

Impact of Technology on Primary Healthcare Information Management: A Case of North India

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Abstract

Health information systems are composed of subsystems that include information on demography, vital events, health status, environmental health statistics, health resources, health services utilization, health outcomes, and health development financial statistics. Computerized information management systems have enabled timely reporting of maternal and child health indicators and thus improved service delivery to the rural areas in the state of Rajasthan, India. A cross-sectional study in this state included 32 key informants; in-depth interviews were conducted to capture information on how technology helps in improving health in a rural setting, to provide an overview of the existing health information management system, and to identify the challenges in the existing system. The Pregnancy, Child Tracking and Health Services Management System (PCTS) is extremely useful in ensuring better health for women by minimizing maternal mortality and neonatal mortality. In a growing world, technology is playing a vital role in healthcare and has changed the way that healthcare is delivered and monitored in Rajasthan, India.

Keywords: health information management, technology, maternal health, child health, primary care

Introduction

In healthcare, the use of information technology has developed considerably all over the world, especially in developed countries. On the other side, developing countries are working on sustainable use of technologies, especially in primary healthcare systems. In support of health and healthcare services, the use of information and communication technology (ICT) in such areas as healthcare services, health surveillance, health literature and health education, and knowledge and research¹ has the potential to greatly improve health services efficiency, expand or scale up treatment delivery to thousands of patients in developing countries, and improve patient outcomes.² In the field of maternal and child health, the use of information and technology is mainly related to primary healthcare services, antenatal care, immunization, and disease control programs and administrative issues such as reporting, inventory management, financial management, and vehicle and personnel management. Therefore, maintaining a good health information management system is an essential part of running a health system. Health information can be maintained manually as is currently done in most of India, or it can be maintained in a computerized system.³ A computerized system can help improve health systems and efficiently manage the data collection process, storage, analysis, and sharing of information. It also assists health workers in providing services to the community in a timely manner.

Improving the health of women and children is a global health imperative, reflected in two of the World Health Organization's most compelling Millennium Development Goals, which seek specifically to reduce maternal and infant deaths by 2015.⁴ E-health has enabled developed and developing countries to save lives of women and their babies in the most vulnerable groups.⁵ Globally, technology-driven health information management systems have improved healthcare delivery. In a few examples in India, computerized health information management systems have resulted in improved quality and access to healthcare. In 1994, the Indian Healthcare Project started a collaborative project between the government of India, Apple Computers, and Computer Maintenance Corporation private limited (CMC), in the state of Rajasthan.⁶ The targeted auxiliary nurse midwives (ANMs) were healthcare workers responsible for 5,000 persons distributed in several villages. The main work of these ANMs was to telephonically call each household once a month to collect demographic details, administer immunizations, and provide counseling on family welfare and mother-child healthcare programs. In this project, the ANMs were provided with support tools based on an information technology platform. The intention was to reduce the time spent on manual paperwork, increase the accuracy and availability of village healthcare data in an electronic format, and thus improve the effectiveness of the

services. The pilot project was based on the Newton handheld computing platform, and the project was discontinued as Apple dropped the Newton from its product profile. The data generated in the project, however, is quite useful for developing applications for similar settings.

The government of Rajasthan has collaborated with the National Information Centre (NIC) for various information technology-driven projects in rural settings. Examples include an integrated financial management system; an online answering information system; information communication technology for addressing public grievances; a web-based hospital management application for free medical treatment of poor patients; an online census for rural households; a midday meal monitoring system for the distribution of grains and related funds to the district, blocks, and schools; and E-gram, which helps to gather village-level basic amenities and their requirements from the grassroots levels. Evaluating the impact of technology on primary healthcare is extremely difficult, especially in a rural setting. In this article, the author shares an overview of the health information management system known as the Pregnancy, Child Tracking and Health Services Management System (PCTS), which has been operational since 2010 in Rajasthan, a northern state in India. The research questions addressed in this study were as follows:

- How has technology helped in improving maternal and child health in rural healthcare settings in Rajasthan?
- What are the key challenges faced by health officials in the existing health information management system?

