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Public Health Information Systems in India: Need for a sustainable Patient centric system for Primary Health Care

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Abstract:	Background Innovation in eHealth Technology has the potential to improve public health. Overtime some progress has been made towards developing IT based Health Information Systems. In Indian context many Health Information Systems and few point of care electronic health record systems have been developed. However, utility of these systems in improving public health is not known. Objective The present study was aimed at review of Health Information Systems in India with a focus on Primary Health Care which may aid the country in moving towards developing IT systems for achieving Universal Health Coverage. Methodology A mix method was used to understand the functioning of various public health IT systems from the perspective of the people using these systems. Literature search, Observation in-depth interviews were conducted for data collection. Results Use of IT in the Health Information Systems in India is presently evolving. The Health Information applications which have advanced to implementation level are Health Management Information System (HMIS), Integrated Disease Surveillance Programme (IDSP), NIKSHAY, Strategic Information Management System (SIMS) and Mother & Child Tracking System (MCTS). It has been felt that most of these systems have been designed keeping in mind the particular needs of vertical health programmes. At present there is limited role of these systems in enhancing effectiveness of Primary Health Care. Integration and sustainability of these systems, which are proprietary-based, remains a challenge. Conclusion There is need for designing a patient centric health information system which is comprehensive and caters to the needs of Primary Health Care. Keywords: Health Information System, Patient centric systems, Primary Health Care, Universal Health Care, India.
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Introduction

In 1977, The Alma-Ata Conference endorsed the "Primary Health Care Approach" However, due to limited resources and lack of appropriate technology health needs of the community especially those who live in remote and underprivileged areas have not yet been met [1]. Hence, in 2005, all WHO Member States, including India, made a commitment to achieve Universal Health Coverage (UHC) [2]. UHC has by definition a focus on Primary Health Care (PHC), making it a critical foundation of the health services for the prevention and management of diseases and promotion of health [3]. Arguably a stronger PHC focus can contribute to better health outcomes, with greater equity and lower costs of care [4]. Many UHC planning efforts are top down, relying on survey data rather than driven by PHC needs arising from routine Health Information Systems (HIS).

Information and Communication Technology (ICT) innovations in health can facilitate the re-design of HIS to incorporate additional indicators for measuring UHC. If effectively implemented, UHC has the potential to reduce health care costs to families, improve equitable access to quality services, link health systems with social protection programs, and increase accountability and sustainability of health services. ICTs can be an important tool for tackling inefficiencies such as inequitable distribution of resources, underserved populations, missed appointments, drug non-adherence, delayed and unreliable data for decision making. It can also help build a transparent system for accountability to people [5].

In 2005, the World Health Assembly (WHA) passed resolution which emphasized the vital role of e-health, and urged member states to adopt these technologies [6]. National ministries of health are now turning to ICTs to increase their efficiency and outreach with easy accessibility to information through large scale digitalization of systems. However, use of the technology lags behind the availability of new ICTs, often because people and organizations change much slower than technology.

However, despite the obvious potential, many researchers have argued that electronic HIS have not delivered optimally [7, 8]. The focus of ICT systems in health has been largely on aggregate systems for national level reporting, while their application for PHC has been very limited [9, 10]. Not much information is available on IT systems which are patient-centred, community-based and are oriented towards PHC. In this paper, we reviewed IT

systems in the Indian context. Such an analysis we believe would be useful to designing HIS of UHC.

Specific aim of this paper was to select a set of systems, typically name-based, which are already implemented in public health sector or are being developed as part of digital India programme, for generating information for surveillance, monitoring healthcare, resource allocating or improving health at the Primary Health Care level. We tried to assess the effectiveness of these systems, challenges that have been faced in implementation, and what could have been done better.

Methodology

We adopted a mix design comprising of (a) literature search, (b) world-wide web search, (c) observation and (d) in-depth interview of key staff. A key criteria used to identify the systems for review included those that were public owned and oriented towards improving health care. The identified systems were evaluated to understand what has been the role of ICTs in the system, and whether these systems have helped in enhancing primary health care.

(a) Literature Review

We carried out scoping search for publications on reviews of health information systems used in public sector in India from Pubmed, Scopus, Medline and Google. The search was limited to studies published only after year 2000. Our search key words included ‘eHealth’ or ‘Health Information Systems’ and Integrated Disease Surveillance Project, eHealth or Health Information Systems and Nikshay or Tuberculosis, eHealth or Health Information Systems and Mother and Child Tracking System (MCTS), eHealth or Health Information Systems and Strategic Management Information System, eHealth or Health Information Systems and primary health care and India in Title/Abstract.

