How Can Routine Health Information Systems Improve Health Systems Functioning in Low-Resource Settings?

Assessing the Evidence Base

MEASURE Evaluation
SPECIAL REPORT

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Assessing the Evidence Base

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Table of Contents

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Abstract

Health system strengthening depends on production and use of quality health data and information at all levels of the health system. Routine health information systems (RHIS) are receiving increasing attention as a sustainable strategy towards country-owned, integrated national systems that reduce reliance on parallel, vertical systems. To guide investment decisions on RHIS strengthening, evidence is needed on which types of strategies work and which do not. This paper reviews the literature on the evaluation of RHIS interventions in low- and middle-income countries, on the premise that investments in RHIS could produce greater benefits than they currently do. The paper describes the conceptual literature on the determinants of RHIS performance and its role in improving health systems functioning and performance at the local level, discusses the evidence base on the effectiveness of strategies to improve RHIS performance, provides an overview of RHIS evaluation challenges, and makes suggestions to improve the evidence base that can be used to help ensure that (a) RHIS interventions are appropriately designed and implemented to improve health systems functioning and (b) resulting RHIS information is used more effectively.

Section 1 Introduction

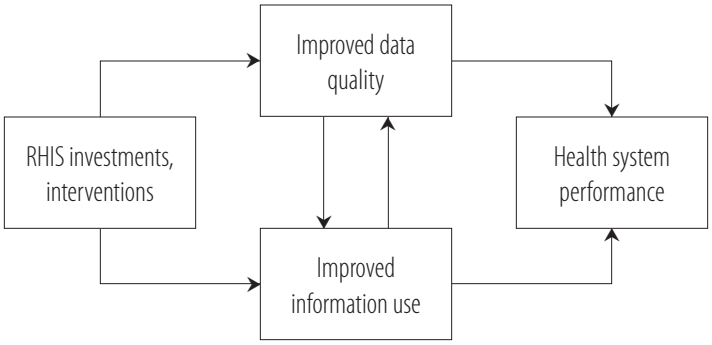
Improving the use of health information is seen to be integral to scaling up the delivery of quality health care services (AbouZahr and Boerma, 2005; Sauerborn and Lippeveld, 2000; Evans and Stansfield, 2003). Improved information use requires improved quality of data and of information products, which in turn requires improved health information systems (HIS). Health information system strengthening has received unprecedented attention in recent years, as evidenced by the formation of the Health Metrics Network, the convening of the Global Health Information Forum in 2010 in Bangkok, and the unveiling of President Obama's Global Health Initiative, which calls for "strengthening existing public heath surveillance and other data collection systems for monitoring diseases, conditions, health service provision, and health outcomes" as part of an integrated approach to strengthen health systems (U.S. Government, 2011).

Health data and information come from a variety of sources, including population-based sources, such as censuses, vital registration, and household surveys, and institution-based sources, such as facility surveys, facility records, and individual records (Health Metrics Network, 2008). As facility-based routine health information systems (RHIS)[1] only collect data on the services provided by those facilities and not services obtained from other sources (e.g., private commercial sector) and those who do not access health care at all, many consider nationally representative population-based household surveys to be the gold standard to track population health, risk factors, and health service coverage. However, nationally representative population-based household surveys are of little value for tracking service delivery, patient management, and underlying health system functions at the district and facility levels.

Health systems strengthening strategies at the district and facility levels require robust RHIS for evidence-based decision making (Lippeveld et al., 2000). For example, to properly implement quality assessment and assurance strategies, RHIS data and information are needed to help ensure adherence to service delivery guidelines, to minimize medical errors, and to ensure that commodities are available. Broader health system reforms also require information from RHIS. Examples include pay-for-performance, where information is needed to verify whether pre-specified targets have been achieved, and government-funded health insurance programs, where data and information are needed to deliver and pay for services that are part of a basic benefits package, and to monitor the quality of care. Figure 1 outlines a framework that describes the linkages between investments in routine health information systems (RHIS), the data they produce, use of health information, and ultimately health system performance.

[1] Sometimes referred to as health management information systems.

Figure 1 Linkages Between RHIS Investments and Health System Performance



Locally managed RHIS become potentially more valuable as countries decentralize health sector responsibilities. Over the past 20 years, as country government health systems have become increasingly decentralized, officials at the district and facility levels have increased roles and responsibilities to make financial and managerial decisions. RHIS can play a key role in improving management and accountability capacity and mechanisms (Mills et al., 2006).

This paper addresses the issue of improving and maintaining the role of routine health information systems at the local level in low- and middle-income countries. A key premise of the paper is that governments and non-governmental organizations spend significant resources on RHIS and such investments could produce greater benefits at the district and facility levels than they currently do. To help guide decisions on how to invest in RHIS to improve health systems performance, evidence on the relative effectiveness of various RHIS strengthening strategies is needed. Evidence of effectiveness is particularly important as countries try to move away from parallel systems and toward using country-owned, integrated national systems (Baughman and Nu, 2011).

The paper is organized as follows. In the following section, we provide an overview of the methods used in the literature review. In the third section, we describe the conceptual literature on the determinants of RHIS performance and its role in improving health systems functioning and performance at the local level. In the fourth section, we discuss the evidence base on the effectiveness of strategies to improve RHIS performance. In the fifth section, we provide an overview of evaluation challenges and knowledge gaps. In the final section, we provide recommendations to improve the evidence base that can be used to help ensure that (a) RHIS interventions are appropriately designed and implemented to improve health systems functioning and (b) resulting RHIS information is used more effectively.

Section 2 Methods

Key definitions of RHIS, RHIS performance, health systems functioning, and health systems performance used in the study are presented in Box 1. For the purposes of this paper, we define RHIS as systems that provide information at regular intervals of a year or less through mechanisms designed to meet predictable information needs (Aqil et al., 2009). We view RHIS as consisting of a broad array of routine systems, including: surveillance systems for identifying the incidence of disease; individual medical records (paper-based or electronic) that can be used by doctors, nurses, and other types of health workers to improve the quality of care delivered to individuals; and facility-based systems (paper-based or electronic) that can be used by district- and facility-level officials to track the delivery of health care services and related support systems, including equipment and supplies, finance, payment, infrastructure, and human resources.

Box 1 Key Definitions

Routine Health Information System
A system that provides information at regular intervals of a year or less through mechanisms designed to meet predictable information needs. This includes paper-based or electronic health records, and facility- and district-level management information systems.

Routine Health Information System Performance
Data quality (relevance, completeness, timeliness, accuracy) and continuous use of routine information for decision-making.

Health Systems Functioning
Service delivery (i.e., service access, service efficiency, adherence to provider guidelines, reduced medical errors, improved patient tracking, improved tracking of equipment, logistics, and supplies), leadership and governance, human resources for health, financing, medicines and supplies.

