e-Health

Scaling e-Health Services in step with ICT Transformation

ITU

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ABSTRACT

The concept of ICT adoption in health Care delivery has attracted international initiatives with huge budgets, as a mechanism for bridging the global digital divide with equitable Care delivery. e-Health is viewed as a major mechanism of Information Communication Technology (ICT) adoption, for proliferating equitable Care delivery from palliative, curative to preventive Care and the top cities to remote rural areas, especially for developing countries. e-Health delivery to remote locations relies on three major links between patient and Care provider–Telecommunication infrastructure, back-end computing/storage infrastructure and User-end platforms.

Global investments for modernization of infrastructure is in a race with rapidly growing health-related economic loss of productive life years associated degradation in quality of life. Hence it is extremely important to understand which e-Health services can be deployed immediately with available infrastructure and which additional services can be added, as the infrastructure is transformed according to the needs and constraints of the target demographics. Adopting this point of view, this paper is presents a methodology of study the ICT requirements of a complex health care system in terms of its activities, transactions and nature of information exchanges, and map their computing and communication needs at the point of Care to existing technology standards.

Case-studies and data from several pioneering e-Health initiatives in India have been sought for applying the methodology and gain useful insight. However, the emphasis is this paper is more on the method than the data samples, so that a typical data-driven governance system may use the method and fit relevant data from their own demography to diligently prioritize investments with more accurate expectation of outcomes by scaling e-Health services in step with ICT transformation.

BACKGROUND

The concept of Information Communication Technology (ICT) adoption in health care delivery popularly known as “e-Health” has attracted international initiatives with huge budgets, as a mechanism for bridging the global digital divide with equitable care delivery. It is viewed as a major mechanism of provisioning equitable health care from top cities to remote rural areas, especially for developing countries. While ICT adoption could cover a broad scope of activities in the field of health, this paper considers the definition by ITU as ‘The use of Communications and Information Technology to deliver health and health care services and information over large and small distances” (1).

Successful e-Health deployment in remote locations depends on three major links between patient and care provider – Telecommunication infrastructure, back-end computing/storage infrastructure and User-end platforms. From a technical standpoint, one may argue that the issues can be solved by just connecting the patient and the care provider through the best of computing and communication infrastructure. But the transformation will face a very bumpy path due to dependency on technology, cost, production, training and support and economic capacities. India, with over 1.17 Billion people, has embraced ICT-transformation over the last decade, and several national and international e-Health initiatives have experimented innovative technologies and methodologies. Considering the valuable learning from such initiatives in such a large, diverse society, the underlying nature of information exchange in various scenarios of health care management have been analysed in an attempt to map their dependencies on ICT transformation. The study further attempts to group transactions and services that could be handled at different Client-end infrastructure standards such that they can be customized for use in ICT transformation planning process in a given target demography.

India has state-of-art data centres, IT and medical personnel, high bandwidth connectivity, available and scalable in the cities. The Telecommunication backbone covers more than 85% of the terrain across 600 thousand villages, extended by Cellular coverage radius of 5km thereafter, but the last 10 to 15 km has most of the holes in connectivity (2). While the country has clocked over 560 Million Mobile wireless connections and over 100 Million Land-line connections connectivity (3) and is now opening up to 3G technologies, high-end Smart phones and multi-media services, less than 25% of the 750 Million+ people in rural areas have access to even basic voice services. Similarly, less than 10% of Indian population are computer literate living in urban areas while Mobile phones far outnumber computers in the country (4). So, there is special emphasis on adapting the User-interfaces of the e-Health system to the Mobile hand-held platform. However, some services may be more suited for Land-line connectivity while some may need wireless, Mobile connectivity, some operations can be done on a Land-line phone or Cell phone and some others need Desktop or Laptop computers. For example, a majority of the medical practitioners are used to writing prescriptions, reports, etc. Typing into a computer may not be a valuable proposition to them, as compared to just using a scanner or providing notebook computers with handwriting interface to ‘write’ their documents into the database.

Therefore, technology solutions successfully adopted in one society may not match the needs, practices and problems and their evolution in another region. Trying to find a GOLD standard that would fit into all needs would be a futile exercise, force-fitting technology solutions from one region to another may induce underutilization of resources and the learning curve may induce reluctance of users. User-acceptance will favour affordable rapidly customizable and scalable automation that does not demand capital reinvestments and minimizes the learning curve for the users.

The latest and greatest technologies take a long time to percolate through the system, while the adoption of e-Health services has to race against disease incidence and prevalence rates in next decade. For example, the economic burden of disease measured in disability-adjusted life years (DALY) (5) at the current Indian GDP per-capita (6) translates to a loss of productivity of over $200 Trillion! In countering this depletion of productivity, there is an acute shortage of physicians (1 per 1000 people) and nurses (0.8 per 1000 people) and care facilities (1 bed per 1000 people) (7) in the country. The spread of available workforce is also disproportionate across various regions, varying from 0.25 to 2.3 per 1000 people (7), with over 70% of the population in rural areas and over 60% of health care work force in urban areas. Thus ICT adoption is not only needed in bridging remote doctors and patients for care delivery, but also in remote healthcare education and training for faster growth rate of human resources to arrest rapid widening of the demand-supply gap. India generates only about 64% of its current electric power demand (8) out of which 93% of the demand is met in urban areas and only 52% of the demand in met in rural areas. More than 44% of rural India faces power cuts of 12 to 15 hours a day (9), (10), where even a battery backup system does not work-out. Thus while most modern technologies designed for developed countries assume continuous availability of power and telecom connectivity, it takes time and cost to customize them to address such gaps.

Another barrier to rapid delivery of equitable care is linguistic diversity. For example in India with over 22 officially recognized languages (11)and over 1600 “mother tongues” (12), linguistic diversity seems a major barrier in the way of a patient in one region being able to talk to a doctor in another region. Although it is technically possible to use electronic language translation, the effort has been mainly academic (13) if populations of people using these various languages are not large enough to attract industry to develop tools in a standardized approach. Also, of 1.17 Billion population in India, about 38% are cannot read/write (14), over 85% cannot understand English (15) and only 8% of Indian population is urban computer literate (4). Hence technologies that need computer literary and typing skills may find road blocks in adoption. There are some examples of a work-around by utilizing local language human interpreters on a video conferencing system (16).

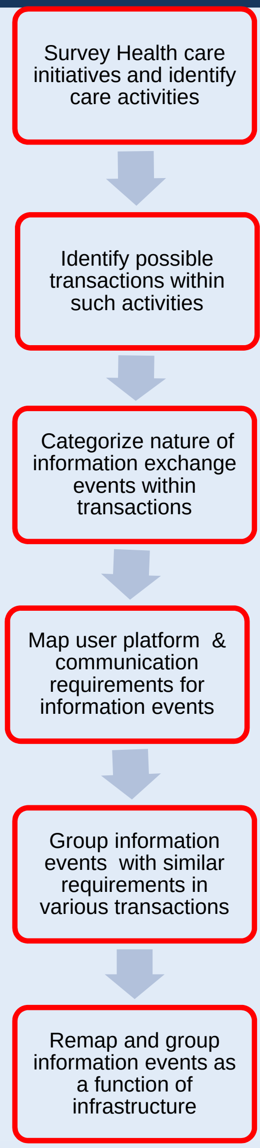
It is therefore extremely important to understand which e-Health services can be provisioned immediately with available infrastructure and which additional services can be added, as the infrastructure is transformed according to the needs of the target demographics. To understand this, one needs to first appreciate that the type of treatment needed for the same disease may be different in different regions, and hence the associated care activities may be different. For example, in some regions it is found there is high incidence rate of cancer primarily due to bad habits (tobacco, etc.), which needs counselling and therapy while in some work places it is due to radiation-exposure and needs people to wear radiation shields.

To propose adoption of a given type of information technology, one has to first map out the typical types of transactions and information exchange events within the context of a care delivery service and then derives the technical requirements for those transactions. These requirements can then be grouped to understand what services can be delivered with different level of infrastructure maturity at the Client-end. Based on the usage density, the requirements of corresponding Server-end infrastructure can then be provisioned. The requirements thus identified help to arrive at costs per information exchange, per transaction and per care service, which can help the governance to prioritize, develop, deploy and charge appropriate services alongside infrastructure evolution. Such an approach is expected to make it easier to decide on investment priorities for ICT adoption in e-Health and reduce wastage of valuable resources and time in containing growth rate of the economic burden of disease. Adopting this point of view, this paper presents a method of break-down analysis of activities, transactions and information exchange requirements of ICT within the health care process, to classify the computing and communication needs at the point of care. While the list of activities, transactions and information content may not represent every possibility in a health care system, the method is useful to apply with updated parameters relevant to a specific demography.

Mapping client platform and connectivity requirements of an e-Health system

Method: This study has adopted the methodology suggested in (17) and customized it as illustrated in flowchart of figure (1). Initially, several real-life scenarios in preventive, curative and palliative care delivery was surveyed covering 26 major e-health initiatives from a mix of private, government and NGO organizations addressing over 200000 patients across India. These e-health networks aggregated the skills and facilities of primary, secondary and tertiary care from rural villages and urban cities, from several thousands of entities (hospitals, clinics, diagnostic labs, insurance claims administrators, medical colleges, call centres, pharmacies, etc.,) across India. India was chosen for its wide spectrum of technological, economic, social, linguistic and cultural diversity and number of pioneering initiatives already underway (18). From their publications, site visits and in some cases interviews with the staff, various usage models and infrastructure at the point-of-care were studied to identify adoption pattern of connectivity and end-user platform technologies in their activities (for details refer (19)).

FIGURE 1: Steps used in this study



The seemingly diverse set of care initiatives were then categorised based on the phase of care management process resulting in a simplification that showed the entire spectrum of programs fit into a set of 6 major health care activities. These activities were analysed to identify different types of underlying transactions (for example, consultation, diagnostics, etc.), which yielded a set of 33 types of transactions from across all activities. Further, the nature of information Exchange Events (IEE) within the transactions was studied and graded in terms of its purpose(for example discharge summaries, prescriptions, conferencing streams, Radiology reports, etc.), the representation (video/image/text/etc.), the data size, the urgency of delivery (real time, offline) and mobility. In this process, IIEs with similar requirements were grouped together within each transaction and resulted in identifying 112 types of discrete information exchange events. Considering the recommendations of the Task Force for Telemedicine in India of the Ministry of India (20)and several definitions of minimum dataset and formats for health care transactions such as in HISP (21), international formats such as DICOM, CDA (22) (23) (23) (24), etc., the graded groups were then mapped into available point-of-care infrastructure standards for communication (ISDN/CDMA/DSL/etc.) and User-H/W platform (Laptop/Mobile phone/etc.). The findings were tabulated in the order of care activity mapping to their component transactions and information exchange events and their requirements as given in appendix [1].

The table was then remapped in order of infrastructure and used to project what type of activities, transactions and information exchange events are achievable with various types of communication and User-platforms at the User-end. Several charts indicating the degree of enablement for information exchange in each transaction and activity as a function of connectivity and Client-platform enablement was derived (and termed as the "applicable fraction of information exchange) to familiarize planners with the observations and outcomes from such analysis process. It is to be noted that in this study 'point-of-care' includes all locations from where patient and staff such as specialists, nurses, physician, etc, participate. However, the focus is on the infrastructure at the User-end and not about those provisioned at data centres to host the e-Health applications. Also, the bandwidth and user-platform requirements are estimated on a per-user basis, and have to be aggregated basis concurrent usage densities. This list of activities, transactions and their gradation may neither be comprehensive nor showcase a total resolution of the problem, but is aimed to catalyse new method for assisting e-Health ICT infrastructure planning.

Typical scenarios of a health care process

A large scale health care system will sustain various activities to govern the development, deployment and management of care programs of relevance to their regions of governance. For example, the programs could be targeting elderly population, disabled population, mother and child care, etc. In another cross section, one may find programs to address populations vulnerable to specific communicable or non communicable diseases, such as: AIDs, Cancer, Malaria, etc. Such care programs should first train and utilize appropriate human resources to survey the demographic and environmental information in regions of governance. Based on the analysis of such data, the care program then identifies prioritized target zones and needs of the disease management/living conditions to be addressed. The care program can then engage appropriate infrastructure and human resources such as health workers, nurses and doctors, trained according for timely intervention in regions of priority.

Once target zones are identified, a phase of preventive care can be deployed to arrest further deterioration of health conditions. This will need screening of the target population for the specific diseases and health conditions to shortlist candidates who need medical intervention. Some citizens may not have a disease but may be found pre-disposed to some diseases based on their living conditions and life style (for example: a person with smoking habit or those not living in clean locality, or those working in hazardous zone is predisposed to several disease conditions) and may need some preventive education /interventions such as vaccination. In such cases, counselling sessions are organized to impart preventive care to the patients and train them accordingly. Such preventive care delivery is conducted usually in form of medical camps at a medical facility (mobile van, clinic, community-centre or a primary health centre) wherein the predisposed candidates are registered into a monitoring program to track their conditions and also assess the dynamics of health condition in the target population.