(b) ICT Systems in Public Health sector

We searched the website of Ministry of Health & Family Welfare, National Health Portal and National Health Programmes to understand the type of IT-based health information systems used: (a) aggregate (b) case or name-based or (c) hybrid and to know how useful is the information generated through these systems.

(c) Observation

We identified the Electronic Health Record and Health Information Systems that were used at primary health centre, community health centres, district hospital and tertiary care centres in four states/UT that included Chandigarh, Punjab, Haryana and Himachal Pradesh. We observed one rural primary health care centre each at Punjab and Himachal Pradesh, one urban primary health centre at Chandigarh. one Civil Hospital at Panchkula, Haryana, one District hospital at Shimla and one Medical College at Chandigarh where ICT in the form of EHR/HMIS was being used.

To assess the flow of information under various national health programmes using health information systems we visited State TB cell, State AIDS control Society, State National Health Mission Office and Regional National Informatics Centre in Chandigarh.

(d) In-depth Interview

The required data on the health information systems was collected by interviewing program analyst and program managers working at State offices. The requisite permission was taken from concerned offices of Director Health services Punjab, UT Chandigarh, Haryana and Himachal Pradesh. For user experience and to understand the advantages and issues with implementation and functioning of ICT systems at state leve,l we interviewed Program Managers & Analysts at NHM office of Punjab & UT Chandigarh, Program Co-ordinator at State TB cell, State AIDS Control Society and Regional National Informatics Centre at UT Chandigarh.

For understanding ground level issues the doctors, health staff and data entry operators at various echelons of healthcare were interviewed. The broad topic questions to be asked during interview were decided beforehand. We were able to interview a total of 12 people regarding their experience of using ICT systems under various programmes using semi-structured questionnaire.

The observation notes made from the interviews were qualitatively analysed by all the authors using thematic coding. Based on our web research, observations, interviews and qualitative analysis we first developed the brief overview narratives of each systems, and then the authors of the paper read them independently, and interpreted from them the role of ICTs, and how it can influence primary health care.

Findings

We were able to identify five important health information systems NHM-HMIS, IDSP, NIKSHAY, MCTS and SIMS being developed and used in various National Health Programmes. We also tried searching for ICT use at Primary Health Care level in government set-up; however, there were very few instances of ICT use at primary health care level and most of them were pilot projects. The details of reviewed systems are given in Table 1.

We could find very limited number of studies that have reviewed the existing health information system which are patient-centric and aimed at improving primary health care in a comprehensive manner. Most of the studies were limited to systems developed in silos for vertical National health programmes catering to a particular aspect of primary health care such as mother and child care, integrated disease surveillance programme (IDSP) etc. or providing individual care through Electronic Health Record (EHR) system on pilot basis. We found Six published studies on HMIS-India, five studies on MCTS, three on IDSP, two on EHR usage in primary care. For some of the systems like NIKSHAY for TB and Strategic Management Information System (SIMS) for HIV we were not able to find any review under peer reviewed published study.

Historically, PHC information systems have been based on aggregate data creating monthly facility-based reports. Data collected at the community level are noted in primary registers, and later computerized at the primary health centre level for reports to flow from the primary health centre to sub-district, district, and then state and national levels. In 2008, following national reform efforts in India, the forms were standardized and computer-based reporting was initiated. Today, all public facilities are reporting data into a national health portal. Some name-based systems including using mobiles were introduced for the health workers at the community level called the Accredited Social Health Activist (ASHAs) to counsel pregnant women, postpartum mothers and their families and to schedule vaccination, antenatal and postpartum care services [11].

The systems reviewed were divided into broad classification of Health Management Information system, Surveillance & Tracking Systems and Point of Care systems as per their primary role.

Health Management Information Systems

National Health Management Information System (HMIS):

National HMIS portal was launched in 2008 as a part of the national reform process. Initially, it was planned as a repository to collect district level aggregate integrated reports, but gradually over time, it has gone right down to the sub-district level, and today around 1,80,000 health facilities in the country are reporting to this portal [12]. This reporting is obligatory for all states, and is closely monitored by the Monitoring & Evaluation (M&E) division of the central Ministry of Health & Family Welfare. In addition to the aggregate reports, there is a degree of individual data comprising of line lists of deaths.

