

mHealth



HEALTH INFORMATION AS HEALTH CARE



THE ROLE OF MOBILES IN UNLOCKING HEALTH DATA AND WELLNESS

DISCUSSION
PAPER



Vodafone
Foundation

AUTHORS

This discussion paper was written by Jody Ranck, DrPH, with input by and collaboration from Ramesh Krishnamurthy, PhD, Dykki Settle and David Lubinski, and edited by Adele Waugaman.

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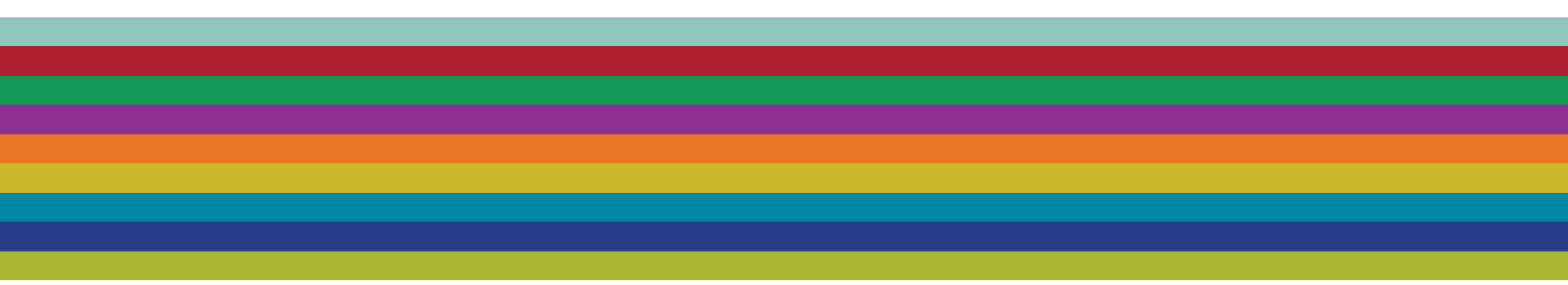
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CONTACT

United Nations Foundation
1800 Massachusetts Ave., NW
Suite 400
Washington, D.C. 20036
USA




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The United Nations Foundation and Vodafone Foundation Technology Partnership is a leading public-private alliance using technology programs to strengthen the UN's humanitarian efforts worldwide. Created in October 2005 with a £10 million commitment from The Vodafone Foundation matched by £5 million from the UN Foundation, the Technology Partnership has three core areas of focus: (1) to strengthen communications in humanitarian emergencies; (2) to support the development of mobile health (mHealth) programs to improve public health systems, decision-making and, ultimately, patient outcomes; and (3) to promote research and innovation using technology as a tool for international development. The UN Foundation and The Vodafone Foundation are among the founding partners of the mHealth Alliance. More information is available at: www.unfoundation.org/vodafone.

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The mHealth Alliance (mHA) mobilizes innovation to deliver quality health at the farthest reaches of wireless networks and mobile devices. Working with diverse partners, the mHA advances mHealth through research, advocacy, and support for the development of interoperable solutions and sustainable deployment models. The mHA sponsors innovation challenges and conferences, leads cross-sector mHealth initiatives, and hosts HUB (www.HealthUnBound.org), a global online community for resource sharing and collaborative solution generation. Founding partners include the Rockefeller Foundation, the United Nations Foundation and the Vodafone Foundation, the U.S. President's Emergency Plan For AIDS Relief, the GSM Association and Hewlett-Packard. More information is available at www.mHealthAlliance.org.



**A DISCUSSION PAPER COMMISSIONED BY THE UNITED NATIONS FOUNDATION
& VODAFONE FOUNDATION TECHNOLOGY PARTNERSHIP IN COLLABORATION
WITH THE MHEALTH ALLIANCE.**

Prepared by Jody Ranck, DrPH, Ramesh Krishnamurthy, PhD, Dykki Settle, David Lubinski



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EXECUTIVE SUMMARY

Around the world, countless lives are lost due to insufficient access to quality health information. The availability of accurate, timely, and analyzed data is directly relevant to the quality of an individual's health and the healthcare system in general, the delivery of individual care, and the understanding and management of overall health systems. This discussion paper will:

- Examine the role information and communication technologies (ICTs), and mobile technology in particular, can play in improving access to quality health information.
- Review the ecosystem of health information related to patients, tracing the data throughout the continuum of care.
- Examine health information flows from patients in villages to international health organizations and the most important steps in between.
- Identify common ground on which technologists and public health professionals can develop innovative strategies and tools to strengthen health care systems by supporting health data flows, working from the premise that better data collection will lead to better health policies and health outcomes.
- Focus on three healthcare domains – surveillance systems, supply chain, and human resources – and through the perspectives of experts in these domains, identify critical gaps in health information flows that technology-based solutions could address. In the case of each of these three domains, we use maternal health as an example to show how technology-backed interventions can improve health information flows.
- Identify barriers, choke points, and other inefficiencies to guide the discussion of how modern ICTs can improve health information flows and health outcomes in the developing world.
- Provide recommendations for using modern ICTs to make health information flow more efficiently and perhaps even transform the process of care delivery itself.

This discussion will continue online through the 'Data Flows' workspace on www.HealthUnbound.org (HUB). HUB provides a new model to foster collaborative knowledge about global health. Check back for new discussion and activity in this space.





GLOSSARY

The following terms are used frequently in this paper, and are defined as follows:

CONTINUUM OF CARE: An integrated system of care that guides and tracks a patient over time through a comprehensive array of health services spanning all levels of intensity of care.¹

COMMUNITY HEALTH WORKER (CHW): Frontline health care workers who, in the developing world, are frequently the primary source of health information and care in rural and low resource environments. The World Health Organization (WHO) further defines a health care worker as anyone whose focus or activity is to improve health, including providers (e.g., doctors, nurses, and midwives) as well as technicians and managers.²

DATA FLOWS: The pathways of health information as it moves from local to regional to national to international levels and from patients and community health workers to public and private health care facilities.

ENTERPRISE ARCHITECTURE: The sub-field of information technology (IT) or information and communication technologies (ICT) that takes the interdependent resources, such as people, capital, information, and knowledge amassed in support of a common mission, and maps them into a unified and efficient technology system.

EHEALTH: Use of ICTs, such as computers, mobile phones, and satellite communications, for health services and information.

GLOBAL STRATEGY FOR WOMEN AND CHILDREN'S HEALTH: Developed under the auspices of the UN Secretary-General, a plan recognizing that the health of women and children is key to progress on all development goals and calling for cross-sector collaboration and the use of ICTs in improving the health of women and children worldwide.

HEALTH SYSTEMS: As defined by WHO, all the organizations, institutions, resources, and people whose primary purpose is to improve health.

INTEROPERABILITY: The ability to share data quickly, accurately, and efficiently between different applications across and throughout a health system.

MHEALTH: Using wireless communications devices, such as mobile phones, netbooks, and remote sensors, for health services and information.

MILLENNIUM DEVELOPMENT GOALS (MDGS): Eight goals for international development agreed to by the UN General Assembly in 2000 and recognized around the world.



INTRODUCTION

THE ROLE OF INFORMATION IN HEALTH SYSTEMS STRENGTHENING

Strengthening health systems is emerging as a cornerstone of global health policy. The poor state of health systems in many parts of the developing world is keeping individuals from accessing essential health care and slowing progress toward health-related UN Millennium Development Goals.

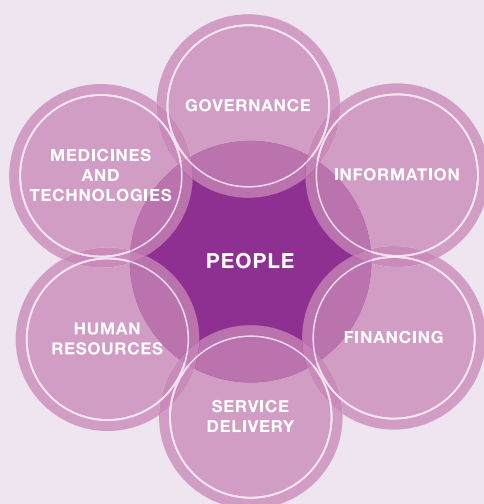
Improving health systems requires enhancements to health worker capacity and levels of staffing, service delivery, infrastructure, commodities (such as equipment and medicines), logistics, progress-tracking, and financing.³ When applied to health systems in all these areas, information and communication technologies can transform health systems globally, improve quality of care, and save lives.

A SEA CHANGE IN COMMUNICATIONS

Until recently, discussions about applying information technologies to health care in the developing world revolved around replacing ubiquitous paper-based systems with computers. Yet, in the past decade a mobile communications revolution has swept the globe and is beginning to reshape how health information and services are shared. An increasingly networked world has changed the way businesses, governments, and individuals organize and communicate. This is especially true in developing countries, where the proliferation of mobile devices, which now far outnumber fixed phones, outpaces the telecommunications technology infrastructure.