Methods

In this cross-sectional study, the study employed qualitative methods of data collection and analysis. The initial process of identifying the key informants started with a review of reference documents and visit to the local district hospitals and community health centers. The data were collected from the reference documents, questionnaires, and in-depth interviews. In-depth interviews and semistructured questionnaires were administered to key informants such as program managers, health workers, and technical support staff; these staff monitored and maintained the computer systems at the location of the central database, that is, in city of Jaipur in Rajasthan. The in-depth interviews gave an opportunity for one-to-one discussion and helped the researcher to collect individual ideas and experiences. Officials and health workers who had more than five years of experience in handling health information and systems were further interviewed. In this study, nonprobabilistic sampling techniques were used. In purposive sampling, the given sample is based on the researcher's judgement, whereas in snowball sampling the sample is further identified by successive key informants. A total of six officials assisting the system, two data managers, two data entry operators, and 22 health workers were identified after snowball sampling for in-depth interviews. All the individuals performed their functions in the area of health information management. For the research questions, in-depth questions and semistructured questionnaires were used as the study instruments. Some of the components of the questionnaire are explained in [Table 1](#). The interviews were audiotaped with the participants' verbal and written informed consent.

Table 1: Representative Questions Used in the Key Informant Interviews

Key Questions	Related Themes
I would like to know about the computerized health management information system with respect to maternal and child health.	Purpose of the system, specific features of the system, flow of information
Do you think the computerized health information management system has made improvements in maternal and child health? If yes, how?	System-level and community-level improvements
Human resources: Who are the people involved in the system?	People involved at different levels
Human resources: Is there any training provided to the human resources? If yes, how?	Process of data management, support provided to the healthcare frontline workers, training and capacity building
Is there any information about the challenges that are faced in implementing this type of system?	At functional level, training, infrastructure, policy implementation, feedback system, data privacy and security

Are there any clear gaps where we need further evidence and planning for follow-up on the initiative?	Technical issues, training, and sustainability
Are standards for data collection maintained and systematically used?	Process of data management

Data were collected between May and July 2012. The data were transcribed in Hindi (local language), Marwari (regional language), and English. The transcripts were carefully studied, a coding framework was then prepared, and codes were assigned. The assigned codes were then categorized into themes (see [Table 1](#)), which proved useful during qualitative data analysis. [Table 2](#) shows participants' perspectives (quotes) captured during the discussion. The data were analyzed manually, and no software was used. The issues encountered during the analysis were discussed and resolved with the help of experts and the information technology department of the institute. The study results are further discussed with the help of research questions to provide a systematic flow of information in the article.

Table 2: Quotes from the Key Informant Interviews

Participant Role and Theme	Opportunity (O) or Challenge (C)
Data management staff: "The system facilitates effective evaluation and assessment. It also provides an opportunity to review the progress made on maternal and child health indicators."	O
Data management staff: "Poor documentation from the health facilities makes data of very low standard . . ."	C
Health and welfare department staff: "The health information management portal is a single window for gathering, aggregating, analyzing, and using the information for improving the maternal and child health."	O
Health worker: "I need good feedback and recognition on my work done . . ."	O
Auxiliary nurse midwife: "There should be information exchange about healthcare and data handling issues from other villages . . ."	C
Health worker: "There are no written standards on what we are supposed to do when we discover some discrepancies . . ."	C
New recruit staff: "The duration of the training is very short to cover the complex structure and components of the health information management system."	C
Policy-level staff: "Despite challenges, the system is able to provide micro-level information for improving healthcare service delivery at the grassroots level."	O
Computer department official: "Our work is to support, supervise, and monitor; the grassroots healthcare workers who are directly involved in this initiative should be encouraged, and we should resolve the issues they encounter in the field."	O

Results

Background of the Health Information Management System

To provide the ability to monitor every registered pregnant woman and child, an important initiative was undertaken to develop an e-governance project in Rajasthan. It was named the Pregnancy, Child Tracking and Health Services Management System (PCTS). The system is extremely useful and provides micro-level details of maternal and child healthcare indicators on a monthly basis. This information is very important in ensuring better health for women and children, thus minimizing maternal mortality and neonatal mortality and also extending universal health coverage. The web-based system was launched in 2009 and is currently operational in all 34 districts of Rajasthan. The tool is a planning and management platform developed by the NIC in Rajasthan for the Department of Medical, Health, and Family Welfare of the government of Rajasthan. By 2012, the system covered 32 hospitals and was functional in around 200 dispensaries, 360 community health centers, 1,650 primary

health centers, and more than 11,300 health subcenters which are the most peripheral contact point between the primary health care system and the community.