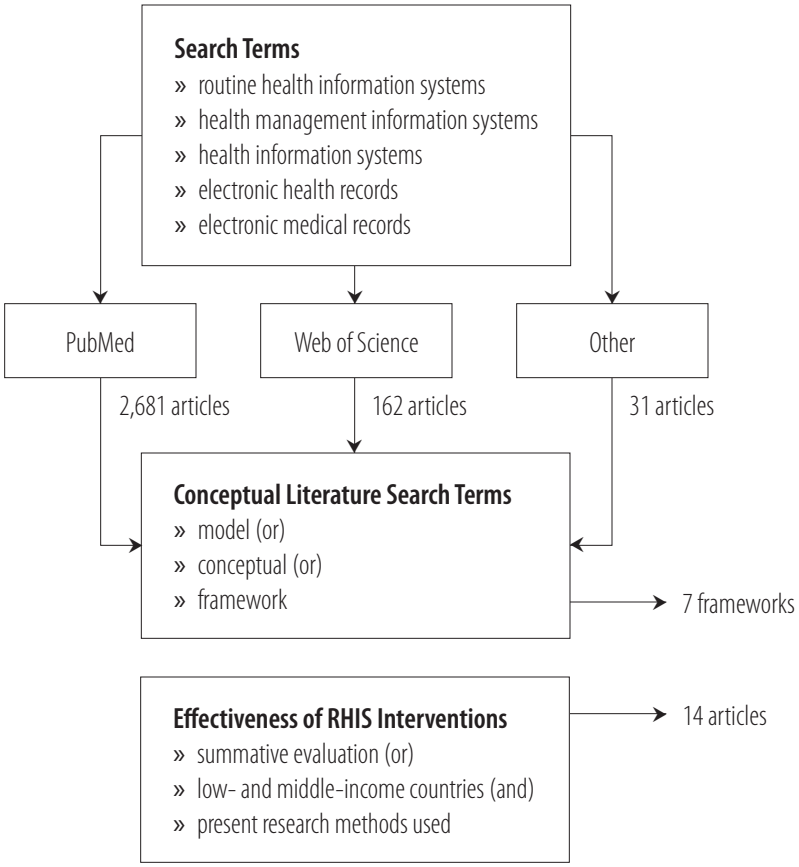
Health Systems Performance
Health outcomes (level and distribution), responsiveness (level and distribution), and financial protection.

We conducted a literature search for RHIS evaluation frameworks research articles on the effectiveness of RHIS strengthening interventions. We searched PubMed and Web of Science for articles published from 1970 to 2011. The search was conducted from May to July 2011, and key words used were “routine health information systems”, “health management information systems”, “health information systems”, “electronic health records”, and “electronic medical records”. The search in PubMed yielded 2,681 articles, Web of Science generated 162 articles, and 31 articles were identified from other sources, for a total of 2,874 articles. We also searched Web sites of organizations working on projects to strengthen RHIS, reference lists from identified articles, and references provided by colleagues.

To identify evaluation frameworks, we searched from within the 2,828 articles by using the keywords "model", "conceptual", and "framework". We then reviewed the abstracts to identify articles that (a) present a conceptual framework that can be used to evaluate the effectiveness of facility-based RHIS interventions (either in developed or developing countries) and (b) discuss RHIS inputs, processes, outputs, or outcomes, which could include RHIS data quality and use as well as various aspects of health systems functioning and performance.

To identify articles that evaluate the effectiveness of RHIS interventions, two graduate researchers independently worked under the supervision of the authors to select from within the 2,828 articles those that: (a) present a summative evaluation that assess the impact of a technical, organizational, or behavioral intervention introduced for the purpose of improving one or more aspects of RHIS performance or health systems functioning, or both; (b) come from low-income and lower middle-income countries (based on the World Bank's classification of country economies into low income, lower middle income, upper middle income, and high income categories); (c) include a clear presentation of the research methods used, which could include quantitative approaches with or without a control group or qualitative approaches that involve focus group discussions and in-depth interviews. The two reviewers independently eliminated articles that did not take place in a lower middle-income or a low-income country, or were not an evaluation of a RHIS strengthening intervention. Following these exclusions, the reviewers assessed the remaining articles to determine if they met the criteria above. If unsure of whether a particular article met the inclusion criteria, the reviewers included the article in the batch of articles to be reviewed by the lead authors. After this process was complete, the two reviewers compared lists and created three libraries for the lead authors to review: a library where both reviewers agreed on the article's applicability (14 articles), and two libraries where only one reviewer agreed on the article's applicability (21 articles). In a meeting where the reviewers and the lead authors discussed each article, it was determined that fourteen articles met the inclusion criteria. Figure 2 summarizes the literature search.

Figure 2 Literature Search



Section 3 Determinants of Routine Health Information System Performance

3.1 Sources and Quality of Evidence

The variation in the types of routine health information systems discussed in the literature ranges from paper-based facility records to electronic health records. Many of the articles meeting our inclusion criteria come from the health informatics literature. These are typically geared toward the evaluation of hospital electronic health records in high-income settings. The articles presenting frameworks for evaluating health information systems in developing country contexts come from the health policy and tropical medicine literature and the grey literature. One of these articles focuses specifically on RHIS (Aqil et al., 2009), while the others focus on the process of evidence-based decision making based on data from a variety of HIS components (De Savigny and Binka, 2004; MEASURE Evaluation, 2006; Health Metrics Network, 2008).

3.2 Determinants of RHIS Performance

As defined in Box 1, RHIS performance encompasses both data quality—relevance, completeness, timeliness, accuracy—and information use for decision making.

The growing attention to the field of RHIS evaluation stems in part from the rapid development of information and communications technology (ICT) and from the high level of attention to the role of quality routine health information in improving planning and management. However, if not appropriately designed and implemented, RHIS interventions can and often do fail. As discussed in Marcelo (2010), there are many examples of failed RHIS projects in both developing and developed country contexts (see Littlejohns et al., 2003 and Balka, 2003 for examples). Improving health care delivery through RHIS-based approaches can be particularly challenging in developing countries, where health systems are often under-resourced, chaotic, and corrupt (Lucas, 2008).[2]

The focus of recent RHIS evaluations encompasses not only technical issues—such as the number and types of indicators, and the type and complexity of the data generation architecture and decision support systems—but also includes behavioral and organizational issues (Yusof et al., 2008; Ammenwerth and de Keizier, 2005). Box 2 presents a range of potential determinants of RHIS performance discussed in the literature we reviewed. Determinants at multiple levels are discussed, including the societal, health systems, organizational or facility, program, and health worker levels. Notice that within each level, technical, organizational, and behavioral factors are all featured.

[2] However, it has been observed that the adoption of information systems within the health care sector in high-income countries such as the United States has lagged behind other sectors.