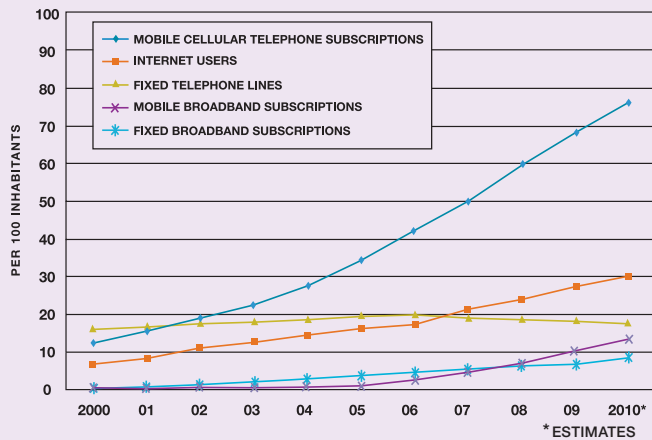
Particularly in the developing world, the rise of mobile communications holds tremendous potential to help ease the flow of health information, whether through simple voice calls, SMS messaging, wireless data, or the burgeoning mobile internet. The International Telecommunications Union (ITU) estimates that 2011 opened with over 5.3 billion mobile subscriptions worldwide, of which over 3.5 billion are found in low and middle income

FIG 1: HEALTH SYSTEMS ARE MORE THAN BUILDING BLOCKS



SOURCE: UNICEF 2010

FIG 2: GLOBAL ICT DEVELOPMENT, 2000–2010



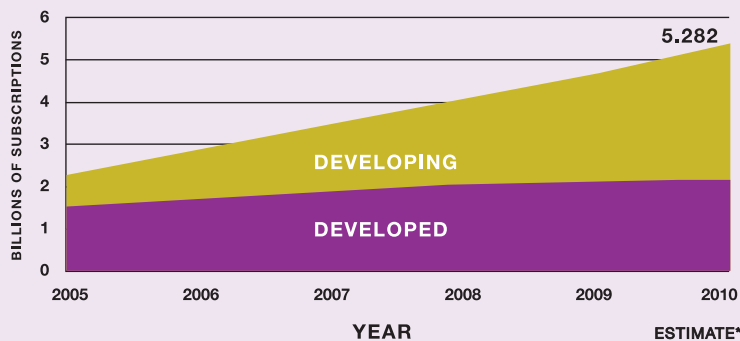
SOURCE: ITU World Telecommunication / ICT Indicators database

countries.⁴ Indeed, mobile markets are growing fastest in the developing world, which increased its share of mobile subscriptions from 53% of total mobile subscriptions at the end of 2005 to 73% at the end of 2010.⁵ An astonishing 90% of the world’s population now has access to a mobile signal, including 80% of people in rural areas. While access to mobile services is still not universal, by the

end of 2010 nearly 70% of the population in the developing world had access to a mobile phone – a trend driven largely by the rapid penetration mobile technology in the Asia and Pacific region.⁶ Mobile services have the most room for growth in Africa, where an estimated 41% of the population had a mobile subscription at the end of 2010. Analysts estimate this percentage will rise to 65% by 2013.⁷

With more than five billion subscribers connecting through mobile technology around the world, new channels of communication are opening between patients, community health workers, nurses, doctors, and specialists, irrespective of their location. The flexibility of mobile communications also enables new forms of communication, whether one-to-one, one-to-many, or many-to-many.⁸ This is shifting the landscape of health information sharing, making it possible to monitor and diagnose patients remotely, center treatment and support on the patient, sound alerts to disease outbreaks, and educate community health workers and others from a distance.⁹

FIG 3: GLOBAL CELLULAR SUBSCRIPTIONS



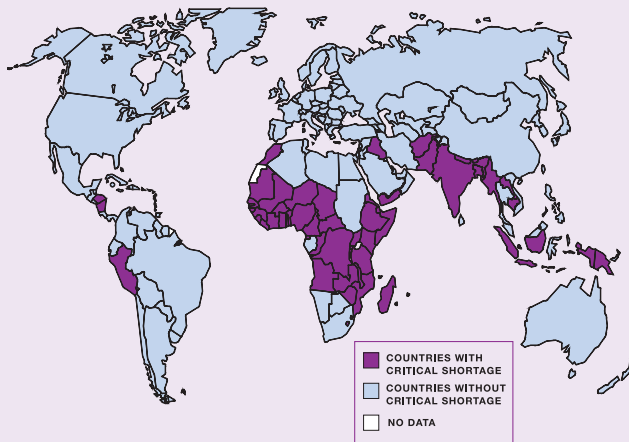
SOURCE: ITU

CORRELATION OF HEALTH INFRA-STRUCTURE TO WELLNESS

While cost and access to medical care present challenges to health care around the world, these barriers are particularly acute in low and middle income countries. The World Health Organization (WHO) estimates there is a shortage of 2.4 million health service providers globally.

While there are 28 doctors and 87 nurses and midwifery personnel per 10,000 people in high income regions of the world, there

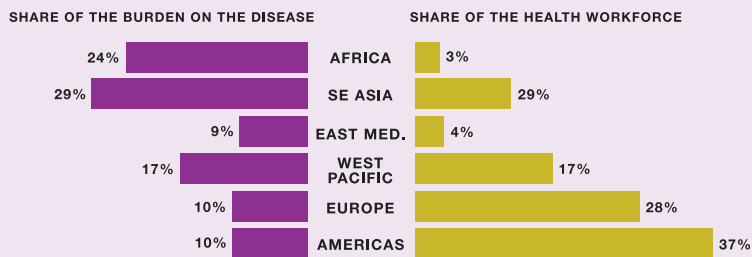
FIG 4: COUNTRIES WITH A CRITICAL SHORTAGE OF HEALTH SERVICE PROVIDERS (PHYSICIANS, NURSES, AND MIDWIVES)



SOURCE: World Health Organization (WHO)

are only 5 doctors and 11 nurses and mid-wifery personnel per 10,000 people in low income regions.¹⁰ These resource shortages are compounded by the burden of global diseases, which disproportionately falls on the developing world.

FIG 5: GLOBAL DISEASE BURDEN AND HEALTH CARE WORKFORCE



SOURCE: Global Health Council

Diseases like polio and measles have been eradicated in Europe and the Americas but still present significant challenges in Africa and Asia. The HIV/AIDS epidemic

and neglected tropical diseases endemic in many parts of the Global South further strain under-resourced health systems. As globalization brings the challenges of obesity, diabetes, and hypertension into emerging market economies, health challenges only continue to grow. Leveraging the growing connectivity enabled by the rise of ICTs is critical to meeting and overcoming these challenges.

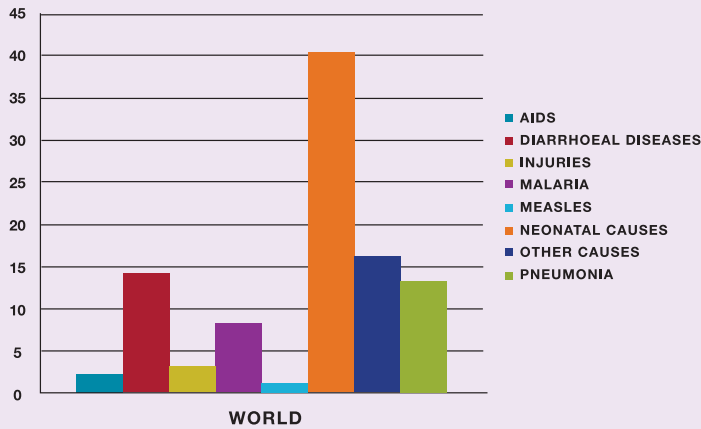
MATERNAL CARE

Maternal health is a fundamental building block of public health, and maternal health outcomes are a leading indicator of how well the system performs. Countries with weak health systems and poor health infrastructure struggle to provide sufficient services to pregnant women. Maternal health is doubly important and determines whether the mother delivers safely and whether the newborn is healthy. One study in Bangladesh found that a child whose mother dies has only a 24% chance of living to age 10, while a child whose mother survives has an 89% chance of remaining alive.¹¹

Indeed, neonatal conditions are by far the leading cause of death for children under five years old. There is a direct correlation between country infrastructure and maternal mortality rates. Nearly all maternal deaths (99%) occur in developing countries, 87% occur in sub-Saharan Africa and South Asia¹², and 65% occur in 11 countries – Afghanistan, Bangladesh, the Democratic Republic of the Congo, Ethiopia, India, Indonesia, Kenya, Nigeria, Pakistan, Sudan, and Tanzania.¹³ These figures do not account for the women who are injured, sometimes for life, in childbirth; for every woman who dies,

at least 20 others suffer injury, infection, or disability.¹⁴

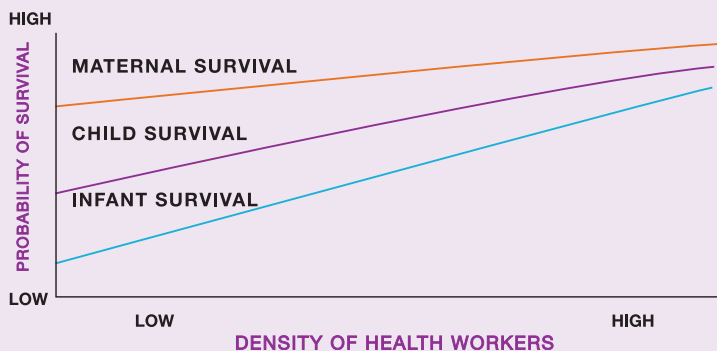
FIG 6: CAUSES OF UNDER-FIVE DEATHS PERCENT – 2008



SOURCE: United Nations MDG Report 2010

It is critical to keep in mind that almost all maternal deaths are preventable. By adopting the 2000 UN Millennium Development Goals (MDGs), the international community supported the drive to improve maternal

FIG 7: IMPACT OF HEALTH CARE WORKERS ON MATERNAL, CHILD AND INFANT SURVIVAL



SOURCE: Global Health Council

health. One of the MDGs establishes targets to lower maternal mortality rates by reducing deaths in childbirth and increasing universal access to reproductive health. In 2010, the UN Secretary-General redoubled these efforts, launching the Global Strategy for Women and Children's Health, which for the first time identified the role ICTs can play in accelerating progress toward safer pregnancies and births.

As in other areas of global health, maternal health relies heavily on access to timely and reliable data. Technology can help open bottlenecks in data on maternal health and improve the delivery of service. Systemic eHealth and mHealth interventions are capable of closing existing gaps in care across the maternal health continuum.

HEALTH INFORMATION FLOWS

Improving data collection is a good first step in creating health systems with data that flows to appropriate points in the network and informs effective decision-making. Peter Byass argues that better data collection will lead to better health policies and health outcomes.¹⁵ In particular, the use of ICTs creates efficiencies in data collection as well as improves health information flows and data quality. This allows timely and accurate depictions of disease burdens and resource flows, enabling policy makers to effectively allocate limited resources.

Focusing on maternal health care, our paper highlights the implications of data flow issues and discusses a broad range of possible ICT interventions.¹⁶ We hope to encourage ongoing discussions to clarify what health systems need so that the future information

technology backbones of these systems can facilitate that. We must identify what the users and systems require before we can develop the overall enterprise architecture development, framework, or process.¹⁷

Fragmentation of health data collection and reporting methods challenges efforts to transform the health care system. A number of trends and forces are at work here. The advent of the World Health Organization in the 1940s led to a hierarchical model for sharing global health information. The introduction of computers and the subsequent expansion of the Internet increased the number and complexity of actors working in information and global health development.¹⁸ Concurrently, private donors began to contribute more to reaching global health goals, and each donor group instituted its own systems for collecting and sharing information. Much good came from the introduction of these new, dedicated players, but the many discrete information networks that they brought with them, both horizontal and bottom-up, fragmented the universe of health data.

