIS went “live” in October 2008. While the HMIS will eventually be expanded to cover the entire country, it is currently being deployed in the 18 states designated “high-focus” by the NRHM (because they are the most heavily rural states). Automation will be introduced gradually at lower levels, as infrastructure allows. In Chhattisgarh, for example, automation initially will be limited to the block level, where all facilities are installing computers that will be connected to the Internet (connectivity has just been fully established at the district level). Data collection at the subcenter and PHC level will remain manual for now and will be aggregated and digitized at the block level. With the national system online and operational, all states are entering data they collected between April and October 2008 in order to provide a historical record and basis for comparison.

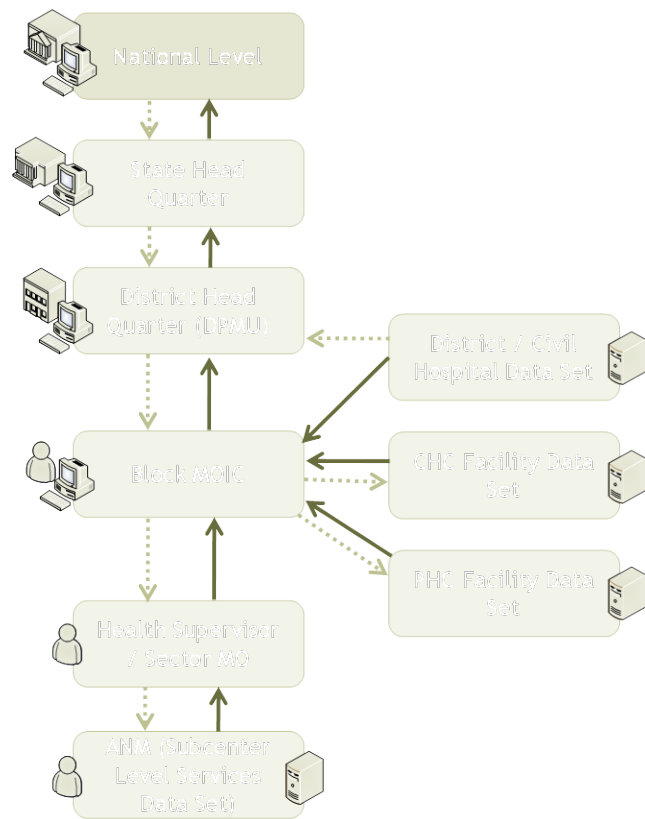


Figure 3 - Information Flow in HMIS

Source: National Health Systems Resource

The Gujarat HMIS: Patient Record Capability, National Interoperability

While the NRHM HMIS will eventually cover all of India, it is a system of limited scope, designed to collect information on indicators related to the NRHM's core programs. At the state level, there is innovation encompassing other HIS functions. Gujarat state in western India, for example, deployed a Hospital Management Information System at its 25 district-level hospitals in 2007.

The system is a module-based application which includes a patient identification number that tracks patients' medical histories. It contains laboratory, pharmaceutical, human resources, and equipment management units. The system is designed to give administrators the ability to comprehensively oversee all aspects of hospital management and patient flow while providing physicians with easy access to patient history as a means of improving care. Despite its complexity, the system is still able to feed required indicators to the NRHM system. The Gujarat experiment illustrates the need for flexibility in HIS design, allowing for local innovation while accommodating national reporting requirements.

Many of the activities to date have focused on the operational and infrastructure requirements of the HMIS. States vary in their progress, however. Chhattisgarh is one of several states that have already achieved several milestones, including computer deployment at nearly all blocks; Internet connectivity in all 16 districts; completion of HMIS training for all responsible state- and district-level staff; and ongoing training for block program managers (BPMs) at the block level.

Intended results

The newness of the NRHM initiative means that there is very little data on outcomes; the deployment of the system is ongoing, and there was no pilot project *per se*. The hope is that the HMIS will provide several benefits to the health system, including:

- The ability to view up-to-date health data on individual administrative units, which will help policy-makers align needs with resources and allow lower-level health officials and data managers to compare their units' conditions. This will ease the burden of arguing for increased resources.
- Reduced data entry at the block level and above (when automation becomes available at the lowest levels).
- Improved data accuracy via the reduction of required data points, the enhanced validation methods used by the NRHM, and the addition of data staff at lower levels.
- Better data, which, in concert with the empowerment and feedback mechanisms being instituted, will arm health workers with better information to "argue their case."

Remaining challenges

Major challenges remain, several of which could stymie the HMIS implementation. Officials agree that poor data quality is a serious problem, adding that the data streamlining and validation efforts noted above are an attempt to mitigate the problem. There are several factors that contribute to poor data quality. Perhaps the primary reason for poor data quality is the shortage of qualified personnel, particularly those responsible for service provision, such as doctors, nurses, and ANMs. By some estimates, only 30% of nursing positions in rural hospitals are filled,⁴⁰ and a single ANM often covers five villages. These overworked ANMs typically spend four to five hours entering data each week. NRHM officials hope that the training of ASHAs for each village will relieve the ANMs and improve data collection and quality, as part of the ASHAs' responsibility is keeping ANMs apprised of vital events. The use of financial incentives for meeting specific goals, such as childhood immunizations, also encourages some users to provide false data.

The volume and duplication of data and data entry have also impeded past efforts to improve health information systems. ANMs in India must maintain up to 14 separate registries for different types of data and are required to re-enter this information into forms that are sent to the PHC level for further aggregation. The current HMIS initiative seeks to reduce the frequency and number of data points collected, but until automation is introduced at the lowest level of service provision, re-entry will adversely effect efficiency.

Perhaps the biggest “soft” challenge facing the HMIS project is cultural. Several MOHFW officials lament the lack of respect for data in Indian government. Top-down data requirements with little downward flow have left health workers with little incentive to accurately collect data. Instead, the system could be used to ensure that the data are used to empower health workers, thus motivating them to collect data accurately. Officials believe that involving the community in creating village health plans will create a demand for better data. The logic is that health care workers will gain a clear understanding of community needs, which will in turn motivate them to collect better data to address those needs. Pravin Srivastava, a director of the NIC and an HMIS leader, said, “Indian government employees have been just told what to do for so long that they don’t feel that they can create change. They’ve forgotten how to make decisions. And so a type of devolution is essential. If workers are empowered, they will learn that they have to use data to make their case for more resources and assistance.”

The success of this HIS initiative – and the hopes of its sponsors – hinges on the notion that (1) the feedback mechanisms created for workers and community members will incentivize them to collect better data, (2) the addition of ASHAs and data staff will relieve the burdens on rural medical staff, and (3) potential data validation strategies will improve the ability to identify sources of bad data. One NRHM described Indian officials as “nervous” about the implementation of the project. If India follows through on its commitment to triple health-care spending, and if resources for workers are improved, then the HMIS might suggest that data have the power to improve health outcomes.

Featured HIS Initiative:
SIGA Saúde

City: Sao Paulo, Brazil

Population: 22 million

GNI per capita (2007):
\$5,910

Acute Health Challenges:
Respiratory and cardiovascular diseases, stroke, homicides and pneumonia

Sponsors/Partners: Sao Paulo City Department of Health

Key System Attributes:
Enterprise Resource Planning-like system with electronic records to manage resource allocation and patient flow

Scale: Regional, managing 20 million health encounters per year at 702 health facilities

Scope: Resource management and recording essential health encounter data

Introduction

The SIGA Saúde Health Information System (HIS) provides a unique perspective on how innovative health information systems can be conceived in a bottom-up fashion by municipalities or health districts as opposed to traditional top-down national-level systems; how these systems benefit health service delivery at or near the front line (in effect, the health care units and workers); and some of the challenges in integrating with and meeting the reporting requirements of national level systems.

Of particular interest is the success with which SIGA is addressing the needs of Sao Paulo's large poor population. Of the 14 million⁴¹ patients registered in the SIGA Saúde database, close to one in every four earns less than \$1 per day. This demographic is similar to conditions found in Sub-Saharan Africa.

Recognizing the need to improve access to health care, Brazil embarked on a major initiative to improve the national health system in 1998. Among other things, the reform led to decentralized health care management and the creation of a national patient identification system to ensure universal access to health care.

To manage health delivery in this decentralized setting, a regional HIS was developed, one of a different caliber and sophistication than those seen in the vast majority of the

developing world, and one that belongs at the higher end of the HIS landscape categorization (see the Landscape Overview section of this document). As such, the HIS serves as model for other countries' health information systems.

The HIS evaluated in this case study is Sao Paulo city's SIGA Saúde. Implemented in 2004 by the Sao Paulo City Department of Health, the system enables the management of health care services in the city, home to about 22 million in the metropolitan area. SIGA implements and promotes all the concepts, policies, standards, and norms of the Brazilian National Health System.

SUS health system and the context for the HIS

Recognizing the need to improve access to health care, Brazil embarked on a major initiative to reform the health system. The initiative culminated in 1998 with an addendum to the Brazilian Constitution that entitles all individuals to equitable, universal, and continuous health care. As part of the reform, the present Brazilian National Health System, called SUS (Sistema Unico de Saúde [SUS], or Unified Health

System) was created in 1998. SUS stipulates that all citizens are entitled to free-of-charge comprehensive health services. The system is funded and operated jointly by the three levels of government: federal, state, and municipal.

The provision of health services is decentralized under the SUS model. All services are delivered and managed at the municipal level based on programs that are defined and agreed upon in advance. Monitoring and evaluation of service delivery is done at all three levels of government - federal, state, and municipal. An obvious advantage of the decentralized model is that municipalities equipped with the best possible knowledge of the demographics of their particular catchment areas can design services and programs to reach hard-to-reach segments of the population.

Under SUS, health services are structured in three tiers (Figure 4). While the type of services provided by each primary care unit can vary from one municipality to the other, the minimum set of services provided include: internal medicine, pediatrics, gynecology, and dental services. Services provided in Tier 2 include specialized treatments such as cardiology and endocrinology. Access to Tier 2 services is controlled strictly through the use of referrals from primary care physicians. Services provided in Tier 3 are primarily high complexity procedures such as kidney substitutive therapy, oncology, nuclear medicine, and prosthesis. Access to Tier 3 services requires prior authorization from the Department of Health.

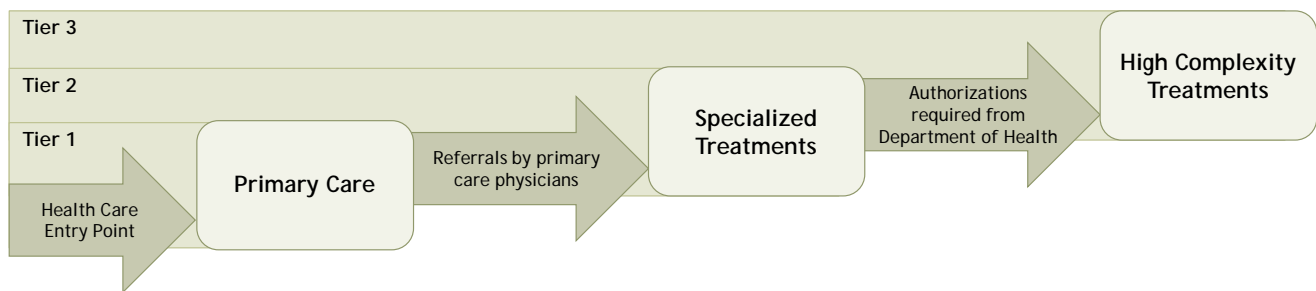


Figure 4 - Structure of Health Services in Brazil's National Health System

SUS encourages states and municipalities to provide primary health care by offering them special incentives and financing to implement family health programs and other community health agent programs. This emphasis has led to a strong preventive care mindset at local levels. According to Dr. Ligia Neaime Almedia, Primary Care Coordinator in Campinas, “We believe in treating the person, and not in treating the disease.”

The procedures and rules specified under SUS provide the requirements and “business rules” for SIGA. Thus, the purpose and objective of the HIS is to implement the rules of the health system; provide information to evaluate the functioning of health care delivery within the health system; and ultimately provide tools to optimize and strengthen the health system.

Solving the needs of primary health care units

With a volume of about 20 million health encounters per year encompassing primary care consultations, specialized consultations and hospital admissions, Sao Paulo city health officials recognized that health care units have to be extremely efficient in the way they manage resources.

Specifically, scheduling appointments for primary care, specialty consultations, and referrals have to be streamlined and optimized to maximize medical professionals' time and minimize patient waiting times.

In 2004, the Sao Paulo Department of Health made the decision to invest in an HIS that could handle all requests for health care services and allocate resources optimally – allowing for constraints such as distance, availability, waiting time, and budget.⁴² They envisioned such a system benefiting multiple stakeholders:

- Primary care unit staff can efficiently use its resources, as well as get timely information on aspects of units that are overburdened or underutilized
- Patients benefit from reduced waiting times for appointments
- City health officials can access up-to-the-minute data on health network usage, providing information for resource planning activities
- State and national reporting of health data can be automated; and more importantly, the data can be collected as part of routine clinical operations

A very important advantage of the system is that it is used by and directly benefits health care units, which has helped to ensure its longevity and continuity. Sao Paulo's HIS has thrived despite several changes in the city's political leadership. As highlighted in the Landscape Overview section of this report, a common deficiency of many health information systems is that data is not relevant to those collecting data. The HIS is challenged with poor data quality and does not have impact on frontline health care provision. The Sao Paulo system has generated real benefits for health care units, and in doing so is becoming indispensable to the provision of health services

SIGA Saúde overview

Having developed clear goals for what the HIS should do, the Sao Paulo City health leaders recognized the magnitude and complexity of building and deploying such a system and the need for strong program management and software development processes.

The Sao Paulo City Department of Health envisioned an Information System that provides capabilities found in Enterprise Resource Planning (ERP) systems, which are typically seen in large corporations. ERP systems are unlike traditional health information systems, whose primary purpose is to facilitate health data collection and reporting. In the case of SIGA Saúde, the system automates key business processes followed at the health department administrative level, and work processes at individual health facilities. According to Dr. Lincoln Moura, president of Zilics, the developers of SIGA, “in an ideal eHealth environment, it is not you that runs the system, but the system that runs you.”

The system captures essential health encounter information, such as who was attended to and by whom, where, and when. This data provides valuable operational information on the health network effectiveness and also provides the core foundation to capture comprehensive Electronic Health Records for diagnostic and other clinical use.

Administrative and support staff at health facilities use the system for:

- Registering patients, health units, equipment, and medical professionals

- Scheduling of primary care and specialized consultation appointments
- Tracking immunizations
- Tracking health encounters
- Processing authorizations for high-complexity and high-cost procedures

Medical professionals at health facilities use the system for:

- Managing their schedules and patient appointments
- Reviewing patient attendance history
- Tracking pregnancies and identifying high-risk pregnancies

City health officials use the system for:

- Analyzing statistical information on the health network usage
- Analyzing the performance of special programs such as Mae Paulistana – a program to track the progress of pregnancies
- Getting information that is required by the Ministry of Health

By recording health encounter data, a host of other functions such as health surveillance, service audit and citizen information portals can be integrated later.

Figure 5 on the next page represents the Sao Paulo City Department of Health's blueprint of the core capabilities of the HIS. This blueprint suggests the sequence and order in which various features needed to be built. Although such a product roadmap is an essential component of good Software Development Life Cycle principles, other developing countries very rarely demonstrate such rigor.

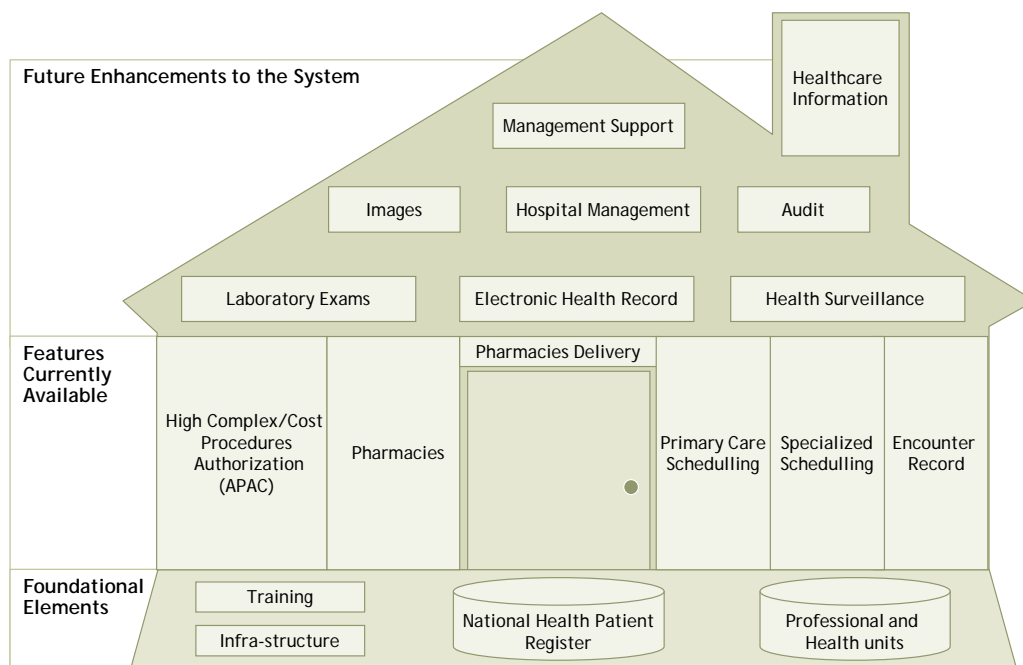


Figure 5 - Key Features of SIGA Saúde

Source: Sao Paulo City Department of Health - Information Technology Unit

System implementation

Sao Paulo city officials recognized that the construction and deployment of an HIS is a complex endeavor. As such, best practices for planning, management, development, training and support of large-scale software initiatives needed to be brought to bear on the HIS implementation.

From the outset, the project was carefully planned and structured to ensure comprehensive management. First, system features were grouped into modules, and individual project leads were charged with the construction of each module. The four major modules were:

1. Municipal Health Registry processes and records identification of health care users, workers, and organizations;
2. Patient Flow Control, which processes scheduling and appointment requests for various health care services;
3. Electronic Record, to collect a small set of health encounter data; and
4. User Access Control, to build user profiles that provided access to appropriate system functions based on the authorization of that user.

Use cases, a best practice in software development, were created for each of these modules. The use cases, numbering about 400-500, provided the basis for the construction of the system and also for validating that the system behaved per specifications. The use cases were defined at a level of detail that closely matched system functions and associated software components.

Second, a Program Management Office (PMO) was established to oversee the HIS project, resolve issues in a timely manner and provide strategic direction. The PMO consisted of several subcommittees, staffed with top-level managers and project leads. The PMO included the Health Secretary, the Health CIO, project managers of all sub-projects and representatives from vendors of various sub-systems.

Third, the City addressed the issue of providing training and technical support to every health care unit. The City created an internship program in which high school and college computer-science students were trained and deployed as technical support agents to primary health care units. These “facilitators,” as they are called, were dedicated support specialists who knew how to operate the system and were tasked with providing technical assistance to users in the health care unit. They served as a technical liaison between health care units and the city’s central support call center, resolving technical issues that could not be resolved by the health care units.

Lastly, the City deployed the system. A range of deployment strategies were considered, including (1) a vertical strategy of full deployment of all features to an entire region in one of the City’s five regions, followed gradually by other regions coming “online;” (2) a horizontal strategy of deploying select features to all health care units in all regions followed gradually by other features; and (3) a hybrid model that mixed elements of both strategies. The hybrid model was selected, and is being employed to rollout of the system. The following table shows information on current system usage.

Building Blocks for an ERP-like System with EMR

First and foremost, Sao Paulo needed to construct a patient register database with capabilities to uniquely identify patients. To this end, the city created a SUS Card that contains a unique patient identification number along with other basic demographic data. This information is stored on a barcode printed on the card, which can then be accessed using barcode readers by health facilities and pharmacies.



Figure 6 - SUS Card

Source: Sao Paulo City Department of Health

Although the card is issued by local municipal departments of health, the intent of the program is that patients would be able to use their cards to access public health care anywhere in the country.

Another key requirement to build an ERP-like system is the registry of health care units, equipment and all health care workers. A provider registry constructs a comprehensive picture of the resources – physical, human and technology – available for deployment in the delivery of health services, providing a snapshot of the supply side of resource planning.