Box 2 Underlying Factors That Might Influence RHIS Data Quality and Information Use

Societal-Level Factors

» Income per capita, transportation infrastructure, communications infrastructure, traditions and values, including the presence of a culture of information; corruption; regulatory environment.

Health System-Level Factors

» **Technical:** indicators (type and number); data collection and reporting standards; infrastructure; complexity of reporting forms; complexity of data generation architecture; software.
» **Organizational:** leadership and governance; planning processes; availability of resources; degree of integration of services and supporting management; training opportunities; management and supervision processes; incentives (both financial and non-financial); presence of quality improvement processes; promotion of a culture of information.

Facility- or Organization-Level Dactors

» **Technical attributes:** indicators (type and number); infrastructure; complexity of reporting forms; complexity of data generation architecture; software.
» **Organizational:** leadership and governance; planning processes; availability of resources; training opportunities; management and supervision processes; incentives (both financial and non-financial); presence of quality improvement processes; promotion of a culture of information.

Health Program-Level Factors

» **Technical attributes:** indicators (type and number); infrastructure; complexity of reporting forms; complexity of data generation architecture; software.
» **Organizational:** leadership and governance; planning processes; availability of resources; training opportunities; management and supervision processes; incentives (both financial and non-financial); presence of quality improvement processes; promotion of a culture of information.

Health Worker-Level Factors

» **Organizational and behavioral:** motivation to use information; skills to collect, analyze, and use information for decision-making; confidence levels for RHIS tasks.
» **Health worker attributes:** age; educational attainment; experience.

3.3 Conceptual Frameworks to Describe RHIS Performance

Seven conceptual frameworks linking RHIS to health systems performance were found. They are summarized in Appendix 1. One framework is the *Performance of Routine Health Information System (PRISM)*, developed by Aqil et al. (2009) with support from USAID's MEASURE Evaluation project. We discuss PRISM first because it is the only framework we reviewed that differentiates between RHIS inputs, processes, outputs, outcomes, and impact—a "classic" evaluation approach that we chose to use to describe the other frameworks. PRISM consists of a conceptual framework and associated data collection and analysis tools to assess, design, strengthen and evaluate RHIS. The PRISM conceptual framework hypothesizes that technical, behavioral and organizational determinants (inputs) influence data collection, transmission, processing, and presentation (processes), which in turn influence data quality and use (outputs), health system performance (outcomes), and ultimately, health outcomes (impact). In their description of the

PRISM approach, the authors stress the importance of "how people react and use information for problem solving or self-regulating their performance (behavioral factors)" and "organizational processes for creating an enabling environment for using and sustaining RHIS" to the success of RHIS strategies (Aqil et al., 2009). An organizational factor included in the framework is the promotion of a culture of information, and behavioral factors include RHIS task competence and confidence and the motivation to analyze and use RHIS information.[3]

Many of the other frameworks also stress the joint importance of technical, behavioral and organizational factors to the success of RHIS interventions. For example, the *Information Systems (IS) Success Model*, first proposed by DeLone and McLean, focuses on measuring the success of information systems (DeLone and McLean, 2003), using a multi-dimensional model of "success" that includes information quality, system quality, service quality, intention to use, actual use, user satisfaction, and net benefits.

The *IS Success Model* was developed to assess IS in general and not specifically RHIS, but a number of health informatics researchers have applied the model to the evaluation of RHIS (e.g., Lau et al., 2010). Yusof et al. (2008) build on the I*S Success Model* in their *human, organization, and technology-fit (HOT-fit) model*. HOT-fit incorporates organizational factors, such as structure and environment, and defines net benefits as aspects of facility-based performance, including clinical practice, efficiency, effectiveness, decision-making quality, error reduction, and clinical outcomes, all aspects of health systems performance.

In addition, most of the frameworks reviewed consider the potential linkages between RHIS data quality and information use for better health systems functioning. Data quality is characterized by the relevance, accuracy, timeliness, and completeness of data. Information use is defined as decision makers explicitly considering information in policymaking, planning, management, and service delivery.

Appendix 1also illustrates several inter-related concepts that are important to evaluating the impact of RHIS strengthening initiatives. The dimensions included in the frameworks consist of service coverage (i.e., service availability, service utilization), service quality (i.e., patient safety, adherence to provider guidelines, reduced errors, improve continuity of care, patient satisfaction), and efficiency (i.e., changes in resource allocation, changes in work practices, unit costs).[4] Such outcomes might be measured using different units of analysis. Service coverage would ideally be measured at the national, regional, and district levels, service quality would be measured at the facility level, and efficiency could be measured at multiple levels.

[3] Based on the framework, four survey instruments and associated sampling procedures and analysis guidelines were developed to assess RHIS performance, processes and technical, behavioral, and organizational determinants at the facility, district, and country levels. The reliability and validity of the PRISM instruments have been supported in Hotchkiss et al. (2010) using facility-based survey and record review data from Uganda. The PRISM approach has been used in a large number of RHIS assessments conducted in Asia, Africa, and Latin America (Aqil et al., 2009).

[4] For an excellent review of systematic reviews of health information system studies, most of which come from high income countries, see Lau et al., 2010.

Examination of these frameworks leads us to several conclusions. First, along with technical factors, all of the frameworks stress the importance of social and organizational factors to the success of information systems. Information systems have multiple users within an organization—for example, health workers, clerks, facility administrators, and decision makers at higher levels—and if the stresses and benefits of adopting the RHIS are not considered from the perspective of each type of user, then the chances that the information system will improve health systems functioning will be reduced. This is a key theme of not only the frameworks we reviewed, but also in the overall literature on evaluating information systems. For example, Berg (2001) and Anderson and Aydin (2005) stress the view that complex social interactions within the organization determine the use and impact of RHIS. According to this view, understanding the dynamic social and political processes that occur within organizations as well as characteristics of individuals and the information system is required in order to predict the impact of RHIS interventions on organizational change.[5]

Second, if we wish to study data quality and information use to improve health systems functioning, we must consider whether local officials have the authority to make decisions (MEASURE Evaluation, 2006). What types of decisions do local officials have authority to make, including service delivery, governance, financing, human resource management, logistics management, etc.? Who makes those decisions? The authority of local officials to make these kinds of decisions depends on their "decision space". According to Bossert, "decision space involves a complex determination of how much choice over different functions and use of funding local officials are allowed/provided from above (i.e., de jure decision space), as well as powers actually exercised in practice (de facto informal decision space)" (Bossert, 1998). Their decision-space over each of these functions depends on whether and how health sector responsibilities have been devolved from the central level to the local level.

Third, demand for data and information is a prerequisite to information use. For example, Aqil et al. (2009) treat data demand as a behavioral determinant of RHIS performance, while DeLone and McLean (2003) discuss the "intention to use" information as an indicator of information system success. The Data Demand and Information Use (DDIU) framework defines data demand as the value that organizations and health workers place on health information and their motivation to use it (MEASURE Evaluation, 2005). As such, data demand is distinct from the use of information; it requires that (a) stakeholders and decision makers specify what kind of information they want to inform a decision and (b) the stakeholders and decision makers proactively seek out that information.

