Session 6- Background Notes- supplement

Architecture in the making: Example : Himachal Pradesh

Himachal Pradesh is a state in Northern India, which is one of the more progressive states in the country with respect to its basic health indicators, for example, related to maternal and child health. Since the routine systems are relatively well stabilized and institutionalized, the state has recently embarked upon a more sophisticated initiative of creating an integrated health information architecture (IHIA) with technical development being carried out through a national NGO called HISP India.

This IHIA is comprised of a set of distinct information systems development processes, which are all integrated through the overall "date warehouse" approach and "glued" together through the application of standards, for example the new WHO initiated, shared standard for data exchange and interoperability called SDMX-HD:

i) ***Building district and state data warehouse, based on the current routine HMIS:*** the basic part of this data warehouse, is already in place with the HMIS database (based on DHIS2) for routine data, where the state carries out data entry at the sub-district level. The initiative in process, is to include more types of data and to extend the data structure of this "data warehouse" by including data on the two lowest level facilities - the PHC (Primary Health Centre) and the sub-centres reporting to this PHC – where till date this data was being aggregated and entered at the sub-district level of the block, which is a group of PHCs. Further, this system forms the framework within which the other projects, described in the following, are being integrated by feeding aggregate data to the "data warehouse" and using data from it.

ii) ***Mobile telephone reporting from sub-centre and peripheral level***: Currently the sub-centres are reporting their data on a monthly basis, on a number of paper forms to the above HMIS system. Given the harsh winter, isolating many valleys in the state during the winters, the project is to use a mobile phone to report data directly and seamlessly to the "data warehouse". This mobile based sub-centre reporting has been previously piloted in one block of the state, with positive results. Taking this many steps further, the mobile application is being extended both geographically and functionally. The geographical scaling plan involves extending from one block in one district to the complete district, and then to the other 12 districts in the state. The plan is to do this scaling in a phased manner, in batches of 4 districts each, where one batch is added each month. The functional scaling is being done, by including all the formats that the field nurse (called the ANM) has to report in a month (nearly 10 different formats) on to a mobile phone, in contrast to the earlier application, which only includes one dataset.

iii) ***Name based tracking of pregnant women, deliveries and children for immunization – the DHIS Tracking system:*** The Government of India, has recently initiated a programme of name based tracking, where all pregnant women would be tracked by names over the lifecycle of the services of

antennal, delivery and postnatal care, and also all newborns over the lifecycle of their immunization. The software to support this tracking (DHIS Tracking) has been developed by HISP India and the Global DHIS development group as a module in the DHIS2. The system is being implemented in the State in a phased manner, and also in some of the other states in the country. From this system, the routine monthly reports on number of ANC visits, deliveries and immunization will be aggregated, transformed into an adopted standard, and exported to the "data warehouse". Over time, the DHIS Tracking data would also be transmitted through a mobile phone application.

iv) ***Comprehensive hospital information system – Integrating electronic medical record system and "data warehouse" for hospital management:*** This project is two-fold: 1) to develop an electronic medical record system for district hospitals, one which is easy to adapt to the needs and available resources, even in smaller hospitals. The system needs to be flexible so that it can be scaled from initial admission and billing modules to more modules and functionalities, as learning and human resources are developed;
2) integrate the aggregate data from the medical record system with other types of data from the hospitals, needed for management, such as human and other resources, finances, laboratories, drugs, etc. in what we are labeling a "data warehouse" of aggregate data for hospital management. Further, to extend this system, to include all patient related data, corresponding to services provided to individuals, in the setting up of 20 district hospitals in the state.

There are particular informational needs of hospital and facility management, which are not covered by medical records systems, since they primarily targe patient management. The "data warehouse" for hospital management can be understood, as in the district, by conceptualizing wards and specialties as facilities in a district; organizing aggregate data by wards and specialties; and correlating the data with the number of beds, staff and other services, thereby being able to analyze and present key hospital indicators, such as:

- Bed occupancy: Number of patient days/ nights divided by number of beds, typically provided by month; bed nights during a month divided by number of beds X 30.
- Average length of stay: Number of patient nights divided by number of discharges, typically by month.
- Death rate: Number of deaths divided by number of patients; by age, service and ward.
- Infection rate: Hospital infections divided by number of patients; by ward, age and service.

v) ***Geographical Information System (GIS) – presentation of data using maps & other data representation tools:*** The geographical coordinates on each health facility, and the borders of districts and sub-districts, will be included in the "data warehouse" and the GIS module in the DHIS2 will enable the mapping of services, health and demographic status related to facilities, districts and other geographical boundaries.