This approach to health information management also enables real-time data capture, an emerging trend in developing countries. Assuming that the electronic system requires no more data entry than the paper system that preceded it, real-time data capture enables end-users to save time in data entry once they’ve overcome the “learning curve.”

Item	Amount
Health care Units Using SIGA Saúde	702
Primary Care consultations Scheduled / month	1,017,463
Specialized Consultations Scheduled / month	189,393
High-cost Procedures Requests Processed / month	35,123
Patients Registered	14,301,383
Prescriptions Over the Counter / month	1,738,807

Table 3 - SIGA Saúde System Usage

Source: Sao Paulo City Department of Health – IT Unit

Results and impact on health service delivery

Considering the primary goal of the system, which is to improve access to health care, Campinas health officials indicated that, without adding any new resources, such as health workers or health care units, they have seen a 30% increase in patient visits. The city of Camacari reported an increase in patient satisfaction from 32% to 50%. Preliminary results from Sao Paulo indicate that outpatient services productivity has increased by about 35%.

Next steps

As SIGA proves its success as a bottom-up HIS model, users are beginning to consider how the system might be improved and expanded. First, the Ministry of Health might establish standard data formats and electronic submission guidelines, and make it easy and inexpensive for regions to integrate with national systems. The national network of health information systems is comprised of a few hundred disparate platforms that are poorly integrated, if at all. The National Health Card project helped clean up some of this fragmentation by defining a standard core data set, as well as a shared view of the patient, the health care worker and the organization location where the service was performed.

Second, the Ministry of Health might support the establishment of best practices in implementation, a common code base, or a technical support team. With SIGA showing promising early results, several other cities are either implementing the system in their own municipalities or have expressed interest in pooling resources to form a coalition of neighboring municipalities for joint implementation, software hosting and system support. A critical need expressed by IT officials in both Campinas and Camacari is the need for a community to share best practices in system implementation across cities, ensure a common code base and provide support for technical queries. With limited local budgets, it is difficult for states and cities to both hire seasoned project developers and invest in computer infrastructure for health facilities.

Featured HIS Initiative:

SmartCare Electronic Health Record System

Country: Zambia

Population: 11.7 million

GNI per capita (2007): \$800

Acute Health Challenges: HIV, infectious diseases (malaria, TB, diarrheal illnesses), maternal and child mortality

Sponsors/Partners: Ministry of Health of Zambia, US President's Emergency Plan for AIDS Relief (PEPFAR), US Centers for Disease Control and Prevention (CDC)

Key System Attributes:

Distributed database system providing a smart card portable patient health record to each patient and a touch screen for provider data entry

Scale: 400 health facilities, with 250,000 patients registered

Scope: Health records for antenatal care and HIV treatment modules, with family planning, outpatient, lab, pharmacy and under age 5 modules to be added in 2009

Introduction

In 2001, Zambia had a 15.6% HIV prevalence.⁴³ With increasing awareness of the potential consequences of the epidemic, the government of Zambia took decisive action against the epidemic. They passed legislation to enable Zambia's National HIV/AIDS Council (NAC) to apply for the international funding required to fight HIV. The government earmarked 10% of their 2002 to 2004 budget⁴⁴ to respond to the epidemic, declared HIV/AIDS a national emergency, and committed to providing more than 10,000 people with anti-retroviral therapy (ART) by the end of 2004.

In 2004, the US President's Emergency Plan for AIDS Relief (PEPFAR) stepped in with \$81.6M to fight HIV/AIDS in Zambia. PEPFAR funding created an opportunity to introduce an electronic health record. The HIV epidemic would require better management of patient health information; if patients' ART was not carefully monitored, patients could develop resistance to progressive rounds of therapy and ultimately exhaust their treatment options. Because patient information management was critical to an effective response to the HIV epidemic and because the lifetime risk of a 15 year old dying of AIDS was 50%, PEPFAR incrementally agreed to fund a general electronic patient health record system.

The CDC used PEPFAR funding to create the SmartCare Electronic Health Record System. SmartCare's aim is to enhance the continuity of care in Zambia by providing each Zambian with a portable, electronic health record. SmartCare is the object of the current case study.

Zambian health system and context for the HIS

Zambia has a three-tier health system, with 144 health posts, 1,533 health centers at last count, 106 hospitals, and 81 Ministry of Health administrative facilities. There are a significant number of private health centers, but their numbers are not accurately quantified. Most other primary care is provided by traditional healers.

Zambia's health system is affected at all levels by shortages of qualified medical personnel. Indicatively, the World Health Organization (WHO) recommends a *minimum* of 20 physicians per 100,000 people. Zambia falls far below this minimum threshold, with 12 physicians for every 100,000 population.⁴⁵

Need to streamline patient record keeping

In the early 2000s, Zambia's patient health records were maintained on paper. Records were often incomplete, cumbersome, and not fully used in patient care decisions. Moreover, despite the severe health care worker shortage, health care professionals were expected to spend significant time on reporting. Even with a recent streamlining of the paper reporting process as shown in Figure 7, the same pieces of data may need to be re-entered or re-counted up to four times before reaching the district health information office, where the data would be entered a fifth time into the government Health Management Information System (HMIS).



Figure 7 - Data Flow at a Representative Health Facility

An additional challenge specific to any ART-related patient record systems were the legacy systems that ran in support of ART treatment programs. By late 2004, there were at least five ART-related patient record systems that were already running at ART treatment programs in Zambia (Table 4). As the programs required rigorous patient management, each program had needed to rapidly develop a system for managing patient records. Any nationwide ART patient record management system would need to replace these legacy systems. It would need to re-deploy hardware, software, and training to all sites that had already received these resources for other programs, and it would need to convert data into the single national system. In some cases, such as with Catholic Relief Services (CRS), the site would have to replace the system used across ART programs in Africa with a system that was specific to Zambia. Any program that was national in intention, as SmartCare was, would need to gain the acceptance of organizations running alternate software programs.

System Name	Organization
CareWare	Catholic Relief Services (CRS)
Fuschia	Doctors Without Borders
Patient Tracking System	Centre for Infectious Disease Research in Zambia (CIDRZ)
ART Information System (ARTIS)	HSSP

Table 4 - ART Patient Record Management Systems in Zambia, 2004

Driving force behind SmartCare

With Zambia's first round of PEPFAR funding expected in 2004, the CDC suggested that an electronic patient record system could create a complete health history for each Zambian and reduce the reporting burden. In late 2004, the Ministry of Health endorsed the CDC's proposal to launch an electronic

patient health record system. It was felt the program had the potential to revolutionize health services delivery in Zambia. Mark Shields, the CDC's head of epidemiology and strategic information in Zambia, wrote to the Ministry, "This application...could become a transforming technology for continuity of health services, much as cell phones have been for voice communications."⁴⁶

2004 was spent intensively preparing for SmartCare (then called the "Continuity of Care" program). Most importantly, the CDC met extensively with the MoH, WHO, and other key partners to identify data requirements and agree upon the best patient identification format. Key actors recognized the strength of this approach, and the significant effort made by the CDC early on to generate their input on the important, nationwide SmartCare program. The CDC also assessed existing information management systems and practices in Zambia. It built its own software development team and supported the MoH in hiring software development staff. Finally, the CDC developed the SmartCare proposal, and PEPFAR approved the program in October 2004.

SmartCare overview

The vision for the SmartCare program is that "each person in Zambia has a complete electronic health record that is used to assure them of a continuity of high-quality, confidential care, by providing timely information to caregivers at the point of service."⁴⁷

Each Zambian carries an electronic card issued by SmartCare that stores her health record. This is called a "SmartCard." SmartCare has two objectives:

1. Improve patient care;
2. Improve health management information for improving health services);

Each SmartCare objective is described as follows:

Greater continuity of care

SmartCare aims to improve continuity of care by building a complete patient health record SmartCare "modules," or areas of care. After a consultation, a health care professional or data entry associate uses a touch screen to enter patient data into the health facility's distributed database. The patient's health data is then saved in the database and on the patient's SmartCard. The system can synchronize health records on a monthly or periodic basis via flash drive, across all facilities that the patient has visited. This provides reconciliation of patient records in the absence of the SmartCard (for example, if the card were lost). The end-goal is to ensure that each patient has a complete, up-to-date, and confidential health record for each visit to a health facility.

Increasing the privacy of sensitive medical information

All patient health information is transitioned from paper files to the SmartCare database and the SmartCard. The SmartCare databases are governed by role-based security protocols that bar those who are not care providers from accessing patient health records. Data merges between health facilities are limited to records for patients who had visited both facilities. Data merges at the district level hide patient identification, and data merges at the

province level strip patient identification. Today, HIV patients do not receive a SmartCard, so that SmartCard will not be associated with HIV positive status. Instead, they receive a tagboard card with their ARV treatment information.

Reducing the burden of paperwork on health clinic staff

SmartCare has aimed to enable electronic data entry of patient health information so that health facility staff do not have to manually collect and aggregate data. The system allows three modes of data entry: “e-first” is entry of client data as the client is cared for; “e-fast” is entry after a client consultation, but before the client leaves the health facility; and “e-last” is entry after the client leaves the health facility.

Improving the quality of information and decision support at the patient level, with inputs into the HMIS

SmartCare seeks to make a complete patient health record available to the clinician. A full patient health record gives the health care professional a complete view of the patient’s medical history, enabling the professional to make better care decisions. SmartCare also collects data required by the HMIS for the modules that SmartCare covers and loads this data into the HMIS.

The Zambia SmartCare system

Facility software and hardware

At the health facility, the SmartCare package includes SmartCards (Figure 8); a SmartCard reader; a desktop computer equipped with a touch-screen and the SmartCare software; a printer; an uninterrupted power supply (UPS) battery back-up; a power strip; and a flash drive for transporting data to the health district or other health facilities. At one workstation per facility, this package would cost roughly \$2,000 per facility.⁴⁸

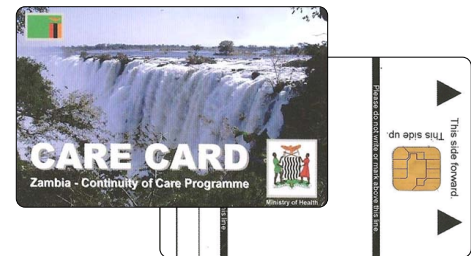


Figure 8 - Zambia SmartCard

Distributed database ‘network’

SmartCare operates on a distributed database, designed to accommodate the lack of Internet connectivity in much of Zambia and the perceived difficulty and high cost of designing private wireless networks. Each facility maintains an off-line database. The system is constructed so that databases could be easily copied and merged at the district level, with patient data hidden at that level.

Project management structure

SmartCare’s project management structure reflects the division of labor between the CDC and the MoH. The CDC manages PEPFAR funding, the project content, on-going software development, and relationships with implementing partners, while the MoH is responsible for the national program rollout.

Health information personnel within Zambia observe that the shared management function has made accountabilities unclear. In addition, the CDC's role as both "funder"⁴⁹ and implementer means that the CDC has considerably more influence in project decision-making and often chooses to exercise this influence. In multi-stakeholder projects, participants may have differing agendas while sharing the same vision of improved health services, and the resulting friction may sometimes result in tension over project implementation, which is a struggle in this and all comprehensive health information system solutions.

Implementation to date

Each year has represented a different stage of SmartCare's implementation. SmartCare was launched in 2006, after a 2005 pilot. The pilot demonstrated that patient record capture is possible in "e-fast" mode, and that patients hold on to their SmartCards between visits. SmartCare was rolled out in 2006 to each of Zambia's nine provinces and 72 districts, starting from the national level down to the health facility level. Training was provided at each level of the health system. Districts chose sites, using high patient volume as the primary criterion for site selection. A limited number of other sites were added in order to increase the equity of site distribution. At the outset, SmartCare's main implementing partners were the Zambia Prevention, Care, and Treatment Program ZPCT and CIDRZ, which were responsible for implementation in the north and the south of Zambia respectively.

SmartCare was chosen in 2006 as the national ART reporting standard for facilities capable of supporting a computer. The MoH completed the standardization of its ART forms (box to the right). At the end of this process, the MoH felt it was best to support the new, single set of ART forms with a single software system. The use of different systems for HIV treatment, care, and reporting created vertical reporting structures, and drove inconsistencies across the care offered by multiple service providers. To eliminate duplicate patient record systems as well as to raise the quality of such systems, the MoH established SmartCare as the national ART reporting standard for facilities capable of supporting a computer and the ART Information System (ARTIS) for all other facilities.

In a 2007 re-organization of the MoH, SmartCare's organizational "home" moved from the Public Health and Research Director to the Sub-Directorate for Monitoring and Evaluation. In August 2007, the Ministry requested CDC support deploying SmartCare to an additional 900 sites by the end of 2009.

In 2008, the MoH began to take greater responsibility for site support. By the fall of 2008, the Ministry had deployed the system directly to the majority of SmartCare sites. For its part, the CDC is focusing

Driving Efficiency by Streamlining Paper Forms

In 2004, the organizations in Zambia that were running HIV care and treatment programs used 17 different ART forms with disparate data fields and different field names (e.g., "gender" v "sex" or "full name" v "Christian name") for common fields. That year, Zambia's MoH initiated a major effort to standardize the ART reporting forms used across the multiple agencies and facilities providing ART services.

Dr Albert Mwango, the MoH National ART Coordinator, spearheaded this effort, bringing together key partners in HIV care and treatment. Partners included the MoH, ZPCT, CRS, CIDRZ, HSSP, nine hospitals, and the MUTI Medical Center.

The effort was widely seen by stakeholders as a success - "amazing," in the words of one. By 2006, the MoH and its health partners had developed a single set of ART reporting forms. These forms are used by health partners across Zambia today and served as the backbone for SmartCare's ART treatment module.

on the conversion of pre-existing ART patient management programs to SmartCare. It has also been able to fund smaller scale initiatives that show high potential for success in the long run. These include a full, “e-first” implementation at the Maina Soko Military Hospital in Lusaka, and a complementary blood transfusion management program at the Zambia National Blood Transfusion Service (ZNBTS).

Today, SmartCare is deployed in more than 400 health facilities in Zambia’s 72 provinces. In 2009, the MoH aims to continue SmartCare deployment, including deployment at the hospital level. The CDC will focus on converting data from legacy ART patient management systems into SmartCare and on adding modules for family planning, care of children under five years of age, and general outpatient services.

Overcoming implementation challenges

SmartCare is a large and complex deployment, in which multiple stakeholders must coordinate activity to implement a novel health information technology in health facilities across Zambia. SmartCare’s stakeholders cite several implementation challenges that they have had to overcome in rolling out the system.

First, SmartCare has had to strike a balance between rapid deployment and allowing sufficient time for each district and health facility to be effectively trained and supported. According to Mark Shields, the CDC is committed to helping the ministry deploy SmartCare to every health facility in Zambia. In part because of donor pressure, the ministry probably “pressed the limits for speed of deployment, when there was a need for a consolidation phase with more training,” he said, though by early 2009 the pace of deployment had moderated, allowing SmartCare to provide additional training to ensure that users understand the system and its features.

A second challenge has been in deploying a sophisticated information system in an environment where limited technical support and expertise exist. For example, viruses have proven difficult to manage: It is hard to consistently update virus protection software because many computers lack connectivity, and it is easy to transmit viruses by flash drive. Managing virus issues across sites has taken time that was intended to be invested in training end users on how to use the system. Yet the installation of SmartCare has also created positive externalities, for example, by driving demand for increased technical capacity, with the ministry upgrading its requirements for district health information officers and speeding up the provision of electricity to clinics. These developments highlight the difficulties inherent in deploying information technology in low resource environments, but they also illustrate the ways in which these deployments may have unanticipated benefits.

A third challenge is striking a balance between the necessity of collecting enough data to provide a full patient health record and the importance of teaching clinicians how to use the health record to improve patient care. In the United States, the Marshfield Clinic, a Wisconsin facility that has used electronic health records since 1985, has found that electronic records improve patient health outcomes only when patient data is analyzed to identify trends and adapt patient care accordingly. As Dr. Carolyn Clancy, the director for the US Agency for Healthcare Research and Quality, has said, “...the electronic health record itself is no silver bullet.”⁵⁰

SmartCare’s focus on building complete, electronic patient health records has focused on institutionalizing the data entry process, so that clinicians will have complete patient data as they are trained to interpret and use that data to improve patient care. When SmartCare is rolled out at the

facility level, the first priority is to enter new patient data into the system, and the second priority is to enter patients' old paper health records into the system. Patient data is entered after the patient consultation, oftentimes by data entry associates hired for the purpose of SmartCare data entry. The data entered into SmartCare already allows the generation of over 60 reports that can be used by clinicians and facility managers. SmartCare's management acknowledges that training clinicians to use data effectively in patient care is a multi-year process, but believes that the offloading of data entry responsibilities from care providers and the complete records that SmartCare provides will result in a more positive attitude on the part of clinicians towards data and the benefits it can provide.

Case Study Findings

In spite of their differences, remarkably consistent lessons emerge from comparisons of HIS in India, Sao Paulo in Brazil, and Zambia. This section will present these lessons in brief, while also providing a transition to the following chapter, which will discuss the challenges and opportunities implied by the case study research, expert interviews, and landscape analysis.

Lessons learned

System interoperability is rare, but can be hugely beneficial. Case study research suggests that it is likely that countries will have several HIS, for a number of reasons. Countries may have different HIS due to decentralization or a proliferation of donor-driven health programs. HIS in decentralized countries are likely to differ across regions, districts, or even municipalities, as is the case in Brazil. Sao Paulo's SIGA Saúde system is well established, while the cities of Campinas and Carnacari are beginning to develop their own systems.

In some cases, the lack of interoperability is associated with legacy systems. In Zambia, the government HMIS and SmartCare have very similar – if not parallel – data-reporting structures from the district level upwards, despite the commitment of the government and other key actors to coordinating reporting frameworks in the health sector. In India, older state systems have yet to be made interoperable with the new national HMIS in part because of technical challenges associated with creating compatibility.

Patient populations, resources, and environmental constraints may also differ, and may create the need for different HIS solutions. The Zambia Electronic Perinatal Record System (ZEPRS) run by CIDRZ collects a robust set of antenatal care data from Lusaka's University Teaching Hospital, which sees the country's most complex medical cases, and from Lusaka area clinics. The data are analyzed to identify changes in clinical practice that can improve patient health outcomes, and Lusaka area clinicians are then coached on the changes they can make to improve clinical practice. By contrast, the Kasisi Rural Health Centre does not treat complex HIV cases, lacks electricity, and uses limited medical equipment. The center uses a paper-based data management system and its clinical officer uses paper-and-pencil graphs of his own design to track disease trends. For specific care areas, the data is analyzed by CIDRZ and used to provide clinician coaching in much the same way that data collected by ZEPRS is.

These examples suggest that a given country is likely to have more than one health information system. Interoperability at scale is rare (the interoperability of India's NRHM and Gujarat's Hospital Management Information System is one notable exception), but is extremely important. Interoperability can eliminate duplicate data processing, and can allow each system to focus on meeting the needs of its core users, while optimizing the functionality of the health information system as a whole.

Health information systems must be adapted to their environment and to user capabilities. In the previous example, the ZEPRS and the paper-based data collection systems are arguably appropriate to the environments in which they operate. In the case of health centers like the Kasisi Rural Health Centre, it is not certain that an electronic health record system will have more impact on patient outcomes than an efficient paper-based system or more clinician coaching opportunities. To accommodate the lack of software and hardware adapted to rural environments and novice computer users, the Indian NRHM's HMIS will initially be automated only to the level of community health

centers. Internet connectivity is being extended to support these health centers. Data collection at most of India's 24,000 primary health centers and 145,000 sub-centers will remain manual for the time being.

Deciding what data to collect might be hard, but the effort is worth it. The data harmonization efforts in Zambia and India highlight the challenges and the tremendous benefits associated with limiting the data elements collected to those that are required to provide effective patient care or to monitor programs, standardizing data collection across agencies, and reducing the frequency of data collection. The harmonization effort led by Dr. Mwango of Zambia's Ministry of Health reduced 17 different ART forms to a single set used by the major HIV care and treatment partners in Zambia today. The coordination effort initiated by the NRHM's M&E division in India reviewed the 3,000 indicators collected by its siloed health programs, and entailed securing agreement from program heads on the approximately 200 indicators that would best inform whether the NRHM was reaching its primary goals. Both of these initiatives have or will enable major time savings in data collection and analysis. In addition, they have arguably increased the quality of care and health service delivery by focusing attention on a manageable number of indicators that are closely related to patient care and service provision.