Citizens, who are identified as patients after screening tests, may be referred to appropriate physicians/specialists in speciality clinics and hospitals. The specialists can remotely study the patient's electronic medical record and prescribe further consultation, medication, treatment or more detailed diagnostics/observations based on the situation. Patients who need emergency care get transferred to emergency management facilities immediately; other patients identified for normal hospitalization are admitted to a referred hospital. If hospitalization is not required and the treatment could be self-managed or assisted by health workers/nurses, then training and support services can be booked accordingly in advance. In some cases where the patient undergoes surgery at a local hospital, the local surgeon can seek help of remotely located experts by booking their services in advance and sharing patient's medical records and patient status before, during and after the operation.

After being discharged from hospitalization, the medication, treatment and symptomatic response of the patient can be recorded by the nurses/paramedics/next of kin or patients themselves and shared in follow up consultations with the physician. In special situations, one may need to continuously track the specified symptoms/parameters within specified bounds and send alert messages the care-taker/health-worker/patient when the parameters go out of bounds. One may also need help to contact support services such as ambulance services, hospital admission desk, etc. Over such interventions, if the disease is cured the episode ends and patient retires from care. In some cases the health condition may not be cured but maintained within bounds by specific medication/dietary/treatments and periodic monitoring of the patient's health by the patient/next-of-kin/health worker with periodic consultation with the physician. However, if the patient reaches a stage of certainty of death or unbearable discomfort due to the disease, the situation may warrant the teamwork of health-worker, next-of-kin and physician for imparting appropriate medication, treatment and counselling quite frequently to give the patient mental respite from pain, disorder and depression.

All these care delivery services are charged by the delivering organizations, either directly to the patient, or through assistance from Grants/insurance/subsidies. Generally, the billing is on per-service basis except when integrated bills are generated during hospitalization. The patient may not be aware of the process and facilities to avail subsidies, procure medicine, make payments, book logistics/physical support services and navigate through the associated formalities. The health care system may be needed to provide appropriate information and logistics support services to aid the patient.

In disastrous situations such as earthquakes, floods, etc., large scale training, deployments and management of resources are needed at very short notice in order to prevent/contain disease outbreak and casualty. Special disaster care protocols may impart rapid training electronically to citizens and workers in disaster zone rapidly provision and scale services. All the above activities need timely data collection, large scale planning, execution, expense, tracking and continuous improvement in a health care system, necessitating several back-office support activities such as accounting, resource management, supply-chain management, reporting, auditing, and data-mining and analytics within the care program management cycle. In many situations, the persons at the two ends of a transaction may not have a common language to interact, creating a need for language translation support services.

Typical activities within a care process

The work in all the scenarios discussed above can be grouped into a few types of activities within a health care system. Each of these activities involves several transactions between various personnel of the health care system (physicians, nurses, administrators, pharmacists, medical specialists, IT personnel, insurance managers, lawyers, call centre respondents, accountants, etc.), from different entities. The activities in several scenarios were studied and grouped into following six categories considering the phase of Health care process in which they are applied are

1. Program Management activities: This is the entire administration process from planning to execution tracking, to continuous improvement of the overall system towards better efficiency, as determined by several performance indicators and root cause analysis of the system.

2. Health Surveillance activities: This phase handles data acquisition, filtering, analysis and generation of periodic indicators followed by classification/quantification/notification of outliers, followed by tracking population/environmental response to corrective programs, as needed for care program management.

3. Preventive care activities: This phase handles staff training for delivering education, mentorship and medication, deployment of plans to prevent/contain/sustain health conditions as directed by care program management, intersecting with patients and healthy citizens at the risk.

4. Patient care activities: This phase deals with citizens declared as patients identified with a specific disease condition. This phase covers the workflow, care flow, and commerce flow automation for curative and palliative care delivered in hospitals, ambulances, clinics and homes of patients.

5. Support activities: These are utilities used by a patient and the administrative setup of a care program. It encompasses providing relevant information upon query, providing guidance and walkthroughs and managed services of language translation, physical, financial and legal support for both the patient as well as the care program administration.

6. Disaster Management activities: This phase covers special situations for management of emergency in large scale operations much like a rapid action force, without depending on infrastructure available under normal circumstances. From assessment of situation, to planning, training, execution, tracking and steering the entire action plan, these activities may utilize the services under various phases above, but with independent, parallel governance and priorities which may override the policies of normal conditions.

Typical transactions within care activities

Each of the activities listed above, involves several transactions between personnel and patients, and between remotely connected sites across the activities mentioned above have been studied. Several transactions are identified within the work flow of various activities. Among the transactions identified, several types of transactions were found to repeat across a number of activities. The transactions were then filtered from the activities into a non-redundant set as given below in figure (2):

FIGURE 2: Non-redundant list of transactions across care activities

1	Register Citizen for screening	18	Ambulance services
2	Conduct screening tests	19	Admission/Discharge/Transfer to hospital
3	Trending of health indicators	20	Surgery
4	Environment monitoring	21	Clinical waste management
5	Genetic and Habitual Risk profiling	22	Post-hospitalization follow-up consultation
6	care program planning	23	Patient education and training
7	care network entities management	24	Post Hospitalization Patient Monitoring
8	care program administration	25	Counselling
9	Education and training for site staff	26	Financial Assistance
10	Public education for preventive care	27	Physical Assistance
11	Register patients into specific care programs	28	Logistics Assistance
12	Consultation with Physician/Specialist	29	Information Assistance
13	Prescription	30	Emergency response
14	Diagnostic (second opinion)	31	Triage
15	Specialist Reporting	32	Emergency care
16	Medication services	33	First aid management
17	Therapy services		

Nature of information exchange in care transactions

The underlying dependencies on infrastructure for the virtually unlimited number of scenarios stem from only a few factors. This study includes objective dependencies, wherein the context in which a transaction takes place is expressed by factors, such as:

1. What is the type of information required (Patient history/diagnostic report/discharge summary/billing information/ etc.)
2. How urgently is it required (real time/offline)
3. In which form is it required (e.g. image/text (including structured binary values)/audio/video/etc.)
4. Accuracy of data needed (e.g. video conferencing needs lesser image resolution than an a radiology video)
5. Extent of details required (e.g. a diagnostic may need 12 leads of ECG while a monitoring may need only a few leads)
6. Where is the information required (e.g. an ambulance may need portability, a rural health worker may need mobility, which a hospital admin may not need)

These factors help to quantify the type of data, range of data size, speed and type of agility required for the information exchange, and to match transaction to available communication and computing platforms. However, other subjective factors can influence acceptance of a technology by the system. For example, consider a few scenarios given below:

1. Doctors may want to spend their time on attending to patients instead of spending time on feeding in data to computers.
2. SMS based intimations is a very useful service, but may lack accountability in a given medico-legal framework for content error, transport delays, delivery failures.
3. Although it is technically possible to receive bill payments from cashless insurance cards after electronic verification of records, the system may mandate hardcopy medical records of patient for claims verification.
4. It may be technically possible to incorporate voice records instead of text records to address literacy barrier. However, it may not have legal authenticity depending on the governing law. In such cases this study considers voice records as a valid option in addition to text records.
5. It may be technically possible to use Text-based Cell phones for specific data entry instead of a PC/Smart-phone, but this is highly subjective based on the regional distribution of computer literacy. In such cases, this study considers both Text-based cell phones and PC/Smart phone options leaving the subjective decision to the planners.

Thus the choice of user interface platform has a significant dependency on the medico-legal implications of the transactions it is used to perform. Hence some end-user devices may be deemed unsuitable even if it is a chosen solution in other legal jurisdictions. Such subjective factors are relevant to a given demography, and beyond the scope of this study to generalize the method to include such factors. However, common usage trends observed in surveys have been considered in identifying multiple alternative platforms from which one can choose based on available level of infrastructure, affordability, usage literacy, etc. Several types of information exchange events were identified and categorized based on the nature of the interaction as discussed below. In cases where the same information may be used in different transactions (for e.g., patient medical records are used not only for diagnosis but also in financial assistance transactions such as insurance claims processing) but such events have been kept discrete to retain the relationship of a transaction to its component information events.

Mapping information exchange types to communication and User-platform system requirements

In general, any redundant information from the data is removed before transmission and/or storage to optimize bandwidth and memory utilization by employing data compression standards such as JPEG for images, MPEG for video streams, ADPCM/CELP for voice, MP3 for audio, etc. The choice of compression standard is a trade-off between processing overheads, transmission bandwidth, and the accuracy of information needed. For example, medical images are passed through lossless compression technologies while video conferencing employs lossy compression. In cases where multiple choices are available, this study has prioritized accuracy first, bandwidth reduction next and then processing load while considering data sizes in compressed forms.

There is also an increasing trend in the software industry to exchange all types of information using internet based applications. However, it is important to note that the raw data gets padded with additional bits due to error correction, encryption, and packet headers at all layers (link, network, transport, application) of a standard communication protocol. In some scenarios (such as environmental monitoring, preventive surveillance of general citizen health indicators, etc.), the data size may be tiny. In such cases, the ratio of actual data payload to the header size and associated packet routing overheads may lead to inefficient utilization of available bandwidth (25), since each additional packet adds header bits overhead and routing effort overhead. Depending on the urgency of the transaction, the applications must diligently pool information into larger blocks buffered before transmission for utilizing available bandwidth efficiently. When data appears in bursts of small chunks, buffering helps to balance between traffic payload and protocol payload and even-out the transmission rate to match the link capacity more efficiently. Buffering also helps at the receiving end to sort out-of-order arrival of packets that suffer jitter in transportation delay on the network. However, in some situations such as monitoring a patient in intensive care situations, even if the data size is small, one may not wait to pool more data samples before transmission. In both of these cases–the buffered and non-buffered varieties, the transaction is online in the sense that the consumer of the data can readily use it in live interactions such as in Tele-Consultations, Tele-Monitoring, etc. In this study, this mode of data transmission has been called as the **'Real-Time'** mode.

In a contrasting set of scenarios, the data required for processing can be uploaded at one time and processed at some time later, and the results can be read out at yet another time, hours or even days apart. For example once a CT scan data of a patient is uploaded into the system it enters a queue. A Radiologist pulls the data from the queue according to his/her own schedule and uploads a study report electronically after inspection. The study report is accessed by the physician probably when the patient visits again. In these kinds of scenarios, it is possible to employ a store and forward mechanism wherein the large quantum of data is locally stored and copied onto a distant database at times when the traffic on the network is less. This mode, called in this study as the **'Offline mode'**, helps better utilization efficiency of available bandwidth by prioritizing to Real-Time traffic over offline traffic. In addition, factors such as rampant power cuts in rural areas will favour offline data transmission and Client-server based applications as compared to real-time, browser based applications. However, for transactions employing mobile phones such as surveillance and other form entry, power cuts may not be an issue at the User-end.

The choice of User-platform is also influenced by the context of the transaction. For example, when an alert message is sent from the patient monitoring system to the patient's next of kin, a Mobile phone based SMS may be a preferred platform whereas it could be delivered to a monitoring nurse as pop-up indicators on a Laptop/Desktop. In most offices where people work from fixed locations (such as: accounting, call centres, etc.), desktops are preferred over Laptop, as they are cheaper and there is no need for mobility of the platform. In other scenarios the user platform is transported from location to location but used after it is setup at a given place of that location, such as the case with medical camps, which needs 'portability' of the user platform. Then there are situations wherein data exchange should be happening even when the user platform is moving (such as in an ambulance) which requires user platform with 'mobile' access.

It may be technically possible to show an MRI image on a Smart phone screen but its usability as a Radiology reporting tool may be poor as compared to a Laptop or Desktop which provide a larger screen, higher resolution and sophisticated analytical and presentation tools. Consider a first aid scenario under emergency care-one does not expect people to have a PC at the point of care, the know-how of using it, and wait till computer boots and then launch a s/w application, start a video conference session and then consult a doctor-here a Mobile phone may be a better choice. Thus, based on the context and common sense, relevant provider entities (kiosk/clinic/hospital/lab/pharmacy/etc.) can employ the appropriate User-platforms required to provide their services diligently. The context expressed in terms of the data type, data size, urgency (mode of transfer), mobility and User-interface determines the preference of connectivity and User-interface platform.

It is also possible that the nature of information exchange may be similar in different activities, necessitating similar infrastructure requirements. For example, Contract/SLAs, Bills, MIS and Audit configuration forms, Status forms are generally alphanumeric, they fall in a similar data size range and can all be handled in store and forward mode from a care program management office. Similarly, Angiogram, Otoscope, Dermoscope records have image/video data with similar size range that can be handled in store and forward transmission in a diagnostic lab. Such information exchanges with similar needs within a transaction can be categorized into groups. This study has considered various scenarios from the several ongoing projects [11], as well as recommendations of HISP and the Task Force for Telemedicine in India of the Ministry of India, and has found 112 groups of information exchange events which can be mapped to 32 types of transactions across the 6 major types of care activities discussed earlier. Further, the resultant matrix was mapped to the type of communication link and User-platform matching closest to the requirements of each information exchange event and consolidated into the table shown in Appendix-1. This study has considered six different types of User-platforms–Telephones, Ordinary Text-based Cell phones, Smart phones, Laptop PCs, Desktop PCs and dedicated equipment (e.g.: video conferencing units/biomedical equipments with built-in network interfaces). Further, the bandwidth requirement at the point of care (on a per User-basis) are graded into slabs as shown in Appendix-1 aligned to several major Land-line and several wireless connectivity standards being employed in India listed below in figure (3).