Initially, the portal was lacking in functionality, but it has been gradually enhanced over time. For strengthening analysis, functionalities were provided to move the data into a proprietary software (SAS), Central M&E conducts analysis and places reports on the portal to be downloaded by the states. Similarly, for spatial analysis, third party proprietary software – (Arc GIS) is used. There is thus a strong dependence on proprietary software which adds significant costs to the system. The portal is promoting centralization as data from all health facilities are uploaded into the national database. Further, primary analysis of data is carried out by the national level rather than by district or facility level staff. Currently, the portal is managed largely by a third party, which may raise concerns about its long-term sustainability.

The HMIS is a facility based programme and doesn't give full information of health status of area served by a facility, as services which haven't been provided by the facility are not entered. The national HMIS system has a rigid structure with very less scope of flexibility to meet additional health information requirements which may vary from state to state. Many states such as Gujarat, Jharkhand, Kerala, and Madhya Pradesh, etc have adopted District Health Information System 2 to redesign HMIS for making it architecturally more flexible to allow customization as per the needs of the states through incorporation of various reporting formats and monitoring indicators [13].

District Health Information Software (DHIS2):

DHIS2 is a free and open source platform which has currently developed into a global de-facto global standard for building health information systems in Low and Middle Income Countries (LMICs) [14].

It is a versatile system which can be used for various roles such as Health Management Information for generating aggregate data reports with basic analytics features and for disease surveillance to capture data and to generate alerts which can be mapped through

Geographical Information System, with DHIS 2 tracker it is possible to do both aggregate and case based reporting & it can also be used to track patients.

In India, DHIS2 has been in operation since 2006, first in the state of Kerala and then in many other state. DHIS2 is now used in 9 states as a state data warehouse, where states enter all their facility based data into the DHIS2, and from there the reports are further submitted to the national HMIS portal in the required format. Further, the system is used to conduct state level analysis of data and provide feedback to peripheral units to support action. Many states have also carried out particular customizations, such as for ASHA monitoring, supportive supervision and others. Currently, the malaria division of National Vector Borne Disease Control Programme under Ministry of Health & Family Welfare is examining the feasibility of DHIS2 for case-based reporting systems for malaria and other neglected tropical diseases.

Tracking & Surveillance Systems:

Mother and Child Tracking System (MCTS)*:*

The MCTS system was launched by the Union Ministry of Health & Family Welfare in 2009, primarily driven by the logic of improving the veracity of data. This led to the National Informatics Centre (NIC) building this tracking system, initially based on the experience of a similar system (called E-Mamta) from the state of Gujarat. The system included modules for registering pregnant mothers and following them for their ANC care visits and also for registering children over the immunization cycle. The central M&E where the data is analysed sends SMS to all the states every day on number of registrations achieved. Initially, the system was not able to generate follow-up reports or work plan for the health workers, but gradually over time this functionality was developed. However, timeliness was an issue as there were delays in registration of data going up to the national level, where reports are generated and then sent back to the health worker. The data is entered at primary health centre /block level by data entry operator, for which ANM has to make a weekly visit to the primary health centre /block office to get their sub-centre data entered.

A key challenge of this system was that it has focussed on monitoring of the health staff, rather than monitoring maternal and child health indicators, on which India lags far behind globally. This system added a huge work burden to the health staff, as they need to enter name-based data into this system, and at the same time aggregate numbers are also entered into the HMIS portal. These two systems do not speak to each other. At a later stage it was

realized that a large portion of reproductive and child health care remains out of the ambit of this system so it was decided to switch over to a Reproductive Child Health (RCH) portal and to close the MCTS.

The MCTS system is currently in the process of being replaced by the **Reproductive and Child Health (RCH) Portal**, which has been developed by the National Informatics Centre (NIC). The RCH portal also incorporates personal details of eligible couples for family planning, which then tracks the women to Antenatal Care, Delivery, Postnatal Care, thereby completing the cycle and allowing tracking of women in subsequent pregnancies, just like MCTS, this portal also allows for tracking of child immunization. RCH portal is also expected to support voice calls.

