Perspective

A Vision for Digitization of Health Data Through an Electronic Medical Registry in Punjab, Pakistan - the Foundation of Universal Health Coverage

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Abstract

Information systems form the backbone of any organization, programme, or project. With the rapid expansion of technology, information systems used by the Governments have also evolved and expanded. In the case of Punjab province, the public sector, and especially the Health sector has seen an exponential growth of information systems. An integrated, robust, and comprehensive electronic medical records and registry system is required to streamline the flow of data as well as to improve the performance of staff, especially those who are working remotely in the field formations. Data accuracy will help the Government in planning better for the future, optimization of current resources in accordance with the need, reduction in pilferage of medicines and supplies, effective management of staff performance, and improvement in quality of services. All of these will directly contribute towards the achievement of the greater goal of universal health coverage for all. The proposed concept shall, once fully operational, be an individual centric database, whereby individuals can also log-in and access their own health records, right from conception. Multiple fragmented information systems are already in place in Punjab. An integration of these systems into a unified health reporting system i.e., the electronic medical records is proposed. This will be done in a stepwise fashion starting with one time registration of individuals and families, followed by real-time entry of any new information, including the health services availed by the individuals at any stage of their lives. The system will also have the functionality to register new births and deaths, as well as service delivery modules for each cadre in the health service delivery model of the Government. Private sector may also be included in the same system at a later stage. Administrative, monitoring, logistics and human resource modules will also be integrated within the same system. Data security and privacy will need to be ensured through appropriate legislations.

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Introduction

Good management is a prerequisite for increasing the efficiency of health services. The ever-increasing needs by the health sector demand that the policy makers and mangers are well informed to take appropriate decisions in the wake of scarce resources. This in turn requires that the information systems that are in place to inform the policy makers and the management stands up to the expectations and are relied upon maximally to influence policy and management in an optimal way.

The World Health Organization has identified health information systems as one of the six key attributes, or building blocks, of a health system[1,2]. The other building blocks are health workforce, leadership and governance, health service delivery, health systems financing, and access to essential medicines. While each of the six building blocks are essential, health information systems are critical for decision-making within each of the other five building blocks, hence forming the foundation of health systems[3]. High quality health information is critical for addressing global health challenges and building strong public health systems[4]. It is necessary for monitoring programme goals and objectives, guiding evidence-based programme management, and ensuring appropriate policy formulation and resource allocation.

Health information systems rely on multiple sources of data such as household surveys, vital registration, census, and routine monitoring and evaluation (M&E) of health services for information[5]. Routinely collected M&E data can provide important information related to the delivery of national health programmes when data are of high quality. Data quality is a complex construct, which encompasses multiple dimensions, including accuracy, reliability, precision, completeness, timeliness, integrity, and confidentiality[6]. Yet, in many resource-limited settings, ensuring data of sufficient quality for meaningful interpretation remains a challenge.

Information systems form the backbone of any organization, programme or project. With the rapid expansion of technology, the information systems used by the governments have also evolved and expanded. In the case of Punjab province, the public sector, and especially the health sector has seen an exponential growth of information systems. New information systems have mushroomed every other day, especially in the past few years. An integrated, robust and comprehensive electronic medical records and registry system is required to streamline the flow of data as well as to improve the performance of staff, especially those who are working remotely in the field formations. Data accuracy will help the Government in planning better for the future, optimization of current resources in accordance with the need, reduction in pilferage of medicines and supplies, effective management of staff performance, and improvement in quality of services. All of these will directly contribute towards the achievement of the greater goal of universal health coverage for all.

Methodology:

The article is based on author's experience with various information technology (IT) related initiatives in the public health sector of the Punjab province over the last decade. The article presents the future vision of IT in the health sector for the province, with a stepwise plan for implementation of the proposal. These recommendations are in line with the overall vision of the public sector to ultimately transform and digitize the entire health and medical record system. The author held several formal and informal discussions with key policy makers and health experts working in the Punjab province, over the last three years. The proposal is partly under implementation through different funding sources, with the Health Information & Service Delivery Unit (HISDU) of the Primary & Secondary Healthcare Department (PSHD) acting as the data repository and the IT backbone.