As a multitude of donors emerged to combat a variety of diseases, they carried with them stove-piped reporting systems. These fragmented data flows have led to duplication of efforts, competition, and poor coordination of health planning. To strengthen the health care system, we will have to put into place enterprise architecture that enables interoperability of devices and open standards; those in turn will help health care data to move across these silos.

The advent of mobile devices presents an opportunity to break through silo walls and increase the production of and access to health information. Addressing bottlenecks in data collection and sharing also holds great potential for strengthening maternal care and health service delivery gaps. ICT-enabled data collection and sharing holds great potential for closing the health care service delivery gaps affecting maternal health care in areas including¹⁹:

- family planning, counseling, services, and supplies
- antenatal care
- communication with providers
- lab results
- proper maternal nutrition

ICT can support limited health care systems by allowing them to transmit critical data to the right people when needed, such as connecting a remote health worker with an urban OB/GYN specialist or enabling a pregnant woman to call in advance to ensure she can receive appropriate medical attention at a clinic where she plans to deliver.

As Peter Byass has argued, “Poverty in material terms is inextricably linked with poverty of data.”²⁰ Policy makers too often base their understanding of health data on an incomplete grasp of reality on the ground. To understand the key drivers of poor health outcomes, it is necessary to distinguish between real gaps in health system coverage and those generated by lack of data. This allows health planners and technologists to prioritize innovations and policies impacting health data and will let us effectively address

critical pressure points in, for example, the maternal health value chain.

Efficient data flows are an integral part of an effective health information system. U.S. health policy expert Don Berwick is well-known for the quote, “information is care.”²¹ A strong health information system enables health workers to respond rapidly and with the appropriate measures. When data flows readily from the village level to central systems, it makes the jobs of health professionals much easier and increases the likelihood that health workers will deliver high quality services. Conversely, uncoordinated systems with data roadblocks amplify the challenge of delivering essential health services. Health systems that are highly fragmented and plagued by gaps in data flows also play a role in high turnover rates for frustrated health workers who spend a great deal of time completing forms by hand.

Currently, lack of organized description and research on the end-to-end flow of health information and data, particularly in the developing world, impedes progress toward these global health goals.²² These bottlenecks directly result in material effects such as insufficient supplies of contraceptives, vaccines, and drugs. In other words, health data flows, while largely invisible, are critically important to achieving greater health access and equity.



PUBLIC HEALTH SURVEILLANCE SYSTEMS

DATA FLOWS WITHIN PUBLIC HEALTH SURVEILLANCE SYSTEMS

*Written in collaboration with Ramesh Krishnamurthy of the Health Metrics Network*²³

Dr. Ramesh Krishnamurthy is the Health Metrics Network's Chief of Information Systems and Frameworks' team leader. Previously he was the senior informatics advisor and scientist at the Centers for Disease Control and Prevention. The Health Metrics Network (HMN) is a WHO entity responsible for strengthening health information systems in the developing world.

DATA FLOWS IN SURVEILLANCE SYSTEMS

This section examines data flows in the context of disease surveillance systems. We define “data” to include distinct factual measurements or items represented as numbers, words, images, and biological samples, and “information” as analyzed and interpreted data. Disease surveillance systems serve as the backbone of public health systems and represent a major portion of the data that feed into country health information systems. Effective surveillance systems monitor disease trends in a population and help identify and control epidemics through the allocation of necessary resources. There are seven major bottlenecks to the flow of health data flows in this environment:

1. Fragmentation of health information
2. Lack of unique health identifiers
3. Poor data quality
4. Lack of standards and interoperability
5. Limited human resources

6. Inadequate ICT infrastructure
7. Jurisdictional barriers to sharing information

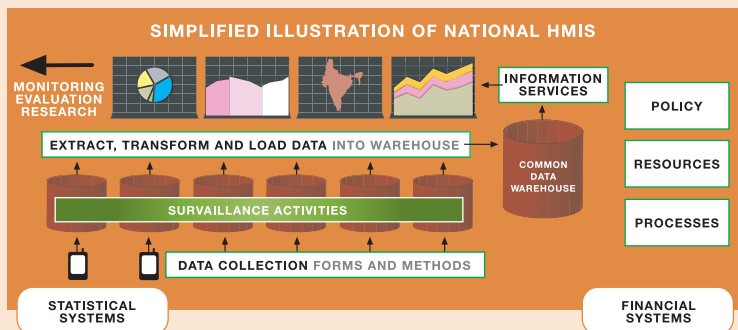
ORGANIZATION OF DATA FLOWS IN SURVEILLANCE SYSTEMS

Public health professionals, including epidemiologists, informatics specialists, and information systems managers, need a comprehensive understanding of the flow of data pertaining to their areas of interest. This is true whether they are embarking on designing new information systems to collect and manage surveillance data or administering existing surveillance information systems.

At the broadest level, the process of public surveillance data activity can be broken into three main categories:

1. Data collection
2. Data storage and analysis
3. Data interpretation, dissemination, and use

FIG 8: PUBLIC HEALTH SURVEILLANCE AT A GLANCE



SOURCE: "Health Metrics Network Framework 2007"

In most countries, national or sub-national public health surveillance systems fall under the jurisdiction of the ministries of health or departments of public health, where surveillance data is generally managed for dissemination and public health action. Key consumers of data include governments (national and sub-national public health agencies), patients, hospitals, practitioners, the research community, donors, philanthropists, and businesses.

Data flow can occur in unstructured and structured forms. Traditionally, data flow has

been slow, as it is collected and transmitted on paper. In recent years, the increased use of ICTs in disease surveillance data collection has influenced the ways public health data is collected and managed. In more advanced surveillance systems, data flow occurs within the context of an intertwined process (Figure 8) under a common data architecture involving standardized vocabularies, messaging, data transportation protocols, and interoperable data collection and management tools.

The data flow activity levels vary substantially based on the complexity of the surveillance system.²⁴ Table 1 provides observations on data collection activities and implies that passive surveillance systems have more complex data activities.

There can be substantial variability in data collection methods at the level of data capture across the primary data sources. In addition, as shown below, the quality of data may vary substantially at different levels of health facilities.

TABLE 1: LEVELS OF COMPLEXITY AND DATA FLOW

LOWER COMPLEXITY DATA ACTIVITIES	HIGHER COMPLEXITY DATA ACTIVITIES
Active Surveillance	Passive Surveillance
Individual patient observations	Geographic or organizational unit observations
Single disease or issue	Integrated surveillance systems
Surveillance only	Surveillance plus case management
Confirmed cases only	Situational awareness and early warning
Universal data collection	Sampling of the population under study
Primary data collection	Using existing data collected for other purposes

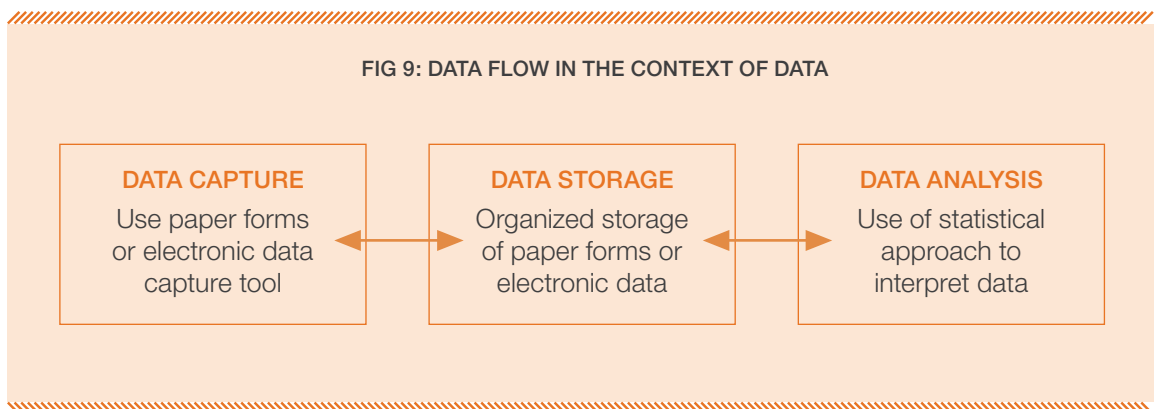
SOURCES OF DATA

The primary source of surveillance data may include direct observations of cases as well as secondary extractions from unstructured or structured diaries of auxiliary health workers, ailment registries, state surveillance registries, or electronic medical records (EMRs), among other sources. These primary data sources are usually paper-based records and forms. However, event-based surveillance can also utilize automated scanning of mass media and internet data sources.²⁵ Other primary sources of health data include censuses, civil registrations, population surveys, individual records, service records, and resource records.²⁶ “Data capture” is a term we use to understand which signals first enter a surveillance system.²⁷ Structured surveillance systems use explicit, predefined data capture modalities. Unstructured surveillance systems, or event-based surveillance, utilize a wider range of data capture methods. These methods include informal and structured reports from local clinicians, traditional healers, civil authorities, the general public, etc.

Raw, unstructured data flows, workflow, and structured information flows are three

distinct pathways within any surveillance system. Figure 9 captures a simplified yet rich view of the critical transactions that occur from the point of original data capture all the way through to the dissemination of findings to inform public health actions. During the course of routine data management, surveillance flow pathway diagrams can serve as a quick reference manual to identify the critical areas that require monitoring and intervention to assure data quality and data integrity. Periodic updating of these diagrams can guide complex and long-term data management activities.