[5] In addition to this theory, there are two other general types of theories that appear in the literature: (1) technology as an external force, and (2) system design as determined by user information needs. The first type of theory views the information system as an exogenous force that leads to the change in the behavior of individuals and their work, and ultimately to changes in the organization. Studies based on this theoretical perspective tend to minimize the role of organizational characteristics in the success of RHIS strengthening initiatives. The second type of theory takes a very different perspective. It views the design of information systems as an endogenous factor that is determined by the information needs of managers, clinicians, and other users. See Anderson and Aydin (2005) for a review of these theories.

Box 3 "Data" vs. "Information"

The distinction between "data" and "information" has received considerable attention in the literature. For example, De Savigny and Binka (2004) argue that there is often confusion in the use of terms such as data, information, and monitoring, and propose a framework for thinking about the linkages between data, information, evidence, knowledge, actions or decisions, and impact. The pathway starts with data, which have no intrinsic value in themselves until they have been compiled, managed, and analyzed to produce information. Information must then be transformed and packaged to reveal the evidence it embodies. If evidence resonates with those responsible for planning and management, knowledge is created. Knowledge can then be the basis for actions or decisions, which can have an impact on health programs and systems that can be monitored and evaluated (De Savigny and Binka, 2004). The Data Demand and Information Use Conceptual (DDIU) framework also stresses that raw data are seldom useful for decision-making and usually must be transformed into information that is usable and that relates to a decision or choice that must be made (MEASURE Evaluation, 2006). A critique of health information systems in many low- and middle-income countries is that they are "data rich" but "information poor" (Health Metrics Network, 2008).

Positing demand for information as important to the success of RHIS performance has interesting implications: (1) it implies that interventions that have the primary aim of collecting data for reporting and that focus on technical factors with insufficient attention to organizational and behavioral factors, are likely to fail in improving the use of information at the local level. Such interventions might be successful in meeting the reporting needs of bureaucrats in ministries of health and international organizations, and in improving data quality, but are likely to be insufficient for improving the use of information; and (2) it implies that broader and more complex health systems strengthening efforts that have key RHIS components can increase the value of information, and as a result, the demand for data and information. We discuss specific examples of broader health systems interventions in Section 4.

Fourth, and related to the discussion above, many frameworks stress health worker motivation as key to the success of information systems. Motivation to carry out general management and service delivery responsibilities, which can influence the demand for information, as well as the motivation to collect, analyze and use RHIS information are both cited. The stress on motivation as an important determinant of RHIS data quality and information use is very much in line with other types of reforms that aim to strengthen health systems in low- and middle-income countries. Motivation is considered to have an important influence on health worker performance, and there is a growing body of research that suggests that both financial and non-financial factors can be used to strengthen health worker motivation. For example, the increased use of pay-for-performance strategies is based on the premise that financial incentives for achieving service delivery targets can help improve health worker performance. Other examples of financial factors include salaries and bonuses, and examples of non-financial factors include prestige, organizational values, self-efficacy, pride, work conditions, and opportunities for career advancement (Franco et al., 2004).

Section 4 RHIS Strategies and Interventions for Improving Health Systems Functioning

4.1 Strategies and Interventions of Interest

The second analysis of the literature search assessed the evidence base on the effectiveness of RHIS interventions. We were interested in three fundamental questions: (1) is there any evidence that suggests that RHIS interventions have been effective in improving RHIS data quality, information use, and health systems functioning at the local level, (2) which interventions have been most effective, and (3) in which situation should a particular intervention be used? Based on the review of the conceptual literature presented in the previous section, we developed a typology of RHIS strengthening interventions, which is presented in Box 4. The intervention types consist of those that address technical barriers to the use of information and communication technology, those that address organizational and behavioral barriers to data quality and information use, and broader, more complex health systems strengthening that include RHIS components, that include but are not limited to pay-for-performance and social insurance strategies. The first two types of interventions are discussed extensively in the RHIS literature. The third type of intervention is not discussed explicitly, but we include it because health systems strengthening interventions that incorporate RHIS potentially can improve the demand for information, a key determinant of information use.

Box 4 Overview of Strategies and Interventions to Improve RHIS Performance and Health Systems Functioning

Technical Interventions

» Address technical barriers to data quality and information use.
» Examples: indicators, data generation architecture (data collection, entry, analysis, flow), decision support systems (information use).

Organizational, Behavioral Interventions

» Address organizational and behavioral barriers to data quality and information use.
» Examples: decision-space analysis at the district/facility level; management and RHIS self-assessment; incentives to collect, analyze and use information.

Broader HSS Interventions That Combine RHIS and Other Health Systems Strengthening Components

» Address organizational, behavioral and technical barriers to data quality and information use.
» Examples include (1) pay-for-performance to improve health worker motivation—where facilities/providers receive bonuses for the achievement of pre-specified targets—and (2) insurance to improve risk-sharing—where providers are paid on a fee-for-service or capitated basis.

There is a range of research methods that could be used to answer the types of questions above. Empirical methods include randomized control trials and quasi-experimental designs using treatment and control groups. They also include research designs without control groups, which are limited in assessing effectiveness. Qualitative methods are also useful to study issues related to organizational and behavioral factors related to the design, adoption, and use of information systems, and the perceptions of system users in carrying out their responsibilities to collect and analyze data, and use information for decisions.

4.2 Overview of Studies

Using the search strategy described in the methods section, fourteen studies were judged to meet the inclusion criteria. Two more studies that might have met the inclusion criteria were not reviewed because the articles could not be accessed. We also found a systemic review of evaluation of e-Health interventions and strategies in developing countries (Blaya et al., 2010) that included electronic health records (EHR) evaluations.

A brief description of the articles identified through the review is presented in Appendix 2. Overall, we found few evaluations of RHIS interventions in developing country settings. Of the fourteen studies identified, ten come from sub-Saharan Africa, one from Eastern Europe, one from India, and one from a country which was not named to protect the identity of the respondents. All the studies evaluated interventions that included both technical and training (behavioral) components, and none of the studies evaluated broader health systems strengthening strategies that included RHIS strengthening components. Only four of the fourteen studies assessed linkages between RHIS strengthening and health systems functioning (i.e., length of in-patient hospital stay, referrals, waiting time, etc.).

As seen in Table 1 below, a wide range of research designs was used. The study with the most rigorous research design was an externally controlled study of the impact of an electronic health records system in South Africa. The other four empirical studies were descriptive and four studies were based on qualitative methods.