FIGURE 3: Bandwidth slabs and associated connectivity technologies used in this study

Client Bandwidth	Tiny <64Kbps	Small <256Kbps	Medium <1Mbps	High <10Mbps	Extremely-high <100Mbps
Wired line	PSTN	ISDN,DSL	HDSL	CABLE, VDSL	OFC
Wireless	GSM, CDMA2K	EDGE	XWIFI, VSAT	EV-DO	HSDPA, LTE , WIMAX

Symbolic representations are used in Appendix-1 to illustrate the type of information content, the urgency of transmission and typical data size range, bandwidth and User-platform requirements of the underlying information exchanges. This list of activities, transactions, information exchange events, etc., can be further customized/enhanced further as needed for specific care program or target demography. A classification of such groups can form the basis for estimating the computing and communication platform requirements in hospitals, clinics, pharmacies, homes and resource centres of a target health care system. The data in Appendix-1 was reordered to reflect the corresponding information exchange events, transactions and activities that can be handled for a given type of connectivity and User-platform, as shown in Appendix-2 and Appendix-3 respectively.

Applicable Fraction of Information Exchange (AFIX)

In most cases, only a fraction of the types of information exchange events (IEE) in a transaction may be possible with a given infrastructure. For example, while conferencing can have video, audio and text data exchanges, only audio transmission is possible with a Land-line telephone. To get a first order indication of the utility of given connectivity standard or User-platform standard, one can first determine the number of types of information exchange events that can be enabled with it in a given transaction 't' (Say, Ne (t)). One can also estimate the number of types IEE possible in that transaction (Say, Np (t)).

Then the ratio $AFIX = \frac{Ne(t)}{Np(t)}$ for a given transaction 't' is defined herewith as the "Applicable Fraction of Information Exchange (AFIX)".

This is a useful indicator of the coverage of IEEs for a given type of connectivity or User-platform. In the current study, AFIX values have been estimated assuming that all types of information exchanges in a transaction are equally important. It is a subjective issue to determine which information exchange event is more important than the others. However, when some types of information exchanges are found more important than others, one can improve this estimate with suitable weight factors W(k,t) for each type of information exchange event 'k' in a transaction 't', which has X types of event types that can be enabled out of Y types of events in the given transaction 't' as

$$Ne(t) = \sum_{k=1}^{k=x} W(k,t) \;;\; Np(t) = \sum_{k=1}^{k=y} W(k,t) \; and \; AFIX = Ne(t)/Np(t)$$

The weight factors can range between 0 (least important and worthy to be dropped), and 1 (most important and absolutely required). From Appendix-2 and Appendix-3, one can estimate the AFIX for each combination of transaction, activity, type of connectivity and type of User-platform.

Figures (9) and (10) show summaries of several AFIX Spectra across all transactions and care activities for various connectivity and User-platform standards considered in this study. One may use the AFIX as a figure of merit of a given connectivity/User-platform standard for a given transaction. For example, it can be seen from the AFIX coverage for a plain old Land-line phone, 96% of information exchange events of patient support activities can be handled. Of these, 100% of physical and logistics support services can be addressed, while information support services can be fully handled except direct display of knowledge bases. Similarly, 100% information exchange events can be handled in over 93% of transactions using VSAT/extended WIFI/HDSL connectivity. This type of breakdown analysis brings forth several insights which help in planning ICT transformation and service provisioning roadmap. An exhaustive compilation of all possible trends and indicators from this matrix is beyond the scope of this paper, and the reader may find other important observations in this data set or even alter the data set to suit their target demography.

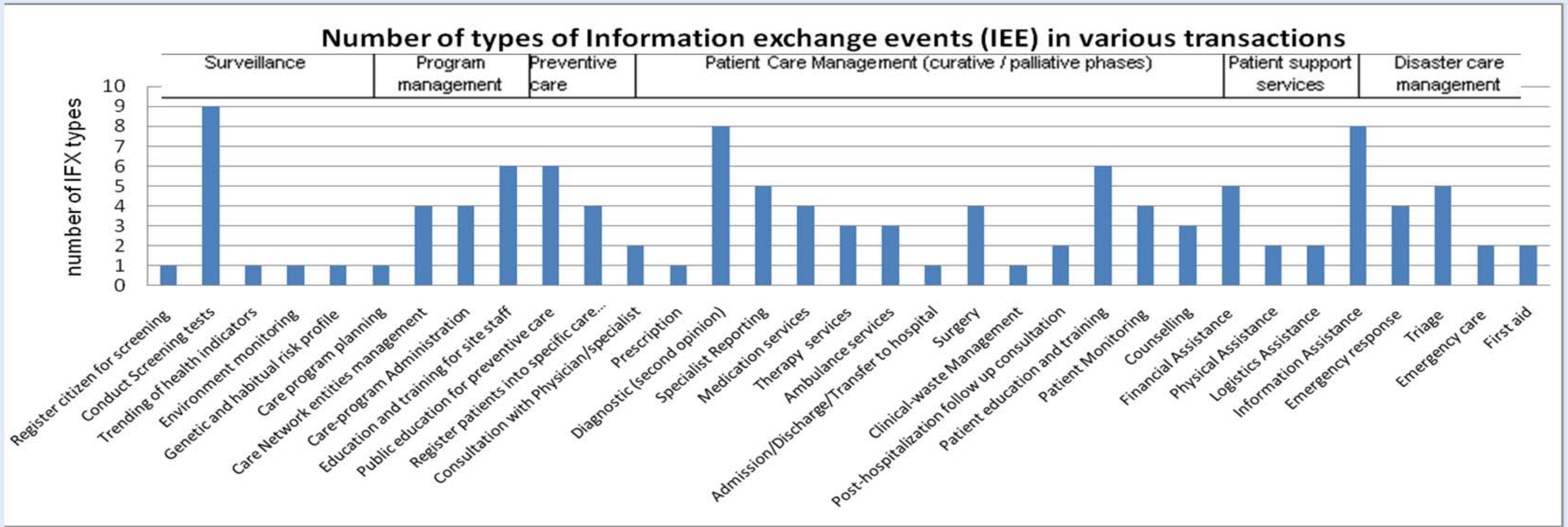
Observations

It is to be noted that all projections are projections from the available data set in tables of Appendix-(1, 2 and 3) are not meant to mandate the usage models. There are indicative of the possibilities, while a specific demography may have differences based on its constraints and established practices. For example the figure (5) indicates over 50% of the information exchanges in all transactions as video content, meaning “given a choice, one used video in over 50% of the information exchanges”, and not a direction that ‘in more than 50% cases, one must use video”. In a given system, one may well choose to send the same information by text instead of video, if feasible within their bandwidth or regulatory constraints.

Distribution in types of information exchange

The observed spectrum of information exchange types across various transactions in appendix-1 is shown in figure (4). It shows relatively fewer types of information exchange in surveillance phase, and most of these transactions are possible with a Text-based Cell phone. Surveillance helps avoid much higher expenditure and infrastructure that are needed in curative and palliative stages. Thus it is relatively cheaper, simpler and easier to induce ICT transformation in the surveillance phase, which is a very important step in arresting the spread of diseases at the earliest opportunity. Thus, there is no need to wait for new infrastructure, ICT enabled preventive care and surveillance services can be designed around existing infrastructure which needs to be done with utmost urgency to arrest the DALY loss spiral.

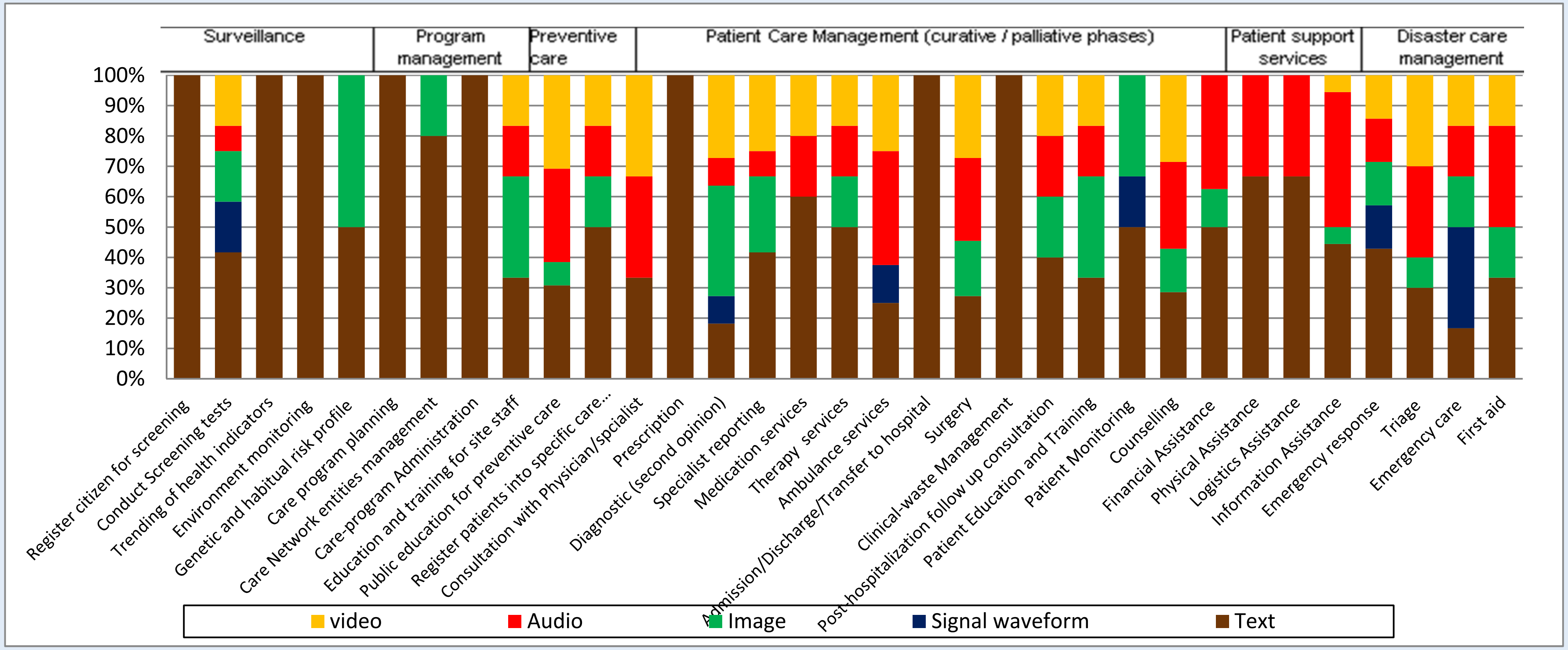
FIGURE 4: Spectrum of information exchange types across various transactions



Distribution of data types

The fraction of data types within various transactions is shown in figure (5). At least 20% of the exchanges in all transactions can be text based, the simplest data type. However, more than 50% of the transactions would benefit by video exchange, which is the most complex data type and the killer application of health ICT in future may well be video conferencing. Due to regulations, voice/video records are not considered as authentic medical documents compared to printed records with handwritten signatures and need higher bandwidth for communication compared to their text equivalent, otherwise audio/video exchanges could have dominated the spectrum. It is also observed that waveform signals, such as ECG, EEG, Spirometry, etc., is needed in less than 20% of the transactions.

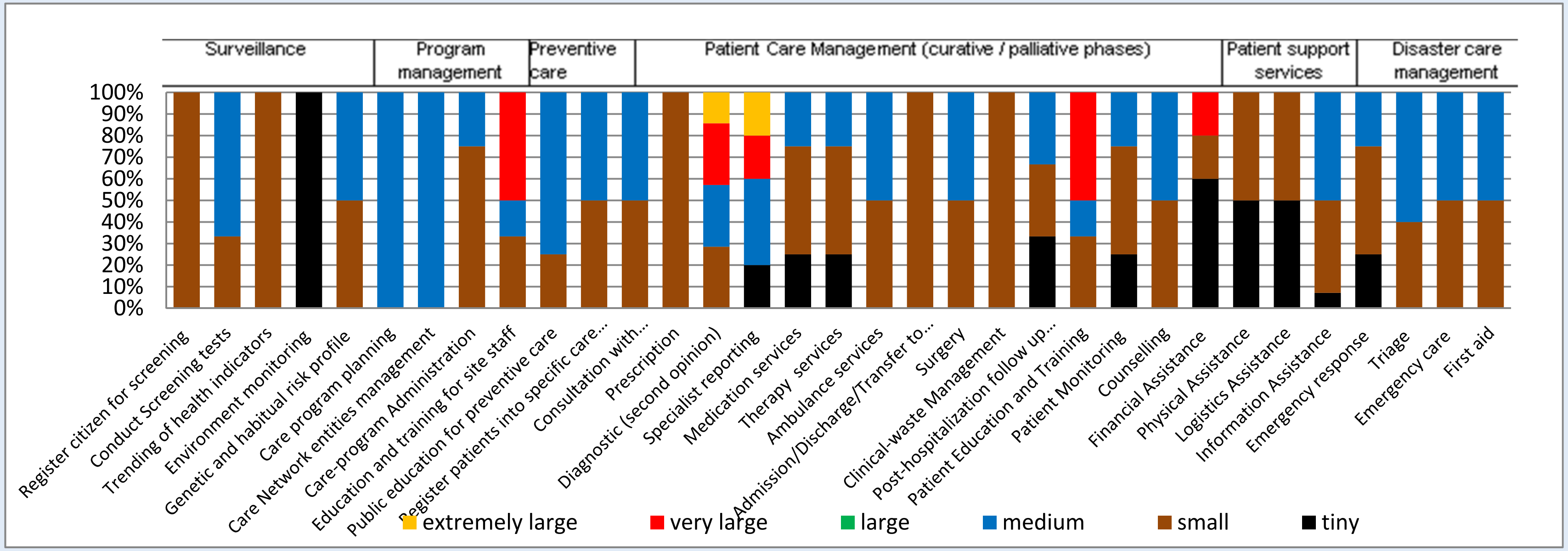
FIGURE 5: Distribution of information data-types within transactions



Distribution of data size

From Figure(6), it is observed in the information exchange of various transactions that over 95% of the transactions, the data size is in 'small' category typically for 25% to 60% of the information exchanges. Extremely high data sizes are observed only in a couple of cases such as full-slide high resolution pathology images. Environmental monitoring needs the smallest size of data exchange, followed by registration which falls completely in the medium data size category. Care program and network entities management transactions fall in the medium size category. Disaster care management needs medium or even lesser data size. These categories also are indicative of the typical storage and transfer volumes from data base servers based on the transactions. It is to be noted that these are single user estimates, and the data volume will aggregate at the data centre based on number of concurrent users.