The Proposed Vision – 2030 and beyond

The concept of family folders with electronic medical records is basically a vision for the future of health sector in Punjab province in particular, and Pakistan in general. It will be a paperless system where digital data record for each individual would start from the day the system is live for current population, while it would start right from conception for the children to be born in the future; and shall continue in the same database / system till the death of an individual. All health services availed by the individuals during the course of their lives shall be available in this system, and shall ultimately be accessible at all healthcare facilities, whether public or private.

The proposed concept shall, once fully operational, be an individual centric database, whereby individuals can also log-in and access their own health records, right from conception. For example, a 40-years old male in 2062 (born: 2022) can access the system and see whether his mother had received the TT vaccination whilst she was pregnant with him, and what vaccinations and medical treatments he received as a child.

The experience of Punjab in real-time reporting of Health Week – 1 (2017)[7] and Health Week – 2 (2018)[7] serves as a benchmark, and a hope that this concept, despite all challenges, is doable. During the 2nd health week, entire data was reported in real-time without any major technological glitches, and all the one million individuals who benefitted from any service offered at the camps during this week were reported online in real-time.

Stakeholders for IT interventions in health

1. The Departments of Health i.e., the Specialized Healthcare & Medical Education Department (SHMED) and Primary & Secondary Healthcare Department (PSHD), as the main users of the software and databases
2. The Punjab IT Board, as the primary body that initiated many of the software currently being used, as well as a data-backup service for Health Information & Service Delivery Unit (HISDU), and the National IT Board (NITB)
3. HISDU of Primary & Secondary Healthcare Department, as the central body for data hosting, software development and maintenance
4. National Database & Registration Authority (NADRA) for birth and death registrations, and linkages between the health data systems and the civil registration of vital statistics (CRVS)
5. Government administration and departments, outside of the health sector, who would require access to the data for various purposes such as the Women Development Department, Population Welfare Department, Social Welfare Department, Environmental Protection Agency, Saaf Paani Company / Water and Sanitation Authority (WASA), Food Authority, etc. for linkages with disease prevalence and corrective measures that are required from the end of these departments and bodies of the state
6. General public, as beneficiaries of the health system

Definitions of key terms used in IT context in Punjab Health Departments

Manual system: Mostly paper based, the only digitization is conversion of reports into excel sheets, emailed to the provincial/central offices by the districts, where it is manually compiled in excel sheets only. The manual system has a high probability of human error and has very limited utilization in terms of data analysis at a later stage. Correlation of various data points for the same individual, or even the same set of population is usually not possible in manual systems. Retrieval of information over the years is also challenging. Practically, it is tedious for the health workers to correlate findings during follow up visits, especially in a country like Pakistan where the public, in general, does not keep medical records safe.

Offline system: Paper based reporting at service provision level, compiled reports submitted to district level, where they are entered into a locally installed software. Once the data is entered into the software, the data is exported from the software, and submitted to provincial / central office as an email attachment. The provincial office downloads the attachments and imports them into the same software, which is installed locally at the provincial level as well. The offline system has a high probability of human error.

Online system: Paper based reporting at service provision level, compiled reports submitted to district level, where they are entered into a web-based online reporting system. The data is, therefore, directly entered into a central server accessible through internet; no special software installation is required. Online system can also have errors at point of entry, but the chances of error in this are comparatively less.

Realtime system: Data entry of individual client / patient right at the level of service delivery. No compilation is required at any level. Data is shared with central server immediately, or with a lag of few hours depending upon internet availability. In a real-time system, there are minimum chances of human error, and negligible fake reporting. This system relies on "single source of truth (SSOT)". SSOT ensures that the data is entered at only one place, which is the point of service delivery, and the source of data are the service providers themselves. However, it is time consuming for the service delivery staff unless paper-based record keeping is abolished.

Key Information Systems Already in Place

There are over a hundred information systems used by the two health departments in Punjab; however, not all of them are used by everyone within the Dep-

artments. Some of the key information systems, having relevance to Reproductive, Maternal, New-born & Child Health (RMNCH)/child births, immunization, OPD care, lab reports and indoor services, are given in table 1.