If an HIS directly benefits its data collectors, it will produce higher quality data and will be more likely to last. Sao Paulo's SIGA Saúde system provides a strong example here. Staff at health facilities in the city of Sao Paulo use SIGA daily to make their jobs easier. In the past, patient scheduling for referrals and follow-ups was painful, because facility administrators had to co-ordinate with other facilities before they could suggest an appointment date and time to patients. As a result, patients had to wait up to three months for referrals or follow-up visits. With SIGA, all schedule information is available centrally to authorized users. When an assistant goes to set up a referral or follow-up consultation, the system will automatically suggest a facility, the doctor, and the appointment time based on a number of factors, such as distance between patient's home and health facility, the soonest available time, and so on.

These design features help to enhance data quality and system longevity. Because SIGA makes the jobs of health facility staff easier, health facility staff have little incentive to report false data. And because SIGA generates tangible benefits for health facility staff (the "data collectors"), it is a popular program and would be difficult to eliminate without significant resistance.

HIS are more likely to be successful when they are part of a broader effort to reform the health sector. Aligning the development of a new HIS to a larger reform effort not only promotes consistency between the health system and the HIS, it also creates champions for effective data collection and analysis. It is not too much to suggest that HIS and strengthening are interdependent. Strengthening depends upon quality information about the performance of the health system, but HIS reform depends on a larger commitment to health system strengthening as well. In India, the newly-launched NRHM created its HMIS in order to obtain data that evaluated the success of its programs, which gave it a strong incentive to see that the system is implemented effectively, and the desire to see this new agency succeed lent it crucial support from senior officials in the ministry of health. This support was essential to the data rationalization effort that reduced the number of indicators collected by health workers. In Brazil, the SIGA Saúde system in Sao Paulo may have been developed for the city, but its alignment with the health insurance and health identification programs created by the federal government has allowed it to operate smoothly within the national health system. It has also made it

easier for the federal government to support the program and provide funding, since system parameters were defined by those who were highly familiar with the needs of the Brazilian health system.

Electronic health information systems are relatively new, so deliberate approaches to implementation are essential to lowering risk – and can foster innovation. The implementation experiences of the three projects profiled in this chapter point to the need for a deliberate approach to implementation. The city of Sao Paulo fully deployed to only one of the city's "regions" (as districts are known) at a time, enabling the city to learn lessons from each deployment and to adapt each rollout to the specificities of each of the city's regions. Dr. Beatriz Faria Leao, the system's health standards architect, said that this decision was made so that they would not "make the same mistake twice."

In contrast to Sao Paulo's measured approach, rollout in India and Zambia has been either large-scale at the outset (India, where the first stage of rollout was to 18 of 27 Indian states), or is now accelerating (Zambia). In taking these approaches, a rollout might miss the opportunity to learn lessons from earlier deployments, or to resolve early implementation issues before rolling out to additional sites. This is especially important because the electronic health systems being rolled out are new to many countries, and there are many lessons that can be learned – and many mistakes avoided – by regularly identifying problems with implementation and resolving them in rollouts to other regions, districts, or sites. There is a distinction, however, between a measured, well-planned implementation, and one that is slow and over-careful. Even a fast rollout can systematically integrate and respond to lessons learned.

Conversely, creating "breathing room" within implementation enables projects to experiment with novel approaches, or to take the time to think about how to solve difficult problems. As the CDC-Zambia has transitioned responsibility for site rollout to the Ministry of Health, it has had more time to identify local "innovators" and to support them as they experiment with SmartCare. The CDC-Zambia

Maina Soko Military Hospital uses SmartCare to streamline HIV case management

The Maina Soko Military Hospital (MSMH) is located in central Lusaka, serving military personnel, their families, and individuals in the local catchment area. Prior to the MSMH's SmartCare implementation, HIV-positive patients at Maina Soko carried large blue files from consultation to consultation. Each file had a patient care code denoting HIV status prominently displayed in large letters on the outside of the file.

The hospital implemented SmartCare in early 2007. Though the initial intent was to use SmartCare in "e-fast" or "e-last" mode, Maina Soko leadership pushed the CDC-Zambia to provide enough computer units for Maina Soko to be "e-first" so that patients would no longer have to carry their thick patient files denoting HIV status around the hospital. Colonel F.L. Simapuka, commanding officer in charge of the hospital's outpatient services, said that the hospital leadership believed that an e-first implementation would reduce the need for paper records and therefore would be "a more relevant way of reducing HIV stigma."

SmartCare is currently used in voluntary counseling and testing (VCT) and the antenatal clinic (ANC), as well as in the laboratory and pharmacy. Patient information is entered by the health care professional at the point of service, and saved onto the patient's SmartCard. SmartCare has allowed the hospital to identify which ART patients are stable and which are not, shifting more stable patients to nurses and less stable patients to physicians. SmartCare has also allowed care providers to check the patient's medical history more easily. This has enabled more consistent patient care, which has resulted in HIV-related hospital admissions declining by more than 70% since SmartCare's implementation.

has helped the Zambian National Blood Transfusion Service to develop a SmartCare “SmartDonor” module to enhance the quality and frequency of voluntary blood donation. It has supported the Maina Soko Military Hospital (MSMH) in implementing SmartCare, resulting in streamlined HIV patient care management (see box above), and it has developed a partnership with MachaWorks, a rural NGO that provides wireless networking in southern Zambia, to provide technical support to SmartCare sites in southern Zambia.

Next Steps

HIS for health systems serving the poorest parts of the world are still in their infancy. The challenges are significant, but the need to improve health outcomes is simply too great to ignore the value of better information to health system performance. Yet, there is still much to be learned and large projects that fail to live up to expectations will produce growing skepticism, disillusionment and loss of interest. Solutions advocated by experts in the developed world are often too complex to be practical in countries where resources and capabilities are severely limited. At the same time, the characteristics of developing countries are often similar, offering unexploited opportunities to identify common needs and simple solutions that can lay essential foundations for scalable, sustainable systems. Key enablers of HIS solutions are foundational to further progress and the ultimate seeding of viable commercial markets supporting specialized providers and solutions. Guided by these principles, Vital Wave Consulting sees the following as the most important next steps for furthering HIS development.

1. **Drive consensus adoption of a minimum set of essential indicators.** As donor, government, and international organization requirements often play a predominant role in determining what data is collected, a cross-sector consensus on a minimum set of standard critical indicators and/or standard reporting requirements would have a profound effect on reducing the burden of data collection and reporting. There is a notable opportunity to streamline the frequency and number of data elements collected by health information systems. Yet although the WHO has made some progress in this area, there is not yet a consensus on a minimal model set of indicators for individual diseases, such as HIV or tuberculosis. Even where guidelines are available, they are not routinely adhered to by donors, governments, and NGOs.⁵¹ Forging a consensus around an essential *minimum* set of standard indicators and reports required is an area where external donors and multilateral agencies have the strongest leverage. Alignment is difficult to achieve but is possible when there is a specific and well-defined outcome desired and strong leadership. There is a two-step process to achieving this objective:

- ***Step 1: Identify a minimum set of essential indicators for critical need areas.*** Determine an adequate minimal set of essential indicators that (1) is generally common to different countries; (2) meets the core needs of health systems and funders; and (3) can be specified with sufficient simplicity and clarity so that they can be readily collected and used by even the least developed countries. In particular, a minimal set of standard indicators for maternal health and prevalent communicable diseases is urgently needed. Although determining adequacy is a value judgment, a systematic sampling of indicators and analysis of their actual use would provide an essential empirical foundation for a program to begin to drive consensus among major funders and multilateral organizations.

Global impact: Consensus adoption of a minimum set of essential indicators could significantly influence the future development of HIS across the developing world. This adoption is valuable whether the system is:

- paper-based or electronic
- deployed in a least-developed or an upper-middle-income country
- implemented in one city or nationwide
- executed by a private or public health institution

- **Step 2: Promote consensus adoption of the minimum set of essential indicators.** A meaningful worldwide consensus around a comprehensive set of indicators for all important health data is far off, however, the more modest objective of agreement around a consensus minimum set, strictly tied to the specific needs of health systems in developing countries, could be achieved. This is an ambitious goal, but few achievements would have greater impact.

2. **Determine the common, essential information needs across countries.** Determine what essential information needs are common to specific roles in the health system across different countries and geographies. The strongest incentive for accurate collection and reporting is that the information is useful to those who collect and report it. To some degree, the information that is most useful will differ among specific locales, roles, and facilities. The extent to which there are needs that are common to many places that might serve as a point of departure for reform efforts still needs to be explored. There is a significant value in comprehensively analyzing the information that would have the greatest impact on improving patient health outcomes. This knowledge could be used to guide investment in appropriate hardware, software, and training solutions and enable greater scale in solution design and implementation.

Additional Recommendations

In addition to the Next Steps listed in the previous section, there are several additional recommendations for governments and organizations to follow to support effective health information management in the developing world.

Recommendation: Enhance HIS success rates by supporting initiatives that have high-level sponsorship and occur in the context of wider health-system reform. HIS initiatives demonstrating signs of success as diverse as those in Ghana, Rwanda, Sao Paulo, and Belize, have strong executive sponsorship and occur in the context of health system reforms or other efforts that provide a clear rationale for HIS investments. In Sao Paulo, the SIGA Saúde system was developed in 2004 under the leadership of several individuals and organizations including Dr. Gonzalo Vecina-Neto who is Sao Paulo's Health Secretary, Dr. Antonio Lira who oversaw medical services and health workers, Lincoln Moura who oversaw all aspects related to the building of the information system and Prodam, the organization that provided the city's data processing infrastructure. In addition, the project enjoyed the strong support of the city's mayor, Marta Suplicy. Ms. Suplicy aspired to national political office and had a strong incentive to enable the development of a health information system that would tangibly and cost-effectively benefit the population while also implementing the recommendations of a major reform of the Brazilian national health system that had taken place a few years earlier. By contrast, HIS projects that are not tied to a broader overall reform initiative and lack broad executive support are vulnerable, especially when they become too closely identified with a single individual.

Recommendation: Support in setting clear priorities for reform. Current HIS assessment tools, including HMN assessments, highlight the range of problems that health information systems address. The next step is to provide a clear view of the sequence and magnitude of the issues that must be addressed. Resources are scarce. Every fault or weakness cannot be addressed at once. It is critical, therefore, that countries can identify and prioritize the interventions that will produce the highest return on investment, are most immediately attainable and will have the most direct impact on health

outcomes. Although each country must set its own priorities, it is important for countries to receive guidance from health informatics experts concerning which components of HIS have the greatest leverage for initial investment and how to set priorities to optimize scarce resources. Particular attention should be given to helping countries focus on the core need or problem and to identify the activities that will enable the country to most effectively address that need. The Value Chain Analysis discussion in the Appendix offers one possible approach to addressing these questions.

Recommendation: Define HIS needs and goals. Any mention of information systems calls to mind computers and databases, data centers, and network infrastructure. It is easy to lose sight of the fact that when HIS projects fail to meet expectations, it is often because needs and goals are not well defined. In Belize, which maintained a rudimentary HIS before its comprehensive new system was introduced, health officials and political leaders established the goal of capturing all health encounters and using the data to manage the health system's resources. Implementers need the project management skill and experience to understand the information needs of an organization and how these needs are aligned to the mission and strategy of the health system. Academics, funders and health-related NGOs can support the development of needs analysis tools that help governments and other organizations focus on the core need or challenge.

Recommendation: Streamline data collection. A pattern in many developing countries is that data is collected on a large number of indicators without clear justification and often with much duplication. As the case-study section of this report indicates, data collection in Zambia or India may require that the same piece of data be entered or counted up to four times before it is sent to the district health information office, where it is entered into the government HIS a final time. Especially for paper-based systems, simplifying the data collection process offers a very immediate return on investment, at relatively low cost. This process is also in the best interest of many stakeholders, as reducing the number of times data is re-entered reduces the opportunity for error and increases the time that clinicians have available to provide patient care. It may therefore represent a relatively easy opportunity to improve health information management and subsequently, health outcomes. Similarly, reducing the amount of unnecessary data collected and reported can dramatically decrease the time spent on data collection, although this shift does require the agreement of stakeholders that use this data. At least one academic created a specific set of guidelines to facilitate the data rationalization process.⁵² No high-risk investment (or additional investment) in IT is required. Any later commitment to computers and databases will be far more likely to succeed if these steps are accomplished first.

Recommendation: Develop HIS to support user decision-making. Many health information systems are structured to provide outputs to the central-level government and to donors. Some health information systems are structured to speed data entry. Only infrequently are health information systems designed and implemented to support members of the health system – health care providers, administrative staff, and management – in making high-quality decisions. There is tremendous potential to orient HIS initiatives to support improvements in quality of care and decision-making. Parts of the solution exist today. The Baobab Health Partnership in Malawi provides a console in each consultation room that clinicians use to enter patient data and to review patient medical history at the touch of a screen. In Zambia, the CIDRZ ART treatment program provides care to 175,000 clients. CIDRZ uses patient data to create a quarterly performance report for each facility in its network, works with the facility to improve care based upon the performance report, and “graduates” facilities that consistently use data to improve patient care. Continued experimentation with the hardware, software, and training

support is needed to identify the approaches that will help health care professionals do their jobs more effectively. Television-based video and telemedicine indicate promise and need to be explored further.

Recommendation: Plan for project operations and maintenance at project outset. HIS-reform budgets need to anticipate and fund the total cost of ownership of HIS solutions. The hidden costs of technology (technical support, user training, hardware replacement, software upgrades) are often not taken into account or budgeted. Total cost of ownership (TCO) models offer an essential tool for planning and budgeting IT projects, a tool that could improve success rates if employed consistently. It is often assumed that local governments will absorb the costs of ongoing support and maintenance and recurrent training when there is no commitment or ability to do so. Donors could also explore alternative models for government counterpart contributions. In lieu of funding equipment up front and leaving operations to government, donors and government could agree on a cost-sharing arrangement to be maintained throughout the project lifespan, with the donor contribution contingent upon the government contribution. Lastly, the likelihood of success of a health-related IT project can be greatly enhanced by ensuring that the core implementation team is staffed with both health (public health managers and experts) and IT (IT program managers, business analysts and architects) professionals.

Recommendation: Invest in adapted technology. Technologies developed for mature markets in developed countries are not necessarily appropriate for emerging markets. This holds especially for HIS serving some of the least developed countries, where the standard personal computer is often too complex and vulnerable for many applications. What is often needed instead is a specially designed information appliance. In the words of Marcus Achiume, CIO of CIDRZ in Zambia, referring to technology for an EMR system, “An information terminal should be like a ‘cash register’ for health information management: no solitaire, no operating system updates, no viruses, and no resale value – just electronic medical records.” There are good examples of appropriate technology meeting these kinds of requirements, for example, the touch-screen appliance developed by Baobab Health Partnership in Malawi. There is significant need for further investment in these types of technologies and, most important, to develop markets of sufficient size to permit economies of scale to reduce costs. Donors can play a significant role by investing in appropriate research and development and promoting best practices in design and adoption of appropriate solutions. Seed funding, awards, and prizes are also well-established mechanisms to stimulate innovation and bring widespread attention to significant achievements.

Recommendation: Develop commercial markets. The market for HIS technology and services in developing countries is nascent. The customers are primarily donors; the products and services are custom consulting or design-build contracts. Costs are high. Economies of scale are largely absent. Needs are often unclear, which makes product development difficult. The market, though potentially large, is currently very small. Major commercial enterprises find that the risks of developing technology for this market are too great to justify the investment. Interventions that reduce risks and barriers to entry can help to expand the commercial marketplace for health technology and services in developing countries. Standards can play a crucial role by reducing risks and costs for technology providers. At a system level, it is necessary to understand existing barriers to entry and the financial value associated with reducing these barriers, to effectively drive market growth in new markets. Value chain analysis, described further in the Appendix of this report, is a methodology designed specifically to perform this type of market analysis.

Recommendation: Increase project accountability by changing the structure of provider contracts. Current funding models reward project implementers for successful completion of contracted projects but contain few incentives for assuring the long-term viability of projects, particularly of technology investments. Contracts may specify that there be a plan for monitoring and evaluation, but the plan lasts only as long as the project is underway. Whether a project has an impact or lasts beyond the implementation phase is not documented or assessed. There is great value and an opportunity for post-implementation assessments, perhaps accompanied by a system of bonuses for contractors, if systems continue to function and be used productively long after the initial installation.

Recommendation: Invest in increasing the attractiveness of the HIS technology and services market. The HIS technology and services “market” in developing countries is characterized by lack of clear definition of product needs, high costs associated with the absence of economies of scale, and potentially low margins due to ceilings on donor funding. There are often multiple clients, in the form of multiple stakeholders, and the operating environment is typically unfamiliar to top-tier providers of HIS technology and services. In addition to the development of standards, there is a need to support the creation of partnerships between top-tier IT corporations, which have a core competency in areas such as complex program and change management, database and application design and local IT firms who are more equipped to do the field support (supporting rural clinics and health posts). The local company receives mentoring and capacity building while the larger company gains expertise, and potentially other projects, in e-government work. Another approach would be to encourage the development of “re-usable components” which are hardware or software designs and modules that can be leveraged across HIS projects in multiple countries.

Next Steps:

- Drive consensus adoption of a minimum set of essential indicators
- Determine the common, essential information needs across countries

Additional Recommendations:

- Enhance HIS success rates by supporting initiatives that have high-level sponsorship and occur in the context of wider health-system reform
- Support in setting clear priorities for reform
- Define HIS needs and goals
- Streamline data collection
- Develop HIS to support user decision-making
- Plan for project operations and maintenance at project outset
- Invest in adapted technology
- Develop commercial markets
- Increase project accountability by changing the structure of provider contracts
- Invest in increasing the attractiveness of the HIS technology and services market

Country HIS Scans

Bangladesh

Country: Bangladesh

Population: 158.6 million

GNI per capita (2007): \$393

Acute Health Challenges:

Very high child and maternal mortality; risk of an HIV/AIDS epidemic; world's fifth highest rate of tuberculosis (TB) and its multi-drug resistant form; prevalence of malaria and polio recurrence; highest malnutrition levels in the world, including childhood protein-energy deficiency; maternal malnutrition

Major Health Sector

Initiatives: Health, Nutrition and Population Sector Program (HNPS), 2003-2010, with emphasis on primary care in child and reproductive health and infectious diseases

HIS Initiatives: Joint project with Health Metrics Network to evaluate HIS

HIS Type: Primarily manual data collection and paper records, with isolated cases of electronic records and a few telemedicine and mobile health initiatives

HIS Category: Group 1

The Government of the People's Republic of Bangladesh is formally committed to providing basic health services to its population. Since 1998, the Health and Population Sector Strategy has been the main pillar of the National Health Policy. The strategy's main principles are integrated into the current *Health, Nutrition and Population Sector Program* (HNPS) 2003-2010, which is implemented by the Bangladesh Ministry of Health and Family Welfare (MOHFW).⁵³ The "Health for All" campaign and the delivery of the Essential Services Package (ESP), with its emphasis on Primary Healthcare (PHC) at the upazila (sub-district) level, are among the top priorities of the National Health Policy.⁵⁴ ESP covers services in four main categories: child health, reproductive health, communicable disease control and limited curative care.⁵⁵ Bangladesh pledged to meet the United Nations' Millennium Development Goals (MDGs) by 2015, in part by pursuing a decentralized policy of health development, meaning that local community organizations, NGOs and various aid donors would take a greater role in improving health delivery outcomes.

Under the new HNPS 2003-2010 Operational Plan, the parameters of electronic health activities are laid out. However, there is limited knowledge or understanding about the status of the HMIS. The MOHFW is currently engaged in a joint project with the WHO Health Metrics Network to evaluate the HMIS and to develop practical solutions for future HIS in Bangladesh.