Table 1 Number of Articles Included in Analysis by RHIS Category and by Evaluation Type

RHIS Category	Quantitative		Qualitative
	Descriptive	Controlled	
HMIS	2	0	1
Health/medical records	1	3	6
Surveillance	1	0	0
Total	4	3	7

We also conducted an informal review (results not reported here) of the provider pay-for-performance literature to explore whether the role of health information systems on the effectiveness of pay-for-performance has been evaluated. Pay-for-performance involves the "transfer of money or material goods conditional on

taking a measurable action or achieving a predetermined performance target", and information from routine health information systems is needed to assess and verify whether providers have achieved the target (Eichler and Levine, 2009). Despite the crucial role of RHIS to the success of pay-for-performance schemes at the district and facility levels, none of the evaluations reviewed included a careful description of the role of RHIS in the intervention. Moreover, according to a recent assessment of World Bank health, nutrition, and population projects with pay-for-performance components implemented between 1995 and 2008, none of the projects adequately documented processes used to verify whether targets were achieved (Brenzel, 2009).

Section 5 Knowledge Gaps

We began with the question posed by title of this paper: how can routine health information systems improve health systems performance in low-resource settings? Based on our review of the evidence, the answer is that we do not yet know.

There are a number of challenges to evaluating the impact of RHIS strengthening on health systems functioning. The first and perhaps most significant challenge is the complexity of RHIS interventions. Our review of existing RHIS evaluation frameworks illustrates the complexity of RHIS and highlights the challenges of effectively examining the impact of RHIS interventions. Complex systems exhibit behavior or properties as a whole that may not be obvious from the behavior of the individual components. Because specific interventions target certain components of RHIS performance, their impact on overall performance is not necessarily clear. This is the likely explanation for why most examinations of RHIS performance we found in the literature focused primarily on technical and behavioral RHIS components, and not on broader, more complex health systems strengthening initiatives that incorporate RHIS components.

A second issue related to the first is that there may be multiple aims for RHIS interventions, including, for example, data quality, information use for a variety of purposes, technology acceptance, health worker motivation, and so on. In addition, the aim of some RHIS interventions might be to improve the availability of usable information at the central level, but not necessarily at the local level, often to meet national-level and global reporting requirements rather than to improve management and implementation at the local level. Coupling interventions with multiple aims and complex systems makes it challenging to detect the effect of the RHIS interventions. Evaluations of such RHIS interventions require a well-planned and rigorous methodology that is so far mostly lacking in the existing literature. We will discuss general methodological issues subsequently.

A third issue focuses on the timing of RHIS interventions and their evaluation. There is evidence in the literature from the United States that it takes a significant period of time, often several years, before HIS interventions begin to achieve the performance gains they were intended to achieve (Borzekowski, 2009). In fact, organizations may exhibit a period of decreased performance immediately following the introduction of an information systems intervention. Moreover, when information systems are introduced, users may be uncertain whether and how routine data may be of use to them to carry out their responsibilities. Their perceptions of how routine information might be useful may change over time. Because of these factors, cross sectional examinations of RHIS interventions are likely to fail to detect their long-term impact. A secondary issue related to the time it takes for an RHIS intervention to achieve its goals is the sustained effort needed to implement the intervention. If the intervention does not show short-term performance gains, it may be prematurely abandoned.

A fourth issue is the concept of "information use" and how it relates to RHIS. A clear theme that runs through the RHIS literature is the desire to support and achieve evidence-based decision making with information provided by an RHIS. To achieve this goal, the RHIS must provide high quality and relevant information for decision makers, which is in part a function of what information the decision makers demand, but the question arises as to how information from the RHIS can be expected to influence the types of decisions being made. In other words, at what point does the RHIS end and the decision process begin? There is an entire literature examining the decision-making process, of which the use of information is only one piece. Individuals make decisions based on a variety of other factors in addition to information, which makes the evaluation of an RHIS on the basis of decision making problematic. One could argue that having useful information is a necessary but not a sufficient condition for effective decision making.

If the use of information is considered an indicator of RHIS functioning, other questions arise. How should the information provided be used? On what basis do we evaluate whether it was used for decision making, rather than to support individual agendas? Who should use it, at what level, and for what purposes? These are hard questions to answer, and they are influenced by factors outside of the RHIS. One example of such a factor is the level of decentralization. Do local managers and staff have the autonomy to make decisions, and is the information provided by the RHIS useful for such decisions, or is the RHIS designed for central-level decisions?[6]

A related issue is how well the design of the RHIS separates data from the information that the system generates. An information system that stores data separately from the information needs of its users is flexible enough to generate a variety of information outputs based on user queries. On the other hand, a system that is designed to store data in relation to specific information needs or reporting requirements is generally not flexible enough to meet varying user information needs that may arise, particularly in a decentralized context. Put another way, an information system that is designed in a vertical fashion to meet the needs of users at a central level may not have the flexibility to meet information needs at the district or local levels. Separating the data collection, storage, and management from the information it will be used to generate allows the flexibility to meet the information needs of varying users.

This last point raises the issue of how "information use" can affect data quality, and vice versa. Simply put, poor quality data leads to low quality information, which

[6] Decentralization poses a critical challenge to ensuring the quality and effectiveness of RHIS in many developing countries (Nsubuga et al., 2006). A number of factors may be in play. First, RHIS may not perform well in a decentralized context if local health managers and staff lack the capacity to carry out devolved RHIS functions previously carried out by national level staff, or if there is low demand for health information at the local government level. Second, demand for information may be limited if RHIS is designed for centralized, disease-focused, and often fragmented programs, and if RHIS is unaligned with the needs of local managers and staff. This mismatch between the availability of information and user needs can be further exacerbated if efforts to reform RHIS are "data led" rather than "action led", and as a result, serve the interests of bureaucrats at the national and international levels rather than front-line health workers (Heywood and Campbell, 1997). Third, other health system factors, such as limited local resources, low health worker motivation, inadequate transportation and communication, and weak accountability, can also limit RHIS system performance.

is less valuable for effective decision making, while high quality data can lead to high quality and useful information for improved decision making. Here we see the interaction of technical and human or behavioral components of the system (Berg, 2001). User demand for useful information for decision making can lead to improvements in data quality. Likewise, useful information can lead to its increased use for decision making. This process of mutual transformation of an information system complicates efforts to evaluate its performance.

A fifth issue is the methodological approach used to evaluate RHIS interventions. Randomized-controlled trials may be considered the gold standard design, but they are practically difficult to implement in RHIS settings (Littlejohns et al., 2003). Case studies based on qualitative methods are useful to assess whether users adopt information systems and whether and how information is used for decision making, but cannot quantify the benefits on health systems functioning. Clearly, a variety of methods are available to examine RHIS interventions, but given the issues of complexity and the potential time lag between implementation and the realization of benefits, the most rigorously controlled approaches are particularly desirable. In particular, prospective, longitudinal designs, ideally with treatment and control groups, are needed, and would be major improvements in the approach to evaluating RHIS.