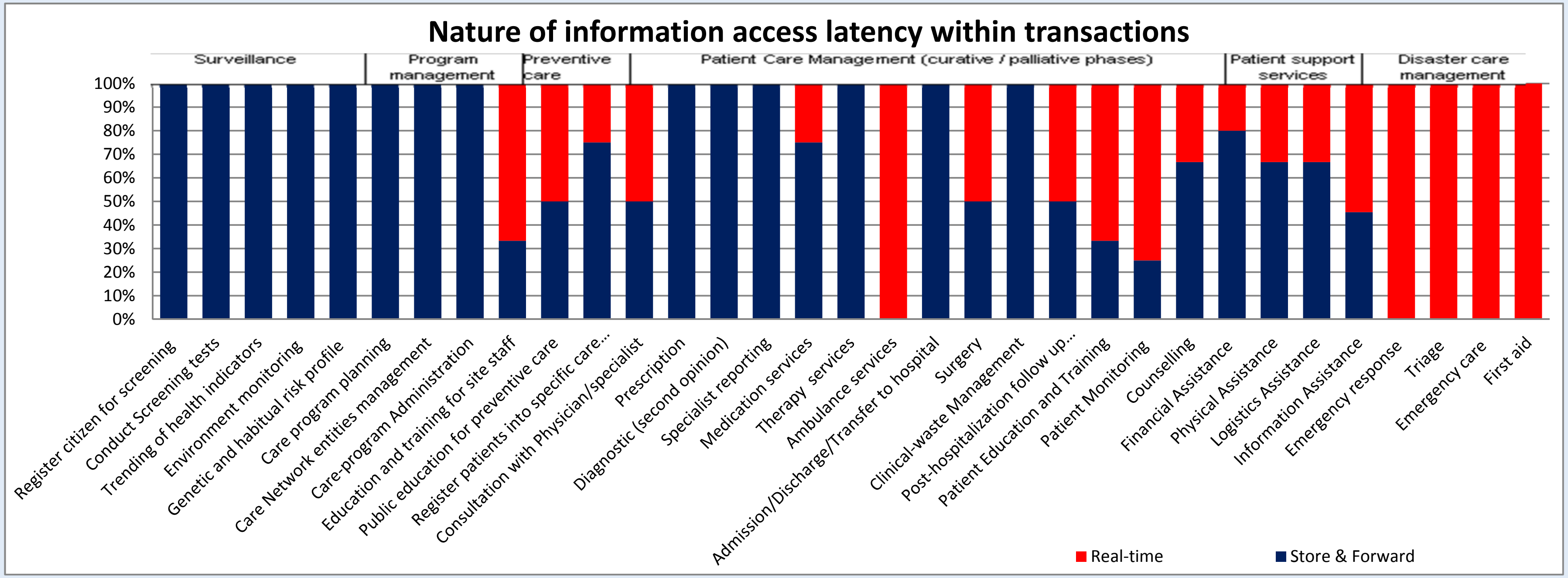
FIGURE 6: Distribution of information data size within transactions



Distribution of real-time and offline exchanges

Figure (7) shows the distribution of information exchanges that require real time data transfer (including buffered transmission), or store-and- forward methods. It can be observed that over 85% of the transactions can employ store and forward methods ranging between 35% to 100% of information exchanges within the transactions. Surveillance diagnostics, prescription and special reporting transactions and >80% of program management can be handled with store forward mode. On the other hand, ambulance services and disaster care transactions are expected to happen in real-time mode. One can judiciously choose the mode of information exchange to save on the cost and complexity of infrastructure needed for real time exchange. Except for live shows and conferences, all transactions of program management can be handled in offline mode.

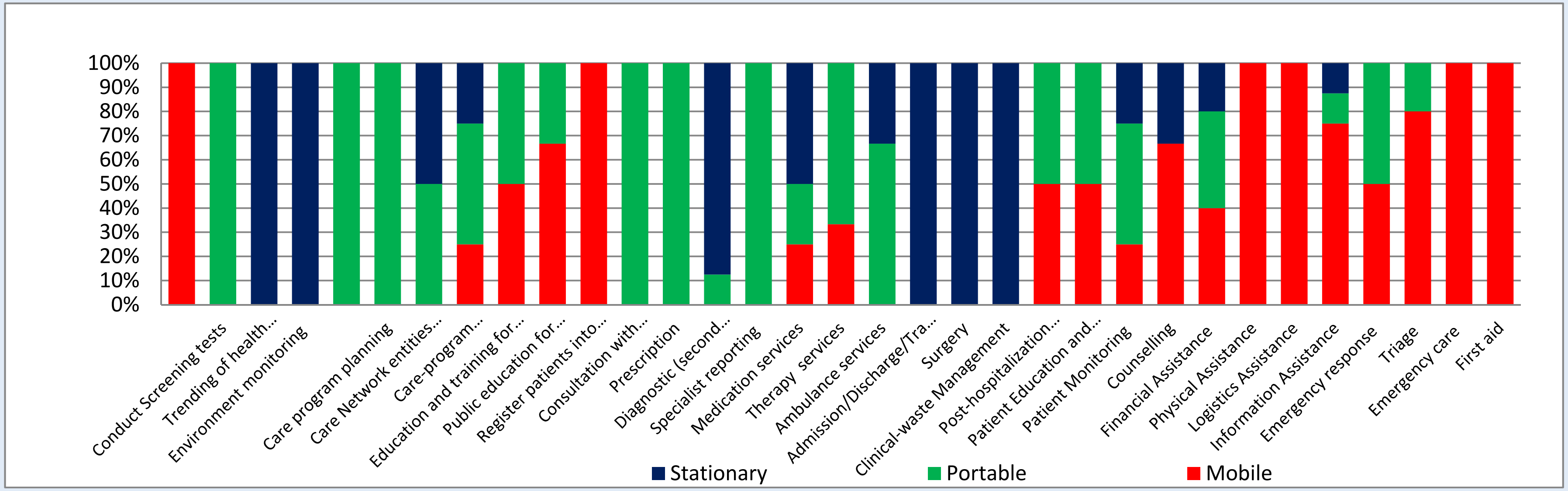
FIGURE 7: Distribution of real-time and offline information access



Distribution of information agility

Figure (8) indicates the nature of agility required in access to information in various transactions. It can be observed that about 15% of the transactions need only fixed workstations, while about 70% of the transactions need access to data through portable stations, that are moved from location to location but may not need data access while being ported. About 20% of the transactions need mobile data access even while travelling for all information exchanges, while an additional 40% of the transactions may need mobile access for only a fraction of information exchanges within them. Most of the back office transactions can go with Desktops while field-transactions, such as patient support and disaster management need mobility. This will help to judge which type of connectivity and User-platform to choose, on the basis of how one is expected to retrieve and store information within the transactions that they have to deal with in the services they provide.

FIGURE 8: Distribution of need for data agility within transactions



Bandwidth utilization

A given infrastructure may not match the requirements of all types of information exchange events for a given transaction. However, this is not necessarily a disadvantage, as all types of information exchange events may not be necessary for a given end-use scenario and associated workflow in which it is employed. For example, consider a diagnostic scenario that may need only basic bio-chemical tests (such as routine Blood, Urine, Stools reports, etc.), which are purely Text-based uploads possible with the PSTN/GSM (SMS)/ GPRS based links. But if diagnostics include an ultra sound scan or a doctor has a video conference with the patient, one may need ISDN/DSL bandwidth. In Tele-Reporting scenarios where a pathologist zooms into and pans across digitized images of associated slides (several tens of Mega/Giga bytes of data depending on the resolution of the slide), it will become necessary to use the highest bandwidth technologies such as LTE/WIMAX/OFC. Hence, primary care or tertiary care hospitals may be equipped with different level of diagnostic equipments and specialists to provide corresponding levels of services. Depending on the specialty services provided/needed in a particular care program the associated care delivery points (such as a kiosk/clinic/small hospital/tertiary hospital/diagnostic lab/ambulance/ etc.) can estimate the bandwidth required to provide their own combination of services. Generally in a bandwidth constrained scenario, one can plan for connectivity standards diligently, choosing between fewer transactions with complete coverage of all information exchange events or more transactions with fewer types of information exchange events. This is useful in particular for emergency care and first aid transactions in a disaster situation, which may require communication despite power disruption and infrastructure damage.

India, with over 70 Million land lines and over 560 Million 2G/2.5G Mobile connections in operation, can take immediate advantage of its infrastructure, to enable graded services in various regions of the country. Majority of this is still GSM/CDMA based voice channels, but can support significant load of SMS/MMS based transactions and are upgradable to GPRS services. This best-effort approach has been demonstrated by pioneering efforts (26), wherein Desktop video conferencing was developed for counselling and consulting activities on a 64 Kbps link, and remote cataract diagnosis was proven at the same bandwidth using a Web-camera.

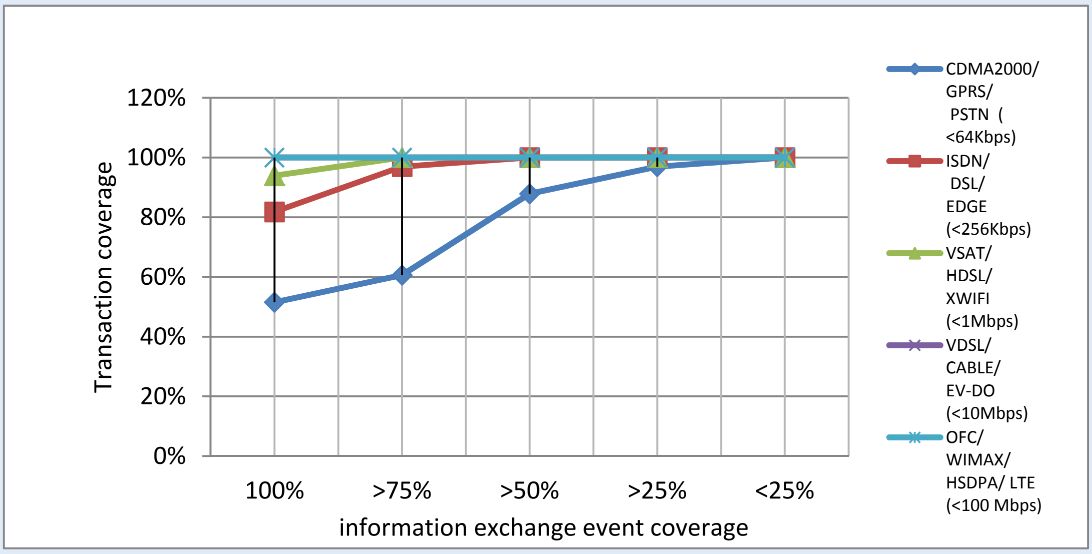
Over 80% of transactions are manageable with 256 Kbps bandwidth, beyond which diminishing returns may take over adoption rate, given the much lower volume of the patients, equipment, skills and expertise of faculty intersecting the remaining set of transactions. Again, these are single user estimates and depending on the user density, the bandwidths and associated standards can be chosen appropriately. Recent addition of 3G in India is expected to enable services to move up the value chain, but it will also take time to reach similar coverage as that of existing connectivity. Given the rapid rate of productivity loss associated with the DALY mentioned in the introduction, the priorities for health service providers and health ICT application providers should be on how to rapidly proliferate services efficiently utilizing whatever already exists, in a way that is scalable to add on other services as the connectivity improves.

Connectivity Based AFIX distribution

The percentage of transactions that can be covered by various types of connectivity standards for various AFIX levels are given in figure (9). It is observed that if one aims for AFIX=100%, then the transaction coverage is over 50% of transactions within 64 Kbps bandwidth choosing appropriate technologies such as CDMA2000/PSTN/GSM-GPRS. With an appropriate choice of ISDN/DSL/EDGE standards, a bandwith upto 256 Kbps can cover more than 80% of the transactions at 100% AFIX. This can be extended to over 90% transaction coverage with upto 1 Mbps bandwidths by appropriate choice of technolgies such as VSAT/HDSL XWIFI/etc., and bandwidths of 10 Mbps or higher virtually encompass 100% of the transactions at 100% AFIX.