The data presentation modules of the "data warehouses" will more generally be developed further, to include a dashboard for easy access to graphical tools (bar charts), mapping, as described above and tabular and pivot enabled formats.

The next phase of the project will also include the creation of *a **Human resource management*** system, which will include records of the employees in the health services. Aggregate data on number of staff and qualification by health facility, represents important information for managing hospitals, districts and more generally the health services in the state, and will be imported into the "data warehouse". Human resource data by facility also represents important data for the mapping functionalities in the GIS.

Integration of these projects and health information systems: the IHIA

All the above initiatives, distinct projects and sub-systems of the HIS, will be integrated within the framework of the integrated "district based" state data warehouse, which may be conceptualized as a development and extension of the former HMIS, where the aggregate data from all hierarchical levels of the health administration will come together. Data standards for exchange of aggregate data will be used to feed data from the various systems to the "HIS data warehouse", which will be created at all levels of the administration; state, district – and to support management in the hospitals. The schema for integration would include the following:

a. The data reported by mobile telephones from the sub-centres are directly fed into the "data warehouse", and will gradually make the reporting on paper and following data capture obsolete.
b. The name-based data tracking will, first, be dominantly reported on paper and captured in the DHIS Tracking database at block level, and second, gradually be registered and sent by mobile phones to the NBITS application. Aggregate data on pregnancies and ANC services, deliveries and immunizations will be fed into the data warehouse. The corresponding aggregate data currently being reported by paper and entered directly into the "data warehouse", would be eliminated over time.
c. Data from the hospital information system at the patient level, will be aggregated and exported directly into the "data warehouse".
d. All data and indicators will be available for presentation and analysis through the GIS and other reporting tools.

In this way, integrated data from different projects will be available to a common set of reporting tools, for generating all required indicators to support management analysis and reporting at different levels of state, district, sub-district and hospital.

Implementing the IHIA: a phased-wise incremental approach

These different sub-systems and initiatives, will be developed and integrated from bottom up in an incremental manner in contrast to, a "big bang and centralized top down" approach. Some of the features of this phasing are detailed below:

1. The state district-based data warehouse –the main "HIS-data warehouse", which is being developed from the previous HMIS system, will include all sub-centres in its database; district by district.

2. The mobile reporting system will also be implemented, district by district.
3. The DHIS Tracking database application will be implemented in a district by district approach, which will also include phase-wise block-by-block implementation within the districts.
4. Similarly, the integrated hospital information system, including the hospital "data warehouse" for aggregate data, will start with one hospital; stabilize the systems there and then in a phased manner, include all the other 19 district hospitals in the state.
5. The mobile application reporting aggregate data, will first include one dataset, then the other paper formats will in course be added (presented in 2 datasets), and then, would gradually extend to also include the DHIS tracking.
6. Once the hospital information system is stabilized in one hospital, it will be extended to the others. Also, the hospital data would need to be integrated with DHIS Tracking (for ANC and immunization service data provided by the hospital, and also with mobile telephones).

The integration of aggregate data, within the "data warehouse" framework, will be based on appropriate data standards for data interoperability. In this way, the state will become a pioneer in the country and even globally, on the development and implementation of an IHIA.

Designing and implementing the data warehouse for Himachal Pradesh, India

In the example of Himachal Pradesh, "data warehouse" represents an integrated framework – an "umbrella" - within which, the various systems and also data warehouses are gradually being plugged in and subsequently scaled. The existing HMIS and routine paper-based reporting, forms the backbone and point of departure.