On a visit to a district, we met an operator who was entering data in this portal. He described it to be painfully slow, taking about 10 minutes to fill one record. He expected it would take more than 3-4 months time to enter all the eligible couple data into the system, only after which the tracking process could start. The closure of the MCTS in such an abrupt manner raises the question of why it was done, after such a huge investment of resources. The RCH portal is still in testing stage and is yet to be fully implemented.

A study conducted to review the MCTS system have highlighted issues of limited utility of data generated through MCTS, as it is only used for generating the workplan and didn't contribute to any health information reports [15]. Its role is only limited to supervision and increasing a sense of accountability among ANMs that too at expense of their routine activity as they have to carry their registers from sub-centre/ primary health centre to data entry clerk who is often located at block level in rural areas and at CHC/District level in urban areas to enter the data and get the workplan printed. The studies on implementation of MCTS in peripheral areas have reported challenges related to irregular electricity supply, inconsistent internet connectivity and the slow speed of the MCTS web portal leading to delays and time wastage [16, 17].

NIKSHAY: Tuberculosis Case Tracking & Surveillance*:*

Following the introduction of a policy of mandatory notification of TB cases in May 2012, India launched a new web-based TB Surveillance System called NIKSHAY [18]. This application was developed for aggregate management reporting and also for the tracking of

TB patients. It provides a centrally accessible name-based detail of TB patients. This helps to monitor the patient from the time of his/her registration to final outcome. The application has modules for Tuberculosis Unit, District TB Unit and State TB Cell, and the system also keeps track of MDR and XDR TB patient. It also provides information on their HIV status and ART treatment. By launching NIKSHAY and reaching out to the private sector, it is claimed that India has achieved a 29% increase in case notifications in 2014 compared with 2013 [19], but still case reporting is only 63% of the expected cases [20].

The system sends daily SMS alerts to district and state TB officers on patients registered under the Revised National Tuberculosis Control Programme (RNTCP). In case a patient migrates to new place, the patient details can be easily transferred to the nearby centre to avoid loss through follow-up. The system is being improved to make it more patient-centric by building mechanisms for alerts and reminders for both the patient and DOTS provider if the patient misses the medicine. The application currently does not offer offline data entry functionalities which is often a requirement in peripheral areas. As a result, at the lowest unit, i.e., the designated Microscopy Centre, data recording is done manually in registers and the patient card which is then later entered into the system through data entry operators at primary health centre /block level. Another limitation is that the system does not support the automatic generation of indicators, and data needs to be taken out into spread sheet to generate the indicator.

Integrated Disease Surveillance Programme (IDSP)*:*

The Integrated Disease Surveillance Programme (IDSP) portal, launched in November 2004, is a one stop portal (www.idsp.nic.in) which has facilities for data entry, viewing of reports, outbreak reporting, data analysis, training modules and resources related to disease surveillance [21]. The IDSP portal is under the management of the National Centre for Disease Control (NCDC), Ministry of Health & Family Welfare which is also supported by CDC USA.

About 90% of the 707 Districts in India are now reporting disease surveillance data in this portal related to notifiable diseases on a weekly basis. Under IDSP data is collected on epidemic prone diseases on weekly basis (Monday to Sunday). The weekly data gives information on disease trends. The NIC has installed Data Centre equipment at 776 sites to enable online data entry for speedy data transmission from the districts, and is also helping IDSP in establishing terrestrial connectivity to all 800 sites, and managing the entire network.

In the existing information flow, data from the most peripheral unit, i.e., sub-centres and the primary health centres/Hospitals fill up three set of forms (S, P and L – Syndromic, Presumptive and Laboratory confirmed), and send them manually to the districts. The L form contains a line list of positive cases, while the others represent aggregates (22). At the district, the operator does online entry of the form to transmit to the national level. Some states have said that to get access to their own data, they need to request the IDSP office at national level. This causes great delays, where time is of essence in disease surveillance. Outputs are weak, not supporting strong response and action. A government task force assessment of the portal has recommended its revamp, and currently a process is ongoing to select another platform to replace the existing one. Further, the government is taking a relook at the diseases being reported on, and discussing how to reprioritize them. Some of these diseases being reported on are also reported by other systems, causing ambiguity for decision makers on what data to use.