In the MOHFW, the Line Director of MIS (Health) is responsible for e-health implementation (health and population activities are divided into "lines" or "sectors"). The Line Director of MIS (Health) "is responsible for (a) the collection and exchange of health service data across all service delivery points, health managers at different tiers, and officials

at MOHFW to support monitoring of progress of health programs and policy decisions; (b) conducting annual household survey personnel, logistic and financial MIS; (c) telemedicine; and (d) e-records, etc."⁵⁶ The current HMIS functions inadequately, as do information support and data usage. Internet-enabled computers are available at "the MOHFW, central store for medical supplies (national level), all national and regional tertiary hospitals, 64 district health centers and most of the 464 sub-district hospitals."⁵⁷ Hospital data is collected locally, with minimal processing and analysis. Field health workers gather household-based data, accumulate it at sub-district health centers and forward it to the MIS headquarters in Dhaka. The human resources database is used for placement purposes for the

Health Services staff, whereas the finance and logistics components of the HMIS are still under development.⁵⁸

Bangladesh is using some innovative technological approaches to solve local health problems and achieve better health outcomes in the country. For instance, the City Corporation of Bangladesh (Rajshahi) developed an Electronic Birth Registration System (EBRS) that provides local citizens with a personal electronic identification card. Citizens now have an incentive to register births because the card is required to access local services, such as immunization schedules and school enrollment. This new system enables health authorities to reliably track each child's immunization history, replacing a disorganized manual system, and effectively provides data to accurately monitor progress and for national decision-making.⁵⁹

The Integrated Rural Health Information System (IRHIS) is leveraging a model developed in the microfinance industry to develop a rural health insurance network that will link 64 private and 64 public health facilities in rural areas.⁶⁰ At least two mobile health initiatives are underway, namely D.Net (Development Research Network), an NGO using a mobile health worker and outreach to provide around-the-clock mobile health services to rural residents, and 24-hour medical advice over the phone, delivered by a partnership between GrameenPhone and Telenor, two mobile communications service providers. There are telemedicine projects run by the Diabetic Association of Bangladesh (in pilot mode) and MEDINOVA, a diagnostic clinic that connects to overseas doctors.

Despite the success with paperless medical records at the privately-owned Apollo Hospitals Dhaka (AHD), the prospect of widespread usage of electronic records for individual patients in public hospitals remains dim, primarily due to a constant influx of patients, shortage of medical staff and lack of ICT resources.⁶¹ Out-patient service is particularly challenging because doctors have, at best, five minutes to spend with each patient.⁶²

HIS Strengths: Line Director of MIS (health) position has clear authority to develop and implement information strategy

HIS Weaknesses: Lack of ICT literate staff and scarce financial resources limit computer purchases and maintenance and recruitment of ICT staff; poor record-keeping; poor and expensive ICT connectivity

Critical HIS Challenges: Huge patient-loads leave little time for electronic record maintenance; concept of the e-health framework (data need, hardware, software, analysis technique, transmission, utilization, etc.) needs strengthening

Belize

Country: Belize

Population: 300,000

GNI per capita (2007): \$3,800

Acute Health Challenges:

Heart and respiratory diseases, malaria, infant and maternal mortality

Major Health Sector

Initiatives: A national health insurance scheme, with the government becoming a single payer in a more decentralized health system; comprehensive health sector reform

HIS Initiatives: Belize Health Information Services, which captures over 80% of health encounters nationally, in personal electronic health records; other modules track patient flow, inventories, lab results, and financial and human resource management

HIS Type: Automated, EMR-based system

HIS Category: Group 4

With only 300,000 people covering an area roughly the size of Massachusetts, Belize is smaller than many of the developing world's cities, let alone its countries. Although Belize had a very rudimentary, paper-based health information system as recently as 2004, today it has perhaps the most comprehensive nationwide HIS in the world, the Belize Health Information System (BHIS).

In 2001, Belize embarked on a comprehensive reform of its health sector, aimed at modernizing the overall structure, providing greater coverage for the population and improving operational efficiency. The BHIS became part of this comprehensive overhaul when planning for it began in 2004. The government of Belize contracted with Canadian software developer Accesstec, with financial and technical assistance from the Inter American Development Bank (IADB) and the Pan American Health Organization, to develop a health information system that tracked all patient encounters with the health system while managing patient flow, monitoring infectious disease outbreaks and keeping track of supply inventories and financial and human resources.

At the heart of the Belize HIS is a personal Electronic Health Record, which is provided for all citizens and which contains comprehensive medical background, treatment history, and health status records. The benefits of the system, according to the Ministry of Health, include "better tracking and monitoring of infectious diseases such as SARS and Bird-Flu, rapid identification of patients in the event of the release of unsafe medicines, country-wide prevention of mother to child transmission of HIV and better care for diabetics."⁶³

The module-based system captures the vast majority of individual encounters with the health care system by linking the Ministry of Health with the country's health facilities. The goal is an integrated resource management tool that integrates all aspects of the health system, where the various components are able to communicate concerning needs and possible actions, replacing siloed or disease-specific systems. Patient-flow, laboratory, pharmacy, HIV/AIDS and human resource management modules comprise the system and are designed to interact with each other.

Although the system is proprietary, it is Java-based and open source components are embedded within it, which allows it to run on any operating system. The licensing scheme is perpetual one-time license, and the system has replication technology that allows it to operate without any network connectivity, a critical component for infrastructure-challenged environments.⁶⁴

The system has been operational in Belize since 2004 (it was also deployed to St. Lucia in 2007), and Accesstec claims that the system can scale to accommodate up to 100 million health records. Nearly 90% of the users have been trained in operating the BHIS. The system has also integrated pharmaceutical tracking by connecting every pharmaceutical warehouse in Belize to the system, in addition to 22 private pharmaceutical suppliers.⁶⁵

In September 2008, the country signed a memorandum of understanding with the Health Metrics Network (HMN), which will allow the Ministry of Health to access resources enabling the BHIS to meet the global standards designed by the HMN.⁶⁶ The BHIS is already being touted as a success and may serve as a model for other developing countries, though specific health outcomes resulting from the HIS implementation will likely not be available for several years.

The Belize HIS represents perhaps the most comprehensive national HIS initiative currently in place, but the lessons that can be drawn from it must be considered in the context of Belize's small size and the lack of entrenched legacy systems, which obviate the need to integrate disparate technologies and the bureaucratic structures attached to them. It also must be viewed in the context of a comprehensive health sector reform and new national health insurance scheme. As in other prominent HIS developments, such as Sao Paulo's, systems often seem likelier to achieve success when they occur alongside a wholesale reform of a health system's structure and functioning, rather than when they are built to accommodate an existing system whose dysfunctionality may preclude attempts to capture and integrate important data.

HIS Strengths: Integrates the entire health sector of Belize, including patient flow, supply management and patient electronic medical records and establishes the Ministry of Health as the central repository for health data

HIS Weaknesses: Trained health personnel are concentrated in the metropolitan areas of Belize, meaning some patient encounters take place outside the formal sector

Critical HIS Challenges: Ensure inclusion of all citizens in formal health sector in order to capture maximum data

China

Country: China

Population: 1.3 billion

GNI per capita (2007): \$2,360

Health Challenges:

Communicable diseases and malnutrition, especially in less developed areas and among children; high infant and under-five mortality rates where access to health services is low; HIV/AIDS, SARS and avian influenza; smoking-related diseases.

Major Health Sector

Initiatives: New Cooperative Medical Scheme (NCMS) implemented in rural areas and community health services development.

HIS Initiatives: 2003–2010 Ministry of Health Guidelines for HIT development call for the introduction of electronic medical records and regional health information networks throughout the country

HIS Type: Automated systems mostly in hospitals

HIS Category: Group 3

Since the beginning of market reforms and economic liberalization in the early 1980s, China's health sector has witnessed a drastic transformation of its landscape. The result has been a fiscal decentralization of health services to the lowest administrative levels, as well as inequalities between more and less developed areas. In order to address these disparities, the Chinese government is pursuing ICT development policies in the health sector, with the desire to electronically connect "health administration departments and hospitals as well as medical education and research institutes."⁶⁷

In 2002, China's Ministry of Health (MOH) introduced the 2003–2010 Guidelines for Development of National Health Informatics.⁶⁸ The Guidelines establish regional health information systems across China by 2010 and emphasize the principle of standardization in an effort to improve information sharing and interoperability. Subsequently, the MOH chose the city of Shenzhen as a pilot site for the development of these regional health information systems. In addition, the MOH has proposed the development of basic infrastructure for hospital information systems, particularly Chinese traditional medicine information systems.

The use of health information systems is dominated by hospitals,⁶⁹ with most of the systems focused on financial and administrative functions.⁷⁰ According to a recent study, patient-centered systems represent only about 10% of all hospital-based HIS.⁷¹ Roughly 70% of hospitals at the county level or above have implemented an HIS.⁷² Regional health information systems and ICT procurements for public hospitals are financed by provincial and local governments. While the MOH is responsible for adopting new standards and developing IT infrastructure, hospitals finance new clinical and institutional IT systems from their own funds. The development of hospital

information systems in China has been somewhat uneven, due to problems such as a lack of standard approaches to hospital management and weak software development.⁷³ Due to inexperience in IT, hospitals now have fragmented, duplicate systems, and poor integration between those systems, leading to "silo" systems that make data sharing difficult.

Prompted by the SARS outbreak in 2003, China developed a Web-based disease surveillance system that provides real-time reports on 37 diseases across the country⁷⁴ and is reportedly the largest infectious disease reporting system in the world.⁷⁵ The system has GIS mapping features that assist in identifying case clusters and early detection of potential outbreaks. The system covers both China's Center for Disease Control (CDC) and the government's public health administration, which operate in parallel – and with equal influence and authority – at the county (district), municipal (prefecture),

provincial and central (national) levels (see Figure 1 at the end of this country scan).⁷⁶ Improved data accuracy and timeliness, earlier detection and containment of outbreaks and more accurate data on disease prevalence are just a few of the benefits the system is producing. Prior to 1985, the government relied on paper-based monthly reports. From 1985—2003, China moved to digital monthly reports, and in 2004, the Web-based system became operational.

In addition to the disease surveillance system, China's HIS has other subsystems, including the Routine Health Statistic Information System (RHSIS), which contains information and

data on health facilities, human resources, equipment and services provided to patients; the National Household Health Services Survey (NHHSS); the Maternal and Child Healthcare Surveillance System; and the Health Supervision Information System (HSIS), which contains information on food, public facilities, schools and the environment.⁷⁷

Computers, the Internet and email access are generally available throughout most of the country, except in the western parts of China, particularly at the county level.⁷⁸ However, at the provincial level, especially in the western regions of China and poor areas, there can be a shortage of full-time HIS staff, as well as insufficient capacity in core health disciplines, such as epidemiology, demography and statistics. The health sector also loses HIS staff to the private sector, where companies can offer better salaries.⁷⁹

HIS Strengths: Established organizational and administrative government structure, high adoption of IT by hospitals, effective disease surveillance system

HIS Weaknesses: Redundant, fragmented systems lead to increased burden for data providers

Critical HIS Challenges: Poor infrastructure in western region, lack of human capacity and skilled IT professionals

Ethiopia

Country: Ethiopia

Population: 79.1 million

GNI per capita (2007): \$220

Acute Health Challenges:

Child and maternal mortality rates among the highest in the world; infectious diseases (HIV, TB, malaria, child diarrhea and intestinal parasites)

Major Health Sector

Initiatives: Health Sector Development Program (HSDP), in its third five-year phase

HIS Initiatives: HIS evaluation and redesign to improve the country's paper-based system, with aim of eventually converting to electronic system

HIS Type: Paper-based, traditional district health indicators

HIS Category: Group 2

Since 1993, Ethiopia has been pursuing a national health policy advocating the decentralization of the health care sector, with a major focus on community level services. In order to make health services available to the local population, in 2004 the Ethiopian government adopted an Essential Health Service Package (EHSP) through the previously created *Health Service Extension Program* (HSEP) in 2004.⁸⁰ The EHSP aims to provide equal access to essential health services and covers five major health interventions: Family Health Services, Communicable Disease Prevention and Control Services, Hygiene and Environmental Health Services, Health Education and Communication Services, Basic Curative Care and Treatment of Major Chronic Conditions.⁸¹

Ethiopia is working toward fulfilling a comprehensive 20-year program, the *Health Sector Development Program* (HSDP). The HSDP timeline is broken into five-year phases, and is currently in its third five-year phase (2005/06 through 2009/10). The third 5-year phase of HSDP seeks to end poverty and meet the Millennium Development Goals (MDGs). In addition, the current HSDP attempts to “strengthen the health management information system [HMIS]” in Ethiopia, which, in general terms, represents a “combination of health services-based data sources”.⁸²

The Ethiopian HMIS is implemented by the Federal Ministry of Health (FMOH). Meanwhile, the Central Statistical Agency (CSA), a division of the Ethiopian government, manages

“population –based health information sources” - censuses, ad hoc surveys, and registering vital events. The HMIS was established to “support informed strategic decision-making by providing quality data that help managers and health workers plan and manage the health service system.”⁸³

In an effort to improve the performance of the HMIS, Ethiopia contracted with the consulting firm John Snow, Inc. (JSI) in 2006 to perform an evaluation and redesign of the HMIS. As the HMIS is predominantly paper-based, this project was to culminate in the design and deployment of an electronic HIS, following reform and revision of the existing paper-based system. As of 2008, a comprehensive electronic HMIS has been developed in conjunction with doctors associated with Tulane University and is now being deployed to health facilities in several regions of the country, with an eventual nationwide rollout eventually slated to occur.

In addition to the 2006 reform of the HMIS, Ethiopia completed an assessment of the HMIS under the auspices of the Health Metrics Network HMN in 2007. This assessment found the HMIS to be “cumbersome and fragmented.” Among the major HMIS challenges and weaknesses were the absence of an implementation strategy and guidelines; the shortage of human resources and high staff turnover; inadequate skills for gathering and analyzing data among health care staff at lower levels; unsatisfactory

quality of data in the reports, resulting in a compromised ability to make informed decisions; fragmented information flow, including parallel reporting system channels causing increased workload.⁸⁴ It would appear from the HMN assessment that the 2006 reform of the HIS, while perhaps effective to some degree, did not address all issues necessary for an effective national HIS. The 2006 reform addressed only minimal changes to routine practices in the health system, namely, reduction of indicators and redesign of forms. However, the reform failed to encourage behavioral changes amongst managers and administrators in the HMIS, a result that would have required substantially more resources and a more coordinated effort.

More recently, Ethiopia has seen a significant deployment of the SmartCare system used in Zambia. Over 100 clinics and hospitals in the Dire Dawa region, covering the entire area, have successfully deployed this system for building and maintaining electronic medical records, which will improve both the quality of health information as well as patient care.

HIS Strengths: Existing paper-based system reformed and improved prior to conversion to electronic systems

HIS Weaknesses: Data collection problems remain and data quality is still in need of improvement

Critical HIS Challenges: Rollout of HIS reforms hindered by lack of human resources and training

Country: Ghana

Population: 22 million

GNI per capita (2007): \$590

Acute Health Challenges:

High child and maternal mortality, infectious diseases (malaria, TB, HIV, child diarrhea)

Major Health Sector

Initiatives: National Health Insurance Scheme (NHIS) begun in 2004 to cover the entire population with access to basic health services. Coverage now reaches 55% of population

HIS Initiatives: District-wide Health Information Management System (DHIMS), launched in 2007, to improve use and analysis of health data for decision-making at service provision level

HIS Type: Automated data collection system at district level

HIS Category: DHIMS an attempt to move from Group 1 to Group 3 or 4

Over the past decades Ghana has undergone various health sector reforms which are aimed at stopping the deterioration of health service delivery caused by the severe economic decline of the late 1970s.⁸⁵ These reforms were shaped by the institutional restructuring and reorganization of the Ministry of Health (MOH) to move toward decentralized planning and management of health care at the national level, while delegating more functional authority to Regional and District Health Services in managing their own health delivery activities.⁸⁶ A key part of these reforms during the current decade is the launch of a national health insurance scheme, which has in turn created the need to develop better health information systems.

Since 2005 Ghana has effectively implemented the National Health Insurance Scheme (NHIS) in all country districts. The NHIS strives to cover the entire population with equal universal access to the basic health services package. It is subsidized by the National Health Insurance Fund for covering workers, their dependents and the elderly. The NHIS witnessed a significant coverage increase from 38% of the Ghana's population at the end of 2006 to 55% by the end of 2007.⁸⁷ Despite this success, the NHIS has struggled to overcome several major problems, including administrative delays, defining and effectively targeting poor people and a lack of adequate equipment and trained staff.

In parallel with the NHIS implementation, the MOH initiated various programs to strengthen its inadequate health information system (HIS). One of them was a design for an

integrated health management information system that promotes better data usage at all levels, including analysis of data at the point of collection and health data action driven decision making process and reporting.⁸⁸ In 2007 MOH's Ghana Health Service (GHS) launched its automated system, called the District-wide Health Information Management System (DHIMS).

The DHIMS has been developed for use at districts in order to improve the use of health data for decision making at the level where data is produced. It is claimed that the system captures the data in the districts from "the community and public health services to the district hospitals"⁸⁹ and provides support for hospital integration of electronic patient records, billing and hospital management system.⁹⁰ The DHIMS attained full country coverage in 2007 after original piloting in 20 districts across the country.⁹¹ Data flows are vertical, with accumulated data from health facilities in districts flowing to the regional and national levels. The GHS has expressed plans to extend it to the sub-districts where untapped capacity for data entry is present.⁹² Several achievements have been made, such as the electronic storage and transmission of data at the national and regional level. Uninterrupted electricity flow in most of Ghana minimizes system disruption. Yet the DHIMS has faced numerous challenges,

such as a lack of qualified information officers in many districts' hospitals, inadequate funding which caused the delay of system deployment in some districts, and insufficient availability of infrastructure equipment (e.g., computers) especially at the district level.⁹³

While the DHIMS implementation is relatively recent, a 2006 HMN assessment report of Ghana's health information system identified the need for major improvements in the way the nation's health system collects and uses data.⁹⁴ The MoH and GHS were cited as having different information needs, which created unclear data flows and areas of responsibility. Other areas of weakness included the lack of a central data warehouse, a "data driven" orientation instead of an "action driven" one and a lack of qualified data and statistical staff at the local and national level.

HIS Strengths: Electronic data storage and transmission capacity, uninterrupted electricity generation for equipment use

HIS Weaknesses: Inconsistent information requirements, lack of qualified information officers in many district hospitals, inadequate funding for deployment and poor equipment availability at the district level

Critical HIS Challenges: Improve staffing skill levels, align information collection with facility and national needs

Haiti

Country: Haiti

Population: 9.4 million

GNI per capita (2007): \$560

Acute Health Challenges: The highest incidence of HIV/AIDS outside of Africa; infectious intestinal diseases (diarrhea, infectious gastroenteritis, typhoid); poor nutrition, unsanitary conditions, and overall inadequate state health service provision

Major Health Sector

Initiatives: National Strategic Plan for health sector reform

HIS Initiatives: NSP mandates modernization of HIS and contains standards for development of tools that would allow tracking of records and resource management; EMR in Partners in Health and PEPFAR programs track ARV treatment for tens of thousands of patients

HIS Type: Functioning HIS restricted primarily to HIV-related programs

HIS Category: Group 1, outside of privately-funded HIS

The political and economic instability that has characterized Haiti virtually from its founding has had a profoundly negative impact on the country's health system, resulting in a highly inadequate public health care infrastructure.⁹⁵ In an effort to improve the situation, the Haitian Ministry of Public Health and Population (MPHP) has embarked on a path of health sector reforms, pursuing a health policy with a focus on decentralized Community Health Units (CHU) that integrate community participation in local health facilities and provide health services under the Basic Package of Services (BPS). Currently, MPHP is guided by the National Strategic Plan (NSP) for health sector reform to be implemented in 2003–2008.⁹⁶

As of 2003, Haiti's health system had neither a public nor a private agency responsible for health technology assessment, and lacked appropriate policies in that area.⁹⁷ Hence, the aforementioned National Strategic Plan for health sector reform formally calls for the modernization of the country's health information system (HIS). It explicitly defines the major features of HIS for the BPS at the primary level, which is subdivided into two tiers with distinctive "tools for management of each patient, the institution's management tools and system tools."⁹⁸ These types of tools would allow health care staff to collect and maintain medical data on each patient with health cards for women and children, individual medical files, and birth certificates, among other forms of information. They also allow administrators to verify onsite control of monitoring and evaluation operations at health facilities, such as records on BPS activities, supply of drugs and vaccines, inventory books for medical and non-medical equipment, files on medical personnel containing individual work description cards, and maintenance logs. Finally, these tools allow officials to manage data on reporting and communication with the CHU

through the use of referral/counter-referral cards, regular reports on diseases, and monitoring books on community activities. Under the BPS, basic health services facilities, called Health Centers, offer First Tier Level Health Services (FTHS), including preventive and curative care and promotional services; the second tier is represented by the first resort Community Reference Hospitals (CRHs) in the CHUs which treat patients referred by the first tier health centers or communal health workers.