In summary, despite the potential role that RHIS can play in improving the functioning of health systems, there are numerous knowledge gaps on the ability of RHIS to improve health systems functioning and performance. We also have little knowledge of the benefits of specific interventions targeted at certain aspects of RHIS. Most of the literature we reviewed examined technical and training interventions, while none examined broader managerial and financial strategies in which RHIS plays a critical role. The cross sectional and quasi-experimental designs of the literature further complicates the current state of knowledge.

Section 6 Recommendations

Although improved health information is viewed as critical to the success of health systems strengthening strategies and interventions, including those related to moving away from parallel systems and toward supporting country-owned, integrated national systems, our literature review demonstrates that there is limited evidence on which types of information systems interventions work, and which do not. This dearth of evidence is not surprising, as in the context of low- and middle-income countries, health information systems are predominately viewed as a source of data for monitoring and evaluation, not as a topic of health systems research (Alliance for Health Systems and Policy Research, 2008).

A concerted effort is needed to build the evidence base on the costs and benefits of varying approaches to strengthen RHIS. One important first step would be to develop a research agenda. Table 2 provides recommendations on both formative and summative evaluation topics that might be included in such an agenda, by type of research and by their relative priority. Recommended components of a research agenda could include the following elements:[7]

» Refinement of existing conceptual frameworks for evaluating RHIS interventions. While there are a number of excellent evaluation frameworks available, most focus on the determinants of the availability of quality data and information use, but do not always clearly depict the linkages at play between data quality, use of information, and health systems functioning at various health system levels (facility, district, regional, national). Existing evaluation frameworks could be refined so that they more clearly show the causal pathways at work between technical, behavioral, and organizational determinants, demand for information, use of information, and service delivery. Such frameworks could be useful not only for guiding evaluations of RHIS interventions, but also for designing RHIS strengthening strategies.

» Research on the technical, organizational, and behavioral determinants of enhanced demand for information, improved data quality, improved information use, and the role of RHIS in improving health systems functioning. Previous studies have found that there is relatively little empirical research that links potential RHIS determinants and drivers and actual performance (Aqil et al., 2009; Alliance for Health Systems and Policy Research, 2008). Of particular interest is research on the role of organizational reforms and incentives that can influence the motivation of district and facility mangers to collect, analyze, and use information. Again, a better understanding of these issues could also be useful in improving the design of health systems strengthening interventions that incorporate RHIS components.

[7] The structure of this section draws on Rowe et al. (2005), an excellent literature review on strategies to improve health worker performance in low-resource settings.

» Research on the costs and effectiveness of strategies and interventions aimed to improve health systems functioning at the local level through improved RHIS data quality and information use. As mentioned earlier, all of the studies meeting our inclusion criteria are assessments of the impact of technical interventions. We did not identify any studies that assess the effects of organizational or other types of health systems strengthening reforms, nor did we identify any economic evaluations of the cost-effectiveness of alternative strategies. Moreover, most of the research designs we reviewed are inadequate to attribute changes in health systems functioning to RHIS interventions. Given the limited evidence base to date, prospective impact studies and economic evaluations based on experimental and quasi-experimental research designs should receive high priority. Retrospective case studies based on qualitative and quantitative research designs can also be useful.

» Work on summarizing study results and translating important findings for decision makers responsible for the design of health-systems-strengthening strategies that incorporate RHIS components.

Table 2 Recommended RHIS Evaluation Topics by Type of Research and Relative Priority

Research area	Type of evaluation research			
	Formative		Summative	
	Conceptualization	Underlying Determinants	Impact Assessment	Economic Evaluation
Demand for information	++	+++	NA	NA
Supply of quality data and information	+	+	++	++
Use of information	+	++	+++	++
Health systems functioning	++	+++	+++	+++

Key: +++ Highest priority; ++ High Priority; + Priority; NA Not applicable.

These topics could be part of a research agenda that concentrates solely on RHIS strengthening interventions, or could be part of a broader research agenda on health systems strengthening, in order to improve understanding of the role of RHIS. Regardless of which approach is taken, further work is needed to develop the research agenda, and build consensus around it among health systems researchers and producers and users of information at the local, national, and global levels, and international organizations and donors. Also critical is the mobilization of resources to support systematic research in this area.

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Appendix 1

Conceptual Frameworks Linking RHIS Investments, Data Quality, Data and Information Use, and Health Systems Functioning/Performance *(in chronological order)*

Authors/Name of Conceptual Framework	**Inputs** Determinants	**Processes**	**Outputs** RHIS data quality and information use	**Outcomes** Health systems functioning, health systems performance
» Goodhue (1995)—Task-technology fit	» Task characteristics » Technology characteristics » Individual characteristics » Precursors of utilization: expected consequences of use, affect toward using, social norms, habit, facilitating conditions.	» Task-technology fit » Utilization	» Individual performance: effectiveness, efficiency, quality	» N/A
» Shaw (2002)—CHEATS	» Technical	» Appropriateness of technologies » Video and sound quality » Ease of use » Technology specific training » Reliability of technology		» Clinical » Human and organizational » Educational » Administrative » Social
» DeLone and McLean (2003)—IS Success Model » Applied to RHIS by Lau et al. (2007)—Benefits Evaluation Framework		» Information quality—completeness, accuracy, availability, timeliness, reliability » System quality—functionality, performance (access, reliability, response time), security » Service quality—responsiveness of IS support	» Intention to use/use—actual system use, self-reported system use » User satisfaction—user competency, user perceptions, ease of use	<u>Net Benefits</u> » Quality of care (patient safety, appropriateness and effectiveness, health outcomes) » Productivity (efficiency, coordination of care, net costs) » Service access
» De Savigny and Binka (2004)—A Pathway for Evidence-Based Planning	» Data	» Data cleaning » Controlling » Organizing » Analyzing	» Information » Evidence » Knowledge	» Actions/decisions regarding implementation of plans and systems » Impact of actions/decisions » Monitoring change » Forecasting

Authors/Name of Conceptual Framework	**Inputs** Determinants	**Processes**	**Outputs** RHIS data quality and information use	**Outcomes** Health systems functioning, health systems performance
» MEASURE/Evaluation (2005)—Data Demand and Information Use Framework	» Technical » Organizational » Behavioral » Health system and individual level factors	Data collection and analysis	» Information availability » Information demand » Information use for decision-making	» Service coverage » Service quality » Efficiency
» Hanmer et al. (2007)	» Technical—software fit with user requirements, information system supplier knowledge of health system environment; appropriateness of information system design » Resource availability at the provincial and health facility levels » Organizational and contractual mechanisms, management commitment to success » Behavioral—knowledge and understanding of information system	» Perceived usefulness of information system	» Effective use of information system and/or outputs	
» Health Metrics Network (2008)—Framework and standards for country health information systems	» HIS planning frameworks » Personnel » Financing » Logistics support » ICT » Coordinating mechanisms	» Indicators » Data sources » Data management (data storage, processes to ensure data quality, data processing and compilation)	» Information products » Dissemination and use	
» Yusof et al. (2008)—HOT-Fit		» System quality » Information quality » Services quality	» System use » User satisfaction » Organization structure and environment	» Net Benefits—clinical practice, efficiency, effectiveness, decision-making quality, error reduction, communication, clinical outcomes