Depending on the scenario at hand, one can opt for a lower AFIX coverage and gain more transaction coverage for the same bandwidth. For example at 50% AFIX, 64 Kbps covers over 80% of transactions and all other higher bandwidth technolgies cover in excess of 95% transactions. To note which information exchange events actually make up this 50% AFIX and check their relevance to the scenario, one can refer the matrix given in Appendix-1. ICT transformation takes time and one cannot practically assume to increase bandwidth as and when needed, thus a judicious optimization can be made balancing between AFIX and transaction coverage for a given level of connectivity. One can hence arrive at a set of graded services based on the transaction and AFIX coverage, that could be deployed immediately as well as alongside infrastrucutre improvement.

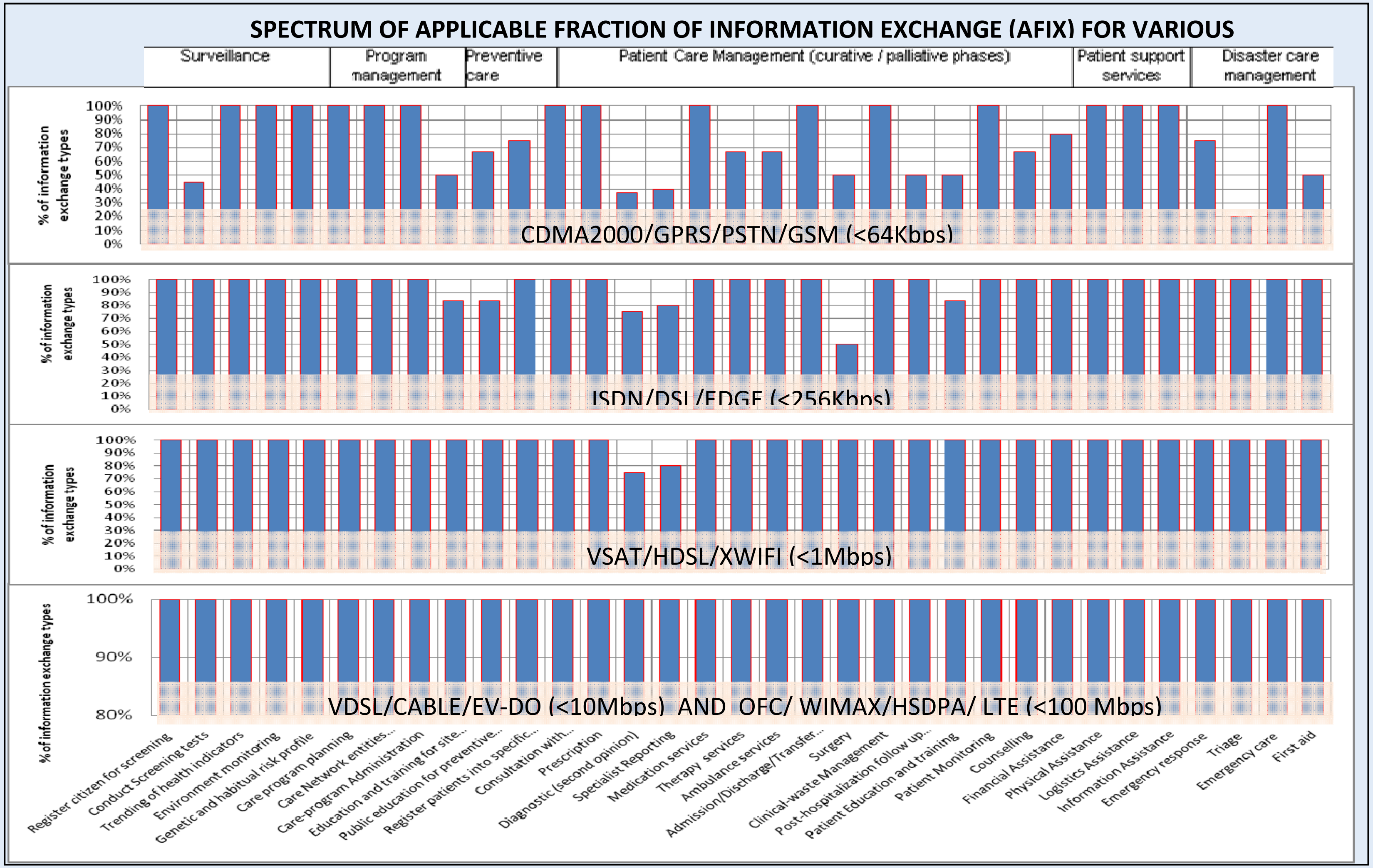
FIGURE 9: Information exchange and Transaction coverage as a function of connectivity



For a more detailed understanding of the dependency of information exchange, figure (10) shows the AFIX spectra (treating all types of information exchange types with equal weights) across various transactions and care activities for various available connectivity standards. It is observed that within a bandwidth of 64 Kbps, all transactions of program management and patient support services can be handled (AFIX=100%) and at least 20% of information exchanges in all phases of the care cycle (minimum AFIX=20%), with appropriate choice among CDMA/GSM/PSTN connectivity. Except for some types of screening tests, this bandwidth has an AFIX of 100% in all surveillance. This slab is relevant to existing infrastructure in most developing countries as a significant enabler considering the importance of surveillance, program management and patient support services, in controlling spread of diseases and associated morbidity and mortality rates. In India, the associated cost would be an insignificant fraction compared to the reduction in current DALY loss (average of $54 Billion per day!).

By adopting the next level of connectivity standards (ISDN/EDGE/DSL) and bandwidth up to 256 Kbps (AFIX>50%), at least half the number of information exchange types across all transactions can be covered. At this level one can scale up the services to cover all transactions of surveillance, patient support, program management and disaster management (AFIX=100%). At the next higher bandwidth slab intersecting standards, such as VSAT/HDSL and extended WIFI, except for a couple of diagnostics and specialist reporting, such as virtual microscopy of histopathological data (wherein even a single image file could have a few Gbytes of data), all other types of information exchange in all transactions are covered. Beyond this bandwidth, technologies, such as VDSL/Cable/EV-DO (upto 10 Mbps), enable all transactions. To scale from single user to high user density and concurrency in a given campus, one can shift to a higher bandwidth standard up to several 100 Mbps provided by OFC/WIMAX/HSDPA/LTE. This mapping can be further customized to suit a specific demography, and used in planning for ICT transformation roadmap in that demography.

FIGURE 10: Map of information exchange coverage across transactions and activities applicable with different connectivity standards



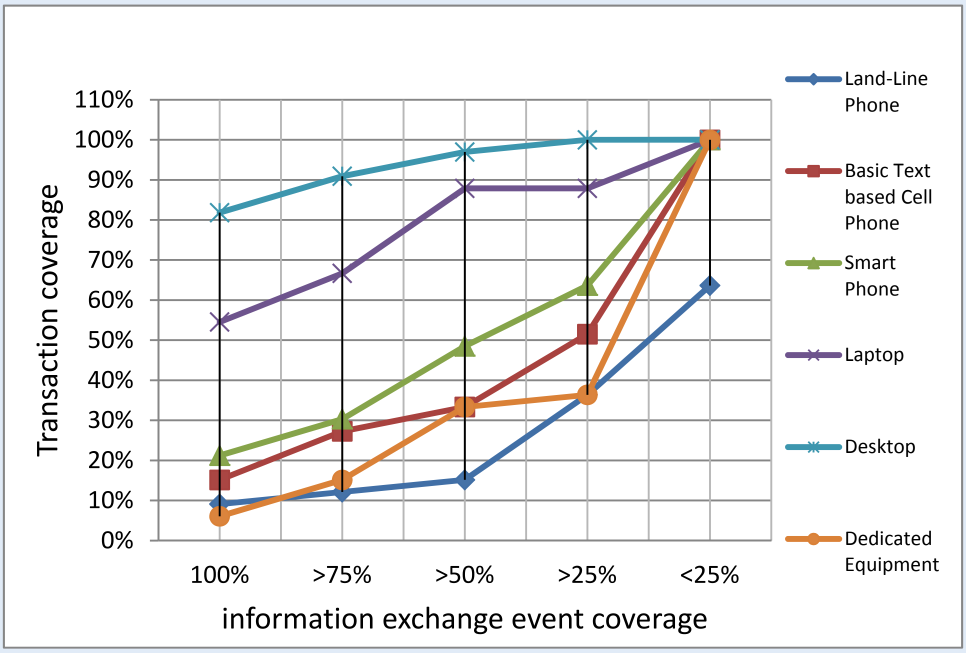
User Platform based AFIX distribution

From the graphs of figure (9) it is observed that if one aims for AFIX=100% even with a Land-line phone, there are about 5% of transactions that are acheivable, and 10% of the transactions are possible with dedicated equipment (such as: video conferencing/special bio-medical equipments, which can directly communicate with a server without a computer or Mobile phone interface). These are easily deployable on a mass scale and configurable at installation time after which they require the lowest level of operating skills from the user as compared to other platforms. Further, about 15% of transactions are possible with Text-based Cell phones, extendable to 20% using a Smart phone. Laptops can cover over 50% of the transactions and Desktops are suitable for over 80% of the transactions.

Although a specific transaction may be technically possible with a given platform, the usage scenarios may force the choice the other way. For example, a Cell phone based video conferencing (although technically possible) may not be preffered during a surgery or in critical care situations where line delays and drops are not tolerable. Similarly, in a typical back office setting one may choose Desktops over Laptops as they are cheaper and the nature of work does not demand portability. It is also observed that no type of platform is a best match for all transactions. The reader can further adapt the tables given in Appendix-3 as appropriate to their context of use and derive corresponding AFIX values. If the scenario permits, one can opt for a lower AFIX coverage and higher transaction coverage for the same User-platform.

Figure (12) shows the spectrum of the applicable fraction of information exchanges (treating all types of information exchange types with equal weights) across various transactions, care activities for various User-platforms. The AFIX for Land-line telephone covers a signicant part of patient support services (AFIX >80%) and intersects disaster managment (AFIX>20%), providing a means for the common house-holder to invoke emergency response from the system, as well as derive help for day-to-day logistics, information and physical support services.

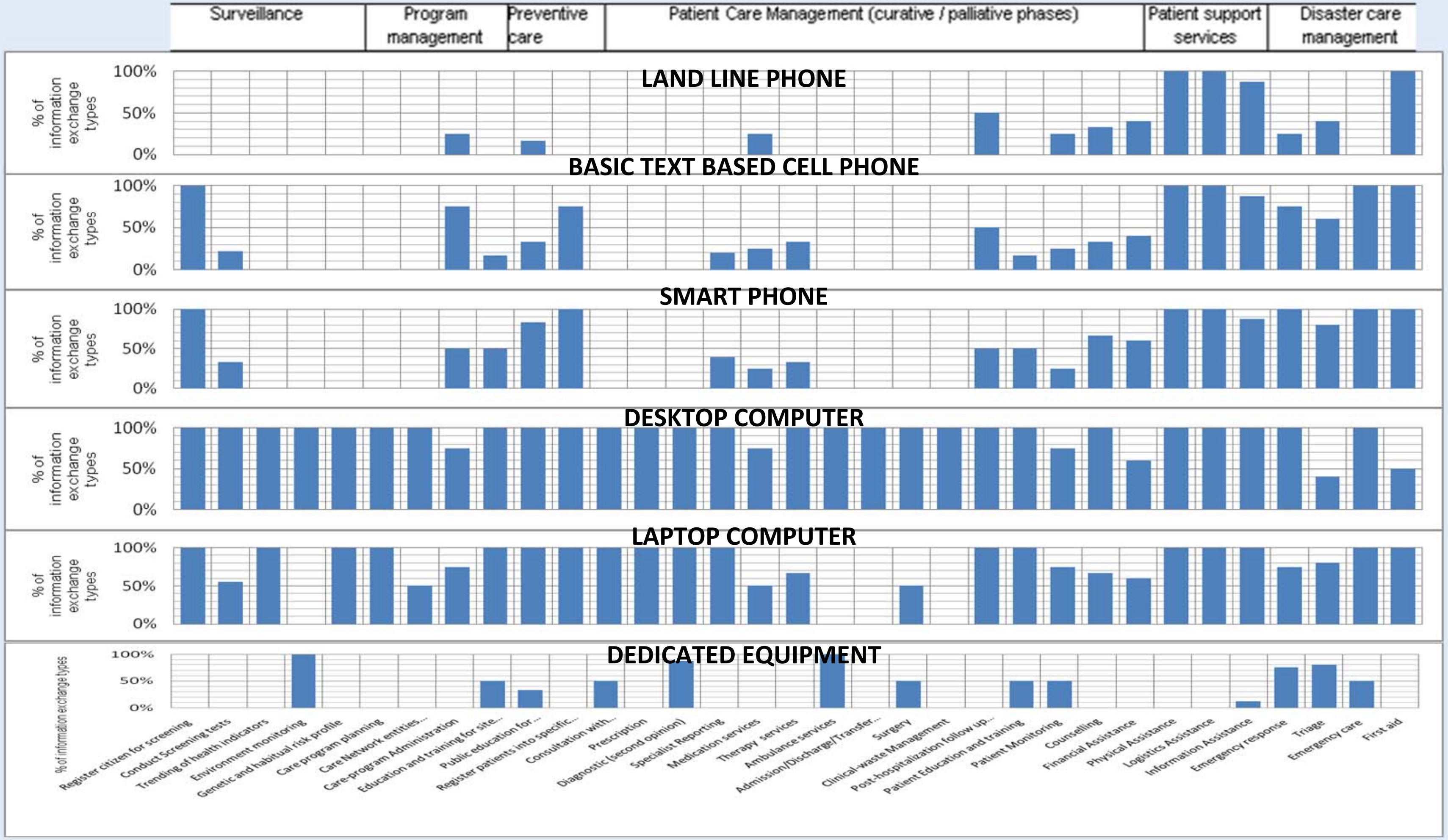
FIGURE 11: Information exchange and Transaction coverage as a function of the user platform



This is specially relevant to in care services for elderly and disabled who may find computers and Smart phones too expensive and complex as well feel ordinary Cell phones an inconvenient form factor and poor in legibility.The ordinary Text-based Cell phone can intersect a minimum of 50% AFIX in all disaster management and patient support transactions, and a minimum of 20% AFIX in preventive care transactions. Smart phones intersect these transactions as well, with AFIX > 80% in all disaster management and patient support transactions, and AFIX >50% AFIX in preventive care transactions. Desktop PCs intersect with all transactions and with AFIX= 100% in surveillance, preventive care and patient support services, and AFIX > 80% in almost all of patient care services.