Public health data is generally collected on paper and then re-entered on a computer for storage and analysis. However, more and more, original electronic data is captured at the point of origin using hand-held devices or direct input to desktop applications. Entities such as the U.S. Centers for Disease Control and Prevention (CDC), WHO, DataDyne, InSTEDD, and Voxiva have developed numerous electronic applications to collect surveillance data. Some are open source applications and some are proprietary. DataDyne created the free and open source EpiSurveyor health data collection



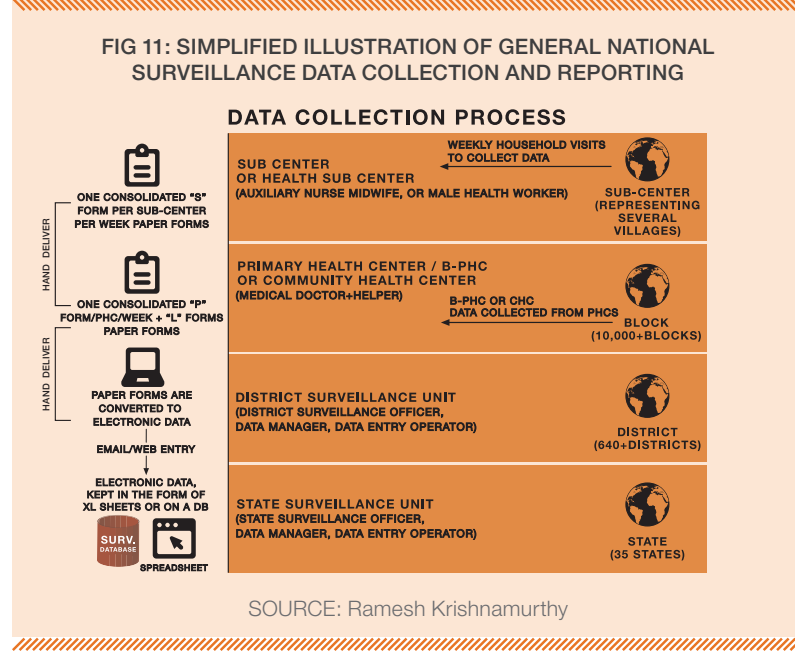
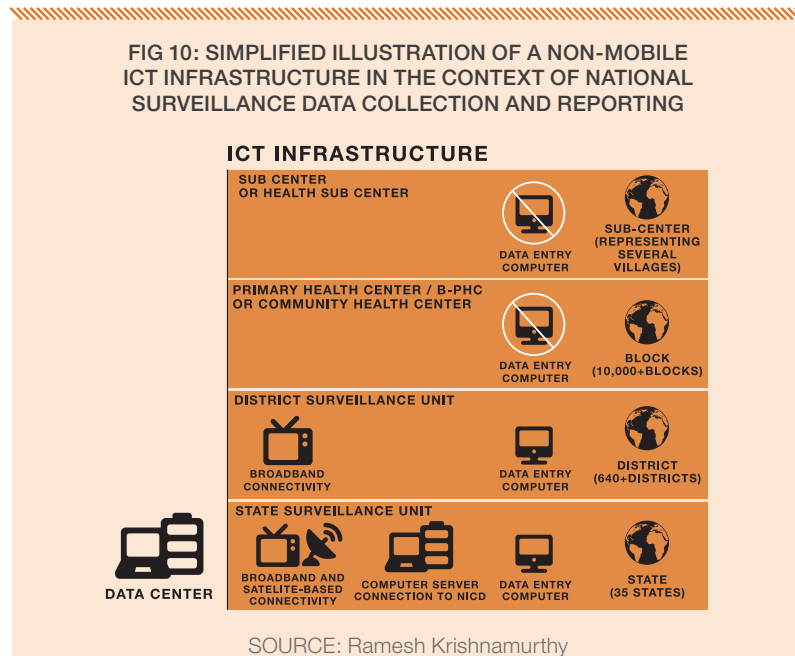
tool with funding from the United Nations Foundation and Vodafone Foundation Technology Partnership and in 2006 deployed it in sub-Saharan Africa in coordination with WHO and participating ministries of health. Other software and software kits that are now being used to capture and/or use data to support health in the developing world include EpiInfo, OpenXdata, Open Data Kit, Open Dream, Open MRS, OpenELIS, OpenClinica, District Health Information System (DHIS), Managing News, Sahana, Geo-Chat, Riff/Evolve, Mesh4x, Ushahidi, and EpiDefender.

A well-designed electronic information system allows:

1. A streamlined data entry process
2. The direct digital capture of laboratory test results or clinical diagnoses
3. Efficient data merge capabilities from multiple data sources
4. Automated data quality checks
5. Rapid search, retrieval, and visualization capabilities
6. Early warning alerts for potential disease threats and disease outbreaks.

After data is captured, data flows must move among the various health care providers and surveillance officers and be translated into data formats (i.e., from hardcopy to digital formats or from a computer drive or wireless handset to a database). The data can then be sent to the different levels of the health system (Figure 10) where there are data feedback mechanisms to ensure quality, manage corrections, and supply analysis. To provide an idea of the potential magnitude of the layers in the system moving from a

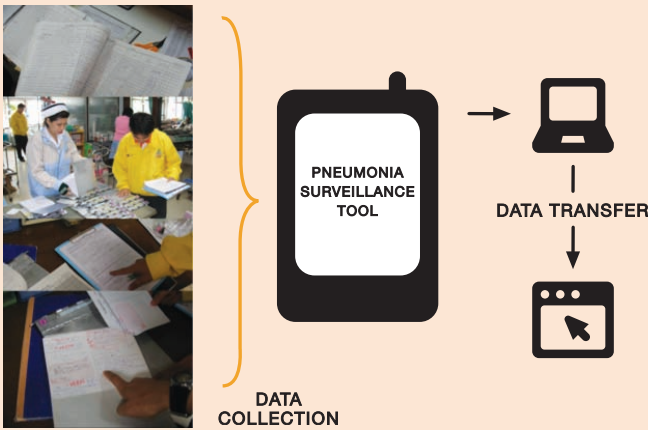
health sub-center to the state, the following figure provides an overview of the National ICT infrastructure for a country. Note that this diagram does not incorporate mHealth capabilities. Figures 10 and 11 assume manual, paper data capture at the front line levels with data entry only at the district level:



A generalized model, as shown above in Figure 11, used database programs at various levels of the public health system to collect and aggregate paper based forms.

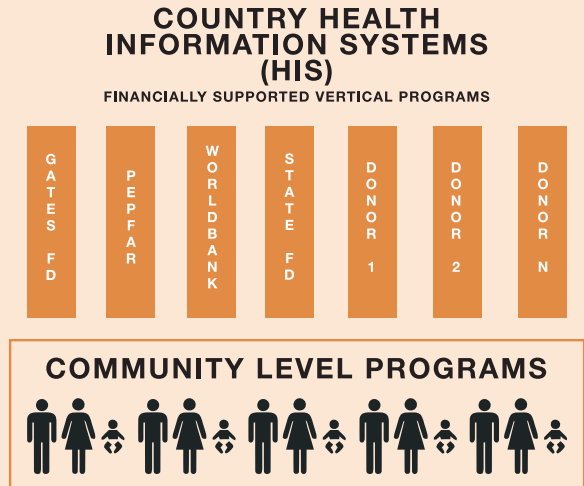
Therefore, the impact on the information system is uncoordinated and may lead to fragmentation of data.

FIG 12: ILLUSTRATION OF SURVEILLANCE DATA COLLECTION USING MOBILE COMPUTING DEVICES



SOURCE: Ramesh Krishnamurthy

FIG 13: EXAMPLE OF COUNTRY HEALTH INFORMATION SYSTEMS



SOURCE: Ramesh Krishnamurthy

MAJOR BOTTLENECKS IN DATA FLOW

ISSUE 1: Fragmentation of Information Systems

The legacy of paper-based records combined with donors' requests for disease-specific indicators for use in their programs have fragmented data, i.e., created data silos. Such approaches have reporting systems that feed vertically from community level programs to national reporting systems and donors.

A vast array of donor and technical agencies now work in public health. They provide much needed financial support to countries with limited resources. They also typically require separate indicators to measure the public health impact of their programs.

In the example above, we see a series of different donors with their respective programs. When a donor funds a country and requests a report of indicators on diseases such as TB or HIV, the country will typically create a vertical program to comply. When multiple donors in the same country make similar requests, the country ends up putting up silos that prohibit systematic data exchange between the silos themselves and across a common national health information system.

ISSUE 2: Lack of Unique Health Identifiers for Persons

Vertically driven systems typically do not share data horizontally. This causes problems because individuals are not uniquely identified within national health information systems. Standards for data are also lacking.

For example, an HIV-positive patient travels from a village to visit a relative in a neighboring city. If the patient contracts and is treated for an opportunistic disease while visiting, the HIV status may be counted twice due to the lack of unique identification numbers. Over-counting can lead to an inefficient allocation of resources.

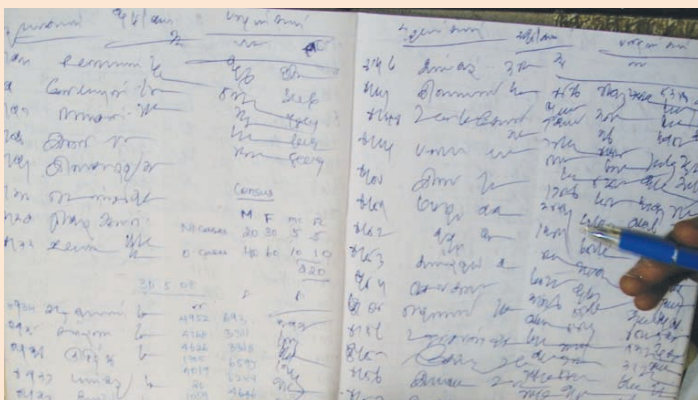
Similar conundrums are found in the field of maternal health. A woman who receives antenatal care in a city but returns to her village for childbirth will likely have uncoordinated and fragmented health records. Such records can result in sub-optimal clinical care.

A number of countries, such as India, have launched major efforts to assign a unique identification number to each citizen.

ISSUE 3: Poor Data Quality

Errors in data can occur in numerous forms. There can be substantial human error in data collected and compiled on paper.