Table 1: *Currently operational key information systems for service delivery and monitoring in health*[1]

Information System	Custodian	Notes
1. District Health Information System (DHIS), being upgraded to DHIS-2	Management Information Systems (MIS) unit of the Directorate General of Health Services	Online
2. EPI MIS	Expanded Programme on Immunization (EPI)	**Offline**
3. E-Vaccs	EPI / PITB; being shifted to HISDU (PSHD)	Realtime
4. Supervisory App & Daily Reporting App for vaccination staff	EPI / HISDU	Realtime
5. vLMIS & cLMIS v for vaccines c for contraceptives	EPI for vLMIS IRMNCHNP & PWD for cLMIS Previously, Chemonics for both, as a partner organization	Online, with capacity to be real-time
6. LHW MIS	IRMNCH Programme	Online
7. MNCH MIS	IRMNCH Programme	Online
8. IRMNCH MIS	IRMNCH Programme	Realtime
9. Disease surveillance system	DGHS/PITB/HISDU	Online, Realtime capacity available but not being used
10. Dengue surveillance system	PITB/HISDU	Realtime
11. Covid surveillance and reporting system	HISDU	Realtime
12. VPD surveillance	EPI/PITB	Online, Realtime capacity available but not being used
13. CCT app	HISDU & PITB	Realtime
14. EMR	PITB / IRMNCHNP	Realtime
15. HIMS	PITB / PSHD	Realtime
16. EMR	HISDU / PSHD	Realtime
17. NIMS, RMS, COVIM	Federal Government / NADRA, NITB & NCOC Planned to be used only for COVID-19 Vaccination at the time of this writing	Realtime
18. Hospital Info System & Online Lab Reports	MIS/ SHMED Cloud based, with no local hosting, so data security is a concern	Realtime
19. CRVS	Federal Government / HISDU, currently only in selected districts (2 in Punjab)	Realtime
20. E-Monitoring System (Health Watch)	PSPU / PITB	Realtime
21. MEA's App	PSPU / PITB	Realtime

[1]Only key information systems related to facility / community level service delivery already in operation are listed. These do not include HR MIS and other administrative software, applications and dashboards developed by the Departments (HISDU, PSHD and SHMED) and being used for various managerial functions.

CCT: Conditional Cash Transfers
cLMIS: Contraceptive Logistic Management Information System
COVIM: COVID Vaccine Inventory Management
CRVS: Civil Registration of Vital Statistics
DHIS: District Health Information System
EMR: Electronic Medical Registry
EPI: Expanded Programme On Immunization

E-Vaccs: Electronic Vaccinations Software
HIMS: Hospital Information Management System
HISDU: Health Information & Service Delivery Unit of PSHD
IRMNCHNP: Integrated Reproductive, Maternal, New-born and Child Health & Nutrition Programme
LHW: Lady Health Worker
MEA: Monitoring and Evaluation Assistants
MIS: Management Information System
MNCH: Maternal, New-born and Child Health Programme
NADRA: National Database & Registration Authority
NCOC: National Command and Operation Centre
NIMS: National Immunization Management System
NITB: National Information Technology Board
PITB: Punjab Information Technology Board
PSHD: Primary & Secondary Healthcare Department, Government of the Punjab
PWD: Population Welfare Department, Government of the Punjab
PSPU: Policy and Strategic Planning Unit of PSHD
RMS: Resource Management System
SHMED: Specialized Healthcare & Medical Education Department, Government of the Punjab
vLMIS: Vaccine Logistic Management Information System
VPD: Vaccine Preventable Diseases

Stepwise Proposal: Electronic Medical Records with Family Folders

Step 1: One Time Family Registration and Data Entry in the Software

1.1 Public Sector Registration Model - Using Lady Health Workers (LHWs)

Lady Health Workers, working at the community level in most of the rural and some of the urban areas, cover of 150-250 households depending on the population density in their respective catchment areas. The LHWs have an excellent and comprehensive data of individual family members, listed in order of household numbers of her catchment population. This data, if digitized, can be an ideal baseline resource for the digital family folders. This can be done in the following steps:

1. Review and finalization of the design of software already developed for digitization of LHW family register
2. Provision of incentives to LHWs for getting their data digitized
3. Ensuring that the National Identification Card (NIC) number of the head of household, the household number, contact details, etc. are all filled completely and correctly as this data will form the foundation of the entire system being proposed.