Although Desktops intersect about 50% AFIX in disaster care scenarios it is predominantly from installations in hospitals and governance offices, as it may not be a convenient choice for field deployment in such situations. Although Laptops are available functionally equivalent to Desktops these days, the distribution points out an intersect for Laptops lesser than Desktops intersect in all care activities, under scenarios where Desktops are cheaper and rugged than Laptops or the if transactions do not need portability/mobility or transactions require larger, higher resoluton displays. Dedicated equipments with AFIX> 50% in diagnostic, conferencing and environmental and patient monitoring transactions are cheaper and robust alternatives in transactions operated by the automated machines/patients/next of kin or low skilled workforce. With translation/transliteration support for voice record conversion into text documents it is possible to reduce dependency on computer operation skills of health workers and doctors. For a more detailed assessment of specific information exchange events, transactions and activities mapped to User-end communication and computing platforms for a specific demography, the matrix of Appendix-1 can be customised accordingly and analyze for specific needs.

FIGURE 12: Map of information exchange coverage across transactions and activities applicable with different user platforms



Conclusion

The current analysis shows that a significant number of information transactions in health care delivery can be ICT enabled with already existing types of ICT infrastructure in India. While there is significant hype about shifting the software applications from 2-tier, Client-server to Web-services platforms, in reality, not all information exchanges are expected to cross the walls of a hospital. For judicious investments into technology development transformation, one has to consider that many transactions may not need external access to data sets and in many cases the provider may suspect leakage of business intelligence or threat to data integrity. Today, with the majority of the health system still working with hard copy patient records maintained within the hospitals and the reluctance of doctors to type in the data, solutions in the interim may involve usage of scanned-image of hard copy records or employment of data entry operators.

Based on the priorities and constraints of a specific region of health care governance, it will become possible to accordingly customize the tables given in this paper and develop services with different grades of performance. Care management programs can also be designed to provide graded services and quality of service based on the infrastructure maturity at corresponding premium. This approach can be used to plan immediate deployment of e-Health services at current maturity levels of the infrastructure without scraping it and waiting for a whole new infrastructure build-up. It also allows for migration planning and improving the quality of service and range of services as the infrastructure evolves. Growth of communication infrastructure in urban and rural areas will result in exponential increase of traffic density at the back-office. For example, even though health insurance has reached only about 2% of the total population in India, which is mostly from the urban areas, it amounts to several Millions of health and life insurance claims processed per year in India (27). Majority of these transactions require documentation that include scanned images of forms and hard copy records. Almost all of this traffic passes through the 30+ third-party-administrator service entities available in the country to handle the claims. The data traffic and computation load may vary with time, place and situation in different localities. The information flow in government health care sector aggregates along a tree-network from state speciality hospitals to district level and block level general hospitals, followed by primary health centres and sub-centres. In private sector it is more likely to be a mesh-network across groups of hospitals. As the insurance penetration increases, the implementation, maintenance and scale-up of servers/networks/applications/database, in-spite of technology obsolescence, is a major capital expenditure item and a logistics nightmare for health care providers. To appreciate the diversity, the reader may refer publications (28) to (75) in addition to survey reports referred in (19) (29) (18).

In parallel, several innovations in data communication systems for better data compression and reliable transmission will move from labs to mainstream infrastructure. For example, voice communication is adopting source coding models of articulation and excitation in the larynx and vocal tract including removal of such modulations to which the human ear is insensitive, such that, instead of transmitting speech, a model of the speech generator is transmitted using which speech is reproduced at the receiving end. This has demonstrated reduction in data rates from typically 64 Kbps to about 4 Kbps without intelligible loss of quality (30). Video compression has gone even beyond source coding (used in MPEG-4) to provide mechanisms that fully describe a video sequence (a still image being considered a particular case of video sequence) by knowledge of shape, colour and texture of objects, shot dissolves, boundaries and fading, scene definitions of the video sequence with the ability to identify, search, index, and publish information about content (31). Complementary advances in channel coding and networking include coded modulation for compensating mobile wireless channels and embedded transmission protocols for networking, which save communication overheads and bring dynamic adaptability in tandem with changes in characteristics and traffic in the communication medium. As communication infrastructure moves from 2G to 4G, the tables and charts presented in this paper can be redrawn to absorb these changes accordingly.

Meanwhile, the ICT industry is evolving from products to solutions to services and from margin-based to volume based profit models. With this paradigm shift, equipment/software becomes available in a pay-per-use model, hosted and maintained by third-parties, reducing capital expenditure to the user. Hence the affordability barrier is reduced and one-time revenues from product sales are converted into to a more stable, long term revenues to the ICT industry. The recent onset of cloud computing services already offer secure software and hardware infrastructure on a rental or pay-per-use basis to the care provider, with virtually unlimited traffic and storage scalability. It is expected to significantly reduce the lead time and investment risk of the health provider for ICT adoption, triggering rapid proliferation. With such a transition, it becomes possible to estimate the charge for each transaction on the basis of cost for various information exchange events that occur inside the transactions listed in Appendix-1. However, cloud will face a significant psychological barrier from care provider entities who suspect data security, given that data of an entity and its competitor may physically lie in the same disk in a cloud data centre without their knowledge, although the cloud service provider may vouch to isolate the datasets under software control.

Estimation of the associated cost of the infrastructure for each transaction in a specific region of governance will help to arrive at a flexible billing system that can charge on a pay-per-use basis depending on the transactions invoked in a care cycle. On one hand introduction of cross-over or hybrid devices (such as netbooks, iPad etc) are expected to blur the traditional categorization of end devices (desktop, laptops and phones), clinical decision support systems are suspected to transform the clinician into more of a counsellor type of role, and web-based services such as BBs and wikis may trigger new process, and associated data transactions. But on the other hand it is to be noted that the current system is still running with hard copy prints that are carried around by patients, which are much more vulnerable to damage, tampering, theft and misplacement and the doctor's 'touch' has more acceptance than video conferencing. So in the near term, affordability may gain priority, while security, availability, and decision support systems may take much longer to gain priority. While Telecommunication industry has achieved global-scale interoperability at the physical layer, link layer, network and transport layers, the health care application layer still faces significant challenges in integration. Several standards have been advocated such as the International Coding of Diseases (ICD), the Standards for Digital Imaging and Communication in Medicine (DICOM), the Systematized Nomenclature of Medicine (Snomed), the laboratory information standards such as Logical Observation Identifiers Names and Codes (LOINC), the inter-application layer messaging standards (HL-7). Although latest software solutions seem to adopt these standards, most of the legacy systems already in use industry pose integration problems and provider reluctance for additional investments. A new set of middle-tier software adapters to bridge the interoperability issue have begun to surface as products, hoping to realize the true value of comprehensive care and collaborative service models. Developing countries where Health ICT is in infancy may be able to leap frog these challenges and adopt such learning in their health ICT transformation.

It is possible to establish a e-Health Service Roadmap as a function of type of Telecom connectivity such that with each superseding technology can handle additional types of transactions in step with capacity improvement. The matrix outlined in Appendix-2, wherein the set of transactions is listed as a function of the connectivity can be used to identify which transactions can be enabled at different levels of connectivity. Similarly, along-side the proliferation of computers and mobile phones various ICT-enabled services, activities and transactions can be enabled in a systematic manner. The matrix outlined in Appendix-3, wherein the set of transactions is listed as a function of the User-platform can be used to identify which transactions can be targeted on different User-platforms. Based on the need of a specific demography and purpose of a specific care program, modified versions of such roadmaps may be derived from the matrix in Appendix-2 and Appendix-3 to include differentiated services including transactions which do not need 100% coverage of all information exchange types. Thus the method illustrated here may be more important than the specific data values sighted in this paper. A typical data-driven governance system equipped by this kind of analysis may be better enabled to diligently prioritize investments with more accurate expectation of outcomes by scaling e-Health services in step with ICT transformation.

Appendix- 1 Table mapping activities, transactions to nature of information exchange

Conventions and Assumptions	
Data type: *Sometimes text/handwritten/waveform data are printed, then scanned into electronic images–in such cases consider the data as image. In all other cases, consider the original form of data (for e.g.: ECG is a waveform signal, heart sound is audio). Graphical analysis reports are also considered as alphanumeric text. Bio-chemistry lab reports may be printed as text but stored and transmitted as structured array of binary values and has been considered as Text category.*	Alphanumeric/binary codes – T Image – I Video – V Waveform signal-S Audio –A
Data Size: *Based on amount of data in a single frame of observation (for example: for a video frame may get refreshed 25 or 30 times per second, but its size is given by the number of pixels in a single frame; for ECG it is data size per scan of all leads considering 2 bytes per sample)*	< 160 Bytes- Tiny (T) <32Kbytes - Small(S) <1Mbytes – Medium(M) <10Mbytes Large (L) <100Mbytes - Very large (V) >100Mbytes-Extremelylarge (E)
Mode of transfer: *In cases where transmission delay jitters can be compensated by streaming buffers choose real-time transfer mode. For transactions where delays/ line drops can be tolerated by local storage that can forward before its use choose store-forward transmission*	Real Time – R Store and forward - S
Mobility: *Information exchange events carried out generally from a fixed location such as accounting, auditing, diagnostic in labs, et.c, have been grouped into 'Stationary' workstations while in scenarios where the information exchange may need the equipment to be ported from place to place, but the equipment need not be used even during the porting, such as portable diagnostic labs, apparatus for live shows, etc., are classified as 'Portable' workstations. Scenarios wherein the information exchange happens even while travelling are classified under 'Mobile' workstations.*	Stationary – S Portable- P Mobile - M
Bandwidth: *Based on the context expressed by size of data and the mode of information transfer the associated bandwidth required for information exchange event is categorized into slabs that encompass currently available communication standards in landline and wireless technologies. For example PSTN/ISDN/ GSM/CDMA2000/DECT are grouped as 'Tiny', ISDN,DSL,EDGE are grouped under 'Small' HDSL, long-range extended WIFI, VSAT have been grouped under medium, cable, VDSL, EV-DO have been grouped into 'High 'bandwidth category and OFC, LTE, WIMAX, HSDPA fall in the extremely high bandwidth category.*	<64Kbps – TINY (T) <256Kbps - Small (S) <1Mbps – Medium (M) <10Mbps – High(H) <100Mbps - Extremely High(E)
User-platform: *Based on the context expressed by size of data type, data size, mode of transfer, mobility, the type of User-interface and the scenario and affordability. The categories have been chosen based on platforms available on a mass scale such as Desktop PCS, Laptop PCs, Text-based Cell phones, Smart phones, Land-Line telephones and dedicated equipment (which is expected to have a built-in electronic communication interface)*	Desktop – D Laptop- L Text based Cell Phone – C Smart Phone – S Dedicated Equipment – E Land-Line Telephone – T