Unfortunately, the implementation of health strategy activities including HIS in Haiti is hindered by the substandard legal system and other inadequate institutions. This precarious situation is characterized as "a state of anarchy in which the Government is unable to regulate, direct, or monitor the quality of services and supplies provided."⁹⁹ Despite what seems a well-ordered plan to improve data collection and analysis, it is difficult to make a qualitative assessment of a national health information system in Haiti.

The general decay of the Haitian public health system has meant that the private sector and non-profit organizations have had to step in to provide services, and several of these have developed functioning, automated HIS. For instance, the Clinical Informatics Research Group (CIRG) at the University of Washington worked with International Training and Education Center on HIV (I-TECH) to develop the Networked Electronic Medical Record System, which facilitates service provision for “both individual and population health care of HIV-infected patients in Haiti”¹⁰⁰ and which has been financed by the US-sponsored President's Emergency Plan for AIDS Relief (PEPFAR). The Networked Electronic Medical Record System is used to provide anti-retroviral treatment, and tracks the records of approximately 18,600 patients with a hybrid paper-electronic workflow architecture deployed on Microsoft SQL Server (WISP). The developed electronic medical record (EMR) system was originally piloted in April 2005 by a single hospital in Port au Prince, Haiti, and was projected to reach 86 sites by September 2008.¹⁰¹ Partners in Health (PIH) has also developed the HIV-EMR system in Haiti, based on its own EMR architecture, which it has used in other countries, including Peru, Rwanda, and Malawi. The HIV-EMR not only contains patient records pertaining to HIV treatment, it also maintains a web-based system for tracking clinic drug supplies. Access is via satellite Internet and data entry is possible even while disconnected from the Internet.¹⁰²

HIS Strengths: Several well-funded HIV-related NGOs have developed working EMR-based HIS for ARV treatment

HIS Weaknesses: General disorganization of the Haitian health system; severe infrastructure deficiencies

Critical HIS Challenges: The general disarray of the health system means that privately-developed HIS will likely have to fill the void left by public health incapacity

Indonesia

Country: Indonesia

Population (2006): 229 million

GNI per capita (2007): \$1,650

Health Challenges: High child mortality caused by acute respiratory infections, diarrhea, malaria and malnutrition; high maternal mortality; continued high prevalence of HIV, malaria and TB

Major Health Sector

Initiatives: Jamkesmas insurance program, which extends individual-based health coverage to the poor with the goal of decreasing catastrophic health expenditures

HIS Initiatives: Online National Health Information System, which rationalizes existing reporting structure and builds data and Internet infrastructure to support online; local district health information pilots

HIS Type: Moving from manual, aggregate-based data reporting to records-based automated system

HIS Category: Currently in Group 1, online NHIS would move to Group 3 with some Group 4 elements

Since 2001, Indonesia has been implementing a steady decentralization of its health sector, empowering the implementation of health service delivery programs at the district level while at the national level providing policy guidance, introducing standards, and conducting epidemic surveillance.¹⁰³ The “Healthy Indonesia 2010” program of the Indonesian Ministry of Health and Social Welfare commits the government to the goal of protecting the health of each Indonesian and facilitating the affordability of health services.

In order to improve the provision of health services to poor people, the Ministry of Health (MoH) initiated the Askeskin Insurance Program in 2005 (now known as Jamkesmas).¹⁰⁴ Under this scheme, the poor are entitled to free health care at public health clinics (Puskesmas) and free inpatient treatment in third-class public hospital wards. Over 60 million Indonesians currently rely on these services. The Askeskin Insurance Program represented a shift from previous health card programs in that it targets individuals while previous programs have targeted households, and the Askeskin insurance cards contain photographs for ID verification.¹⁰⁵

The National Health Information System (NHIS) in Indonesia is structured vertically, with central, provincial, district, and village levels. At the village level, health centers collect data from local facilities, including integrated health service posts and midwife homes or clinics. Routine health data (e.g., birth registration, immunization, mortality, etc.) is accumulated at the district level, where it is combined with other health data from public and private hospitals (primarily based on outpatient and inpatient records). At the district level, the routine health data is reported to the province-level health offices and then flows all the way up to “the Center of Health Data and Information (PusDatIn) at the central level.”¹⁰⁶ Mostly data analysis is done at the district health office, though a few health centers at

village level are capable as well. The results are reported once a year. The same time frequency for analyzing data is used by the district hospitals in their own hospital reports.

Because of changes caused by the health system decentralization, the NHIS has experienced problems in gathering data at provincial and central levels, specifically with routine data entry and reporting functions. It appears that at the lower levels much more data exists, and it is often not finding its way to the provincial and central levels. WHO’s office in Indonesia reports that as a result of this, there is little data available that reflects the health status of the country as a whole. This lack of information puts pressure on the entire system, causing difficulties in planning and implementing health programs at lower structural levels, especially within the districts.¹⁰⁷ Other constraints and challenges include

existence of multilayered reporting systems in HIS for different program purposes, inadequate data usage for management purposes use and decision making by the community, high level of absenteeism among health workers, low availability of statistics from the private sector (due to complications with incorporating data from private sector providers and NGOs; this is an especially serious problem because most health services are performed by the private institutions), and chronic underfunding for ICT and equipment.

In response to these shortcomings, the MoH released Decree No. 837 for the “Development of Online National HIS” in 2007. The decree sets out to establish a more rational, coordinated approach for two-way information flow, with the goal of reaching Target 14 of Grand Strategy 3, “the functioning of evidence-based health information system throughout Indonesia”.¹⁰⁸ The process involved in reaching this goal entails building the data banks and Internet infrastructure to aggregate and transmit patient and resource records from health facilities to district, province, and national-level offices. Responsibility for building this infrastructure is shared between different levels of government, and progressive goals are set until a fully built national online HIS connects all hospitals and district offices to the provincial and national centers.¹⁰⁹

One successful case study on implementing an open source application for district health information systems (DHIS) development is the Wonosobo district in Central Java province. In 2006, the district, with a population of over 700,000, started to develop a wireless wide area network DHIS connecting 21 Primary Health Centers (PHC) and the District Health Office (DHO). The open source DHIS software was deployed in the DHO and the PHCs. Every PHC provided two computers to run web-based applications to support community health activities, including patient electronic medical records, while at the DHO a similar web-based application was introduced. The DHO’s software application is used to incorporate data reports from the PHCs, based on data conversion inputs creating maps, charts and tables, and vertical reports. PHP 5.1 and AJAX were used to develop the DHO’s application that is supported by MySQL 5.0.23 database.¹¹⁰ The project has met with success thus far, providing a more integrated view of the health indicators across the population while still allowing for individual medical records.

HIS Strengths: Online NHIS represents MoH commitment and plan to move from inadequate data reporting to ICT-enabled transmission of health data

HIS Weaknesses: Inadequate funding for ICT, exclusion from HIS of private providers, multiple layers and standards for reporting requirements

Critical HIS Challenges: Improve technical capacity at lower levels in order to leverage newly built infrastructure and include private health providers

Kenya

Country: Kenya

Population: 38 million

GNI per capita (2007): \$680

Acute Health Challenges:

Malaria, respiratory disease, HIV/AIDS, high infant and maternal mortality

Major Health Sector

Initiatives: The Kenya Essential Package for Health (KEPH) shifted the approach from service delivery and disease burden to promoting healthy lifestyles throughout the human life cycle

HIS Initiatives: AMPATH, numerous donor programs, projects using the PDA and mobile phone as the data collection or delivery channel

HIS Type: Manual, paper-based at lower levels, computer system at national level

HIS Category: Group 1

Kenya has a long history of health sector reform. In 1972 the Ministry of Health, WHO, Central Bureau of Statistics and the Attorney General Chambers formed a committee to design a health information system (HIS) for Kenya. In 1984, the Ministry of Health established health information systems offices in each district, thereby decentralizing its reporting activities and making the districts responsible for processing health data from all health facilities. With Kenya's National Health Sector Strategic Plan (1999 – 2004), the ministry laid out strategies to improve coordination with the private sector and NGOs and recognized the need for integrated health information systems.¹¹¹

The private sector and FBOs/NGOs play a large role in delivering health care in Kenya, but this role is decreasing with the investment of government funds in the construction of health facilities. The ministry's HMIS report from 2006 stated that 59% of health care delivery was by the private sector, NGOs, and FBOs.¹¹² By the end of 2007 the numbers reversed: the government managed 58%.¹¹³ Hospitals, which make up just 7% of all health facilities, employ the majority of health workers and care for the majority of patients.¹¹⁴ Other health facilities include "health centers, dispensaries and specialized clinics for physicians, dentists, and other health practitioners."¹¹⁵

More investment is needed in health infrastructure to address the urban-rural divide and regional variability as well as the shortage of health workers. In 2000, there was only one doctor for 10,150 people and in 2007 the situation worsened, with the ratio declining to one doctor per 16,000 people.¹¹⁶

The goal of HIS stated in the Annual Health Sector Status Report for 2005-2007 is "to generate and use health information for policy formulation, management, planning, budgeting, implementation, monitoring and evaluation of health services and programme interventions in the health sector."¹¹⁷ However, Kenya's HMIS is not delivering on this goal. The information systems at the central (ministry) level are stand-alone and therefore focused on a specific vertical function. The provincial and district level systems, which provide data to centrally managed health service units and hospitals at their respective levels, are also fragmented.¹¹⁸

Kenya's HMIS systems have historically supported epidemiological data, explaining the lack of other subsystems of a comprehensive HMIS, such as drugs, lab services, logistics, finance, and human resources. There are many vertical programs creating their own program-specific databases which are not integrated with the national HIS. The national HIS is based on a computer system called CLARION.¹¹⁹

Donor	Type of Assistance
UNICEF	Data collection for the Expanded Program on Immunization (EPI).
WHO, World Bank, CDC	Surveillance of communicable diseases through the IDSR strategy
Danida (Government of Denmark)	Health Sector Programme Support (HSPS Danida) is rolling out an automated Integrated District Health Management Information System and supporting coordination by the National HMIS
PEPFAR, Clinton Foundation	Payment of salaries for key HIS staff in each district
WHO	Service Availability Mapping (SAM) initial exercise in 2004 (but no guarantee of support to update the database)
USAID	National Health Accounts assessment survey (May - September 2007)
European Union	HMIS in two provinces (Eastern and Central) through a Health Sector Support Project (HSSP).

Table 5 - Donor and Type of Assistance

Each district has at least two health records and information officers and one disease surveillance officer, responsible for collecting data at the district level. Most districts have computers but do not have a database for data entry and analysis of indicators. Within the 78 health districts of Kenya are 234 hospitals and 5,170 peripheral health facilities (peripheral health units or PHUs). These officers perform routine health data collection but are hampered by a number of problems. The HIS Assessment reports that “Data collection registers are often improvised at the PHUs and reporting forms are not always available at all PHUs for monthly reporting of morbidity data and other health statistics.”¹²⁰ It is a one-way data flow, so PHUs lack the incentive to completely and accurately collect and report the data. The end result is poor data quality in all respects and thus the data is not used.¹²¹ Reporting rates are below 60%, partly due to the lack of a written policy regarding reporting compliance and enforcement.¹²² Causes can be as simple as the lack of self-addressed envelopes to inadequate reporting forms. Some provinces did not report for an entire year.¹²³

The list of donors and programs assisting with some aspect of HIS development is long, but these programs represent an uncoordinated and piecemeal approach rather than forming an integrated assistance plan. There is support for various activities but not for capacity building. Individual programs play a dominant role in certain aspects such as monitoring and evaluation. HIS policy guidelines and a strategic plan need to be developed but have not yet garnered support from the various development partners. The list of donor projects below is accurate as of the June 2008 HIS Assessment and is likely a subset of all projects.¹²⁴

HIS Strengths: Information officers are available at the district level; recognition of need for HIS policies and guidelines; harmonized list of health indicators have been developed

HIS Weaknesses: Fragmented systems, donor-driven vertical programs, poor data quality due to low reporting rates and inconsistent reporting

Critical HIS Challenges: There is a personnel shortage, a need for integrated information systems, and policy standards

Mexico

Country: Mexico

Population: 100 million

GNI per capita (2007): \$8,340

Acute Health Challenges:

Combined health problems of an industrial society in cities and infectious diseases in rural areas

Major Health Sector

Initiatives: e-Health initiative to improve dissemination of public health information, including outbreaks

HIS Initiatives: National Health Information System for health data collection; limited tertiary hospital HIS and diseases surveillance system

HIS Type: NHIS allows evaluation of health system performance; disease surveillance system provides information to general public, including emergency readiness

HIS Category: From Group 1 to Group 3

The Mexican health system is primarily socialized and decentralized, with the nation's 32 states responsible for providing most services and private providers playing an active if secondary role. Often, private providers serve as higher quality alternatives to the overburdened public health sector, with individuals choosing their own physicians, as opposed to being assigned to specific physicians in the public health system. In recent years, private providers in Mexico have been covered by private medical insurance in a manner similar to that in the US.

Socialized medical services in Mexico are comprised by three major institutions:

Instituto Mexicano del Seguro Social (IMSS)

provides medical coverage to the private-sector population.

Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado (ISSSTE) provides coverage for government employees.

Secretaria de Salud (SSA) provides medical services to citizens not directly covered by other providers (IMSS, ISSSTE, or the armed forces). Besides providing direct medical services, SSA is the government agency regulating health policies and disease control.

According to the Health Metrics Network review of Mexico's health information systems, all public and private institutions and providers feed data on health provision, resources, and results to the National Health Information System (NHIS), which is overseen by the Ministry of Health (MoH).¹²⁵ In addition, the NHIS also collects information from survey and statistical agencies such as the National System of Health Surveys and National Institute of Statistics, Geography, and Informatics.¹²⁶ The MoH in turn acts as the guardian and disseminator of health data back to these sectors and to the population at large.

At the local level, the subsystems for services provided and for health needs are used to provide information about supply and demand for health services and about disease prevalence (though the System for Epidemiological Surveillance is the primary source of information in this area). A Technical Committee on Health Statistics is headed by the Minister of Health and comprised of the heads of the various agencies and institutions that contribute data to the NHIS.¹²⁷

Because health provision is largely done by the states, the NHIS is effectively the sum of the state health ministries and systems, and the quality of NHIS data is therefore dependent on the quality of regional data. The federal government enforces compliance with data forms and standards through visits to state facilities.¹²⁸ The federal MoH then aggregates data and publishes reports used to evaluate the success of individual health programs and to gain a clearer picture of the nation's health status and challenges.

Despite a structure designed to collect and accurately synthesize and analyze information, the NHIS suffers from major gaps, including the duplication of forms and reports as they travel from lower levels up to the state and national levels. Data quality remains highly variable, and private providers often follow different standards or do not feed data to the appropriate institutions at all. Most data collection and entry remains manual, and infrastructure in rural areas is a major barrier to improving that situation. In addition, health data are not attached to specific patients and cannot be used to improve treatment at the clinical level.¹²⁹

HIS Strengths: Institutional infrastructure for data collection and dissemination already in place; public-dominated health system makes development of national HIS easier if governments agree on standards

HIS Weaknesses: Top-down imposition of data; poor data quality; communication deficiencies due to the lack of infrastructure in rural areas

Critical HIS Challenges: Developing a national, automated HIS with uniform data forms and standards will require agreement from national and state stakeholders, as well as private stakeholder input

Initiatives are moving toward some form of national HIS

The IMSS developed a computerized, records-based information system for use at tertiary hospitals decades ago, and a limited deployment of the US Veterans Administration's VistA patient flow system was launched in Mexico before being eventually cancelled, and in its place a comprehensive electronic medical record system is being developed and deployed by IMSS. Mexico already has an e-Health program in place, initiated and administered by the federal government, which is currently being used for disease surveillance and alerting purposes. The deployment of a comprehensive, automated health information system that uses consistent technology and standards country-wide has been identified as a priority by the government. Though infrastructure remains problematic, the socialized nature of Mexico's health system may make deploying such a system easier once agreement on standards is reached and a plan for implementation moves forward.

Mozambique

Country: Mozambique

Population: 21 million

GNI per capita (2007): \$310

Acute Health Challenges:

HIV/AIDS, malaria, tuberculosis, diarrheal diseases, high infant and maternal mortality

Major Health Sector

Initiatives: Mozambique's Action Plan for Reduction of Absolute Poverty to expand primary health services, especially to disadvantaged groups, reduce maternal mortality by increasing the availability of obstetric care, improve infant and under-5 health by expanding overall care and vaccination coverage, and reduce malaria rates by expanding a home-spraying campaign

HIS Initiatives: Initiative to establish a national Health Information Network; Open MRS in use for HIV data collection; AED-SATELLIFE-sponsored mobile data collection for malaria control. Weekly epidemiology reports from district and provincial health facilities

HIS Type: Mostly paper-based with some automated systems operated by NGOs

HIS Category: Group 1

Mozambique is one of the poorer countries in the Southern African Development Community (SADC), with a 2002 Human Development Index (HDI) of 0.354⁹. Malaria is endemic and highly prevalent,¹³⁰ and the country's HIV prevalence approaches 16% of the general population.¹³¹ Other major causes of death and illness include respiratory infections and diarrheal diseases.¹³²

In spite of these significant health challenges, the macroeconomic outlook for Mozambique has improved in recent years. The country's HDI increased throughout the 1990s, and has continued to do so in this century. Similarly, GDP has increased between 7% and 11% per year since 1996.¹³³ The Mozambican government has undertaken a large-scale national poverty reduction program¹³⁴ that includes governmental reforms as well as significant expenditures on the health system (doubling the per-capita funding from \$4.60 to \$9.60 between 1997 and 2001), including improving the country's HIS.¹³⁵

In spite of its poverty, Mozambique has traditionally been more aggressive than many of its neighbors in terms of its ICT policy. As early as 2000, the Mozambican government created a National Council on ICT Policy, which has coordinated ICT development efforts. This has included the purchase of a fiber-optic submarine cable connecting Mozambique to the global telecommunications network as well as developing a variety of "e-government" systems to improve governmental efficiency.¹³⁶

Unfortunately, these developments are largely confined to cities. Vast swaths of the country are without Internet or telephone access, and rely on unreliable radio links or cellular telephones.¹³⁷ This emphatically includes most of the country's health care facilities, almost all of whom still rely on outdated and inefficient paper-based information systems. A 2006 assessment of the country's epidemiological reporting infrastructure found significant under-reporting of many

diseases as well as poorly-trained and poorly-equipped staff at the local levels.¹³⁸

Other assessments found the nation's HIS to be a combination of paper-based reporting along with a variety of computer systems dating back to the early 1990s, focusing on vertical submission of data to specific programs or donor organizations with little or no downward movement of data.¹³⁹ The assessments also identified major staffing problems in the nation's HIS, and little to no coordination between the MOH and the national ICT council. Furthermore, the assessments revealed a large number

of different systems in use at the larger hospitals and some of the district-level health offices. Unfortunately, the assessments found that the quality of these systems was highly variable and few if any were considered adequate.