This model is proposed to be used in all LHW covered areas.

1.2 Health Facility Registration Model - Using Public Health Facilities / General Practitioners (GPs) / Private Practitioners and Hospitals (for urban and rural LHW uncovered areas)

Individuals who visit any hospital or clinic, either public or private, and are from LHW uncovered areas, can be registered at these health facilities upon first contact after deployment of the software. The facility-based software shall also collect the data on same pattern as on the LHW family register. Missing information can be added later, if the visiting person does not have NIC number or complete required details of other family members of their household[2]

1.3 Self Registration[3]

Individuals will be able to register themselves as well as their families, using their NIC number, contact details etc. This will be offered through an online (web-based) portal and shall be available for anyone residing in Punjab. The public will have the following incentives for self registration:

1. Saving the time taken to register, during visit to a hospital
2. Linkage with public and private sector hospitals
3. Linkage with health insurance providers, both the Government provided insurance as well as

[2]The definition of household shall be used as used by NADRA, i.e. a new family/household will be considered upon marriage.Unmarried siblings shall come under their parent's families.

[3]Verification will be done by the system to ensure that the person / household is not registered multiple times. This will be done through a check on the entry of same NIC more than once.

the private sector insurance companies leading to easy and timely settlement of claims.

Step 2: Registration of new births and deaths

This step needs to be linked with the ongoing project on civil registration of vital statistics (CRVS), which is currently being implemented through the Federal Government.

Once the entire baseline data from LHW's family registers is online, it will just need updating upon birth of a child, or death of any individual. Child births in the public sector (especially at Basic Health Units and Rural Health Centres i.e., BHUs and RHCs) is already being digitally recorded in real-time. The same model, scaled up for internet based as well as SMS based service, can be rolled out in every public sector health facility. Moreover, the LHWs are also registering women as soon as their pregnancy is identified. This registration is linked to the rural ambulance service database, which is currently being used to pre-enrol women for ambulance availability at the time of delivery.

Thus, every birth and death happening at community level will be recorded by the LHWs while these events happening at health facilities shall be recorded by the health facility staff.

Step 3: Service Delivery Modules

Separate modules for each service, by staff type, shall be developed. Ultimately, every staff member involved in the delivery of health services shall have an individual login-based access to the central database, whereby the staff member can enter details of the services provided by them at their respective levels, in real-time. The back-end technology for real time data entry may vary by circumstances. For example, the LHWs can use Unstructured Supplementary Service Data (USSD) based, Short Messaging Service (SMS) based or internet-based data entry models; as the Government has had experience of all these three models for the LHWs Programme. Similarly, other workers who are mobile and may have connectivity issues can use the USSD or SMS based reporting options. Another alternate option for such circumstances could be the flexibility in the software; whereby it can send data over internet if connectivity is available, or the same data can be converted into an SMS code by the software itself, and sent over simple GSM connectivity. The decision on how this would be done shall lie with the software design team i.e. the technical experts.

Following levels of data entry will be developed:

3.1 Community Level Services by Lady Health Workers
3.2 Community Level Services by Vaccinators
3.3 Community Level Services for Surveillance (dengue, covid-19, Vaccine Preventable Diseases - VPDs, polio, other diseases)
3.4 Facility Level Services - Primary Facilities (Basic Health Units - BHUs, Government Rural Dispensaries - GRDs, Mother and Child Health - MCH Centres, etc)
3.5 Facility Level Services - Primary Facilities (Rural Health Centre - RHC level)
3.6 Facility Level Services - Secondary & Tertiary Level (THQHs, DHQHs, Teaching Hospitals)
3.7 Facility Level Services - Special Institutes (Cardiology institutes, Kidney and liver institutes, etc.)