Description of the Technology-driven Health Information Management System

The system was designed in such a way that even the lowest-level health institution in the state was covered; hence, the data are generated and managed right from the village health subcenter level. The other institutions in the network include district hospitals, hospitals attached to medical colleges, dispensaries, community health centers, and primary health centers. The system is web-based and accessible via intranet service. It is based on the existing infrastructure known as Health Information System for Government (HEALING) that was designed for the National Rural Health Mission, a health program aimed at providing better healthcare services to the poor. The lowest-level and most important reporting personnel are the ANMs, who capture the data at the block level. The data collected are based on a predetermined format that includes demographic details and the number of pregnant women and newborns in the village area. As soon as a pregnant woman reports for her antenatal checkup, a unique identification number is assigned to enable future tracking. The data are updated automatically in real time on the central server. After the updates, the reports can be viewed by all those who have role-based authentication. The regular review also prioritizes critical cases that need immediate attention. In the example of immunization, the system automatically prepares an immunization requirement and follow-up chart for each newborn registered. Thus, it also helps ensure the availability of vaccine dosage at each institution. The system planning also ensures strong immunization coverage, thereby reducing child mortality and improving child health. An online directory of government institutions is efficiently maintained along with an inventory of vaccines, medicines, and cold chain equipment, and information is also available on institutional medical professionals. A set of key daily and monthly performance indicators is regularly maintained. These indicators include an antenatal checkup chart for registered pregnant women; individual child immunization schedules; vaccine requirements for each health institution; family planning and counseling requirements for sterilization; maternal death reports; consolidated reports for each department for monitoring; demographic details and contact numbers of doctors, ANMs, and accredited social health activists; graphical representations of maternal and child health indicators; and state-level reports ranging from districts to the lowest subcenters. The system also features useful filters to track women who registered their pregnancy but did not report for or after delivery. This information can be further scrutinized for safe newborn delivery to track maternal or child deaths, abortions, and feticides. The system overall serves as an easy and user-friendly data capture and management tool.

Human Resources—a Key Role in Managing the Health Information Management System

The ANMs are the key personnel for data entry at the grassroots level. However, at the district and state levels, the NIC maintains a dedicated computer department and all the data are compiled by the staff recruited. The centralized computer department is available to provide support to all the field units via e-mail or telephone. The process is then monitored by special staff of the Department of Medical, Health, and Family Welfare. System-specific training is provided for the state- and district-level trainers in the form of training of the trainers. The trainers further provide training to all the operational staff below the district level, that is, the primary health centers, community health centers, and subcenters. Workshop sessions were also conducted for chief medical health officers, reproductive and child health officers, and data managers. Instruction on the system usage was provided to all the locations by NIC officials. Adequate exposure to hands-on training of the system was provided to all the users. The modules and user manuals are present at each location, and training manuals are updated annually. The staff personnel who are newly recruited in the department also receive the training in a similar way. Additionally, technical and operational help is available online and integrated into the system.

Research Questions

How has technology helped in improving maternal and child health in rural healthcare settings in Rajasthan?

High-quality prenatal and postnatal care is a key entry point in the continuum of care, especially for improving the lives of mothers and children. Enhancing the timely reporting and monitoring of maternal and child healthcare services will contribute to achieving the World Health Organization's Millennium Development Goals. Recent developments in information technology have made government and private players aware of technology as a tool for addressing old challenges in new ways. The

PCTS is one such feasible solution that can streamline the processes of maternal and child healthcare. The predefined maternal and child health indicators generate extensive information. The key information areas include beneficiaries' demographic details, antenatal care, postnatal care, immunization, newborn delivery, and details of conditional cash transfer programs. The ICT-based integrated system serves as an efficient system that reduces documentation by compiling data in a common database. It was also found that the technology-based systems have helped in generation of districtwide data on the numbers of pregnancies, abortions, stillbirths, and institutional newborn deliveries, thus providing an e-health solution for improving maternal and child health.