First, the data structure in the state data warehouse, previously called the HMIS database, is extended to include sub-centres, which is important to strengthen data quality, data analysis and information use.
Second, it enables data reporting from sub-centres, with the use of mobile phones. This is especially useful in the state, where parts of it are closed during winter as snow makes physical travel for data reporting problematic. The mobile network, covers most of the state with all the sub-centres having access, yet some may need to go to the nearest PHC, in order to submit their reports by SMS, or through the GPRS network.
Third, electronic medical records in the district hospitals; starts with patient admissions aggregate to developing management reports, such as for discharges and billing. Monthly hospital summary reports will be aggregated automatically by the electronic patient record system and transferred to the data warehouse.
Fourth, registration of each pregnant woman and her follow-up until delivery, as well as, the registration of every individual infant and the doses of vaccines given to them, is a large undertaking as, initially, paper forms will be filled out in each sub-centre and then submitted to the block, where the data is captured in the database. Later, mobile phones will be used for reporting data, a system currently being developed in one district. Aggregate reports from this system will automatically be generated every month, or at different intervals, and sent to the data warehouse in co-ordination with other sub-centre reporting. Furthermore, reports and schedules of pregnant women for deliveries will be communicated to the relevant hospital, and data will be transferred to the hospital database.

Fifth, a human resource management system will be developed within the same framework, to feed aggregate data on human resources into the data warehouse. *Sixth*, GIS, analytical and reporting tools will encompass data from all the different systems through the "data warehouse".

The planning and development of the IHIA in Himachal Pradesh, illustrates the benefits of a shared architecture and integrated framework, represented by the "data warehouse". Without that, the different components would have been easily developed as totally separate/ independent entities, with little or no interconnectivity; for example two separate mobile projects, one hospital project, one GIS project, one HMIS project and one human resource management project, which would have contributed to further fragmentation rather than to strengthen integration leading to more effective monitoring and decision- making, as is the case here.

The making of a health information architecture: Example from Sierra Leone

Sierra Leone, a small country in West Africa and one of the poorest countries in the world, and was ravaged by civil war in 1992-2002. The public health system suffered from loss of personnel and destruction of infrastructure, but is now gradually being rebuilt with considerable support from a variety of international donor agencies. The rapid growth of relatively uncoordinated health initiatives has created a situation of fragmented information systems, typical for most developing countries. As a result, in early 2008, each health facility is required to report data every month, on 17 different paper forms, with nearly 50% overlap of data across the forms.

Given this fragmented HIS; the main issue was to provide meaningful and relevant information for decision making and to diminish the workload of staff responsible for collecting and reporting data. The strategy selected was to use DHIS 2 as a tool to integrate the various data flows and data sources, through a participatory prototyping strategy, involving all "owners" of data collection tools alongside the various levels of users. All paper forms and data elements included in these were identified and sorted out to identify duplication from overlapping data forms and data elements. As a result, a coherent integrated data warehouse was built, where one data element in the database could be related to a field in several data collection forms. In order to satisfy the "owners" of the forms, each paper form was included in the data entry screen. Duplicate data elements from the existing paper system, were integrated "behind the scenes" in the data warehouse. Data already captured, would then appear as already included in the data entry form.

In January 2008, this integration approach was implemented in 4 of the 13 districts, and 6 months later in 3 more districts. Intensive training was carried out to support each district to capture their data in the DHIS, and export the data to the national DHIS by the use of memory sticks. An extensive process to capture and import backlog data from the various electronic systems, from all districts was put in place, and a rather comprehensive national data set was available for analysis during the second half of 2008. All stakeholders were made part of the process which documented the problems with the current system such as overlapping data collection forms, inconsistent data definitions, poor data quality in terms of both correctness and completeness. At the same time, through actually doing it, it was also documented that shared common data sets in a national repository was possible to achieve. This learning process sparked an increased interest to revise the current collection forms, and during 2009, a series of meetings took place among the key stakeholders to negotiate a new set of harmonised data collection forms. As a result, since January 2010, a new set of completely rationalised and harmonised forms have been in use, very different from those of the previous years.

Sierra Leone is today HMN's primary "best practice" example of how even a poor African country can develop an integrated HIS –following the HMN Framework.