FIG 14: EXAMPLE OF A PUBLIC HEALTH HOSPITAL DATA RECORDED IN OPD REGISTER

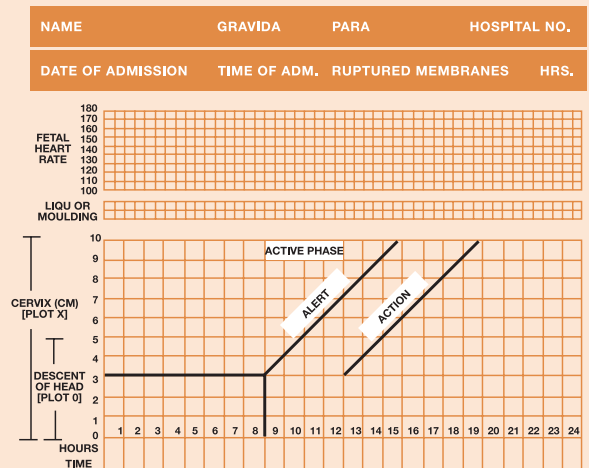


SOURCE: Ramesh Krishnamurthy

Aggregate data – often tallied by hand and then recorded in an electronic database or carried to the next level via paper formats – is also fertile ground for mistakes.

Maternal health and labor records or partographs used by midwives and clinicians involved in child delivery provide an excellent example of poor data quality. A partograph records cervical dilation, descent of fetal head and uterine contractions. Partographs can also monitor fetal conditions with the following parameters: fetal heart rate, membranes and liquor (amniotic fluid), and molding of fetal skull. Additionally the partograph monitors the mother’s condition including pulse, blood pressure, temperature, urine, drugs, IV fluids and administration of oxytocin.

FIG 15: EXAMPLE OF A PARTOGRAPH USED TO MONITOR LABOR



SOURCE: “The Internet Journal of Gynecology and Obstetrics”

Health care practitioners in the United States and Europe have used the partograph to improve maternal and neonatal health outcomes. Unfortunately it is rarely used in developing country health care contexts, and

the warning signs the partograph reveals are often missed. Maternal health practitioners do not know why the form has not had the same success in developing countries. The material effect can be seen in the number of obstructed or distressed labor cases in the developing world. Furthermore, the lack of reporting or misreporting of problematic childbirths makes it difficult to discern the true extent of these problems. As we contemplate redesigning forms and process to work in new electronic health data systems, we need to integrate the partograph into developing countries' data collection practices.

In a related issue, an initial use of the Epi-Surveyor application on mobile handsets to support a supply chain was shown to increase the availability of partographs in Senegal. This is further explored in the case study on the next page.

TECHNOLOGY'S ANSWER TO AGE OLD QUESTIONS: A CASE STUDY OF HEALTH SURVEYS USING EPISURVEYOR IN SENEGAL

In 2009, the United Nations Foundation and The Vodafone Foundation commissioned an evaluation of mHealth activities undertaken by the World Health Organization in collaboration with the Ministry of Health in Senegal using EpiSurveyor to collect and analyze health data. EpiSurveyor is an open source software tool for mobile devices (including PDAs and mobile phones), that makes data collection more efficient and accurate.

In early 2008, the Senegalese Ministry of Health (MOH), in partnership with WHO, asked its field officers to begin collecting data for multiple health departments using EpiSurveyor. The Ministry piloted the tool in ten districts, providing officers with PDAs running EpiSurveyor loaded with an integrated health data gathering survey. The EpiSurveyor mobile health data collection trial marked the first time in more than two decades that the health ministry had taken an integrated approach to health data collection.

The evaluation, produced by Dalberg Global Development Advisors, found that the EpiSurveyor-backed survey enabled faster data-gathering and improved decision making. In the six months of the program, pilot clinics using PDAs were able to show an improvement of 67% in health indicators (out of 79, 53 showed improvement). In one district, data that had previously taken a day to compile was gathered in one hour. Furthermore, this district's health budget was reprioritized based on the needs identified by the survey. As a result, the district saw a 500% increase in infant vaccinations, and an

increase of 10,000 Vitamin A tablets ordered after data gathered by the survey indicated a shortage.

The study also found that the survey data alerted medical authorities to the insufficient use of the basic birthing tool called the partograph. The partograph is used by midwives to monitor the process of labor. This effective, inexpensive, and simple system helps medical officers identify deviations from the expected trajectory of labor that might require intervention. Despite the fact that Senegalese midwives believe the partograph reduces labor and delivery complications, around 310,000 babies were delivered in Senegal in 2008 without a partograph.

The survey revealed that only 55% of districts were systematically monitoring labor using the partograph. Based on this newly-collected information, the Senegalese health ministry recommended that field officers encourage the use of the partograph. Using EpiSurveyor, health workers then were able to verify usage, provide training, and ensure subsequent distribution as needed of the forms. From March to August 2008, usage of the partograph in clinics involved in the pilot survey increased from 55% to 69%. To place this figure in context, the Senegalese Reproductive Health Program's biannual survey conducted at the end of 2008 showed that the number of births involving partographs in the districts covered by the pilot EpiSurveyor program rose by 28% in 2008, compared to an increase of just 1% in the rest of the country.



CREDIT: DALBER GLOBAL DEVELOPMENT ADVISORS

ISSUE 4: Standards and interoperability of data and systems

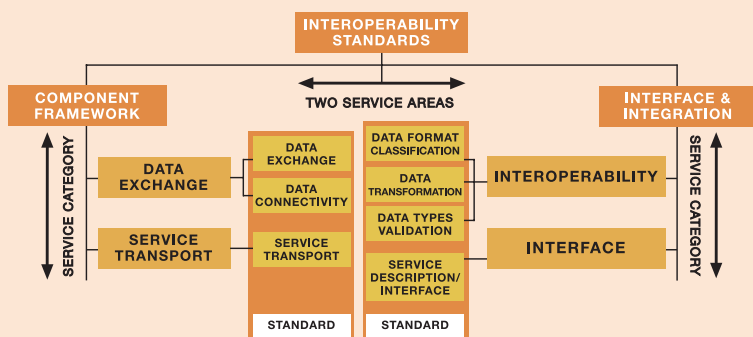
Interoperability allows data to be shared quickly and be linked from multiple sources.

Data flow in surveillance systems (and for all other purposes) requires standards to enable interoperability. A technical standard is an established norm or requirement that describes data format and rules governing the formats. Standards are usually reflected in a formal document that establishes uniform engineering or technical criteria, definitions, methods, processes and practices. Most voluntary standards are used by people, professional societies, regulators, or industry. When a published standard achieves widespread acceptance and dominance, it can become a broader de facto standard for an industry.

Combined with the complexity of information silos, the lack of interoperability and data standards present some of the biggest stumbling blocks to public health systems.

While there has been a great deal of attention focused in the developed world on health information exchange standards, this has not occurred in the developing world. Moreover, the standards that have been developed and deployed for the developed world are often inappropriate as they tend to focus on hospitals, rather than primary care.

FIG 16: ILLUSTRATION OF MANY DATA STANDARDS REQUIRED FOR INTEROPERABILITY



SOURCE: Ramesh Krishnamurthy

ISSUE 5: Inadequate Technical and Human Capacity and Resources

Human error and lack of capacity to train sufficient numbers of technologically-literate health workers is a major problem. To date there has been little research conducted to adequately capture the extent of the health workforce technological literacy problem.²⁸ In the U.S. alone there is a shortfall of 50,000 health informatics professionals.²⁹ We expect the numbers to be far greater in developing countries.³⁰

Health workers, patients and decision-makers need a better understanding of basic health technology literacy levels to assess capacity and critical needs. From senior policy makers and managers to frontline care providers, health professionals need to understand how ICT capabilities can enhance the delivery of health information and services. Most health ministries in developing countries are short on expertise in health ICT.

Overall, a shift in health data ownership may be required. The change should involve moving from the idea that health data is owned by various providers within the health system to the view that health data is produced and held by the patient as well. The growth of smartphones and related applications will allow patients to see, understand, manipulate and share their own health data. This may accelerate a trend toward more personal control of health data. The trend may be reinforced by data produced and stored outside of the formal health care system.

ISSUE 6: ICT Infrastructure Failure

Interruption of data flow can occur through ICT infrastructure failure such as: IT communication and network errors; interruptions in electrical supply; and ICT devices infected with malware or viruses. Currently, little information exist to determine the magnitude of this problem. It is clear that all devices gathering or using electronic data need to have store and forward capabilities, rather than assume constant connectivity.

ISSUE 7: Jurisdictional Boundaries Often Dictate the Flow of Data Within and Between Health Sub-Sectors

Data captured within jurisdictional boundaries can leave important gaps or misrepresentations of disease realities on the ground. Standards enabling interoperability across jurisdictional boundaries are critical. Equally important are policy agreements to share the data across boundaries.

SUMMARY OF DATA FLOWS IN SURVEILLANCE SYSTEMS

- ICT-backed interventions have the potential to address the most important barriers facing health information flows in disease surveillance systems.
- In siloed and fragmented health systems, the adoption of data standards and interoperable platforms can ease the flow of health information to all required data points. Legacy systems, however, will continue to pose a challenge. Technology is not enough; technical interoperability needs to be supplemented with information-sharing policies that take advantage of it.
- Where patients are not currently tracked at the national level, the adoption of unique health identifiers monitored by electronic devices can ensure better coordination across health systems and enable improved epidemiological profiles.
- Where data were previously collected and analyzed on paper, electronic capture and synthesis can eliminate human error and increase the speed of analysis and use by policy makers.

- Data standards developed to support interoperability are critical to enable health information flows. The rapid proliferation of mHealth and eHealth applications and tools require those concerned about public health to work actively to develop methods for various tools to 'plug in' to one another.
- Where health staff is limited, electronic collection can speed data capture and compensate, to some extent, for lack of training. Yet the lack of sufficient numbers and training for health informatics professionals will retard this growth.



DATA FLOWS IN HEALTH HUMAN RESOURCES ECOSYSTEMS

Written in collaboration with Dykki Settle of IntraHealth³¹

Dykki Settle leads IntraHealth and CapacityPlus efforts in health worker informatics, bringing a health worker-centered approach to the availability and use of high quality information for better health. Settle's areas of leadership include developing and implementing Open Source human resources for health information solutions; helping countries build capacity to absorb new health technologies; and supporting regional and country health organizations as they realize the power of Open Source for global health.

Human resources are another central domain of health systems where improved information can provide significant benefits. Better data on health worker supply and demand can help allocate human resources appropriately across geographies and specialties. This is particularly critical where there is a shortage of healthcare workers and where health managers may face issues of absenteeism, lack of certification and proper qualification and training of workers. Meeting MDG 5 depends on deploying healthcare human resources effectively because childbirths do not stick to normal office hours and require, in addition to skilled staff, that medications be available.