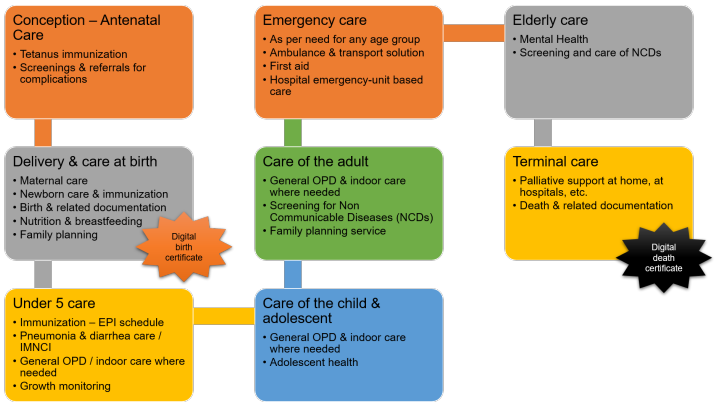


Figure 1: *Flow of data from an individual's perspective*

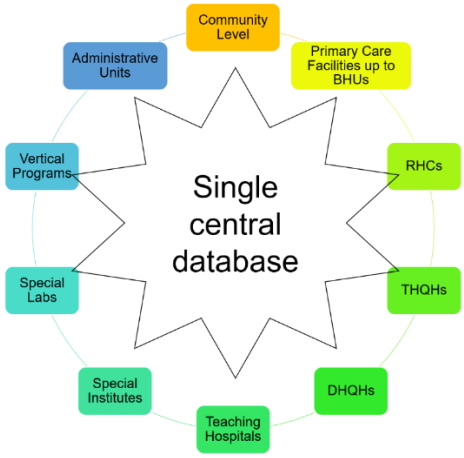


Figure 2: *Linkage of all services to one database*

Table 2: *Key staff categories and examples of services offered through them*

Staff Category (service delivery)	Key Services
Lady Health Worker	Awareness, basic community screening, basic primary healthcare, family planning disease surveillance, immunization & polio
Lady Health Visitor	RMNCH, nutrition, family planning, immunization & polio, basic primary healthcare, disease surveillance
Vaccinator	Immunization, disease surveillance
Medical Officer / Woman Medical Officer / Dental Surgeon	OPD care, indoor care, emergency services, supervision of preventive care
Senior Medical Officer	OPD care, indoor care, emergency services, supervision of preventive care
Specialists & faculty at DHQHs and teaching hospitals	OPD care, indoor care by specialty, emergency care
Dietitian	OPD care, indoor care
Pharmacist	Pharmacy services, dispensing for in-door as well as OPD cases
Nursing staff	Indoor care services, support services in OPD
Lab & blood bank staff	Lab diagnostics and tests
Other paramedical staff	Support in various indoor and outdoor services
Emergency Services Staff in ambulances	Emergency transport (1122 and 1034 ambulance service), emergency treatment at the site of incidence, treatment in transit

Step 4: Monitoring Modules

A number of monitoring systems are in place within the health sector, starting from the provincial departments and directorates and the district health administration (DHAs) to the community level through the Assistant Superintendents Vaccination (ASVs), Deputy District Health Officers (DDHOs) and Lady Health Supervisors (LHSs). These staff members will have special logins for entry of their monitoring and supervision reports in real time. The performance reports of corresponding supervisees under each of the monitor shall be accessible to the monitor to review and verify during the field visits.

Step 4: Administrative Modules

Administrative modules shall have following main purposes:

1. Human Resource (HR) status; hiring, transfers & postings, termination, retirement, etc.
2. HR capacity; information about academic qualifications, on-job trainings, etc.
3. HR performance: this will be directly linked with the EMR, for example a surgeon may be assessed based on the number of successful surgeries performed annually while a vaccinator may be assessed based on the proportion of eligible children immunized by him within his catchment population
4. Payroll system
5. Dashboards for provincial, district and tehsil level administration (Secretariat, directorate, DHAs, etc.)

Step 5: Logistics module

Two different logistic information systems have been used by the health sector in Punjab i.e., the Logistics Management Information System (LMIS) for vaccines and contraceptives developed with support of United States Agency for International Development (USAID) and later on shifted to the Government, and the Medicine Inventory Management System (MIMS) developed by Health Information and Service Delivery Unit (HISDU). Similarly, a procurement management system has also been developed by HISDU and is being used by some units of the Department. It is proposed that all these systems may be integrated so that the procurement, warehousing, and supply chain related records can be made in real-time.