Activities	Transactions	Type of Information exchanged in the transaction	Data type	Data Size	Transfer mode	Mobility	Link type	User-platform
Surveillance	Register citizen for screening	Citizen details	T	S	S	M	TSMLE	DCSL
	Conduct Screening tests	ECG/PFT	S	M	S	P	TSMLE	LDS
		HR /BP/Temperature/Weight/etc.	TS	S	S	P	TSMLE	SCD
		Biochemistry lab images	IT	L	S	P	SMLE	D
		Microbiology images	IV	V	S	P	SMLE	D
		Heart Sound, Audiogram	AT	M	S	P	SMLE	DL
		Ophthalmology tests	IV	M	S	P	SMLE	DL
		Endoscope, Otoscope, Dermoscope	V	L	S	P	SMLE	DL
		Screening reports	T	M	S	P	TSMLE	DL
		Lifestyle issues	T	S	S	P	TSMLE	DSC
	Trending of health indicators	Regional, seasonal and sporadic disease incidence, morbidity-mortality reports, etc.	T	S	S	S	TSMLE	DL
	Environment monitoring	Hygiene, pollution levels in air/water/food, industrial efflux, pests, insects, climatic change, etc.	T	T	S	S	TSMLE	DE
	Genetic and habitual risk profile	Known/unknown symptoms of genetic disorders, ethnic predisposition, habitual disorders, etc., in target population	TI	SM	S	P	TSMLE	DLC
care program management	care program planning	Surveillance trend reports, target prioritization, pert-charts, resource scheduling and booking forms, inventory ordering, supply chain configuration, etc.	T	M	S	P	SMLE	DL
	care Network entities management	Registration/authorization/suspension/termination forms for care entities and care personnel	T	M	S	S	TSMLE	D
		B2B SLAs, contracts, MIS and audit configuration forms, status upload forms	T	M	S	S	SMLE	D
		Marketing collaterals	TI	L	S	P	SMLE	DL
		MIS reports, business intelligence reports	T	L	S	P	SMLE	DL
	care program Administration	FAQs and instructions	T	M	S	P	TSMLE	DLC
		Complaints and issue tracking forms	T	S	S	P	TSMLE	DLTCS

Activities	Transactions	Type of Information exchanged in the transaction	Data type	Data Size	Transfer mode	Mobility	Link type	User-platform
		Notifications	T	S	S	M	TSMLE	SC
		Invoices, bills and receipts	T	S	S	S	TSMLE	DL
	Education and training for site staff	Information brochures	TI	V	S	M	SMLE	DLS
		Recorded Lectures	AVTI	S	S	M	SMLE	DLS
		Tele-exams	TI	M	R	P	TSMLE	DL
		Announcements	TI	S	R	M	TSMLE	DLCSE
		Live shows	AVTI	V	R	P	MLE	DLE
		Virtual class rooms with conferencing	AVTI	V	R	P	SMLE	DLE
Preventive care intervention	Public education for preventive care	Information brochures,	TAVI	M	S	M	SMLE	DLS
		Recorded Lectures	AV	L	S	M	SMLE	DLS
		Live shows	AV	L	R	P	MLE	DLSE
		Counselling	AVT	M	R	M	TSMLE	DLSTC
		Announcements	T	S	R	M	TSMLE	DLSCE
		Registration and cancellation forms, etc.	T	M	S	P	TSMLE	DL
	Register patients into specific care programs	Patient demographic and referral notes	T	S	S	M	TSMLE	DLSC
		Photo, biometric	I	M	S	M	TSMLE	DLS
		Family history, patient history	T	S	S	M	TSMLE	DLSC
		Conferencing	AVT	M	R	M	SMLE	DLSC
Patient Care management	Consultation with Physician/Specialist	Patient history data analysis, patient risk quantification genetic/familial predispositions, allergies and adverse reactions to medication, medication history, patient medical record	T	M	S	P	TSMLE	DL
		Conferencing	AV	S	R	P	TSMLE	DLE
	Prescription	Diagnostics, Medication, Treatment	T	S	S	P	TSMLE	DLE
	Diagnostic (second opinion)	ECG, PFT, EEG, etc.	S	L	S	S	SMLE	DLE
		Heart Sounds, Audiogram	A	M	S	S	SMLE	DLE
		Ultrasound, Mammogram, X-ray, CT, MRI imaging, Ophthalmoscope and Slit-lamp	IV	LV	S	S	LE	DLE

Activities	Transactions	Type of Information exchanged in the transaction	Data type	Data Size	Transfer mode	Mobility	Link type	User-platform
		Angiogram, Otoscope, Dermoscope	IV	ML	S	S	SMLE	DLE
		Microbiology , ECHO, Otoscope, Endoscope, Dermoscope video	IV	L	S	S	SMLE	DLE
		Bio-chemical analysis of Blood [Urine, Stools reports, TMT, etc.], BP, Weight, Temperature	T	S	S	S	TSMLE	DLE
		Pathology imaging	I	VE	S	S	LE	DLE
		Summary reports	T	S	S	P	TSMLE	DL
	Specialist reporting	Patient diagnostic data–vital	T	T	S	P	TSMLE	DLSC
		Patient diagnostic data-general	AVTI	M	S	P	SMLE	DLS
		Patient diagnostic data-Radiology	VTI	V	S	P	SMLE	DL
		Patient diagnostic data-Pathology	VTI	E	S	P	LE	DL
		Specialist report on disease stage, assessment of complications for treatment, prognostic classification, rarity of disease condition, etc.	T	M	S	P	TSMLE	DL
	Medication services	Medication service order, prescription of diet and medication schedule, correlation of symptom to schedule mismatch	T	S	S	P	TSMLE	DL
		Schedule and dosage tracking reports, symptom and complication capture and alerts	T	S	S	S	TSMLE	D
		Inventory and door-to-door delivery scheduling	T	T	S	S	TSMLE	D
		Follow up with patient for counselling and tracking of medication	AV	M	R	M	SMLE	CLST
	Therapy services	Therapy service order, prescription of diet and schedule, correlation of symptom to schedule mismatch	T	S	S	P	TSMLE	DL
		Patient training information (live/recorded)	AVTI	ML	S	P	SMLE	DL
		Therapy progress tracking form	T	TS	S	M	TSMLE	DSC
	Ambulance services	Real time patient data monitoring	STVA	M	R	P	TSMLE	DE
		Conferencing	AV	L	R	P	SMLE	DE
		Fleet management, other logistics support	AT	S	R	S	SMLE	DE

Activities	Transactions	Type of Information exchanged in the transaction	Data type	Data Size	Transfer mode	Mobility	Link type	User-platform
	Admission/Discharge/Transfer to hospital	Bed booking, admission/transfer form, discharge summary, legal forms	T	S	S	S	TSMLE	D
	Surgery	OT resource planning	T	S	S	S	TSMLE	D
		Sharing prior information with remote experts	TAVI	M	S	S	MLE	D
		Conferencing during surgery with fail over channel	AV	L	R	S	MLE	LDE
		Live local and remote monitoring of apparatus & patient during surgery with failover channel	TAVI	L	R	S	MLE	DLE
	Clinical-waste Management	Waste inventory, disposal order and tracking forms	T	S	S	S	TSMLE	D
	Post-hospitalization follow up consultation	Conferencing	ITAV	M	R	M	SMLE	SDLCT
		Patient records, patient health trend report, progress notes	T	TS	S	P	SMLE	DL
	Patient Monitoring	Monitoring Configuration form, monitoring report	TI	S	S	S	TSMLE	DL
		Recording of temperature, heart and respiration rate, BP, height, weight, urine, stools, foetal heart rate, blood glucose, oxygen, etc.	TI	S	R	P	TSMLE	DLE
		Signals such as ECG/EEG	S	M	R	P	TSMLE	DLE
		Alert messages with critical information	T	T	R	M	TSMLE	CST
	Counselling	Information brochures, FAQ	VTAI	L	S	M	TSMLE	SDL
		Conferencing	AV	M	R	M	SMLE	CSDLT
		Tracker of Patient response to counselling	T	S	S	S	TSMLE	D
	Financial Assistance	Telephonic support for education about insurance/other subsidy information brochure/FAQ lists	TA	S	S	M	TSMLE	CST
		Insurance/subsidy policy application forms, Claim forms, bills, claims processing reports	TA	T	S	P	TSMLE	DL
		Patient medical records	TI	V	S	P	SMLE	SDL
		collection follow-up calls	A	T	R	M	TSMLE	CST
		Claims audit reports	T	T	S	S	TSMLE	DL
Patient care support	Physical Assistance	Physical care services and rules information	TA	S	SR	M	TSMLE	SDLT
		Assistance service ordering, complaints form	T	T	S	M	TSMLE	SDLT

Activities	Transactions	Type of Information exchanged in the transaction	Data type	Data Size	Transfer mode	Mobility	Link type	User-platform
	Logistics Assistance	Concierge services and rules information	TA	S	SR	M	TSMLE	SDLT
		Concierge service ordering, complaints form	T	T	S	M	TSMLE	SDLT
	Information Assistance	Voice to Voice transliteration	TA	M	R	M	TSMLE	SDLT
		Voice to Text transliteration	TA	SM	S	M	TSMLE	SDLT
		Text to Voice transliteration	TA	SM	RS	M	TSMLE	SDLT
		Voice to Text translation	TA	SM	RS	M	TSMLE	SDLT
		Text to Voice translation	TA	SM	RS	M	TSMLE	SDLT
		IVR	TA	SM	R	M	TSMLE	DSCLET
		Knowledgebase	TAVI	ML	S	P	TSMLE	DLS
		Help-Desk	TA	TS	R	S	TSMLE	DLT
Disaster care management	Emergency response	Conferencing from emergency site	AVI	M	R	P	SMLE	DLESC
		Real time vital signs of patients	T	T	R	P	TSMLE	DLECS
		Abnormality alerts from monitoring	ST	S	R	M	TSMLE	DECST
		Emergency admission forms	T	S	R	M	TSMLE	SDL
	Triage	Disaster assessment form, disaster management protocol, resource allocation form	T	S	R	P	TSMLE	LDE
		Conferencing for Triage	AV	M	R	M	SMLE	LSTEC
		Live video of affected area	AV	M	R	M	SMLE	LSE
		Emergency training, counselling, consulting	TAVI	M	R	M	SMLE	DLSC
		Environmental surveillance reports	T	S	R	M	SMLE	ESCT
	Emergency care	Emergency treatment plan, health insurance/subsidy information form, specialist notes	SIT	S	R	M	TSMLE	DLSC
		Patient tagging, patient vital signs and other medical parameters monitor	SAV	M	R	M	TSMLE	DLESC
	First aid	Primary symptoms capture	TAI	S	R	M	TSMLE	LCST
		Real time counselling and preventive care guidance	TAV	M	R	M	SMLE	DLSTC

Appendix- 2 care activities, transactions and information exchange events prioritized for various connectivity standards

Connectivity	Care Activity	care transaction	Type of Information exchanged
VDSL/ CABLE/ EV-DO (<10Mbps)	Patient care management	Diagnostic (second opinion)	Ultrasound, Mammogram, X-ray, CT, MRI imaging, Ophthalmoscope and Slit-lamp
		Specialist reporting	Patient diagnostic data-Ppathology
		Diagnostic (second opinion)	Pathology imaging
VSAT/ HDSL/ XWIFI (<1Mbps)	care program management	Education and training for site staff	Live shows
	Preventive care intervention	Public education for preventive care	Live shows
	Patient care management	Surgery	Sharing prior information with remote experts
		Surgery	Conferencing during surgery with fail over channel
		Surgery	Live local and remote monitoring of apparatus & patient during surgery with failover channel
ISDN/ DSL/ EDGE (<256Kbps)	Surveillance	Conduct Screening tests	Biochemistry lab images
		Conduct Screening tests	Microbiology images
		Conduct Screening tests	Heart Sound, Audiogram
		Conduct Screening tests	Ophthalmology tests
		Conduct Screening tests	Endoscope, Otoscope, Dermoscope
	care program management	care program planning	Surveillance trend reports, target prioritization, pert-charts, resource scheduling and booking forms, inventory ordering, supply chain configuration, etc.
		care Network entities management	B2B SLAs, contracts, MIS and audit configuration forms, status upload forms
		care Network entities management	Marketing collaterals
		care Network entities management	MIS reports, business intelligence reports
		Education and training for site staff	Information brochures
		Education and training for site staff	Recorded lectures
		Education and training for site staff	Virtual class rooms with conferencing
	Preventive care intervention	Public education for preventive care	Information brochures
		Public education for preventive care	Recorded lectures
		Register patients into specific care programs	Conferencing
	Patient care management	Diagnostic (second opinion)	ECG, PFT, EEG, etc.
		Diagnostic (second opinion)	Heart Sounds, Audiogram

Connectivity	Care Activity	care transaction	Type of Information exchanged
		Diagnostic (second opinion)	Angiogram, Otoscope ,Dermoscope
		Diagnostic (second opinion)	Microbiology , ECHO, Otoscope, Endoscope, Dermoscope video
		Specialist reporting	Patient diagnostic data -general
		Specialist reporting	Patient diagnostic data -Radiology
		Medication services	Follow up with patient for counselling and tracking of medication
		Therapy services	Patient training information (live/recorded)
		Ambulance services	Conferencing
		Ambulance services	Fleet management, other logistics support
		Post-hospitalization follow up consultation	Conferencing
		Post-hospitalization follow up consultation	Patient records, patient health trend report, progress notes
		Counselling	Conferencing
		Financial assistance	Patient medical records
	Disaster care management	Emergency response	Conferencing from emergency site
		Triage	Conferencing for Triage
		Triage	Live video of affected area
		Triage	Emergency training, counselling, consulting
		Triage	Environmental surveillance reports
		First aid	Real time counselling and preventive care guidance
CDMA2000/ GPRS/GSM PSTN <64Kbps)	Surveillance	Register citizen for screening	Citizen details
		Conduct screening tests	ECG /PFT
		Conduct screening tests	HR / BP/Temperature/Weight/etc.
		Conduct screening tests	Screening reports
		Conduct screening tests	Lifestyle issues
		Trending of health indicators	Regional, seasonal and sporadic disease incidence, morbidity-mortality reports, etc.
		Environment monitoring	Hygiene, pollution levels in air/water/food, industrial efflux, pests, insects, climatic change, etc.
		Genetic and habitual risk profile	Known/unknown symptoms of genetic disorders , ethnic predisposition, habitual disorders, etc., in target population
	care program management	care network entities management	Registration/authorization/suspension/termination forms for care entities and care personnel
		care program administration	FAQs and instructions
		care program administration	Complaints and issue tracking forms
		care program administration	Notifications
		care program administration	Invoices, bills and receipts
		Education and training for site staff	Tele-exams
		Education and training for site staff	Announcements
	Preventive care intervention	Public education for preventive care	Counselling
		Public education for preventive care	Announcements