Unintended consequences understood from a social systems perspective to HIAs

Information as symbol and signal – an example from South Africa

In the Day Hospital in Mitchell's Plain district, South Africa, the manager wanted to replace the data collection forms used in the wards with simple tally sheets (see Figure below). While the old form included patient folder numbers and other scribbles, not used afterwards; the new tally sheet intentionally included only what was regarded useful information. The two forms represent roughly the same amount of work carried out in the injection room on a particular day in 1995 and 1996, respectively. The old form had 59 entries, whereas the new form had 66. The health workers initially refused to use the tally sheet, because they felt that an anonymous *tick* did not reflect the amount of work it represented. The reporting system was, thus, seen as a way to legitimate their work. The old form contained text and figures representing *real* patients. Furthermore, it looked much "busier" than the tick sheet, and it gave a certain personal touch in relation to each activity performed. The old form therefore represented a "personalization" of work; a particular health worker dealing with particular patients. This was not seen as being represented by a tick in the new "anonymous" form. In other words, the *unintended consequences* of the data reporting system, to confirm and re-enforce social contracts and existing power structures, were as important as the *intended purposes* of the system, to report on activities in the injection room. These dynamics needed to be understood in the social context, as the health system in South Africa,was undergoing changes at the time, and many health workers feared loosing their jobs. As they felt the new reporting forms did not sufficiently acknowledge the amount of work they did, they saw it as a threat to their job security. This example illustrates the way all reporting forms, data standards and procedures have similar origins of being embedded in daily reporting routines and work practices.

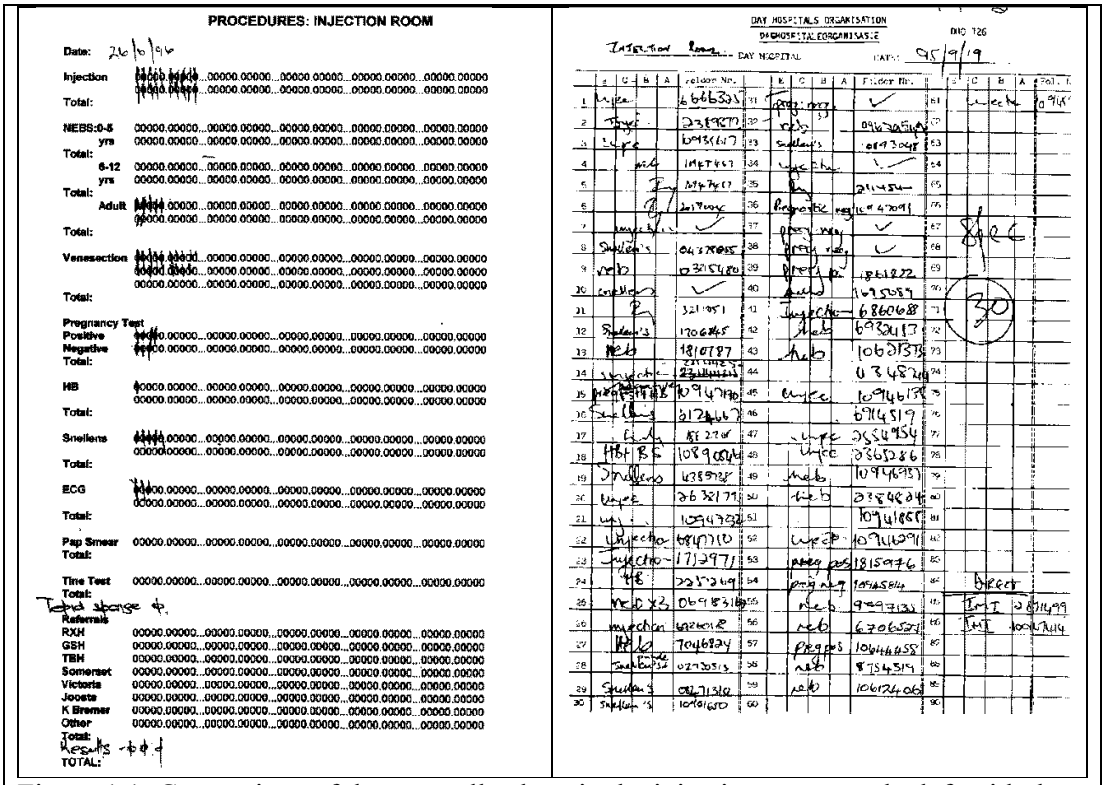

Figure 1.1: Comparison of the new tally sheet in the injection room on the left with the old reporting form on the right, reporting 66 and 59 'events', respectively. Note the columns marked 'E', 'C', 'B' and 'A' in the old form, for European, Coloured, Black and Asian patients. These columns are not in use anymore, and the space is used for marking the categories of the events reported.

Box 1.2 Unintended consequences of change: Example from South Africa