Authors/Name of Conceptual Framework	**Inputs** Determinants	**Processes**	**Outputs** RHIS data quality and information use	**Outcomes** Health systems functioning, health systems performance
» Aqil et al. (2009)—PRISM Framework	» Technical—complexity of reporting form, RHIS design, software, IT complexity » Organizational—governance, planning, training, supervision, finances, information distribution, promotion of a culture of information » Behavioral—data demand, RHIS task competence, RHIS task confidence; motivation	» Data collection » Data transmission » Data processing » Data analysis » Data display » Data quality checking » Feedback	» Data quality—relevance, completeness, timeliness, accuracy » Information use—for identifying problems, for considering and making decisions, and for advocacy	» Service Coverage

Appendix 2

Overview of RHIS Evaluation Studies That Met Inclusion Criteria (Including Surveillance, Electronic Medical/Health Records, Facility-Based, and District-Based HMIS)

Study, Country	Purpose of study	Intervention/ Research Design	Outcomes (assessed quantitatively or qualitatively)			Results and Conclusions	Limitations
			RHIS functioning	Health system functioning	Use of services/ health status		
Surveillance							
» Nsubuga et al. (2002); Tanzania	» To assess the structure and performance of and support for five infectious disease surveillance systems	» Introduction of HMIS and four other infectious disease surveillance and response (IDSR) systems. » Cross-sectional descriptive analysis at the regional-, district- and facility-levels in 3 of 20 regions. » Regions selected purposively. » Districts and facilities selected randomly. » Structured interviews and observation.	» Existence of surveillance system.	» Assessment of core activities (detection, reporting, analysis, investigation, community prevention and control, feedback). » Assessment of support activities (supervision, training). » Satisfaction.		» None of the 5 IDSR systems was adequately implemented, nor adequately performed at any level; few users conducted trend analysis; no access to transport and limited paper and computer. » While HMIS could serve as the backbone for IDSR in Tanzania, this will require supervision, standardized case definitions, and improvements in the quality of reporting, analysis, and feedback.	» The assessment was incomplete, did not evaluate the role of the central Ministry of Health. » Indicators used to measure the performance of core activities and supports need further refinement. » Data quality not assessed; Data use based on self-reporting.

Study, Country	Purpose of study	Intervention/ Research Design	Outcomes (assessed quantitatively or qualitatively)			Results and Conclusions	Limitations
			RHIS functioning	Health system functioning	Use of services/ health status		
Medical records							
» Littlejohns et al. (2003) and Mbananga et al. (2002); South Africa	» To assess the efficiency and effectiveness of a hospital health information system in Limpopo province.	» Introduction of hospital HMIS. » Initially a Randomized Controlled Trial of 24 district hospitals (12 treatment and 12 control); later modified to an externally controlled before and after design (8 treatment and 15 control). » Nested qualitative assessment.		» Median time outpatients spend at hospital. » Length of stay. » Bed occupancy. » Number of drug prescriptions per patient. » Improved revenue collection. » Cost per patient per day. » Number of referrals.		» Little empirical evidence of benefits of HIS; Some qualitative evidence that the HIS improved some activities, including efficiency in registration and admission, retrieving patient records. » The intervention was a failure, due to not ensuring that users understood the reasons for implementation and underestimating the complexity of the health care tasks.	» Weak evaluation framework; research design had to be weakened during the study.

Study, Country	Purpose of study	Intervention/ Research Design	Outcomes (assessed quantitatively or qualitatively)			Results and Conclusions	Limitations
			RHIS functioning	Health system functioning	Use of services/ health status		
» Kamadjeu et al. (2005); Cameroon	» To review the key issues related to the design and implementation of an electronic health record (EHR) system in urban primary care practice.	» Introduction of EHR system. » Qualitative interviews and observations one month and five months after implementation.	» Usability of system. » Benefits to user. » Possible areas of improvement and weakness.	» Promotion of good medical practice.		» Early stage of implementation: increased workload due to shift of focus from patients to computers and increase in duration of contact. » Later stage of implementation: decrease in coding time; reduction of duration of contact; better management of patient flow; improved data availability. » EHR can contribute to improve health care delivery, public health and policymaking. Understanding of local medical practice critical.	» Research design not clearly described. Original cohort of users self-selected. Limited generalizability.

Study, Country	Purpose of study	Intervention/ Research Design	Outcomes (assessed quantitatively or qualitatively)			Results and Conclusions	Limitations
			RHIS functioning	Health system functioning	Use of services/ health status		
» Lowrance et al. (2007); Malawi	» To assess the national ART monitoring and evaluation system (paper-based medical records) in Malawi to ensure the response to the epidemic was being monitored efficiently and effectively, and that data collected were useful.	» Introduction of a monitoring and evaluation system developed by the Ministry of Health's HIV/AIDS unit. » Qualitative methods based on in-depth interviews at 12 ART sites with ART clinic coordinators, clinical staff, and data managers. Evaluation followed Updated Guidelines for Evaluating Public Health Surveillance System (CDC) and Interim Patient Monitoring Guidelines for HIV Care and ART (WHO)	» Usefulness. » Simplicity. » Flexibility. » Data quality. » Acceptability. » Representative-ness. » Timeliness.	» N/A		» Qualitative results suggest that is successful in achieving its objectives in terms of RHIS functioning (attributes in previous fourth column). This includes the use of data from resource allocation. Changes in the data collection tools and systems suggested to help ensure long-term effectiveness of system. » Assessment of ART monitoring and evaluation system can optimize effectiveness of national ART programs.	» System is entirety paper-based.

Study, Country	Purpose of study	Intervention/ Research Design	Outcomes (assessed quantitatively or qualitatively)			Results and Conclusions	Limitations
			RHIS functioning	Health system functioning	Use of services/ health status		
» Sivic et al. (2009); Bosnia and Herzegovina	» To evaluate the effects of the implementation of Health Information Systems on patient satisfaction, cost, utilization, human errors, and wait times.	» Introduction of a computer-based information system in Zavidovici Medical Center » Retrospective, before and after design using routine data collected via four modules: ambulatory, radiological, laboratory, business information.		» Patient and service load; » Waiting time; » Number of human errors	» Patient satisfaction;	» Improved patient administration and work organization, including reduced repeat visits, lower costs, shorter wait times, and fewer human errors. » Significant results on economic and professional level have been achieved, with a higher quality health care and a higher level of patient's content.	» Retrospective design; significant lag time between measurements; no analysis of the cost of implementing the system.
» Were (2010); Uganda	» To assess the impact of patient-specific Electronic Medical Records (EMR)-based clinical summaries for providers taking care of HIV-positive adult patients.	» Introduction of EMR-based clinical summaries. » Time-motion techniques and provider surveys.		» Provider time spent with patients. » Length of visit. » Provider perception of usefulness of clinical summaries. » Human errors.		» Providers increased time for direct care to patients. » Overall average length of patient visits reduced. » Provider satisfaction with clinical summaries was high. » By taking advantage of data stored in EMRs, efficiency and quality of care can be improved through clinical summaries, even in settings with limited resources.	