Currently many countries' health systems have projections or mandates for where their employees should be located, but few have measures in place to show where their health human resources are actually deployed. Health systems also need to track personnel skills and resources to serve community needs.

A snapshot of the five main areas where public health planners use data about human resources underscores the importance of this domain.

- **EDUCATION AND TRAINING:** data used to make sound decisions about the number and type of health workers needed to meet health system goals
- **REGULATION:** data used to ensure patient safety and the quality of health information and services
- **DEPLOYMENT:** data used to meet service provision needs and ensure efficiency
- **MANAGEMENT:** data used to track number and location of personnel and their movements
- **PLANNING:** data used to deploy the appropriate number of personnel to the right place

The diagram below provides an overview of the role of human resources in the nationwide organization of health services, showing national and local government as well as the public and private sectors. On the left, the figure depicts the public sector with the public service Human Resource Information System (HRIS) and the Ministry of Health. The government uses the Health Medical Information Service (HMIS) and HRIS to manage activities at the local government level. On the right is the range of private stakeholders that use HRIS, including faith-based organizations (FBOs), non-governmental organizations (NGOs) and for-profit entities.

to pay public sector health workers. The professional councils oversee the licensing of all regulated health professions. In most systems this is where one can find data on each qualified worker. However there are significant gaps in data requirements between the local and national levels: Local systems focus on everyday practice and management while national systems require broader system wide planning.

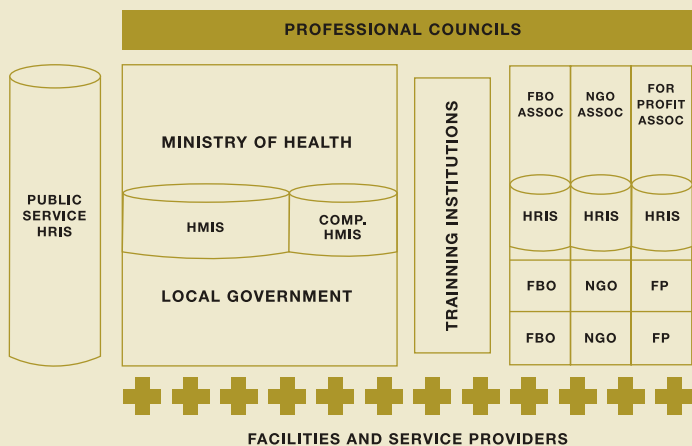
GOVERNMENT HUMAN RESOURCE DATA CHOKEPOINTS

The most critical chokepoints in the system occur between both local facilities, such those managed by villages, and those managed by the central government. Frequently there are separate systems for tracking and recording human resources information, e.g., one for payroll, one for staffing, and one for training. Only if these systems have the same standards can data be extracted from one system and cross-referenced for further examination with another, for instance to check where workers with a particular skill set are currently assigned, or to identify potential absentee workers. Central governments typically review data from health workers in the HMIS on a quarterly basis. In many countries, a major source of health worker data is the payroll office, managed by the Ministry of Finance, but this data is rarely used in making decisions about health human resources.

Between the public and private sectors are the training institutions for the health work force. The facilities and service providers are the doctors, nurses, midwives, community health workers and other providers of health services to families and communities. Within the public sector the HRIS is used

The most critical bottlenecks occur within human resource information systems as we move away from a country's capital. Human resource systems are less likely to reach the hinterlands and data is not entered as frequently. Yet current and accurate

FIG 17: ORGANIZATION OF HEALTH HUMAN RESOURCES IN THE PUBLIC AND PRIVATE SECTORS



SOURCE: Dykki Settle

community-level health data is vital to any attempt to strengthen health systems.

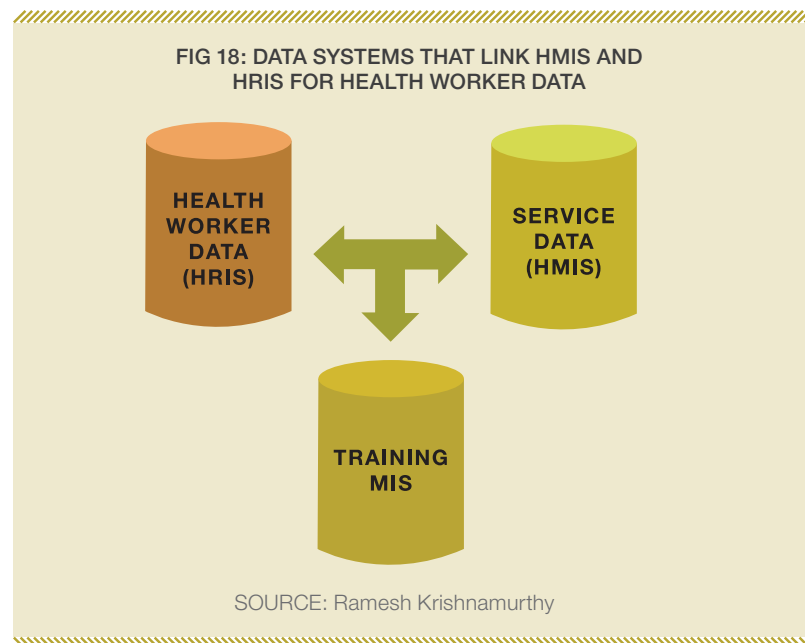
mHealth offers major opportunities for improving human resources management, particularly of remote staff. Real time measuring and reporting of activity can reduce absenteeism, for example, by showing whether community health workers are actually visiting patients or simply entering data. In the same way, electronic payments can be tied to work and the accuracy of work.

PRIVATE AND THIRD SECTOR HUMAN RESOURCE DATA CHOKEPOINTS

In the private sector and the so-called third sector, that is, nonprofits, the same bottlenecks exist and are often exacerbated. In most countries, private entities do not have the national infrastructure that ministries of health enjoy. One exception is Ghana, where faith-based organizations have much more sophisticated administrative capacity.) Health workers frequently move back and forth between government and private sector/NGOs, but most countries do not have standardized electronic registries to track them. It is important to build trust and a spirit of collaboration between the public and private sectors and to develop policy frameworks that incentivize truthful reporting. One way would be for the private sector to provide more information on its health workforce to the Ministry of Health.

Training institutions, or the associations and professional organizations responsible for accrediting health professionals, also can be a chokepoint for health human resource data flows. In most countries the training institutions report to the Ministry of Education

and lack strong direct ties to the Ministry of Health. This results in planning in the education sector that does not adequately reflect healthcare workforce needs. IntraHealth, a U.S. based nonprofit dedicated to strengthening health workers and the systems that support them, has addressed this gap. It developed “iHRIS” software, an open source human resources information system for managing health worker data. The system builds necessary links so accurate data from training institutions can converge with better data on existing health worker resources at the village level. The diagram below demonstrates how training institutions sit relative to HRIS and HMIS systems.



There is a final bottleneck at the level of the professional councils, which maintain records of trained health professionals. All health workers in the system must register with the councils, in most cases annually. Obtaining or updating one’s license often requires a long trip to the capital city. The

relicensing procedure, however, offers a rich opportunity for ICT-based intervention, which could turn the bottleneck into an asset. Licensing paperwork and fees could be filed electronically. And a country's electronic payment system (including mPayments, or payments via mobile device) could be integrated with the online certification infrastructure through human resource electronic management software applications such as iHRIS. The result: bottleneck unclogged and the health system improved.

about the supply of and demand for health workers. There must be closer collaboration between the ministries of health and education through integrated HRIS.

SUMMARY OF CRITICAL DATA FLOW ISSUES IN HUMAN RESOURCE SYSTEMS

The discussion of human resource systems has emphasized the following bottlenecks:

- Data does not flow smoothly or regularly between local clinics and regional and national entities. This makes it difficult to determine how or even if human resources are deployed within the system (ghost workers). Greater investments are needed to extend the reach of HR systems beyond the center to the periphery.
- Private sector organizations must collect more data on their human resources and share it with government systems to create an accurate picture of the actual human resources issues within countries.
- Training and certification processes must be strengthened and tracked via information systems so that accurate data on supply and demand area available.
- Gaps between training institutions and the health system lead to inaccurate data and misinformed policy decision-making



DATA FLOWS IN HEALTH SUPPLY CHAINS

*Written in collaboration with David Lubinski of PATH*³²

As a senior technical advisor at PAT, David Lubinski, M.B.A., M.A., leads the development of the technical framework for strengthening country health information systems. Previously he was chief technology officer to the Health Metrics Network (HMN), a Geneva-based partnership with the World Health Organization that seeks to increase the availability, quality, value, and use of timely and accurate health information by catalyzing the joint funding and development of country health information systems. David brings more than 30 years of experience in commercial, government, and non-governmental organizations focused on health information systems.

Health supply chains are a third critical component of effective health systems. Managers are tasked with providing medical goods such as vaccines, drugs and equipment to clinics, hospitals and community health workers at various service delivery points. Underperforming health systems frequently are traced back to broken supply chains, which often result from poor data flows. According to one study the availability of essential medicines in public sector facilities is roughly 38%, and under 60% in nongovernmental facilities.³³ When data does not flow freely within the supply chain, the result can be stock outages of essential drugs and scarceness of up-to-date information. In the context of maternal health, disrupted supply chains can mean that patients do not have access to family planning tools or drugs required for safe births. Broken supply chains negatively impact patients and health care providers and create barriers to incentives for research and

development of pharmaceutical products for developing country markets.

Like other health systems domains, supply chains are adversely affected by the fact that drugs and supplies for global health have been funded in disease-specific verticals. For example, there have been major efforts devoted to distributing AIDS and polio medicines but little effort devoted to increasing access to contraceptives. Consequently, the supplies of drugs needed for maternal health are frequently unavailable in clinics, forcing a pregnant woman or her relatives to procure essential drugs from the private sector or to go without them.