In addition to systems being used or created directly by the MOH, there are a variety of third parties implementing HIT in Mozambique. At least once NGO is using OpenMRS to manage HIV treatment.¹⁴⁰ Another, AED-SATELLIFE, has carried out pilot projects using hand-held GPS devices to track malaria treatment and prevention programs.¹⁴¹ AED is also involved in a project to build a national health information network.¹⁴² Mozambique's MOH has long-term plans to improve its health information system, but faces significant infrastructure challenges and will have to somehow bring the current ecosystem of poorly-coordinated and overlapping efforts under control.¹⁴³

HIS Strengths: Strong government commitment to ICT use and infrastructure; several functioning automated and mobile-enabled silo systems

HIS Weaknesses: Existing HIS does not cover the entire health sector; it is one among several routine collection systems, and is not coordinated with periodic data collection; and it is a one-directional system

Critical HIS Challenges: Restructuring of the system does not seem to be well-coordinated, although the government's national-level capacity to do so is closer to sufficient than in many other countries

Peru

Country: Peru

Population: 27 million

GNI per capita (2007): \$3,886

Acute Health Challenges:

Infectious diseases (especially respiratory) and immunizations

Major Health Sector

Initiatives: Decentralization of health services, improvement of basic health provision to rural areas

HIS Initiatives: Disease surveillance programs such as Alerta DISAMAR and Cell PREVEN; local and private EMR programs

HIS Type: Most effective programs relate to disease surveillance; no functioning comprehensive HIS

HIS Category: Group 1

With its challenging geography and ethnically and socioeconomically diverse population, Peru has long struggled to provide effective public services to its poorest and most remote citizens. Recent economic growth has done little to lift the fortunes of these people, who continue to suffer from high rates of infectious diseases and a lack of primary health care services.

The Peruvian health system is dominated by publicly-funded agencies, with the private practice providing services to approximately 12% of the population.¹⁴⁴ Private practice in Peru operates as an alternative option to the sometimes insufficient public medical services (25% of the population in Peru does not have access to consistent, accessible health services).¹⁴⁵

Socialized medical services comprise three major participants:

The Ministry of Health (MINSA) is in charge of public health initiatives in Peru. It has launched several initiatives aimed at combating the spread of infectious diseases and improving the provision of basic health services, particularly for rural Peruvians.

EsSalud, the social security system, covers workers in the formal sector and their dependents, comprising

about 25% of the Peruvian population. This system is currently working to decentralize and empower local units.

The military health system (Armed Forces Health Services and National Peruvian Police Health Services) provides health services to 3% of the Peruvian population.¹⁴⁶

The HIS initiatives in Peru fall into two main categories: disease surveillance programs and electronic medical record systems developed at the local level or in private hospitals. All of the more integrative or advanced HIS initiatives are isolated pilot projects, none of which have crystallized into a scalable system that could be used for all of Peru. Scale of a different kind has been achieved by the most prominent disease surveillance case, Alerta DISAMAR, a disease surveillance system developed by Voxiva and implemented by the Peruvian Navy covering 97.5% of the Navy population (active duty personnel and family members).¹⁴⁷ The system uses multiple communication channels (radio, cell phone, land line, and a web interface) to convey near real-time disease outbreak data from Navy bases and medical units to a central unit. Instead of a disease outbreak report taking anywhere from ten days to three weeks to reach the central unit where the decision is taken, it now takes only two to three minutes. Reports and analysis can be performed immediately against this data. The reports and analysis have enabled the Peruvian Navy to recommend improvements to vector control and food procurement

processes.¹⁴⁸ Versions of Alerta DISAMAR have been implemented at the Peruvian Army (Alerta DISALE) and Air Force, and in the military in Ecuador, Colombia, and Paraguay.¹⁴⁹

Another successful disease surveillance program is Cell PREVEN, also based on the Voxiva platform, which monitored adverse events to metronidazole treatment among female sex workers. Interviewers collected data from female sex workers in three neighborhoods and used cell phones to enter and send the data to an online database that was accessible worldwide over a secure Internet connection. In return, key personnel received email and text messages on their cell phones alerting them about certain symptoms.

Several EMR-based or functional area systems have been developed in Peru, but most have not been designed to scale nationally. The e-Chasqui system developed by Partners in Health included an EMR component as part of its tuberculosis treatment tracking and the NETLab lab result registration system used by the Peruvian National Institutes of Health has proved effective at allowing patients and doctors to access lab results and speeding up processing times.¹⁵⁰

Despite these isolated successes, Peru has not yet developed a long-range national eHealth vision and strategy nor a cohesive plan for either developing a new comprehensive HIS or stitching together its successful programs into a workable whole. A combination of factors serve to limit progress towards this ideal: 1) Systems have been developed in isolation, not as part of a greater framework or plan or design, resulting in fragmented, redundant systems and the use of obsolete technology; 2) The organizational culture and political environment of the main health providers has led to a lack of coordination, duplication of effort, promising projects that do not reach fruition, and loss of time and human resources. 3) Standards and legislation are at an insufficient stage of development, and essential components such as patient identity registration, data coding (diseases, treatments, etc.), and information exchange, security and confidentiality are not strongly enforced.¹⁵¹

In 2006 a national study commission was convened to evaluate challenges facing the Peruvian health system and make recommendations. In the commission's final report HIS was identified as a critical area of need and it was recommended that the government enlist consultants to evaluate HIS needs and make specific recommendations.¹⁵² It does not appear that any such action has yet been taken.

HIS Strengths: Several small, successful disease surveillance and EMR-based systems

HIS Weaknesses: Lack of a long-range national eHealth vision and strategy and a comprehensive national plan for integrating or scaling successful programs

Critical HIS Challenges: Implementation of a nationwide strategy and resources for adequate reach and service to the entire Peruvian population

Rwanda

Country: Rwanda

Population (2006): 9.5 million

GNI per capita (2007): \$320

Acute Health Challenges:

HIV/AIDS, malaria, TB, diarrheal diseases, lower respiratory infections, malnutrition

Major Health Sector

Initiatives: Expanded Program on Immunization dedicated to “reducing child morbidity and mortality due to vaccine-preventable diseases”; community insurance schemes supplement health-sector spending by the government; Health Sector Strategic Plan 2005-2009 a major effort by the Rwandan government to achieve MDG targets

HIS Initiatives: GESIS, TRACnet, FUCHIA, Quantimed, OpenMRS

HIS Type: National HIS is district-based; NGO programs are HIV-related EMR; TRACnet has mobile functionality

HIS Category: Moving from Group 1 to Group 3

Rwanda's current health system, as with all other aspects of the country, is shaped by the legacy of the 1994 genocide that claimed the lives of approximately 1,000,000 Rwandans. This catastrophe devastated the country's health care infrastructure and decimated its workforce¹⁵³. Since the cessation of hostilities in 1995, the government has made revitalizing the health care system one of its top priorities, but many challenges still remain. Like many of its neighbors, Rwanda suffers from high prevalence of HIV/AIDS (3.1% overall¹⁵⁴, as high as 8.6% among females in Kigali¹⁵⁵) as well as a considerable burden of disease from malaria, tuberculosis, and diarrheal diseases.¹⁵⁶

The majority of health care expenditures in Rwanda come from public sources, although private-sector health care is growing.¹⁵⁷ As of 2007, there were nearly 400 private health facilities in Rwanda, the majority of which were run by nurses rather than physicians.¹⁵⁸ The Ministry of Health (MoH) is responsible for managing the public health care system, although eight other government ministries are involved in various aspects of health in Rwanda. The public health system is organized into health centers or hospitals, health districts, and the national level.

The Rwandan MoH has implemented several innovative initiatives, including forms of pay-for-performance as well as major donor-coordination efforts. Rwanda has also launched a community-based health insurance scheme, Mutuelle de Sante, as an attempt to reduce the government's share of health-care funding. Mutuelle de Sante has met with some success, although it is not without its critics.¹⁵⁹ In addition to these structural reforms, there are a variety of HIS systems in use in Rwanda, and they constitute a priority for the government.¹⁶⁰

The Système d'Information Sanitaire (SIS or Health Information System) is Rwanda's national health data system defining the overall structures, processes, and information flows. Officially, clinic- and center-level data are reported in aggregate using paper forms to district-level supervisors each month, who are then responsible for entering the data into their local installations of GESIS (Gestion du Système d'Information Sanitaire), the country's standard health information database application supporting SIS (built in a long-obsolete version of Microsoft Access in 1997). After the data is entered, the district-level supervisors physically send via disk their district's data to the central MoH, where each district's data are loaded into the central database. According to a USAID/Rwandan MoH assessment completed in 2006, this process was more or less adequate, with reporting rates in the 95% range at the health center level and in the 75% range at the district level. In 2006, though, the Rwandan health care system underwent major decentralization reforms, which included staffing and organizational changes. This caused a significant disruption, and as of mid-2006 reporting rates for the center and district levels had dropped to 47% and 35%, respectively.¹⁶¹

Developed by Voxiva, TRACnet is a web- and IVR-based reporting system built on a Microsoft SQL Server database platform to track a variety of indicators related to the provision of anti-retroviral treatments for HIV/AIDS. As of mid-2006, the system was in use by approximately 100 clinics and that number was expected to grow to 160 by the end of the year.¹⁶² By utilizing cellular phones, TRACnet enables medical personnel all over Rwanda to enter data directly, although in practice it appears as though most data are initially collected using paper forms and then manually entered via telephone or web form. This process appears to be the major problem with the system, as manually combining and then entering the data can take considerable time due to the large amount of information captured by each form.¹⁶³

Other HIS systems in use in Rwanda for HIV/AIDS and ARV management include Quantimed (an MS Access-based drugs logistics system used for tracking drug consumption and supply) and the Partners in Health OpenMRS system.¹⁶⁴ There is some overlap between the functionality of TRACnet, Quantimed, and Partners in Health. There are also a small number of facilities using Médecins sans Frontières' FUCHIA system for TB and HIV/AIDS patient-level data collection.¹⁶⁵ Finally, Rwanda's CNLS (Conseil National de Lutte contre le SIDA/National Council of the Fight Against AIDS) maintains its own master database of donors and their programs in Rwanda.

HIS Strengths: 10+ years of experience successfully using computers for data collection, strong governmental support for HIS

HIS Weaknesses: Several different systems collecting varied health statistics, duplication of data, insufficient (and insufficiently) trained staff

Critical HIS Challenges: Centralizing different HIS systems into a single

Sierra Leone

Country: Sierra Leone

Population: 5.7 million

GNI per capita (2006): \$230

Acute Health Challenges:

High child and maternal mortality, diarrheal diseases, respiratory infections and other infectious diseases including drug-resistant TB

Major Health Sector

Initiatives: Decentralization of health services, reintegration of combatants from civil war, malaria and tuberculosis management

HIS Initiatives: Newly-launched District Health Information Management System, captures and aggregates data from peripheral health units

HIS Type: Built using HMN reference framework; includes specialized low-power hardware as well as paper-based components

HIS Category: Group 3

Sierra Leone has spent the first part of this century emerging from a decade-long civil war that had profound effects on the nation's health care system. A 2002 assessment by the Ministry of Health and Sanitation and Statistics (MoHS) found that roughly 50% of the Sierra Leone's health care facilities were destroyed during the war,¹⁶⁶ and resulted in thousands of amputees and more than 100,000 deaths.¹⁶⁷ Furthermore, the conflict disrupted numerous long-standing public health projects, which has allowed several diseases that had been under control before the war to stage comebacks (most notably Onchocerciasis).¹⁶⁸

Today, Sierra Leone is one of the poorest countries on Earth. A 2004 WHO report described the country's poverty as stemming from a variety of causes, including "the decade long war, low agricultural productivity, low educational levels; low levels of wages and salaries for formal and informal workers; poor investment climate, high unemployment rate, corruption and failure to better make use of natural resources; poor health status, and high fertility and population growth rates."¹⁶⁹ Given the country's economic challenges, it is unsurprising that most of its major health problems stem from poverty: malaria, respiratory infections, diarrheal diseases, STIs, and tuberculosis are some of the major causes of outpatient morbidity.¹⁷⁰

Nevertheless, Sierra Leone's economic outlook has improved somewhat in recent years. The World Bank's "Doing Business 2009" report noted that the country's business reforms have made it much easier to start new businesses or register and buy land, and rates Sierra Leone favorably when compared with its neighbors.¹⁷¹ Furthermore, the country's GNI has increased

dramatically in recent years, nearly doubling between 2000 and 2007.¹⁷²

Following the cessation of hostilities in 2002, Sierra Leone's government— together with the WHO and the UN— set about rebuilding its health care system, and one of their major priorities has been the country's HIS. In 2004 and 2005, the government sponsored several studies of the existing HIS infrastructure. These studies identified numerous challenges facing health information in Sierra Leone, including poorly-trained staff, under-reporting of data, and the presence of poorly-coordinated and overlapping data collection systems.¹⁷³ In 2006, Sierra Leone received a Health Metrics Network (HMN) grant, part of which funded a formal assessment of the country's health information system status conducted by the country's consumers and producers of health information, as well as representatives from various donor organizations. The assessment was carried out using the HMN Assessment Tool, and painted a similar picture to that of the 2004 and 2005 assessments. It also proposed several specific courses of action to the Ministry of Health Services, mostly involving capacity building.

Following the 2006 assessment, the MoHS and the HMN continued to collaborate. Sierra Leone has served as a pilot site for several different HIS projects, including OpenMRS and DHIS, and has continued to use the HMN.¹⁷⁴ Furthermore, NGOs such as Inveneo have piloted innovative hardware projects, including low-power-consumption computers that can take better advantage of solar power than traditional PCs.¹⁷⁵ In addition to computerized information systems, Sierra Leone has served as a proving ground for several creative informatics solutions that require no power and can be used anywhere. For example, the University of Oslo's informatics department has developed and fielded a stone-based birth registration system intended for use by traditional birth attendants, who are often illiterate and work in remote parts of the country.¹⁷⁶

In late 2008, the Ministry of Health and Sanitation announced a new HIS initiative built on version 2 of HISP's DHIS system that will collect a wide variety of data from all levels of the health system, including immunization, ART, and malaria control data. The new system represents a collaboration between Sierra Leone's MoHS, the University of Sierra Leone College of Medicine and Allied Health Services, the WHO's HMN, the World Bank, the University of Oslo's HISP, and Inveneo.¹⁷⁷ As of August 2008, the new system was already in use in four of Sierra Leone's thirteen health districts, and the immediate post-launch plan called for the system to be rolled out to the remaining nine districts.¹⁷⁸

HIS Strengths: Computerized system to systematically collect data, immediate information for evidence based decision making, improved drug management and tracking, efficient and transparent procedures

HIS Weaknesses: Lack of qualified information officers in many district hospitals, insufficient availability of infrastructure equipment (e.g., computers) at the district level

Critical HIS Challenges: Effective coordination of health information is lacking, resulting in duplication and gaps in data collection, reporting, use and management of data. Consequently, vast amounts of data collected remain mostly incomplete, unreliable, and unused

South Africa

Country: South Africa

Population: 49 million

GNI per capita (2007): \$5,760

Acute Health Challenges:

HIV/AIDS (16.6% of the population), cardiovascular disease, infant mortality

Major Health Sector

Initiatives: National Strategic HIV/AIDS plan, which will guide the South African National AIDS Council from 2007 to 2011

HIS Initiatives: National DOH developed a strategic framework for the development of a national electronic health record system (eHR.za) that requires interoperability with legacy systems. A contract has been awarded to a consortium of vendors to develop this system

HIS Type: Paper-based at the clinic level, computerized at the sub-district or district levels.

HIS Category: Group 3

In 1994, the Ministry of Health established the National Health Information System/South Africa (NHIS/SA) committee, comprised of multiple stakeholders from government, academia, and the private sector, charged with creating a strategy to develop a national health information system. NHIS/SA projects include the “National Health

Care Management Information System (NHC/MIS), standards, vital registration, telemedicine, geographic information systems, ... the district health information system.”¹⁷⁹

The National Department of Health (NDOH) and provincial departments of health for each of the nine provinces are responsible for public health services and budgets, with municipalities providing a limited amount of primary health care. The government is the dominant health care provider, with 9,500 doctors serving 82% of the population, or 40 million people, using just 40% of annual national health spending. The other 60% is expended on the private sector, comprised of 25,000 doctors who serve the remainder of the population, 8.5 million people.¹⁸⁰

There is strong national support for the development of eHealth in general. eHealth is a priority for the Presidential National Commission on Information Society and Development (PNC on ISAD) for the creation of an information society and a means to bridging the digital divide. The NDOH has created a Draft e-Health White Paper Discussion Document outlining an e-Health policy.¹⁸¹

However, there are weaknesses in the policy and in execution.

For instance, the document highlights the human capacity issue but capacity development and planning for health informatics are missing from the National Human Resources for Health plan.¹⁸²

The HIS environment is characterized by numerous fragmented computerized systems for electronic medical records, certain vertical programs, yet South Africa is also innovating in mHealth solutions. NDOH, provinces, and commercial providers comprise the main developers of HIS for both hospitals and smaller clinics. The following is a sample of the systems in place:

The District Health Information System (DHIS)

DHIS originated out of a project by the Health Information Systems Programme (HISP) in the western Cape funded by NORAD in 1996-1998. It has since become well-established in South Africa and has been implemented in other developing countries in Africa and Asia.¹⁸³ The system records data about all facility services as well as infrastructure and human resources.¹⁸⁴ Clinics fill out paper-based registers, tallies, and monthly collection forms and on a monthly basis send them to the sub-district or district for

data entry into DHIS. At this level the data is analyzed and reports are generated for distribution to the district, province, and national level. The technology used is based on free and open source software. A recent study that reviewed ten primary health care clinics found that “each clinic reported a high perceived work burden for data collection and collation” and “Seven out of 10 clinics reported that collation took 1 staff member about 2 days per month” with only one clinic having a clerk¹⁸⁵.

National Electronic TB Register

The Electronic TB Register is a nation-wide system with about 200 users over nine provinces. More than 1 million patients from 2003 to 2005 are in the system, which is based on SQL Server.¹⁸⁶

Other systems include the Patient Administration and Billing (PAAB) system developed by the NDOH running in a few locations, and PADS, a web-based patient registration and billing system developed by an in-house team of the Free State province. There is an active market of commercial software providers offering large-scale hospital EMR systems and major international IT companies researching or piloting eHealth solutions.¹⁸⁷ Western Cape Province appears to be progressive, implementing a central hospital information system with a unique patient ID, a pharmacy system, digital radiology, and community health care clinics and local city clinics that access the same provincial level patient ID.¹⁸⁸

Despite all the support and active implementations of various HIS, not all provinces have all components of the NHC/MIS. EMR systems are somewhat functional in just one-third of provincial hospitals. There are five types of systems in use and there is little integration between them.¹⁸⁹

Computer and Internet access is not commonly found in state hospitals or at the provincial level. “Several studies have shown that nurses often return, after training, to work environments where they are denied access to computers for various reasons, or work in settings in which computer usage is not part of their daily job requirement. Many health workers do not have, or have not been exposed to a culture of data acquisition and analysis.”¹⁹⁰

The private sector also faces the same problem of fragmented systems. The government projects do not appear to include integration with private sector systems in their scope.¹⁹¹

One tool used for national level data analysis is the District Health Barometer (DHB), to analyze the quality, efficiency, and equity of primary health care delivery. It combines data from DHIS as well as the national TB register, and systems such as StatsSA and the National Treasury.

South Africa has notable mobile health initiatives under way. The OpenROSA/JavaROSA project is developing open source health applications for mobile phones and personal digital assistants (PDAs). Cell-Life is a well-known nonprofit company that has developed a variety of HIV/AIDS health management solutions for mobile phones and PDAs based on open source technology (they are a part of the OpenROSA/JavaROSA consortium). SmartCare, a patient records system deployed in both Zambia and Ethiopia, has also been adapted for piloting at 13 sites in Eastern Cape

HIS Strengths: Political will for eHealth, active commercial market for EMR and eHealth solutions, innovations in mobile health

HIS Weaknesses: Fragmented systems; low computer literacy and too few people trained or experienced in health informatics; burdensome data collection; broadband is still out of reach of many and is expensive and is inhibiting the growth of HIS

Critical HIS Challenges: Need to create holistic plans to develop human capacity; need to develop culture of using data for decision-making; e-Health policy is behind e-Health development

province.