The main objective of IDSP was early detection of disease outbreak so that timely remedial measures are implemented to contain the outbreak. During our visit at one of the centres, we observed that report is prepared by health assistant/MPW/ANMs from the OPD registers which are often incomprehensible and many a times are without any diagnosis. In a centre we found that even when 20-30 routine fever cases are erroneously reported as Pyrexia of Unknown origin, no query was raised by higher level IDSP echelons.

Strategic Information Management System (SIMS), National AIDS Control Organization (NACO)*:*

SIMS was developed over the existing Computerized Management Information System (CMIS) used by NACO. IT was officially launched in August 2010. It is a web based centralised application which has integrated all program components of NACO into one system. The system was piloted in August 2011 at Delhi after which it was extended to 6 high focus States in September 2011, later from December 2011 it was implemented country-wide [15].

The vendor who has developed this system is the same who has built the national HMIS portal, and many design limitations seen there can also be viewed in this portal. The system supports data entry at various levels including Reporting Units (RU), District and State levels. Data collected is primarily aggregate in nature, though there is demand felt for case based data, especially for HIV positive cases to strengthen follow-up. The application is

supposed to support both online and offline modes of data entry. Once data is entered at the RU level, all higher levels can view the data in real time. The data is entered from Integrated Counselling and Testing Centres, Blood Bank, Sexually Transmitted Infections Clinics, Community Care Centres, Targeted Intervention (TI), Drop-in-Centre, Antiretroviral Treatment and HIV Sentinel Surveillance sites. The application generates output reports using third party analytic tools (SAS, GIS). SIMS captures monthly programme monitoring data over of 30,000 users.

A key limitation of this application is that it is geared primarily towards upward national reporting, and provides very little feedback to users on the ground to guide action taking. Further, there is little to no flexibility given to state users and below to do any modifications and all have to report only to stipulated national standards.

The user feedback on the system has been that the system has not been upgraded for some time and works only on Internet explorer-7; once the file is uploaded the user is not allowed to make any amendments and permission needs to be taken from NACO central office to upload a new file.

Point-of-Care Systems: Electronic Health Records (EHR)

We visited two tertiary care hospitals, one in Haryana using e-upchhar EHR system developed by a private vendor and other one in Chandigarh where an offline version of e-Hospital is being used. On review it was observed that the main use of these EHR systems in public sector has been limited to registration, laboratory facility, stock maintenance, blood banks etc. Its use in IPDs is limited to few wards where there is less workload, while its use in OPD is almost negligible as doctors find it difficult to manage computer entries of patient data because of high patient load. The National Informatics Centre is currently working on development of online e-Hospital system which can be used by any government/private after registration on its web-site.

We also visited and analysed a point of care system which is an Indian adapted version of OpenMRS developed by Health Information System Programme (HISP) Indian. It is based on an open source platform and has been modified for Indian settings. It's an EHR system which has been modified as per the level of care available in the facility and has operational Registration, OPD, IPD, Pharmacy, Stock, Laboratory and Health Information System. We observed that whereas the usage of EHR system in OPD was difficult for doctors in

government secondary/tertiary care centre without external help, i.e., data entry operator, it was being effectively utilized in primary health care centre as the OPD patient load is far lesser than secondary or tertiary care hospitals. One of the important limitation of these systems are that are only focused to clinical care while the other facets of healthcare, i.e., preventive and promotive care are left out of these purview of systems.

We also reviewed a hybrid EHR and Health Information system piloted in a primary health centre in the state of Punjab developed by Reliance JIO for supporting UHC. This system has been developed by a corporate giant Reliance as a part of their corporate social responsibility. The system was developed with an idea of combining clinical care and public health care at community level. It has an electronic medical record for primary health centre clinic and modules for health services entries and outreach services provided by community worker using a tablet. In this pilot tested system, the health worker enters the health services provided to the patient in the community into the online connected tablet, and the same can then be accessed from primary health centre computer system. However, due to technical issues of poor connectivity in remote areas, slow internet speed, electricity outages this system was not able to function optimally. The key limitation of this system is its complete dependence on the internet, which is very slow. The system provides very poor reports, and does not enable referral linkages. These limitations make it in its current form not useful to support the provision of UHC in the state.

Discussion

Health information Systems (HIS) have been developed in public sector under vertical health programmes using different technologies and so far are mostly oriented towards Health Management and for providing programme specific inputs to policy makers and not much progress have been made in developing HIS which are comprehensive patient-centric and community based. These systems don't fully address the health needs of the community and are not supportive of the PHC. The HIS system evaluation was based on criteria used in planning commission, government of India report [23] and evaluation criteria developed by Hanmer Lyn [24] for district health information system. The evaluation details are given in Table 2.