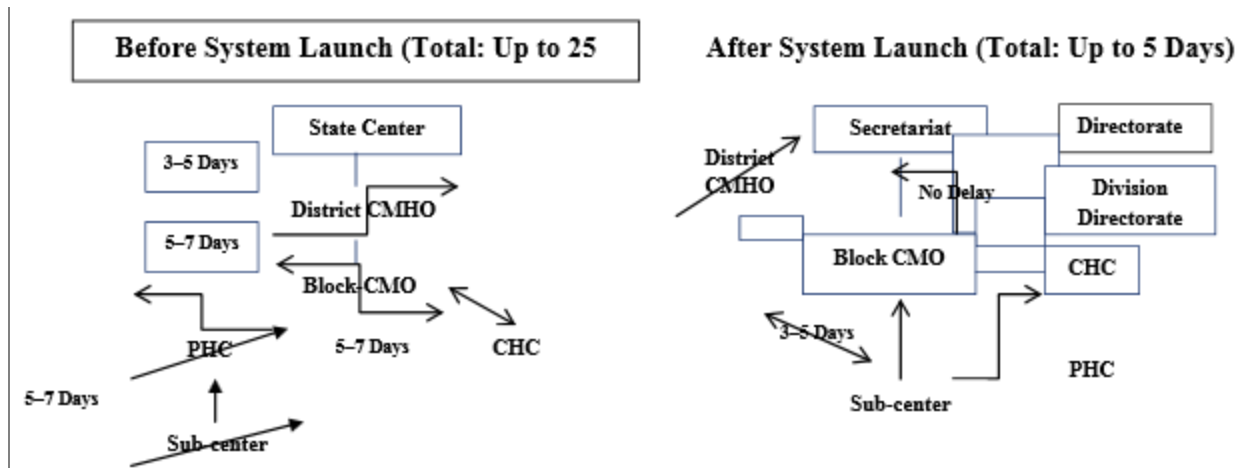
At the community level, the details of registered pregnant women and mothers are regularly tracked and updated in the system. The registered pregnant women and mothers are then made aware of healthy pregnancies, safe deliveries, and also improved maternal and child healthcare protection. At the national level, official registration and documentation of births and deaths has improved, thus extending basic healthcare services to children. Within Rajasthan, the PCTS was launched as a unique e-governance project implemented in the health sector. This project addressed the need for health services in Rajasthan, which was one of India's Empowered Action Group (EAG) states in regard to utilization of maternal and child health services. Children from EAG states are 1.5 times more malnourished (weight-for-age) compared to children from other states, and Rajasthan is one of the most vulnerable states in maternal and child care issues.⁷ The focus is slowly shifting toward providing a continuum of care for mothers and children, beginning with protecting women during pregnancy, advancing safe and institutional deliveries, providing care for newborns, promoting good nutrition, and improving health systems. Previously, it was not possible to monitor all pregnant women and children for healthcare services in all the districts of Rajasthan. However, with the advent of this e-health project, it is now possible to track every single pregnant woman to provide prenatal healthcare services before the newborn delivery and then to provide subsequent services.

The system is mainly used by health institutions for their performance reporting, thus monitoring newborn deliveries and neonatal healthcare services. The hospital-based indicators also provide information on inpatient departments, outpatient departments, and investigations that play an important role in assessing service delivery. The key improvements after the system implementation include improved information on maternal health and newborn care, and better health services, which were key concerns of the Rajasthan government. Previously, the delay in timely maternal care and health checkups and the lack of immunization records resulted in a huge number of maternal deaths every year. This technology-driven innovation is also considered a pathbreaking initiative because of reduced maternal mortality and infant mortality and also because of its focus on health facility-based reporting at the rural block level. Within a year of its launch, the system registered 1 million pregnant women from remote areas of Rajasthan, which proved its effectiveness to the government.

The data were manually compiled at the primary health center, community health center, block primary health center, district, and then state levels. Before the launch of the system, multiple channels of data reporting existed. However, the process has been automated with improved speed of communication, thus reducing the time required for a subcenter report to reach the state level from 25 days to 5 days (see [Figure 1](#)).⁸ At the back end, pretested data formats were developed and introduced at each subcenter, which makes data capture simple. Several planning tools (vaccination schedule, schedule for expected newborn deliveries, antenatal care charts) within the system help in providing better and timely healthcare services.

Figure 1

Comparison of Information Flow and Management Before and After Launch of the System



Abbreviations: CMHO/MHO, chief medical health officer; CMO, chief medical officer; PHC, primary health center; CHC, CHC, community health center. Note: The single-sided straight arrows represent information flow in an upward direction. The double-sided arrow shows data flow in both directions and between both levels. Source: Gupta, I., and C. Sen. "Pregnancy, Child Tracking and Health Services Management System." *Informatics* 19, no. 2 (2010): 18. Available at http://informatics.nic.in/uploads/pdfs/6e8363a7_October_2010.pdf

The analysis also provides qualitative findings in the form of quotes represented in [Table 2](#). The table captures participants' perspectives on the health information management system and whether the participants' statements represent opportunities in improving the maternal and child healthcare services or challenges faced by the participants in maintaining the system. The opportunities and challenges were coded as O and C, respectively. The quotes were noted during the interviews.

What are the key challenges faced by health officials in the existing health information management system?