Uganda

Country: Uganda

Population: 31 million

GNI per capita (2007): \$340

Acute Health Challenges:

HIV/AIDS, high infant and maternal mortality

Major Health Sector

Initiatives: Government establishment of the Health Review Commission which resulted in the development of three-year, five-year and ten-year plans as well as the Health Sector Strategic Plan (HSSP) I and II

HIS Initiatives: Investments made for development of routine facility based HIS. Surveys for population-based data sources; Uganda HIN uses wireless PDAs for data transmission

HIS Type: Paper-based at the local levels, computer-based at the district and national level

HIS Category: Group 3

As one of the first countries affected by the AIDS pandemic, Uganda also became one of the first to implement a serious, effective strategy at slowing the rate of infection and coping with the disease burden the disease poses. The struggle against AIDS has colored and shaped many of Uganda's health reform efforts in the past two decades.

Uganda achieved or surpassed many output targets under the Health Sector Strategic Plan I 2000/01 – 2004/05 (HSSP I).¹⁹² Health care usage became much more affordable for the poor, with the elimination of usage fees at government health facilities except for private wings of hospitals. The health system refocused its approach to focus on primary health care, reallocating resources and decentralizing health service delivery to lower levels of the system, specifically the districts and health sub-districts (HSD).

Health sector strategic plan II 2005/06 – 2009/10

(HSSP II) extends the goals of HSSP I through the Uganda National Minimum Healthcare Package (UNMHCP). UNMHCP is both a set of interventions targeting morbidity and mortality as well as a tool for health sector resource allocation primarily at the district and HSD levels. HSSP II is aimed squarely at the Millennium Development Goals (MDGs).

The Ugandan HMIS has evolved over more than 15 years,¹⁹³ encompassing data from all levels of the health system: the village or grass roots health unit, parish, sub-county, HSD, district, and national level. Data are captured using a hybrid of paper forms, registers, and tally sheets at the health unit level. The kind of data collected is primarily patient data and mortality but also includes health care facilities, staffing, drug supplies, family planning, and population. On a weekly, monthly, and annual basis routine data are sent to the district level, which in turn recompiles the data and sends them to the national headquarters either in person or via fax. A few districts have computers and use spreadsheets to compile the reports and email them to the headquarters. There, data are entered into the national health databank using software called EPI Info.¹⁹⁴ An attempt is being made to standardize the software used at the district level by piloting a local version of EPI Info in seven districts.¹⁹⁵

Uganda has invested heavily to develop the HMIS and the Integrated Diseases Surveillance and Response System (IDSR). Health Metrics Network's assessment of the various data sources in Uganda is that the census data and data acquired through population surveys are adequate in most respects

(content, capacity and practices, dissemination, integration and use), but vital records, health and disease records (from HMIS, IDSR and the Demographic Surveillance System [DSS]), health service records, and administrative records are present but not adequate.¹⁹⁶ There is a well-defined, core set of indicators for which data are being generated at all levels, but with respect to the HMIS and IDSR data, the effort to collect this indicator data overwhelms the human capacity at the local levels and possibly impacts the quality of the data.

At the national level, health and population information is being used to inform policy and priority discussions and decisions, including in health sector budget negotiations between the Ministry of Health and Finance. At the lower levels, however, health information is not being analyzed or used for resource planning or policy advocacy, due to the lack of capacity.

Uganda has also seen innovation in HIS in the mobile health sphere. The Uganda Health Information Network, a project of AED-SATELLIFE, Uganda Chartered HealthNet, and Makerere University, allows health workers to collect patient information via wirelessly-enabled PDAs. The information they collect can then be “beamed” to an access point and uploaded to a central data warehouse, and information can also be downloaded to the PDAs, giving workers access to health data about their area.¹⁹⁷ The Uganda HIN is an example of how mobile technology can be used to compensate for infrastructure weaknesses by leveraging cellular networks.

Unfortunately, there is a proliferation of information systems development efforts, often donor-driven, without an overarching framework and coordination to reduce redundancy and leverage existing systems. Uganda’s health system also lacks a strategy to maximize the potential of the data from routine health information systems such as the HMIS and the population data sources to be used to measure health sector performance and impact of interventions.

Not surprisingly, there is a rural-urban divide with respect to ICT infrastructure and human capacity. The ICT infrastructure between the district and national levels is adequate enough for data transmission, whereas it is weak at the lower levels. ICT management is stronger at the national level, where the Resource Centre of the Ministry of Health coordinates HIS activities. There is high staff turnover in rural districts yet no plan for long-term training on health information to ensure sustainability of the HIS and quality of the data. There is no training policy in general for health information officers regardless of the level in the health system.

HIS Strengths: Good use of HIS information at national level for planning, budgeting, and resource allocation; well-defined national core indicator set used by most data sources, including reporting on MDGs

HIS Weaknesses: Lower levels are not using HIS data for decision-making and suffer higher staff turnover and weaker ICT infrastructure than at the national level

Critical HIS Challenges: Insufficient funding and shortage of qualified staff; poor harmonization and streamlining of various data sources; proliferation of parallel, hence redundant, HIS development projects

Vietnam

Country: Vietnam

Population: 86.2 million

GNI per capita (2007): \$790

Health Challenges: Relatively high maternal and neonatal mortality, primarily among ethnic minorities in remote areas; high rate of induced abortion; infectious, vector-borne and communicable diseases such as SARS, avian influenza, malaria and parasitic diseases; increasing incidence of TB, HIV/AIDS, dengue fever and Japanese encephalitis

Major Health Sector

Initiatives: Vietnam Health Insurance (VHI), consisting of both mandatory and voluntary schemes

HIS Initiatives: Medisoft 2003, built by the MoH for hospital statistical reporting

HIS Type: Combination of paper reports, log books, and PCs; hierarchical data flow from the village level to the central level

HIS Category: Group 1 overall, automation occurs mostly at higher levels in the health sector

Since the launch of doi moi (“renovation”) in 1986, Vietnam’s health sector has undergone dramatic changes. The health system has been developing under the guidelines of the Ten-Year Socio-Economic Development Strategy, the Comprehensive Poverty Reduction and Growth Strategy and the National Strategy for People’s Healthcare 2001–2010.¹⁹⁸

The Vietnamese government has issued a series of decisions related to the country’s health statistical information system, creating part of the empowering environment for a national health information system, exemplified by this sample of decisions by the Minister of Health:

- Decision on Regulation No. 379/2002/QD-BYT dated August 2, 2002, legislating the collection and analysis of health statistics, recording and reporting functions, tasks and authority of health facilities nationwide, and greater responsibilities of managers and workers involved in the health information system.¹⁹⁹
- Decision No. 2553/2002/QD-BYT dated April 7, 2002, establishing a list of essential health indicators. The goal of the decision includes standardizing data collection and calculation methods, improved data quality, and enhanced use of data in analysis, assessments and policy making.²⁰⁰
- Decision No. 1833/2002/QD-BYT dated May 17, 2002, on management software for the grassroots health system.²⁰¹
- Decision No. 2824/2004/QD-BYT dated August 19, 2004, stipulating that Medisoft 2003 be the standard software for all hospital statistic medical reports.²⁰²

In the early 90s, the Ministry of Health (MoH) introduced mandatory and voluntary health insurance schemes managed by Vietnam Health Insurance (VHI). Today there are three types of insurance schemes on the market: 1) Mandatory coverage, which covers all types of workers in the public sector, and only permanent workers in private sector. 2) Voluntary schemes, including various types of coverage for school children, and the Farmer Voluntary Insurance Scheme, in which the provincial authorities contribute up to 70% of the farmers’ premiums. 3) Government coverage scheme, which primarily provides fully subsidized health care for the poor. According to one report, these “schemes disadvantage the most vulnerable in the face of informal user charges” because in practice many physicians are reluctant to provide health care to patients who have insurance cards in favor of those who can afford to pay service fees out-of-pocket.²⁰³

The Ministry of Health is driving the use of information technology in the health sector in Vietnam, in particular by providing financial support for hospital usage of IT.²⁰⁴ As a result, national and provincial hospitals appear to be making greater use of IT than the rest of the public health system.²⁰⁵ Approximately 300 hospitals in Vietnam were using Medisoft 2003 software (developed by MoH) in 2007 to manage medical statistics reports and records.²⁰⁶ Some hospitals are using telemedicine, specifically tele-consultation, tele-surgery assistance, tele-imaging, and tele-cardiology.²⁰⁷

General Health Statistics Information System (GHSIS)

Vietnam's General Health Statistical Information System aggregates health data from various subsystems and from the different levels of the public health system to assess health outcomes and effectiveness of the health sector. Health information is derived from multiple subsystems of national health programs, communicable disease surveillance systems, and statistical information systems of other sectors and ministries, such as the General Statistics Office (GSO), National Committee on Population, Family and Child Affairs, and Ministry of Justice. These systems, however, still fail to provide the information needed to support management and policy decisions.²⁰⁸

GHSIS is hierarchical in structure, interlinked with each health system level (the village, the commune, the district, the provincial and the central levels). The process is fairly typical, with the lower levels sending data to the next higher level for compilation and summarization before sending the summarized report to the next level. At the provincial level, there are on average one or two statistical and information workers who are responsible for the data collection and processing covering all people in the province.

A shortcoming of the GHSIS, according to the Health Metrics Network Assessment Report, participants at all levels reported that despite government support, there is no real database to support data reporting and management. Data are still recorded in books, on paper, and on computers for those who have them, making data consolidation a time-consuming process. The software for HIS and the subsystems is inadequate for the task.

Shortages in the provision of basic IT systems are common. Computers and software are more likely to be found at the upper levels of the public health system than the lower levels,²⁰⁹ yet provincial and district hospitals, even at the central level, still are not equipped with computers in many departments and wards, and at the provincial and district level statistical workers must share a computer.²¹⁰ Financing also appears to be unevenly distributed within the levels of the health system. Lack of financial resources is affecting the rollout of software and is also having a detrimental effect on investment in equipment and in people.²¹¹

HIS Strengths: Support of the government through legislation and policy decisions recognizing the need for standard data collection and reporting mechanisms, data quality, list of indicators, the use of data for decision-making, and the benefits information technology can bring to the health sector

HIS Weaknesses: Data are captured using multiple means, making data consolidation difficult and time-consuming; lack of quality data inhibits the use of data for decision-making

Critical HIS Challenges: Lack of stable network connectivity and reliable mobile service limits the technical options for developing a national, integrated HIS

Appendix A: Value Chain Analysis

Introduction

The health sector in developing countries is a complex network of formal and informal institutions facing immense challenges of resource capacity, infrastructure, geography, economy, and politics. Numerous papers have cited these challenges and suggested remedies, yet there has been little guidance regarding where to begin and how to prioritize efforts, a course of treatment if you will. For similarly complex sectors, such as the automobile and agriculture industries, value chain analysis (VCA) has been a tool for analyzing where value or competitive advantage is created in the chain (such as marketing), where there may be bottlenecks or constraints (such as suppliers), and quantifying the impact. This approach is also being used by the US health sector. Value chain analysis can and is being applied just as effectively to the health sector in developing countries, offering a methodical and rational approach to not only identifying but also prioritizing the numerous challenges and opportunities in the health sector value chain. Specifically with respect to this paper's research objective, VCA can help identify what information is key to evaluating performance of the health system and where in the value chain is good indicator data most needed for good decision-making. HIS interventions and upgrading strategies can then be targeted at these specific needs at these specific points in the value chain.

Background and definition of value chain analysis

The traditional definition of a value chain is the set of activities within a firm necessary to produce the product or service sold by the firmⁱ. Each activity along the chain may create or increase the value of the end product or service, and may incur a cost. Management and strategy professionals have used value chain analysis to help firms identify where the most value is created, which activities are most costly, and ultimately where resources should be applied to gain competitive advantage. Using a variety of sources of information, they're able to identify and estimate various activities and relationships, such as the cost of inputs and outputs at each point in the value chain, the volume of the physical flow of commodities along the value chain, and the flow and value of services, consultants, and skills along the chain²¹².

The international development community is applying the value chain concept more broadly to examine industry sectors, such as the avocado industry in Kenya and handmade leather shoes in India, in the realization that in globalized markets, the competitiveness of a firm and specifically micro, small, and medium enterprise (MSME) competitiveness is linked to the competitiveness of their industry as a whole²¹³. A particular industry involves multiple actors to bring the product to market, starting with the suppliers of raw inputs such as fertilizer and seeds, firms that assemble, finish, and package the product the intermediaries such as distributors who sell to local retailers or exporters who will in turn sell the product to global retailers who sell to consumers. A weakness at any point in the value chain can render an industry less competitive in a global market.

ⁱ See "Competitive Advantage: Creating and Sustaining Superior Performance" by Michael Porter, the pioneer of the value chain concept, for the classic definition of value chains.

Value chain analysis involves reviewing the **end market** or consumer of the good or service. As they say, the “customer is king”, and they will drive the product features, pricing, quality, and distribution as well as other factors that the value chain must accommodate in order to satisfy the end market.

Vertical linkages are the relationships and activities between actors at different levels in the chain. These interactions require communication, information, and trust. The power dynamics within these vertical linkages can determine incentives and potential benefits for an actor in the chain, as well as drive their behavior. Actors also work within **horizontal linkages** either in competition or collaboration with each other. Industry associations are an example of horizontal cooperation. Particularly for the health sector but important for all sectors is an understanding of the **business enabling environment**, that is, the overall context within which an industry operates. Government stability, political environment, trends, policies, standards, international agreements, and public infrastructure (roads, transportation, electricity, and telecommunications) can all have positive or negative effects on the performance of a value chain or create incentives or disincentives. The strength of **supporting markets** can also affect value chain performance, as they provide support services to actors or help them perform better or increase capacity. Supporting markets may be sector-specific, such as custom design houses, cross-cutting such as information technology services, or financial such as banks and investors.

The diagram below illustrates these components and linkages:

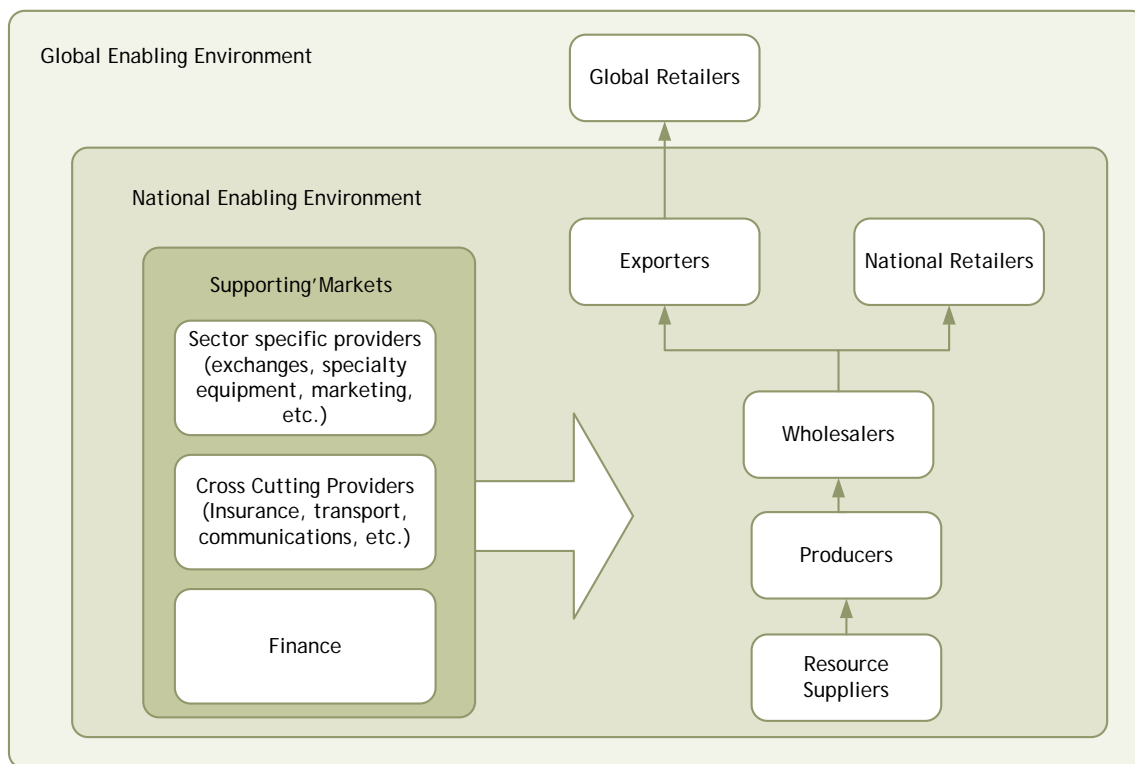


Figure 9 - Value Chain Structure for Markets

Value chain analysis of the health sector

In the US, experts have recognized the applicability of VCA to the health sector and are employing value chain analysis to identify ways to improve the US health sector, as evidenced by various publications such as “The Healthcare Value Chain: Producers, Purchasers, and Providers” and “The Business of Healthcare Innovation” by Lawton R. Burns published in 2002 and 2005 respectively, and “Redefining Healthcare: Creating Value-Based Competition on Results” co-written by the expert on value chain analysis, Michael Porter, published in 2006. In 2007 and 2008 the Federal Reserve Bank of Chicago and the Detroit Regional Chamber held conferences discussing the value chain approach to evaluating the health care delivery system, and how it might lead to higher quality health care, lower costs, and greater user accessibility²¹⁴.

The following high-level diagram of the US health care value chain does not attempt to show every linkage between the value chain actors but groups them according to role. Implicit in the diagram is that funding flows along the upper tier, while innovation flows along the lower tier.

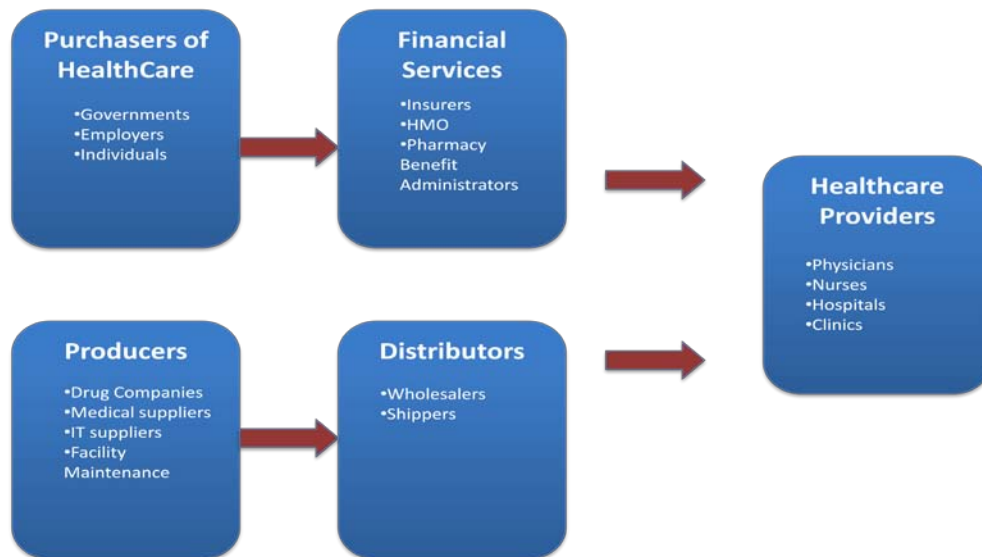


Figure 10 - US Health Care Value Chain

International development practitioners are beginning to apply value chain analysis to the health care sector in developing countries. ACIDI/VOCA is addressing geographic constraints in the Philippines, in an area comprised of 300 islands by providing distance education via radio and a floating clinic²¹⁵. The Private Sector Partnerships-One Project (PSP-*One*) is using the value chain approach to examine the value chain for contraceptive products and services²¹⁶:

Using value chain analysis to analyze health sector performance in developing countries

Just as in other sectors, the health sector in developing countries is a complex network of actors, relationships, and activities, each with different incentives and capabilities operating under an overall governance structure and context. The challenges are many, the needs are great, but resources to apply to these challenges are scarce or in high demand and therefore must be applied wisely to maximize the

return on the investment. The holistic approach that value chain analysis offers enables one to understand the interdependencies and dynamics within the sector, so that any proposed interventions will improve the overall performance of the value chain, not be counter-productive, and have lasting, broader impact.