Connectivity	Care Activity	care transaction	Type of Information exchanged
		Public education for preventive care	Registration and cancellation forms, etc.
		Register patients into specific care programs	Patient demographic and referral notes
		Register patients into specific care programs	Photo, biometric
		Register patients into specific care programs	Family history, patient history
	Patient care management	Consultation with Physician/Specialist	Patient history data analysis, patient risk quantification genetic/ familial predispositions, allergies and adverse reactions to medication, medication history, patient medical record
		Consultation with Physician/Specialist	Conferencing
		Prescription	Diagnostics, Medication, Treatment
		Diagnostic (second opinion)	Bio-chemical analysis of Blood [Urine, Stools reports, TMT, etc.], BP, Weight, Temperature
		Diagnostic (second opinion)	Summary reports
		Specialist reporting	Patient diagnostic data–vital
		Specialist reporting	Specialist report on disease stage, assessment of complications for treatment, prognostic classification, rarity of disease condition, etc.
		Medication services	Medication service order, prescription of diet and medication schedule , correlation of symptom to schedule mismatch
		Medication services	Schedule and dosage tracking reports, Symptom and complication capture and alerts
		Medication services	Inventory and door-to-door delivery scheduling
		Therapy services	Therapy service order, prescription of diet and schedule, correlation of symptom to schedule mismatch
		Therapy services	Therapy progress tracking form
		Ambulance services	Real time patient data monitoring
		Admission/Discharge/Transfer to hospital	Bed booking, admission/transfer form, discharge summary, legal forms
		Surgery	OT resource planning
		Clinical-waste management	Waste inventory, disposal order and tracking forms
		Patient monitoring	Monitoring configuration form, monitoring report
		Patient monitoring	Recording of temperature, heart and respiration rate, BP, height ,weight ,urine, stools, foetal heart rate, blood glucose, oxygen, etc.
		Patient monitoring	Signals such as ECG/EEG
		Patient monitoring	Alert messages with critical information
		Counselling	Information brochures, FAQ

Connectivity	Care Activity	care transaction	Type of Information exchanged
		Counselling	Tracker of patient response to counselling
		Financial assistance	Telephonic support for education about insurance /other subsidy information brochure/FAQ lists
		Financial assistance	Insurance/ ubsidy policy application forms, claim forms, bills, claims processing reports
		Financial assistance	Collection follow-up calls
		Financial assistance	Claims audit reports
	Patient care support	Physical assistance	Physical care services and rules information
		Physical assistance	Assistance service ordering, complaints form
		Logistics assistance	Concierge services and rules information
		Logistics assistance	Concierge service ordering, complaints form
		Information assistance	Voice to Voice transliteration
		Information assistance	Voice to Text transliteration
		Information assistance	Text to Voice transliteration
		Information assistance	Voice to Text translation
		Information assistance	Text to Voice translation
		Information assistance	IVR
		Information assistance	Knowledgebase
		Information assistance	HelpDesk
	Disaster care management	Emergency response	Real time vital signs of patients
		Emergency response	Abnormality alerts from monitoring
		Emergency response	Emergency admission forms
		Triage	Disaster assessment form, disaster management protocol, resource allocation form
		Emergency care	Emergency treatment plan, health insurance/subsidy information form, specialist notes
		Emergency care	Patient tagging, patient vital signs and other medical parameters monitor
		First aid	Primary symptoms capture

Appendix- 3 care activities, transactions and information exchange events prioritized for various User-platforms

User-platform type	Activities	Transactions	Type of Information exchanged in the transaction
Basic Text based Cell Phone	Preventive care intervention	Register patients into specific care programs	Conferencing
	Disaster care management	Triage	Emergency training, counselling, consulting
	Surveillance	Register citizen for screening	Citizen details
	Surveillance	Conduct screening tests	HR /BP/Temperature/Weight/etc.
	Surveillance	Conduct screening tests	Lifestyle issues
	Surveillance	Genetic and habitual risk profile	Known/unknown symptoms of genetic disorders ,ethnic predisposition, habitual disorders, etc., in target population
	care program management	care program administration	FAQs and instructions
	care program management	care program administration	Notifications
	Preventive care intervention	Register patients into specific care programs	Patient demographic and referral notes
	Preventive care intervention	Register patients into specific care programs	Family history, patient history
	Patient care management	Specialist Reporting	Patient diagnostic data–vital
	Patient care management	Therapy services	Therapy progress tracking form
	Disaster care management	Emergency care	Emergency treatment plan, health Insurance/subsidy information form, specialist notes
Dedicated Equipment	Patient care management	Diagnostic (second opinion)	Ultrasound, Mammogram, X-ray, CT, MRI imaging, Ophthalmoscope and Slit- lamp
	Patient care management	Diagnostic (second opinion)	Pathology imaging
	care program management	Education and training for site staff	Live shows
	Preventive care intervention	Public education for preventive care	Live shows
	Patient care management	Surgery	Conferencing during surgery with fail over channel
	Patient care management	Surgery	Live local and remote monitoring of apparatus & patient during surgery with failover channel
	care program management	Education and training for site staff	Virtual class rooms with conferencing
	Patient care management	Diagnostic (second opinion)	ECG, PFT, EEG, etc.

User-platform type	Activities	Transactions	Type of Information exchanged in the transaction
	Patient care management	Diagnostic (second opinion)	Heart Sounds, Audiogram
	Patient care management	Diagnostic (second opinion)	Angiogram, Otoscope, Dermoscope
	Patient care management	Diagnostic (second opinion)	Microbiology , ECHO, Otoscope, Endoscope, Dermoscope video
	Patient care management	Ambulance services	Conferencing
	Patient care management	Ambulance services	Fleet management, other logistics support
	Disaster care management	Emergency response	Conferencing from emergency site
	Disaster care management	Triage	Conferencing for triage
	Disaster care management	Triage	Live video of affected area
	Disaster care management	Triage	Environmental surveillance reports
	Surveillance	Environment monitoring	Hygiene, pollution levels in air/water/food, industrial efflux, pests, insects, climatic change, etc.
	care program management	Education and training for site staff	Announcements
	Preventive care intervention	Public education for preventive care	Announcements
	Patient care management	Consultation with Physician/Specialist	Conferencing
	Patient care management	Prescription	Diagnostics, Medication, Treatment
	Patient care management	Diagnostic (second opinion)	Bio-chemical analysis of Blood [Urine, Stools reports, TMT, etc], BP, Weight, Temperature)
	Patient care management	Ambulance services	Real time patient data monitoring
	Patient care management	Patient monitoring	Recording of temperature, heart and respiration rate, BP, height, weight, urine, stools, foetal heart rate, blood glucose, oxygen, etc.
	Patient care management	Patient monitoring	Signals such as ECG/EEG
	Patient care support	Information assistance	IVR
	Disaster care management	Emergency response	Real time vital signs of patients
	Disaster care management	Emergency response	Abnormality alerts from monitoring
	Disaster care management	Triage	Disaster assessment form, disaster management protocol, resource allocation form
	Disaster care management	Emergency care	Patient tagging, patient vital signs and other medical parameters monitor

User-platform type	Activities	Transactions	Type of Information exchanged in the transaction
Desktop	Patient care management	Surgery	Sharing prior information with remote experts
	Surveillance	Conduct screening tests	Biochemistry lab images
	Surveillance	Conduct screening tests	Microbiology images
	care program management	care network entities management	B2B SLAs, contracts , MIS and audit configuration forms, status upload forms
	care program management	care network entities management	Registration/authorization/suspension/termination forms for care entities and care personnel
	Patient care management	Medication services	Schedule and dosage tracking reports, symptom and complication capture and alerts
	Patient care management	Medication services	Inventory and door-to-door delivery scheduling
	Patient care management	Admission/Discharge/Transfer to hospital	Bed booking, admission/transfer form, discharge summary, legal forms
	Patient care management	Surgery	OT resource planning
	Patient care management	Clinical-waste management	Waste inventory, disposal order and tracking forms
	Patient care management	Counselling	Tracker of patient response to counselling
Land-Line Phone	Patient care management	Medication services	Follow up with patient for counselling and tracking of medication
	Patient care management	Post-hospitalization follow up consultation	Conferencing
	Patient care management	Counselling	Conferencing
	Disaster care management	First aid	Real time counselling and preventive care guidance
	care program management	careprogram administration	Complaints and issue tracking forms
	Preventive care intervention	Public education for preventive care	Counselling
	Patient care management	Patient monitoring	Alert messages with critical information
	Patient care management	Financial assistance	Telephonic support for education about insurance /other subsidy information brochure/FAQ lists
	Patient care management	Financial assistance	Collection follow-up calls
	Patient care support	Physical assistance	Physical care services and rules information
	Patient care support	Physical assistance	Assistance service ordering, complaints form
	Patient care support	Logistics assistance	Concierge services and rules information
	Patient care support	Logistics assistance	Concierge service ordering, complaints form

User-platform type	Activities	Transactions	Type of Information exchanged in the transaction
	Patient care support	Information assistance	Voice to Voice transliteration
	Patient care support	Information assistance	Voice to Text transliteration
	Patient care support	Information assistance	Text to Voice transliteration
	Patient care support	Information assistance	Voice to Text translation
	Patient care support	Information assistance	Text to Voice translation
	Patient care support	Information assistance	Help-Desk
	Disaster care management	First aid	Primary symptoms capture
Laptop	Patient care management	Specialist reporting	Patient diagnostic data -Pathology
	Surveillance	Conduct screening tests	Heart Sound, Audiogram
	Surveillance	Conduct screening tests	Ophthalmology tests
	Surveillance	Conduct screening tests	Endoscope, Otoscope, Dermoscope
	care program management	care program planning	Surveillance trend reports, target prioritization, pert-charts, resource scheduling and booking forms, inventory ordering, supply chain configuration, etc.
	care program management	care network entities management	Marketing collaterals
	care program management	care network entities management	MIS reports, business intelligence reports
	Patient care management	Specialist consultation	Patient diagnostic data -Radiology
	Patient care management	Therapy services	Patient training information (live/recorded)
	Patient care management	Post-hospitalization follow up consultation	Patient records, patient health trend report, progress notes
	Surveillance	Conduct screening tests	Screening reports
	Surveillance	Trending of health indicators	Regional, seasonal and sporadic disease incidence, morbidity-mortality reports etc.
	care program management	care program administration	Invoices, bills and receipts
	care program management	Education and training for site staff	Tele-exams
	Preventive care intervention	Public education for preventive care	Registration and cancellation forms, etc.
	Patient care management	Consultation with Physician/Scientist	Patient history data analysis, patient risk quantification genetic/familial predispositions, allergies and adverse reactions to medication, medication history, patient medical record

User-platform type	Activities	Transactions	Type of Information exchanged in the transaction
	Patient care management	Diagnostic (second opinion)	Summary reports
	Patient care management	Specialist reporting	Specialist report on disease stage, assessment of complications for treatment, prognostic classification, rarity of disease condition, etc.
	Patient care management	Medication services	Medication service order, prescription of diet and medication schedule , correlation of symptom to schedule mismatch
	Patient care management	Therapy services	Therapy service order, prescription of diet and schedule , correlation of symptom to schedule mismatch
	Patient care management	Patient monitoring	Monitoring configuration form, monitoring report
	Patient care management	Financial assistance	Insurance/subsidy policy application forms, claim forms, bills, claims processing reports
	Patient care management	Financial assistance	Claims audit reports
Smart Phone	care program management	Education and training for site staff	Information brochures
	care program management	Education and training for site staff	Recorded lectures
	Preventive care intervention	Public education for preventive care	Information brochures
	Preventive care intervention	Public education for preventive care	Recorded lectures
	Patient care management	Specialist reporting	Patient diagnostic data-general
	Patient care management	Financial assistance	Patient medical records
	Surveillance	Conduct screening tests	ECG/PFT
	Preventive care intervention	Register patients into specific care programs	Photo, biometric
	Patient care management	Counselling	Information brochures, FAQ
	Patient care support	Information assistance	Knowledgebase
	Disaster care management	Emergency response	Emergency admission forms

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International Telecommunication Union
ICT Applications and Cybersecurity Division
Policies and Strategies Department
ITU Telecommunication Development Sector

Place des Nations
1211 Geneva 20
Switzerland

Tel: +41 22 730 5111
Fax: +41 22 733 7256
E-mail: cybmail@itu.int

URL: www.itu.int/net/ITU-D/index.aspx

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