Some common characteristics identified in these systems include:

i) Focus on centralization: Most systems have focused on central reporting, and thus have favoured centralization, rather than the Health Ministry articulated NHM agenda of decentralization. A centralization focus naturally is supportive of the agenda of surveillance and monitoring,

ii) Limited focus on supporting local action: A centralization focus automatically comes at the expense of supporting local reporting. Typically, the systems were seen to have limited functionalities on feedback and promotion of local use. When functionalities were there, they were less than optimally used.

iii) Systems developed in silos: Most of the systems are developed using different platforms, technologies and lack interoperability so it is difficult integrating components of various programs to give a holistic picture of the patient enrolled in various programme at one point of care.

iv) Use of proprietary platforms: Many of the large systems (such as HMIS and SIMS) are based on proprietary systems, and also third party software like SAS and Arc GIS. While such software contributes to high costs, they also create vendor lock-ins which put at risk the future sustainability of systems.

Primary health care is largely seen by policy makers, and even by most doctors, as involving low technology, non-professional care for the rural poor, and primarily focused on maternal and child health. Hence, the PHC sector suffers from less than adequate funding and resources. As a result ICT projects may not have been backed with adequate resources for infrastructure, capacity building and long term support. This leads to sub-optimal outcomes of ICT projects, often dying as pilots.

Citizens not satisfied with the quality of care at the primary health centre level, often bypass it and go directly to the district levels. This leads to overcrowding of patients at that level, and sub-optimal use of specialist resources. It is expected that the UHC system based on a scheme of personal identification should address some of these problems through introducing a strong system of referral linkages [25]. Not only are these referral linkages expected to flow upwards to the district hospitals, but also backwards to the community health worker to ensure better follow up of care at the patient's home.

Building such sophisticated linkages of systems is not an easy task, as even the basic systems at the PHC level are at a nascent stage. Many challenges have to be engaged with including relating to largely manual systems, poor infrastructure, high work burden of community

workers, poor electricity and internet. Much technical and institutional work is required if UHC has to effectively deliver care as per its agenda.

Studies conducted using EHR and HIS systems in rural and primary health care level in India have concluded that these systems saves time of health workers spent on record keeping and report generation, allows easy accessibility of standardized patient data for analysis, understand health seeking behaviour and needs of the community and improve administration as well as clinical outcome [10, 26].

A study to find reasons for non-implementation of eHealth systems at primary health centre level have found that in-spite of healthcare staff willing to use eHealth systems at primary health centre, the basic support for ICT at the organizational levels is significantly lacking in the primary health centres. The study recommended that measures have to be adopted at organizational level to improve ICT infrastructure (Computers, Software, internet connection and uninterrupted electric supply) to make implementation of eHealth possible at Indian primary health centres [27].

An interview based study on persons involved with programmes using eHealth technologies in India has indicated in its conclusion that the programmes which are independently run by government are not very effective and they have suggested that a partnership between the government and either a for-profit or a non-profit is the most likely to succeed [28].

Limitations: We couldn't find enough published literature on the existing systems as most of them have been developed by private vendors or are in the testing phase and evaluation is pending. We tried contacting officials at the centre who have implemented and managing these systems for getting their views, however because of lack of permission and limitation of time we had to restrict ourselves to State and Regional level officials.

In-spite of the limitation we could get an deep insight of the existing IT based health systems developed to support health services and improve health outcomes, identify bottlenecks related to infrastructure & resources that are hampering the full potential of these systems and the need to make these systems more patient-centric and oriented towards primary care.

Conclusion

While a number of systems have been deployed, including at the primary health centre level, they have not really contributed to enhancing primary health care, and they have not been

able to demonstrate evidence of impacting health outcomes. Systems are generally characterized by design not geared to primary health care, infrastructural and human capacity constraints. As a result, they are not sustainable, and not locally owned. The systems are not optimized to the organizational needs and have been made primarily based on the concept of 'one size fits all' and not customized to particular requirements of primary health centres.

There is need to design a system which covers all the services being provided at primary health care level including curative promotive and preventive care, allows for analysis of data through an health information system which is derived directly from case based data in the system and can act as a feeder for various portals developed under national health programmes.