Ultimately, the logistics system is to be linked with the service delivery system in such a way that stocks of health facilities and service delivery points (e.g., vaccinators and LHWs in the community) can have their stocks up to date in real-time based on the service report they enter. For example, if a doctor prescribes 10 tablets of paracetamol, the same are issued by the pharmacist/storekeeper and immediately deducted from the store balance of that health facility. Similarly, if a vaccinator enters that he opened a vial of BCG vaccine, it will automatically be deducted from his stock report. Thus, a real-time stock position of the entire field formation can be obtained, ensuring the issue of under as well as over stocking and save valuable exchequer.

Step 6: Individual's Module

This module shall be available for the general public, as an end user of the health sector services. The users will be able to log-in to the mobile application using their NIC number (or of the head of household), and password. The unique identification number for the individuals will be available in the form of a readable number as well as a Quick Response (QR) code which can be scanned at the health facilities. The module shall offer the following to the users:

1. Personal details & family history as recorded during various interactions with the health system from time to time
2. Facility to download and print medical certificates, birth and death certificates, etc.
3. Facility to edit basic demographic information such as updating of address, contact number, etc.

Implementation Plan

As challenging as this proposal may seem, it is doable. The health sector in Punjab has a history of using IT for real-time reporting, but in a fragmented way. The time is now appropriate to integrate all these fragmented systems into one comprehensive module and aim to implement it across all districts in a phasic manner. Following sequence may be adapted:

1. Development of the registration module and initiation of entry of currently available family registers data (by the Lady Health Workers)
    a. Incentivize LHWs to enter and digitize all the data from their family registers through the registration module
    b. Random verification of digitized record
    c. Facility for public to self-verify personal data (through NIC and/or mobile number, with view-only rights initially and editing rights at a later stage)
2. Development of an integrated software for primary care, covering all services from community level up to the level of RHC. This software will basically integrate all the existing applications and software into a single software / application with separate modules for each staff category.
    a. Incentivize staff to make digital entries and abolish manual recording systems
    b. Random verification of digitized records
3. Integration of the software for primary care with the Hospital Information Management System (HIMS) which has been tested / functional at selected Tehsil and District Head Quarter Hospitals (THQHs/DHQHs) of Punjab.
    a. Incentivize staff to make digital entries and abolish manual recording systems
    b. Random verification of digitized records
4. Upgradation and integration of existing supervisory software
    a. Incentivize staff to make digital entries and abolish manual recording systems
    b. Random verification of digitized records
5. Upgradation and integration of existing logistic management information systems
6. Upgradation and integration of existing HR information systems

Data Security and Privacy

Data security and privacy will be an important aspect to be considered. Regulations such as Health Insurance Portability and Accountability Act (HIPAA) of the United States may need to be promulgated in the

country to ensure compliance with security and privacy of individual's health records. Similarly, a policy regarding data encryption, physical location of main, primary and secondary back-ups will also be required to be developed.

Conclusion:

A robust real-time data entry and records system in the health sector is the future of health records, and is recommended to be implemented in the Punjab Province. Implementation of the complete package may take many years, but every step of the IT interventions being implemented, or in pipeline, must be in the same direction i.e., an integrated system with multiple modules for each category of service delivery in the health sector.

Salient Points:

- Manual reports result in delayed reporting and gives the opportunity for data manipulation for over or under reporting of various services and diseases incidences.
- Electronic reports are real-time, reducing the chances of fabrication of data, and improve the timeliness.
- A single source of truth is the hallmark of a real-time reporting system whereby data of individuals seeking any form of health service is directly entered into the health database i.e., the electronic medical registry.
- The electronic medical registry/records system also helps in remote monitoring of the quality and quantity of services being delivered, and its linkage with the routine monitoring systems further strengthens monitoring in real-time as well.
- Day to day situation analysis and changes at implementation level can be done based on evidence generated from such reports.

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