To illustrate, below is an initial conceptual diagram of a typical health sector value chain in a developing country:

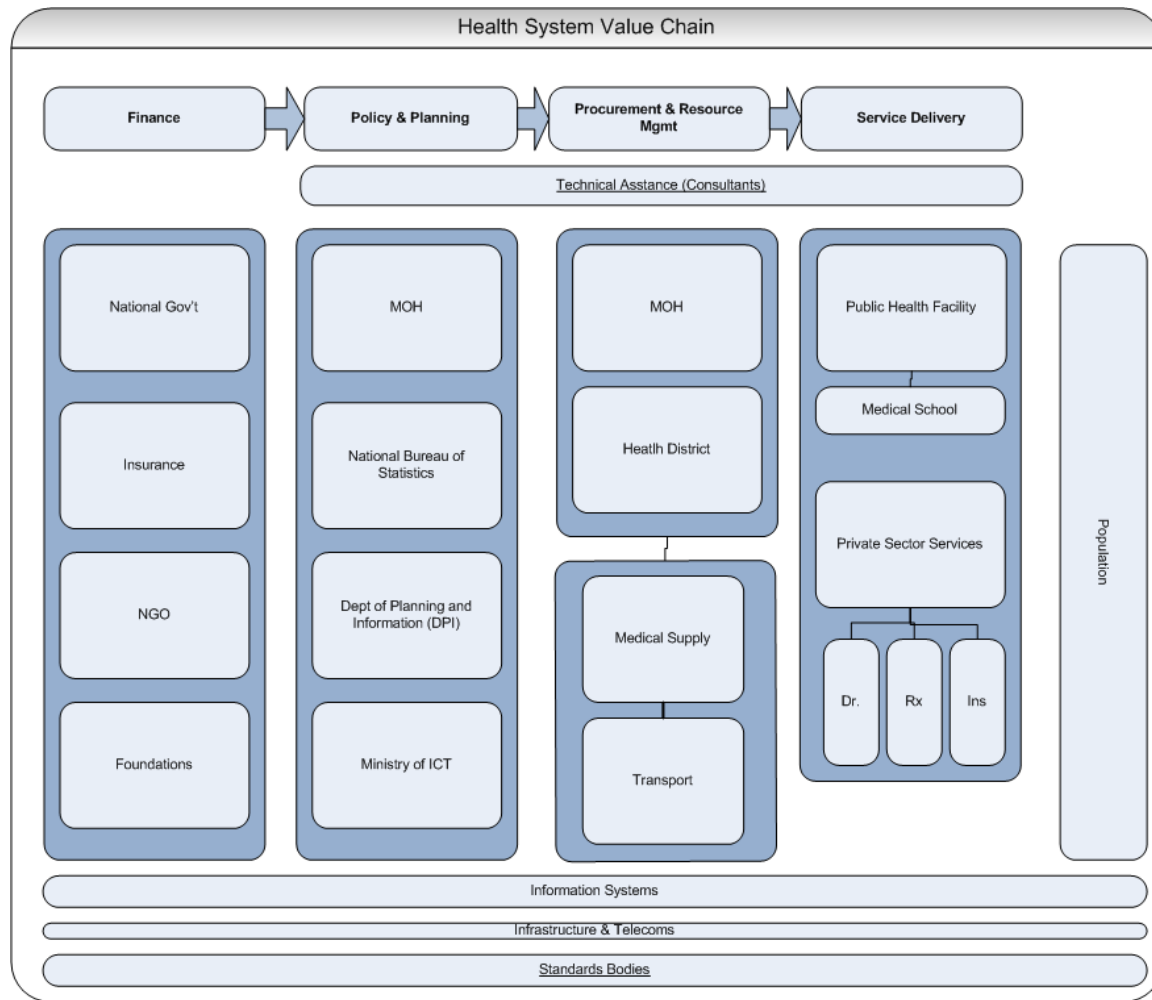


Figure 11 - Illustrative Health Sector Value Chain in a Developing Country

This diagram does not attempt to depict every actor in the health sector, but shows a few key actors under each of the major segments of Finance, Policy and Planning, Procurement and Resource Management, and Service Delivery. It also shows components that provide a foundation for HIS throughout the value chain.

In a chain of activities as complex as those involved in the health system it is challenging to determine what changes might deliver the most valuable improvements and which investments therefore offer the greatest return. Value chain analysis provides a framework to dive deeper into the question of where HIS could improve health sector performance by focusing attention on two key questions. What is the

value contributed by a particular activity or function? What information is essential to performing that function or activity most effectively and efficiently? With answers to these questions it is then possible to prioritize reforms to make essential information available when and where it is needed with quality and reliability.

Detailed value chain analysis is beyond the scope of this study, but a simple example of a disease surveillance system serves to illustrate the approach. The ultimate value of disease surveillance to health is reduced incidence of disease. The immediate value added to the health system is the rapid delivery of information (notifications) to other parts of the health system and the certain detection of outbreaks upon which the health system can respond. Information must quickly reach those who can act upon it. The actors might include not only policy makers in central ministries, but clinicians, suppliers, facility managers and others. They are all rendered less effective by the typical manual, paper-based information capture process that must traverse a vertical chain to reach a central or national office. This process diminishes the value of the surveillance system. Information technology adds value by networking all the links in the chain and enabling electronic data capture and transmission to the central office within seconds through the use of a PC, cell phone, or PDA connected to a database system. The IT intervention empowers these actors with information and the ability to act and make decisions more quickly. For the process of detection, information systems add value by providing the reporting, analysis, and GIS tools to accurately detect an emerging outbreak, pattern or hot spot. The alternative process is unwieldy and ineffective: the time-consuming, manual compilation and analysis of data that must be extracted from mounds of paper reports. By the time an outbreak pattern is detected, it could be too late or the response must be amplified in the way of more resources or more drastic containment measures, straining the capacity of the health system. Effectiveness means that speed of detection and response is vital. Time is the scarce resource whose value must be maximized. Determining what information enables each of these functions to respond most effectively is key to maximizing the value added by such a surveillance system. Viewing a surveillance system in the context of a larger value chain thus highlights the full spectrum of information dependencies across the value chain and encourages a systemic approach to health information systems.

Childhood immunizations programs provide another useful example. The value added by immunization, the prevention of disease, depends on a number of prior activities in the health system value chain: identification of those not (or already) immunized, order and delivery of supplies, recruitment, training and assignment of personnel, and notice to the population of the event. Maximizing the effectiveness of an immunization campaign thus depends on information systems that are both directly and indirectly related to the administration of immunizations. Improving the effectiveness of a particular immunization campaign, and the resulting value added to the health system, will depend on better information from information systems that monitor vaccine supplies and health records that document vaccinations. If the immunization campaign was targeted at infants, birth registries can be compared to immunization records to see if the immunization reached all infants. These systems are both outside the immediate domain of supply chain management or clinical care yet they add value to the planning of vaccination campaigns. The analysis of the value of any component information system, and designing it to add greatest value, must take into account the value added to these downstream activities.

Realizing how various activities in the health system depend on the value added by other activities earlier in the value chain, and how information systems supporting activities at one place in the value

chain indirectly add value to activities later in the chain, provides a more substantial basis upon which to evaluate the potential return on information system investments.

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Appendix B: HIS 2.0

A Service-oriented view of HIS

A health system is composed of people performing a variety of activities. It's therefore difficult to imagine strengthening health systems without improving the effectiveness of the people who make up the system, particularly those immediately responsible for providing services (educational and preventive as well as clinical services). Strengthening health systems and improving the effectiveness of service delivery relies on two broadly distinct types of information. Basic operational data underpin the routine business activities of the health system. Medical records enable effective clinical care. Inventory records track supplies and medicines, and so forth. At the same time, one also requires summary data ("indicators") to manage the overall resources of the health system, set policies and evaluate the effectiveness of programs. Health system strengthening requires quality information of both types, but current thinking about HIS often emphasizes the latter at the expense of the former.

Established thinking views HIS as an overlay on the activities of the health system to collect data on indicators for use by a limited group of managers, policy makers and researchers. Emphasis focuses consolidating indicators from a variety of separate sources into a single datastore (so-called "data warehouse") for analysis and reporting. In this conception, information flows upward through isolated independent silos from front-line health workers to a repository at higher levels. Minimal attention is given to the information needs of practitioners at the local level or the importance of sharing of information across different parts of the health system.

An alternative approach sees HIS as an integral part of a health system in which critical data is routinely captured at the point of service and is readily and immediately made available wherever else it is needed. Conceived in this way, HIS is understood as a network of information flows among actors in the health system, each with particular needs according to the activities they are engaged in. But the information that will enhance the effectiveness and efficiency of their activities will often originate elsewhere. Determining what information is most needed where and making that information available where it is needed is the central purpose of HIS in this understanding. To be sure, technology has an important role to play in this kind of system. But what matters most from this perspective is not the technology, but what information is needed, by whom and for what purposes.

By way of illustration, suppose a community health worker (CHW) attends a birth. Information on the successful delivery may be added to a patient health record. A live birth is documented for vital registration. A new health record may be generated for the child. Birth weight and other indicator data will be communicated to the health district. Immunizations will be administered and documented for the health ministry. The use of a birthing kit and immunization packet consumes supplies that reduce inventory and need to be reordered. If the mother is HIV positive, lab tests for the child may be required. Lab results will be communicated to the patient and a clinician who may prescribe medication. The CHW will need to schedule a follow up visit to mother and child and will need to know about the test results to advise the mother appropriately. The diagram in Figure 1 illustrates how information originating in such an interaction is associated with a variety of hypothetical information flows through the health system. This view does not attempt to capture all entities or activities in the health system, but merely illustrates how a single event can trigger the flow of information to enable multiple activities.

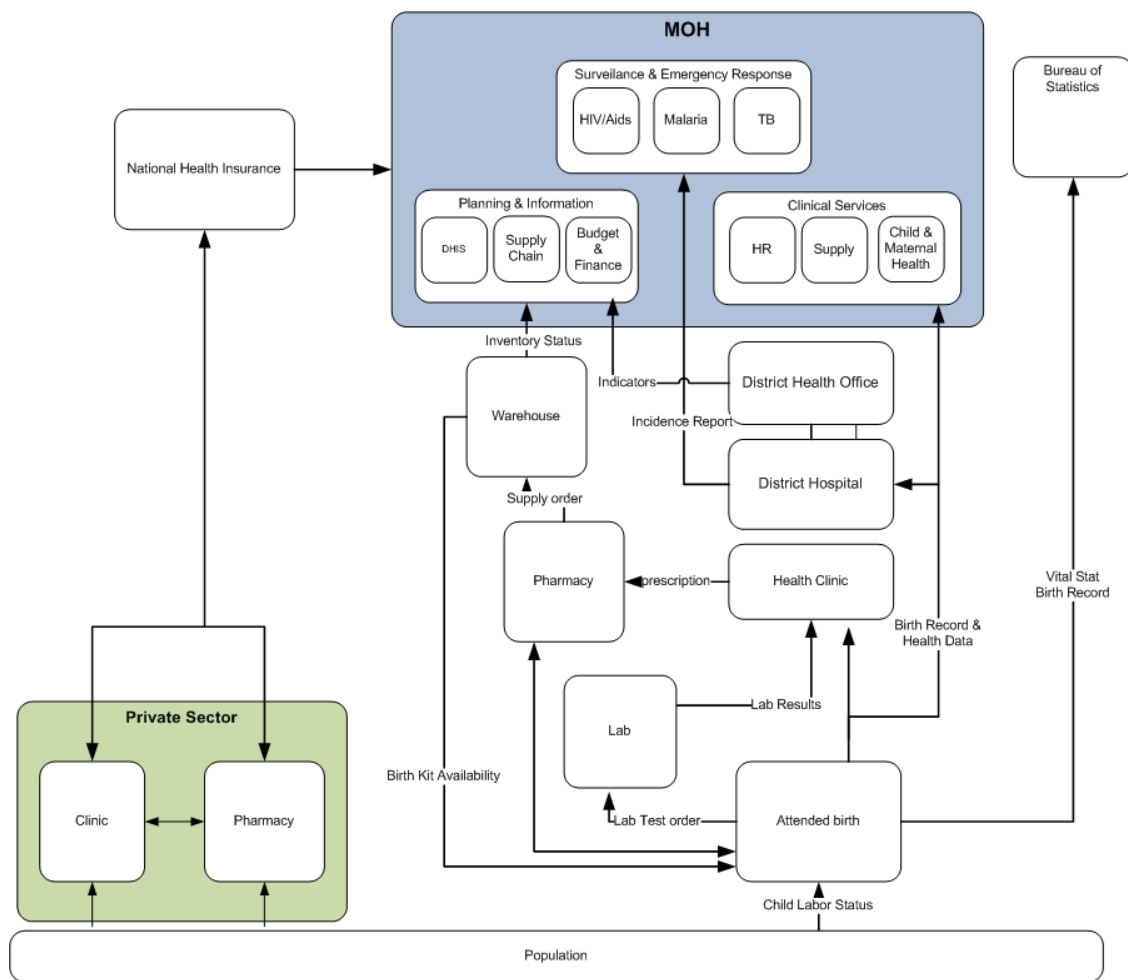


Figure 12 - Hypothetical Information Flow

Note that the information flows described do not occur within any single application or organization, but occur predominantly between organizations that might be using entirely different arrangements, including different computer applications, for the management information relevant to their respective activities. Information flows also move in different directions up, down and across the system. What matters is that information be available where it is needed (which does not preclude central repositories, but repositions them as a part of the information system, not the focus).

In this view, the principal goal is not collecting or aggregating data, but optimizing information flows among heterogeneous systems and building human capacity throughout to use information to improve performance. Optimizing information flows emphasizes what information is most needed to conduct specific activities well and where that information originates. Technology is then a means to increase the efficiency of collection, communication and management.

This approach to thinking about HIS has several important advantages.

- It recognizes the importance of front line service delivery activities and the value of operational information to directly support those activities.

- It does not exclude the private sector, where significant spending and service delivery occur even in low income countries.
- Because it does not hinge upon the building of any large unified computerized information system, this approach recognizes the value of incremental optimization of specific information flows. There is no single path or blueprint for overall integration, but value can be added at many points simultaneously as individual specific information flows are enabled one at a time.
- This approach is highly flexible and assumes that needs and technology will evolve over time. Individual systems will come, go, and change. So long as each has the capacity to share information and adheres to standards for data exchange, evolving requirements for amended information flows can be met.

Loosely coupled systems

Though it is important not to think of HIS strictly in terms of technology, it is also important to recognize the potential of appropriate technology as an enabler. If an HIS is defined by the level of integration among various component systems, then the most critical function technology can provide is as the means of bridging between these systems. Modern information systems approaches often refer to this bridging as creating a federation of loosely coupled systems. They are loosely coupled because they are autonomous systems each designed to support specific activities or functions but have the capacity to recognize and share information with other systems of different design (and usually operated by different organizations). The diagram below depicts a hypothetical set of HIS-related systems in a country and how they might share data through a web services layer through which systems send and receive requests for data.

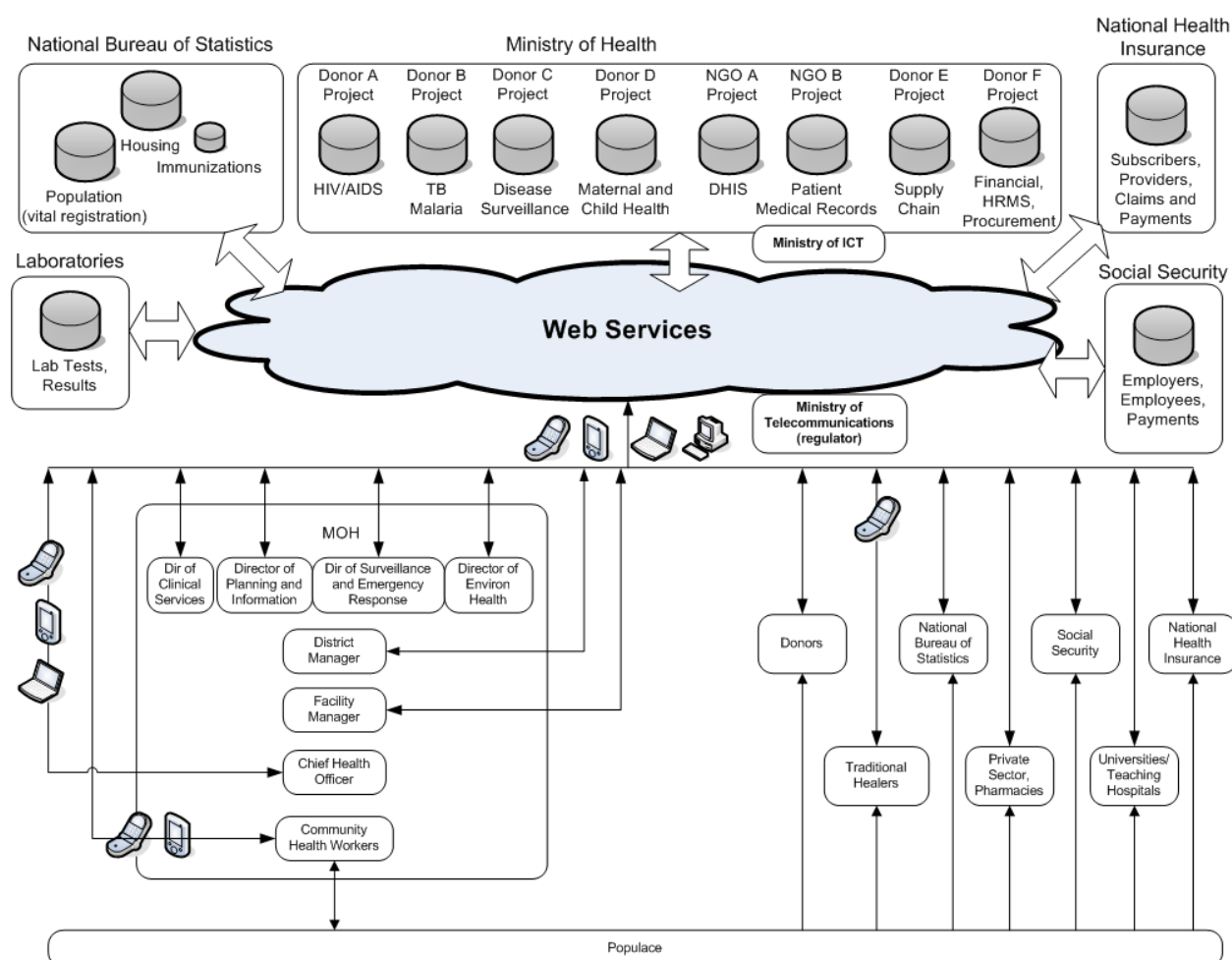


Figure 13 - HIS 2.0

Web services is used here as an example but there are multiple technologies and approaches available. The exact choice of technologies does not matter here. It does not imply that there will never be a need for a data warehouse, but it does present an alternative. The main distinction is that this concept moves the thinking of HIS away from the physical integration of data into a separate, standalone data warehouse, and into a virtual integration of data by enabling a consolidated view of the data across systems. Still, there are challenges. Diversity among applications and hardware are readily accommodated, but standard semantics and formats for data interchange are necessary. The semantic standards may be the most difficult to achieve because it requires people to agree on the meaning and purpose of a data element, as well as the valid values for a given element. One paper lists over 30 “vocabularies” or terminology sets.²¹⁷ In the health field these things have been difficult to achieve because of the complexity of health data and the variety of activities related to health. Format standards may be a less contentious issue because the discussion as to whether a data element should be represented as text or a number, or a text field should be 20 characters or 30, is simpler. Interoperability also will depend on a policy regarding security, access, and data privacy, as these policies will likely also vary between systems and need to be respected by other systems. But the opportunity for interoperability might actually be greater in developing countries where data requirements might be scaled down to an essential minimum. Standardization efforts will also reveal

inconsistencies and data quality issues within a single system. This may prove to be an embarrassment to that system owner but also be the incentive needed to address the root causes.

This conceptual model also accommodates the reality in most developing countries of multiple fragmented systems and donor-driven programs where the donor need for reporting drives the development of program-specific systems, adding to the proliferation of systems performing similar functions. The data collection is still duplicative but perhaps once there is an easier way to view and access the data, mindshare will begin to build about the need to coordinate and eliminate redundant data collection, which might result in the consolidation of some systems and be a welcome outcome to the overburdened and understaffed public health institutions.

The path to creating a loosely coupled set of systems is still not easy and straightforward, but the benefit is that resources are focused on data standardization and data quality, rather than on construction of complex data warehouses and the constant supervision of the data feed process into the data warehouse.

End Notes

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