Declarations

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Availability of data and materials

Most of the data for the study was collected from openly available reports & literature. The observational and in-depth interview data of the current study are available from the corresponding author on reasonable request.

Consent for publication

Not applicable.

Authors' contributions

RK, DSF, SS and TP conceptualized this study and carried out independent analysis of all health information systems. DSF, RK & SS carried out the post processing of all the collected information. All authors have revised the manuscript and read and approved the final version.

Ethics approval

This article does not contain any studies with human or animal subjects performed by any of the authors. All participants gave informed consent before taking part in the study. The study is a part of project funded by Norwegian research council which has been approved by ethical committee of Post Graduate Institute of Medical Education & Research, Chandigarh, India.

Competing interests

The authors declare that they have no competing interests.

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Table 1: IT based Health Information Systems in India

Health Information Systems Reviewed	Purpose	Open/ Proprietary Source	Developed By	State where Review done
Health Management Information System	Providing Facility based health information for planning & resource allocation	Proprietary system	Vyam technologies	Punjab & Chandigarh
Mother and Child Tracking System (MCTS)	Improve Maternal & Child Health services	Open Source	National Informatics Centre	Punjab & Chandigarh
Integrated Disease Surveillance Programme (IDSP)	Strengthening of Disease Surveillance System for epidemic prone diseases to detect and respond to outbreaks	Open Source	National Informatics Centre	Chandigarh
NIKSHAY*: Online Tool For Monitoring TB Control Programme	Create database of all TB patients and use this database for monitoring and research purposes	Open Source	National Informatics Centre	State TB cell, Chandigarh
Strategic Information Management System (SIMS)	For strategic planning, monitoring, evaluation, surveillance and research in the effective tracking of and response to HIV cases	Proprietary	Vyam technologies	State AIDS Control Society, Chandigarh
District Health Information System 2 (DHIS2)	Tool for collection, management, visualization and generating Health Information data	Open Source	Health Information System Programme	Haryana and HISP, India, Noida
e-Hospital	Electronic Health Record system for Patient care in a Hospital	Open Source	National Informatics Centre	Chandigarh
openMRS	Electronic Health Record system for Patient care in a Hospital	Open Source	Regenstrief Institute, Boston, USA	Himachal Pradesh
e-upchar	Electronic Health Record system for Patient care in a Hospital	Proprietary	UBQ technologies	Haryana
Relience Jio eHealth System	Integrated Electronic Health Record & Health service information for some selective condition for Primary Health Care	Proprietary	Relience Jio	Punjab

* A combination of hindi words ‘NI’ and ‘KSHAY’ meaning ‘no’ ‘tuberculosis’

Table 2: Evaluation of IT based Health information Systems in India

Health Information System	Functionality	Management & Data Entry	Data Authentication	Offline Data Collection Capability	Up-to date Information	User/ patient Interaction	Local use of data
NHM-HMIS	a. Aggregate System b. Validations c. Offline Excel Import d. Analysis at District level & above	Block Level & above	No	Partial	No	No	No
DHIS2	a. Aggregate System b. Validations c. Inputs to HMIS d. Basic Analytics	At PHC level	No	Yes	Yes	No	Yes
MCTS	a. Name Based b. Validations c. Generates Workplans	At Block Level	Yes	No	No	No	Yes
NIKSHAY	a. Name Based b. Notification b. Allows Monitoring & follow-up	At Block Level	Yes	No	No	No	No
IDSP	a. Aggregate System b. Validations & alerts c. Analytics	District	No	No	One week lag	No	No
SIMS	a. Aggregate system b. Validations & Alerts c. Multiple Modules d. Advanced Analytics	ICTC/FICTC	No	Partial	No	No	No
openMRS	Partially compatible with EHR Standard (HL7, SNOMED etc.)	DH/CHC/ PHC	Yes	Local Network	Yes	Yes	Yes
e-Upchaar	EHR Standard Compatible	DH/CHC/ PHC	Yes	Local Network	Yes	Yes	Yes
Reliance Jio	Not Compatible with EHR Standards	PHC	Yes	No	Yes	Yes	Yes

DH: District Hospital, CHC: Community Health Centre, PHC: Primary Health Centre, ICTC: Integrated Counselling and testing centre, FICTC: Facility Integrated Counselling and Testing Centre