In most developing countries, local levels of the supply chains are managed through paper records. Missing data at the lowest rungs of the chain create significant challenges at the ministry level. This can lead to a system of irrational allocation of resources

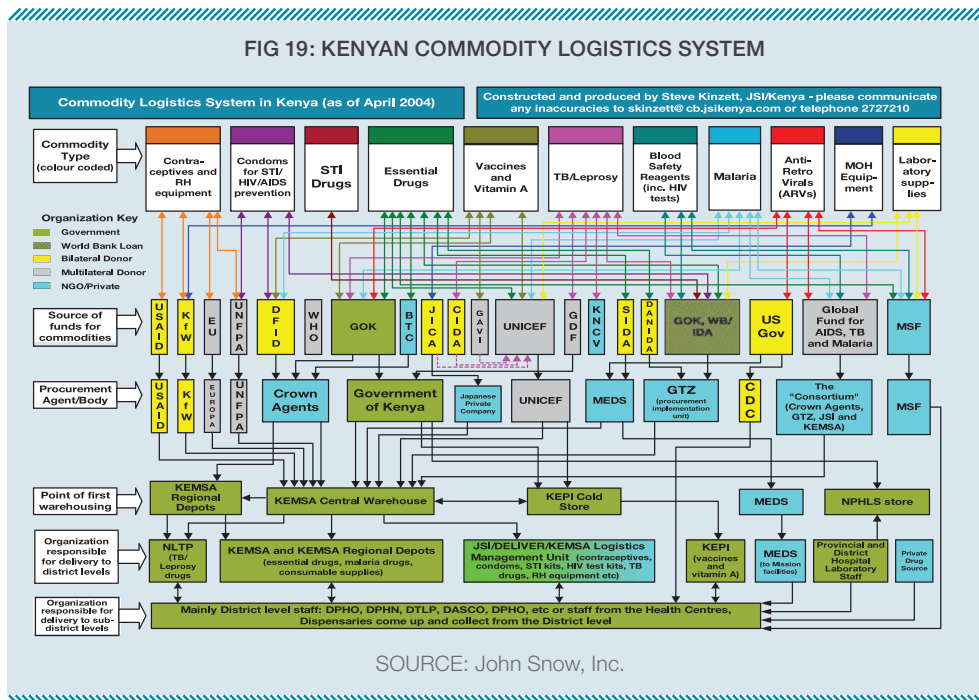
proving costly to health infrastructure and outcomes. Paper-based data collection makes it difficult for local governments to capture a timely picture of their health needs and it becomes virtually impossible for health ministries to build supply chains based on supply and demand. As a result, health supplies, including those for maternal health, are allocated on the basis of legacy distribution systems and experiences that do not account for shifting demographics and needs. One of the reasons for this type of legacy system is that supply chains have historically been designed from the top down. Technology-enabled enterprise architectures can bridge the needs of both top-down and bottom-up systems, creating workaround systems that make supply chains perform better at the local level. Local data can then be merged into a broader system.

COMPLEXITY OF SUPPLY CHAIN SYSTEMS

Supply chains have grown incredibly complex over the past several decades as the systems for procurement, financing and distribution of health commodities have become inserted within vertically-driven donor and disease portfolios. To illustrate the complexity of the supply chains for health commodities, below is a diagram of the system for Kenya that was developed as a case study several years ago.

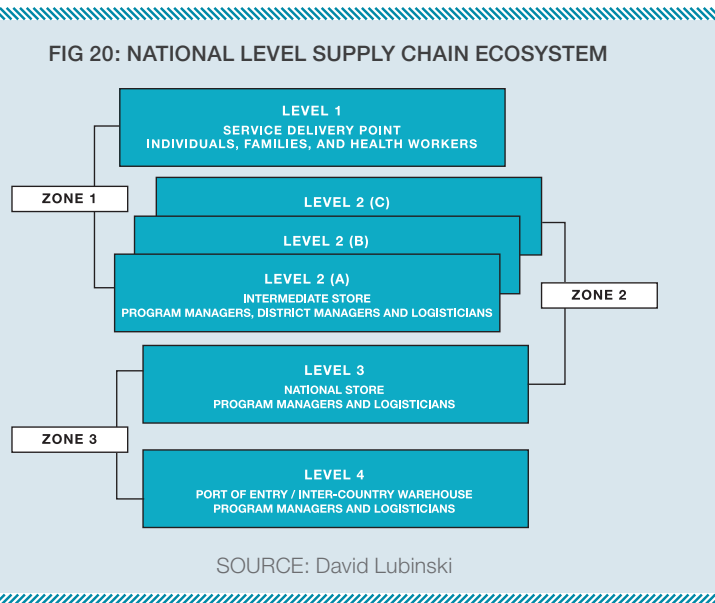
As David Lubinski points out, this is a system built from the top down with little focus on

the data needs of frontline health workers. Considering the complexity of the system and the few incentives in place to drive collection and transmission of accurate data, it is easy to see how many supply chains struggle to deliver the right commodities to the right points in the system at the right time. Before examining supply chain data flows in more detail, it is useful to look at concepts and constructs that are fundamental to understanding the supply chain ecosystem.



A service delivery point is the point in the supply chain where the drug, vaccine or medical supply is administered to a patient. It is the goal of supply chain administration to ensure service delivery points are stocked with the right product, in the proper condition, and at the right time to meet demand at that precise point. The primary delivery points are community health workers, clinics, and hospitals.

The following diagram depicts the multiple levels of a typical supply chain ecosystem. It shows how supplies enter into the health system, move through a series of inventory intermediaries in national supply warehouses, and then reach final delivery points.



KEY CHALLENGES FACING SUPPLY CHAINS

Understanding inventory data, or what supplies are available, is key to a properly working chain. In general, the service delivery points have immediate access to the information on their inventory. But in some contexts this can be difficult. The biggest challenge is getting reliable data from frontline workers and clinics. Most frontline service delivery points lack data on available inventory in nearby clinics or service delivery points, much less data at the inventory intermediaries. It is difficult to make decisions without reliable inventory data. It can result in district-level managers not knowing whether it is even worth ordering supplies because they believe the product(s) may

be unavailable from neighboring centers or intermediaries.

A second challenge concerns supply chain communications between local clinics, inventory intermediaries, and the health ministry. Many countries have automated inventory systems. Yet managers at the intermediary level (between national clearing houses and local clinics and pharmacies) cannot see what is available at the local level. Managers or storekeepers often have little access to online information about what is available. Lack of communication can also compromise the ability to respond to outbreaks. Taking the supply chain as a whole, we see the information asymmetries or data flow blockages at the lowest level cascading upward through the district and intermediate levels until the entire health system is compromised.

The power, infrastructure and training to adequately address the needs of the entire system exist only at the national level. There, supply chain information typically is automated via a warehouse management system. The challenge is to move beyond the walls of the warehouse and see inventory and usage at local levels. The data flow blockages rising from below create a scenario where inventory is determined by forecasts based on consumption histories from the past that contain inaccuracies and dated information. Adequately forecasting demand becomes a serious challenge and compromises the ability to meet health outcome targets.

A third challenge is posed by the lack of proper monitoring and evaluation in the

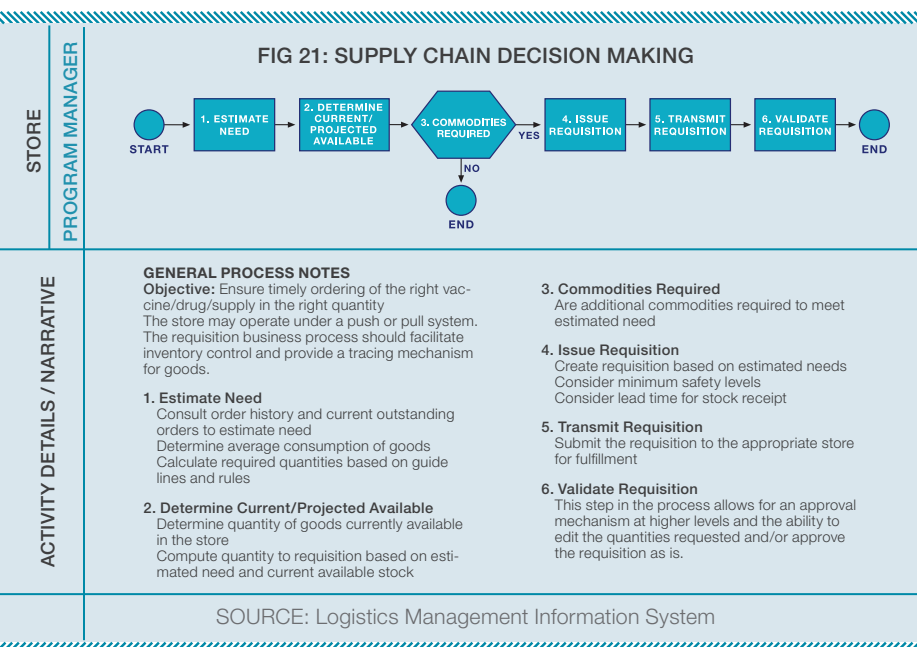
supply chain data flows, thereby hindering efforts to analyze improvements in those flows. Take as an example donors who want to assess the economic impact of health interventions. They may look at vaccines, which are seen as a public good. However, countries typically do not bear the expense of vaccines as they might for other health and medical commodities. Therefore, accurate financial data on the improvement of the system will likely be difficult to come by since national governments do not track this data. This challenge raises an interesting question: how we can encourage adopting eHealth/mHealth solutions when it may be difficult to structure incentives around economic gains?

The illustration below provides an overview of the supply chain process for a typical medical commodity such as a vaccine. Here we can see the types of data that must flow through the system to ensure proper decision making.

Typically, given current systems, little data exists on the temperature and other qualitative indicators of the vaccine's lifespan throughout the supply chain. However, as the price of sensors and RFID begin to fall we should expect this situation to gradually change. At the present time the high price of remote sensors has kept them from being widely adopted in low-income markets.

Many mHealth and eHealth tools have been used within supply chains to remedy some of the challenges addressed above. The National Malaria Control Programme and Rollback Malaria Partnership employed SMS for Life to track anti-malarial medications and serve as an alert for stock outages. Stop the Stockouts deployed FrontlineSMS in a number of partnerships to map drug availability. And UNICEF uses RapidSMS for inventory management.³⁴

We have learned some important things from enterprise architecture work on supply chain management. The primary focus on users and their needs has caused a lack of focus on overall system requirements. For example, many current pilots in mHealth have demonstrated anecdotal success stories on a small scale. In Zambia, SMS has been used to communicate better about the supply chain for malaria drugs and supplies in one part of the country. However, no study has yet reviewed the entire drug and supplies system. Consequently, we do not know if this initial success can scale up to cover all needs. One recent relevant example is the



case of EpiSurveyor in Malawi (MSH 2010) for data collection for End Use Verification as part of the President’s malaria initiative. This system is relatively inexpensive and easier to scale up. It could readily play a role in supply chain management as a system moves from paper to electronic records.