Study, Country	Purpose of study	Intervention/ Research Design	Outcomes (assessed quantitatively or qualitatively)			Results and Conclusions	Limitations
			RHIS functioning	Health system functioning	Use of services/ health status		
» Amoroso (2010); Rwanda	» To evaluate the deployment of EMR interventions on data quality and access to data and information	» Introduction of several EMR interventions in 16 rural health centers. » Interventions included components to decrease errors in electronic data used by clinicians, improving transmission of CD4 results to clinicians, increasing clinician access to electronic patient summary data, and increasing detection and program enrollment of HIV positive children. » Program auditing of EMR data and process analysis over time.	» Errors in electronic data » Clinician access of data (lab results, patient summaries)	» Identification of pediatric patients with HIV		» Statistically significant decrease in the proportion of completed critical CD4 lab results that did not reach clinicians. Automated data quality improvement system reduced known errors by 92% by providing local data officers a tool and training to allow them to easily access and correct data errors. » Electronic systems can be used to support care in rural resource-poor settings, and frequent assessment of data quality and clinical use of data can be used to support that goal.	» Lack of external validity.

Study, Country	Purpose of study	Intervention/ Research Design	Outcomes (assessed quantitatively or qualitatively)			Results and Conclusions	Limitations
			RHIS functioning	Health system functioning	Use of services/ health status		
HMIS							
» Loevinsohn (1993): Developing country not named	» To examine the extent to which managers understand and are aware of the data from a new health information system (facility-based RHIS).	» Introduction of new HMIS that simplifies the collection of routine data from health facilities and used microcomputers to collate results. » Post intervention mixed methods approach, including self-administered survey questionnaire among 168 mid-level provincial health managers and municipal health officers and structured in-depth interviews among 25 programme managers.	» Indicators of skills in interpreting and manipulating HMIS data.			» Managers found to have difficulty in interpreting and analyzing HMIS data. » Managers interviewed appeared not to use and displayed little familiarity with the data they receive from the new HMIS. » Training managers in data analysis and use critical; data needs to be presented to managers in simple ways; further research is needed to understand how managers perceive and use data; efforts to ensure data use needs to be well integrated into the HMIS design.	» Study intended to be an assessment of data utilization and analytical skills and not an evaluation of the new HMIS; No baseline and control groups included in the study design.

Study, Country	Purpose of study	Intervention/ Research Design	Outcomes (assessed quantitatively or qualitatively)			Results and Conclusions	Limitations
			RHIS functioning	Health system functioning	Use of services/ health status		
» Braa (1997); South Africa	» To evaluate district-based health and management information systems in two districts	» Introduction of district-based health and management information system in two districts. » Case studies based on interviews and focus group discussions with clinic staff.	» Finding areas of duplication. » Staff awareness, perception and use of RHIS. » Coordination of RHIS. » Ease of use of RHIS.			» No evidence of use of information for decision making; little or no feedback on information sent to managers; no use of goals or objectives in planning of the services; a total of 172 forms for data collection were in use; data collection was conducted by nurses and occupied 40% of their time. » At one site, data was not kept centrally so analysis could not be performed. » A successful H & MIS must address local needs and create staff buy-in.	» Case study based on small number of districts (2)

Study, Country	Purpose of study	Intervention/ Research Design	Outcomes (assessed quantitatively or qualitatively)			Results and Conclusions	Limitations
			RHIS functioning	Health system functioning	Use of services/ health status		
» Heywood and Campbell (1997); Ghana	» To discuss lessons learned from the introduction of an integrated Health Management Information System in Ghana.	» Introduction of an integrated HMIS in 25 districts. Intervention included: participatory design of planning, data collection, feedback and reporting tools; training; indicator development; development of tools for self-assessment. » A case study approach, which included "baseline and follow-up rapid appraisal surveys using a standardize methodology."	» Information use at the district-, hospital-, and health facility-levels			» Marked improvement in information use at the district-, hospital- and health-facility levels after ten months, but a stagnation of results four years later » Achievements included promotion of self-reliance, improved data relevance and accuracy, strengthened supervision and support. Problems identified include difficulty for identifying most appropriate institutional location of HMIS; overemphasis on process and reporting, cumbersome and time-consuming processes.	» Methods used to conduct baseline and follow-up surveys not described.

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» Odhiambo-Otieno (2005); Kenya	» To evaluate the extent to which existing district health management information systems have supported the operational management of health services at the district level.	» Introduction of district-level HMIS. » Cross-sectional mixed-methods approach, which includes questionnaires, focus group discussions, and review of literature. » Sample of 30 respondents in 3 study areas using snowball sampling.	» Training. » Adequacy of resources. » Data quality.			» Fragmentation of HMIS; mismatch between information and job functions; limited feedback. » Resources inadequate. » Poor data quality » HMIS plagued by numerous design, operational, resource and managerial problems.	» Descriptive, cross-sectional design.
» Lungo (2008); Tanzania	» To investigate the reliability and usability of District Health Information System software among RHIS staff.	» Introduction of DHIS software. » Case study based on 18 heath workers in 5 districts in eastern Tanzania. Workers selected purposively. » Data included close-ended questionnaires, semi-structured interviews, observation.	» Reliability and usability scales.			» Reliability of software found to be high, but usability found to be low » Mismatch between the implemented online data entry forms/reports and their respective paper based forms/reports. » Software could not accommodate health data from various programs.	» Small sample size; purposeful sampling.

Study, Country	Purpose of study	Intervention/ Research Design	Outcomes (assessed quantitatively or qualitatively)			Results and Conclusions	Limitations
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» Abdul (2010); India	» To assess the impact of an Electronic Medical Records in an eye hospital on documentation time.	» Introduction of an EMR system in an eye hospital. » Ten randomly selected optometrists documented the time they spent during consultation with both paper and EMR documentation. The time spent was documented for a total of 200 records (100 EMR and 100 paper records).	» Time spent on documentation.			» No statistically significant difference in time spent for documentation between electronic and paper records. » EMR systems can be adopted in eye hospitals without having significant negative impact on duration of consultation and documentation for optometrists.	» Small sample; Hawthorne effect; did not account for seasonal changes at the clinic.

MEASURE Evaluation

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