The officials feared that managing the huge amount of health information revolving around 13,000 institutions would be difficult. The key challenges include inconsistent data management practices, the development of policies for data management, training of the staff at different locations, a staff feedback system to improve functioning of the system, and lack of infrastructure to support the system. The key officials were concerned about the data management practices at each level. There was no sustainable use of information on a regular basis or any cross-verification of the data from the source and destination, which resulted in inconsistencies between the data sets; there were data privacy and confidentiality issues that were not discussed openly by the staff officials. The system was newly implemented; hence, there was a backlog of old data sets to be updated on the systems. There was a lack of evidence about the benefits of e-health systems; this lack of evidence made the experts hesitant to develop focused policies for the efficient use of health information management systems.

Training manuals were created; however, training of a huge workforce at each location proved difficult. The challenges within training were tackled by a comprehensive training strategy including this core group, and the training was conducted at the state, district, and block levels.

Government, in the form of implementing and policymaking agencies, plays a pivotal role in recognizing the importance of ICT and formulating key policies. However, surprisingly, most of the higher official respondents were not aware of the direct benefits of the system in the context of health and welfare of the society. The use of health data was also linked to privacy and security concerns of the beneficiaries. Therefore, the healthcare institutions need to install security checks to use the systems installed efficiently. Also identified was a need to build strong logistics and infrastructure, especially backup electrical power, to continuously support the systems in place.

Suggestions to tackle the existing challenges were offered. A built-in feedback mechanism may provide an opportunity to resolve the issues collectively by cooperation between health personnel and the government. Also identified was the need to develop systematic ways to make the government-level officials aware of the key benefits of the application and its requirements. The cooperation of policy makers and state-level officials was important to integrate the technology into the health sector.

Discussion

In the discussions with the officials and healthcare providers, the e-health and tracking system represented a very good example of an essential and effective technology solution for strengthening the healthcare delivery system in rural India. The systems installed have the potential to improve the health status of the rural community by providing access to healthcare information from the grassroots level. The e-health system provides extensive coverage of the 34 districts of Rajasthan. It also facilitates better management of healthcare institutions located at the grassroots levels in the state. Studies by Moidu, Singh, and colleagues have indicated that computerized health management systems in India can improve the maternal and child healthcare services, especially antenatal care and immunization services.^{9,10}

A few technical and training concerns were encountered by the program and data managers. The health workers and data managers had huge workloads, which generated huge demand for strong investment in trained resources for the sustainable use of systems. A need for strengthening information systems and building local capacity to increase utilization of data for planning and decision making has also been identified by Adindu and Babatunde.¹¹ Therefore, the need to strengthen information systems in public health and the role of information technology has been emphasized by many authors.¹²⁻¹⁷ Due to lack of infrastructure and backup systems in a resource-poor setup, a well-designed system may help to have a large impact on the quality of care and information management.

The study also revealed that many potential uses of the application installed. For example, the information can be exchanged with neighboring villages at the village level. A special section of the system can be utilized for displaying information about healthcare events on a larger scale. Short-term online training courses can upgrade the skills of health workers and officials. The insights of study participants suggests that before a sophisticated development is made in the system, there is a need to streamline the flow of information at the village level, build capacity in terms of the healthcare personnel, and promote information-seeking and information-sharing platforms.

Limitations

The study examines information about the system, its benefits, and its challenges only from the current end users. In-depth interviews with the beneficiaries would have given more insights on the functionality and benefits of the system. The future work plan and an outline of the development of the system were not provided clearly during the interviews. Overall, the system needs to be matured in terms of planning for strategic health needs assessment and sustainability issues.

Conclusion

Before this system was launched in Rajasthan, the information was recorded manually on different sets of registers at each level. This setup resulted in information duplicity, and retrieval of information over time became difficult because of degradation of the paper registers. With the introduction of automated systems, several issues related to the capturing of information were resolved to some extent. The healthcare workers mostly appreciated the standard modules and templates that were developed. All the information is available at the back end and can be retrieved at any time. The most important feature of this information management solution is that the healthcare institutions now have complete information on pregnant women and children that previously was not available. The health-seeking behavior of women is now known and can be explored further. However, the sustainability and replication of such a system depends on mix of process planning, technology, and social behavior of individuals.

Scope of Future Research

As a next step, the study can be extended to the evaluation phase of the system implemented at the grassroots level. Also, beneficiaries can be included in the study to examine their in-depth experiences about the services received after they registered under this system. This research will further elucidate how the system components can be improved for future information management and functioning.

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Notes

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