Lubinski points out that we must be able to demonstrate scope (beyond malaria), scale (across districts), and financial sustainability. It is no longer simply a question of whether the ICT-backed health interventions can be introduced to demonstrate impact. Instead, the question now is whether the design of an application is sufficient to enable scalable and sustainable interventions when the total cost of ownership – across a country and across all relevant uses – is factored in.

SUMMARY OF KEY ISSUES IN SUPPLY CHAIN DATA FLOWS

Strong health systems rely on a functioning supply chain. Improvements in this domain can vastly improve the availability and quality of care at the local level and bolster supply chain systems nationally. Across health verticals, and for maternal health in particular, data flows that provide reliable and valid indications of supply and demand of drugs and other supplies will be central to producing better health outcomes.

Some key findings in the supply chain area include:

- There are critical chokepoints across the system. But much of the problem begins at the local level where data on inventories are neither electronically recorded nor available across localities.

This makes it difficult to address gaps in supply and demand. Most of the records collected at the local level are paper-based. Moving from paper-based records to electronic systems will make data more transparent both horizontally and vertically.

- The lack of transparency at the most local level means that intermediaries are unable to make decisions based on real supply and demand. Once systems move to electronic formats it will be necessary to instill a “culture of data” that encourages making decisions on real inventories.
- The cascade of data flow blockages beginning at the local level means that national level warehouses make decisions based on sketchy forecasts rather than actual inventories and actual demand. Mobiles and electronic systems are needed.

We must design systems that are built on and scaled for local needs. One model to consider is that of Belize, where the Belize Health Information System integrates various health ecosystem domains. Belize is, however, a relatively small country. It overcame many of its challenges by employing a single IT system. While it is unlikely that Belize’s particular solution would work in much larger countries, we should study it for ideas that might be relevant in other settings.



RECOMMENDATIONS

This discussion paper has analyzed the three major domains of the eHealth ecosystems and has identified several ways to strengthen health data flows. Our recommendations address a continuum of issues that range from technological to organizational to building health workforce capacity.

DEVELOP A CULTURE OF DATA AND INFORMATION:

Hozumi et al (2002) define “culture of information” as “the capacity and control to promote values and beliefs among members of an organization by collecting, analyzing and using information to accomplish the organization’s goals and mission.” The question of data flows is not purely a technological matter but an organizational challenge where decision-making needs to be shaped around obtaining and using the best available data. Leadership in health organizations must commit resources for planning, training (capacity-building), financing, and supervising in order to strengthen ehealth systems.

DEVELOP TOOLS FOR CAPACITY BUILDING IN EHEALTH ACROSS THE PUBLIC HEALTH PROFESSIONS:

Information and communications technologies are playing an increasingly important role in making health systems stronger. They have the potential ability to scale up or down and to cut across the vertical silos that have plagued those systems in recent years. The fundamental building blocks must be in place to allow a system to interoperate. Then the health workforce must maintain and build that system for future use.. This requires a layer of supervisory technology professionals who can manage health information systems

at the regional level and who can respond to the needs of frontline workers. Having a well-trained cadre of midlevel hybrid professionals who understand both health systems and eHealth technologies will be important for making sure that data flows both across and up vertically driven programs.

DESIGN THINKING FOR DATA COLLECTION:

Designers are playing an increasingly important role in global health and development. Insights taken from the design field could be useful in the context of eHealth systems. For example, the partogram experience described in the report addresses the manner in which vital data forms are often left incomplete in developing countries and demonstrates deleterious effects when problematic pregnancies occur. Designers might be able to develop creative “work arounds” or forms more friendly to health workers or platforms that are more clearly integrated into workflows and clinical contexts.

BUILDING SYSTEMS FROM THE GROUND UP:

A sound design approach begins with the end users and then structures incentives and rewards for collecting and transmitting accurate data – and the right data – for making good decisions at all levels. The supply chain case study is a good illustration in this respect. Systems have

been created to push data up the supply chain without giving consideration to the uses of data and priorities at the local level. We must pay attention to the multiple directions data can flow as well as how senior management will use it if we are to develop better systems.

OPPORTUNITY OR INNOVATION MAPPING FOR DATA FLOWS: We have provided an overview of the typical scenarios for data flow challenges in the domains. The next step in addressing these challenges would be to crowd source an inventory of tools and approaches that have dealt with bottlenecks in diverse geographic contexts and find out how these tools were deployed and scaled. Ministries of health could then turn to a list of “best in class” tools and deployments as they seek to build robust eHealth systems.

MATERNAL HEALTH CONTINUUM OF CARE AND OVERALL HEALTH SYSTEM STRENGTHENING MUST WORK HAND IN HAND: Throughout this paper we have used maternal health as a particular focal point where possible. We believe this is important because there is a growing interest in maternal health as an indicator of how effective an entire health system is. However, we must avoid creating another silo for maternal care and focus instead on it as an eHealth model for transforming an entire system. Systems and platforms designed for this domain must be scalable to other problem spaces as well as being capable of engaging with sectors outside of health. This is a point that is often neglected in the current eHealth discussions.

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- ⁵ World Telecommunication/ICT Development Report 2010, 2.
- ⁶ World Telecommunication/ICT Development Report 2010, 2.
- ⁷ "Ericsson: Benefits of mobile communication in rural and developing areas" Reuters, Sep. 20, 2010, (<http://www.reuters.com/article/idUS91685+20-Sep-2010+HUG20100920>).
- ⁸ Diane Coyle, Patrick Meier, *New Technologies in Emergencies and Conflicts: The Role of Information and Social Networks*, (Washington, D.C. and London, UK: UN Foundation-Vodafone Foundation Partnership, 2009) 6.
- ⁹ Vital Wave Consulting, *mHealth for Development: The Opportunity of Mobile Technology for Healthcare in the Developing World*, (Washington, D.C. and Berkshire, UK: UN Foundation-Vodafone Foundation Partnership, 2009), 9.
- ¹⁰ S Naicker, JB Eastwood, J Plange-Rhule, RC Tutt, "Shortage of healthcare works in sub-Saharan Africa: a nephrological perspective," *Clin Nephrol Sup* 74:S1: 129-133.
- ¹¹ Save the Children. *A Fair Chance At Life: Why Equity Matters for Child Mortality. A Report for the 2010 Summit on the Millennium Development Goals*. London, UK: 2010, p. 5. (References study by H. Yusuf and H. Atrash, 'Parents' death and survival of their children' in *The Lancet*, 375, 9730, 2010, pp 1944–1946.) Online at http://www.savethechildren.org.uk/en/docs/A_Fair_Chance_at_Life.pdf (last accessed on February 1, 2011).
- ¹² http://whqlibdoc.who.int/publications/2010/9789241500265_eng.pdf
- ¹³ *Ibid.*

- ¹⁴ <http://www.countdown2015mnch.org/documents/2010report/CountdownReportOnly.pdf>
- ¹⁵ Peter Byass, "The unequal world of health data," *PLoS medicine* 6:11, <http://dx.plos.org/10.1371/journal.pmed.1000155> (2009).
- ¹⁶ A future version of this project may attempt to track data flows across the continuum of care for maternal health. Astute readers of this paper may recognize that surveillance systems are not necessarily an aspect of the maternal continuum of care. Data flows for maternal care would most certainly include health care facilities and clinical data flows.
- ¹⁷ Sally Stansfield, Nosa Orobato, David Lubinski, Steven Uggowitz, Henry Mwanyika, "Remarks of Theo Lippeveld on the paper: The Case for a National Health Information System Enterprise Architecture: the Missing Link to Guiding Global Development and Implementation," http://www.who.int/healthmetrics/tools/1HMN_Architecture_for_National_HIS_20080620.pdf One should note that data architectures are several steps downstream from the core or initial enterprise architecture systems requirements process.
- ¹⁸ Yochai Benkler, *The Wealth of Networks*. 2006, Yale University Press, New Haven.
- ¹⁹ MV Kinney, KJ Kerber, RE Black, B Cohen, F Nkrumah, et al., "Sub-Saharan Africa's Mothers, Newborns, and Children: Where and Why Do They Die?," *PLoS Med* 7:6, e1000294. doi:10.1371/journal.pmed.1000294, (2010) and Fabiano Teixeira da Cruz, "How Mobile Phone Technology can Fight Maternal Mortality," *UN Dispatch*, <http://www.undispatch.com/node/9952>, (June 8, 2010).
- ²⁰ Peter Byass
- ²¹ Donald Berwick (2003). *Escape Fire: Lessons for the Future of Health Care*. Jossey Bass.
- ²² For further information, see Patrician Mechel, *Barriers and Gaps Affecting mHealth Policy and Research in the Developing World*, (Washington, D.C.: mHealth Alliance, 2010).
- ²³ The following section was written in collaboration with Ramesh Krishnamurthy, June 2010.
- ²⁴ Lennert and Krishnamurthy, 2009.
- ²⁵ Krishnamurthy and St. Louis, 2010.
- ²⁶ HMN Framework, 2007. <http://www.who.int/healthmetrics/documents/framework/en/index.html>

²⁷ Ibid.

²⁸ According to William Hersch et al, 2010. Hersh WR, Margolis A, Quirós F, Otero P, Building a health informatics workforce in developing countries, *Health Affairs*, 2010, 29: 274-277.

²⁹ David Blumenthal, National Coordinator for Health IT, quoted in 2009:
<http://www.healthcareitnews.com/news/health-it-effort-create-thousands-new-jobs-says-blumenthal>

³⁰ We are essentially at the beginning of the movement to build ehealth capacity with initiatives, such as the American Medical Informatics Association's 10 x 10 program that aims to train 10,000 health workers in health informatics by the end of 2010, and several other nascent partnerships.

³¹ The following section is written in collaboration with Dykki Settle, June 2010.

³² The following section is written in collaboration with David Lubinski, June 2010.

³³ Center for Global Development (2007). *Global Health Forecasting Working Group. A Risky Business: Saving Money and Improving Global Health Through Better Demand Forecasts*. Washington, DC.

³⁴ See study by Ali Bloch for mHealth Alliance (forthcoming).

