

Role of ICT to improve Healthcare System in Rajasthan, India

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Abstract:- The use of ICT/IT and its recent advances of technology could play important role in improving health systems in developing countries like India. Most of the hospitals in urban area are equipped with advanced tools using digitized analysis and embedded technology for operations but the use of ICT based administrative tools to coordinate activities and communicate knowledge in the area of health is limited. Combining a case study approach with a general discussion of the issues, this paper attempts to assess the potential benefits of a diverse range of ICT innovations and some of the constraints they will need to overcome. In this paper four broad areas are considered for the application of ICT in health system i.e. improvements in traditional health information systems, computer aided diagnosis and treatment monitoring, a range of applications generically labeled ‘telemedicine’ and the use of ICT to inform general population on health and healthcare. The final section speculates on the possible medium term impacts of ICT in terms of improving the performance of existing systems, allowing scope for radical innovations or even changing basic assumptions about the service provider and patient relationship. In this paper an attempt has been made by the authors to assess the penetration of Information and Communication Technologies in present health care system in the State of Rajasthan in India. The impact of these technologies in health care system of the state has been studied in terms of various facilities existing in various hospitals established at the block, district and divisional level. The authors have tried to make an extensive study of various infrastructural facilities in these hospitals along with the use of ICT tools to make the best use of these facilities. The study of the existing healthcare system has been carried from the government. published available literature as well as by seeking public opinion through questionnaire and personal interviews. The data so obtained from the literature and through the questionnaires have been analyzed. Based on the observations made through the data analysis and by making a thorough investigations of the similar infrastructural facilities in the neighbouring states, the authors have proposed an ICT supported healthcare model for implementation in the state of Rajasthan with an objective to carry out the benefits of the facilities existing in district level hospitals and the village level hospitals as well.

Keywords - ICT, Healthcare Systems, Telemedicine, Remote Consultation Centres (RCC), Electronic Health Records (EHR).

I. INTRODUCTION

The application of information and communication technology (ICT) in health sector would improve it if all parties involved can coordinate their efforts to take advantage of new technology. This is very different from the common conception of introducing some new ICT tools. Information and communication Technology though lately introduced in the healthcare system due to its variety of uses is proving wonders in the improvement of the system [4].

E-health and telemedicine services are promising business areas in Europe and other developed countries and it is spreading in India also but it is facing challenges in rural area. Rural and distant hospitals may send and order e-health products and services from a district hospitals and over national borders in the future [5]. Typical cross-organizational e-health applications are:

- Telemedicine and diagnosis
- Sharing of patient records among different healthcare professionals
- Access to distributed Electronic Health Records (EHR) from any place and any time
- On-line teleconsultation, telemonitoring and

assistance

- Patient--doctor consultation services
- Patients access to their own EHRs.

Healthcare providers have been providing assessments, procedures, and therapies for patient care. There are several administrative processes that need to be coordinated, which result in delays in providing patient care. Healthcare providers have realized the importance of automating these administrative processes to provide appropriate care to patients in time. To atomize these administrative processes, several systems have been procured from external vendors or built in-house. This automation has led to the process of capturing information related to patient care and storing them electronically. The electronic clinical record of patients helps clinicians to treat patients more effectively by providing the required information at the required time. However, these systems catered to specialist departments and are usually best-in-class systems for the specific department, but not across an enterprise. This created a huge Challenge in presenting the data in these disparate systems as a single unit. The introduction of the Integrated Healthcare Delivery Networks and moving beyond the single episode of care in a single enterprise to the entire

continuum of care in multiple enterprises generated the need for availability of information as a single entity. Economies world-wide have also started to realize the burgeoning costs of providing healthcare to its population, several studies support the fact that the availability of correct data at the point of care reduces the patient's costs to a large extent. Real-time messaging between clinical systems did solve the problem of data being available at the right time to some extent but it did not solve the problem of presenting data available in disparate systems as a single unit. [6]

II. EXISTING SCENARIO OF ICT/IT IN HEALTH CARE SYSTEM OF RAJASTHAN

Rajasthan with a population of 74,791,568 (2016) people is ranked as 7th populous state of India. Rajasthan located at the North-Western part of India is the biggest state in country. This colossal state has an area of 342339 sq.kms encompassing 11% of the total geographical area of the country. The state is divided into seven divisions namely, Jaipur, Ajmer, Jodhpur, Bikaner, Kota, Udaipur and Bharatpur and further subdivided into 33 districts for administration and carrying out developmental programmes.

Rajasthan has many bottlenecks in ICT which are needed to solve immediately, such as gap to access the technology in rural and urban areas. Very limited people in rural areas have access to the internet, but since last three years it is increasing. ICT infrastructures are very limited, expensive and not even spread out. On the other hand, fortunately many schools especially the private ones in urban area are equipped with computers. The economic growth in urban area is very fast, but it is growing very slow in rural area. Different opportunities to access information via ICT at urban and rural area cause the digital divide larger and larger. While many people in urban area are already using ICT for many activities, the people in the rural area are comparatively less familiar with computers. There is a need to prioritize access to ICT resources to the more underserved population, which is being left behind on a digital divide. In Rajasthan state most of its part is covered by desert and population is scattered. In such adverse conditions, it is a challenge for government to provide infrastructure and other facilities for health sector. Using ICT in health sector more and more people in such desert area can be served at minimum expenses and time. The details of main health institutions in brief are given in table-1

Table 1

Institution	Total number
Medical Colleges	18
District Hospitals	34
Ayurvedic Hospitals	20

Ayurvedic Dispensaries	3665
Unani Hospitals	11
Unani Dispensaries	269
Sub Centres(SCs)	11487
Primary Health Centres (PHCs)	1517
Community Health Centres (CHCs)	408

The table-2 given below shows total population, Crude birth rate, Crude death rate, total fertility rate, infant mortality rate, population below poverty line and maternal mortality ratio state versus India

Table 2

S. No.	Item	Rajasthan	India
1	Population density (per square kilometre)	201	382
2	Crude Birth Rate (per thousand)	25.6	21.8
3	Crude Death Rate (per thousand)	6.5	7.0
4	Total Fertility Rate (Birth/Woman)	2.8	2.3
5	Infant Mortality Rate (per thousand)	47	40
6	Population Below Poverty line (%)	14.71	21.9
7	Maternal Mortality Ratio (per lac)	244	167

Extension of health services at grass root level and implementation of various health care programmes has shown significant improvement in important health indicators i.e. CBR, CDR, IMR, MMR and TFR. It is still high in the state in comparison to the country except for CDR, in which the State is better than the country. The health indicators in Rajasthan can be improved by using telemedicine facilities through ICT. Telemedicine facilities can be accessed through INSAT satellite network, which will provide expert medical services from metro hospitals to poor villagers of Rajasthan without wasting time and money.

III. DATA COLLECTION AND ANALYSIS

Data has been collected from different sources through observation method, personal interviews and questionnaire. A questionnaire was prepared and distributed in different health, institutions and personal areas of the state. The graphs below show the opinion of the people about various aspects of the Health Care system in the State. The following observations were made-

Availability of Health Care Centre

The numbers of public health institutions and their functional status is critical for an effective delivery of health services in rural and urban area. Table 3 depicts the scenario

of government allopathic medical institutions at the end of 2011, 2012 and 2016. There has been a 5.3% overall increase in the total number of allopathic medical institutions during 2011-16. Importantly, there is a significant rise in the medical institutions during this period- PHCs 7.2%, CHCs 10% and SCs 5%. The number of inpatient beds increased by 6% in comparison to population growth rate 1.8% per annum.

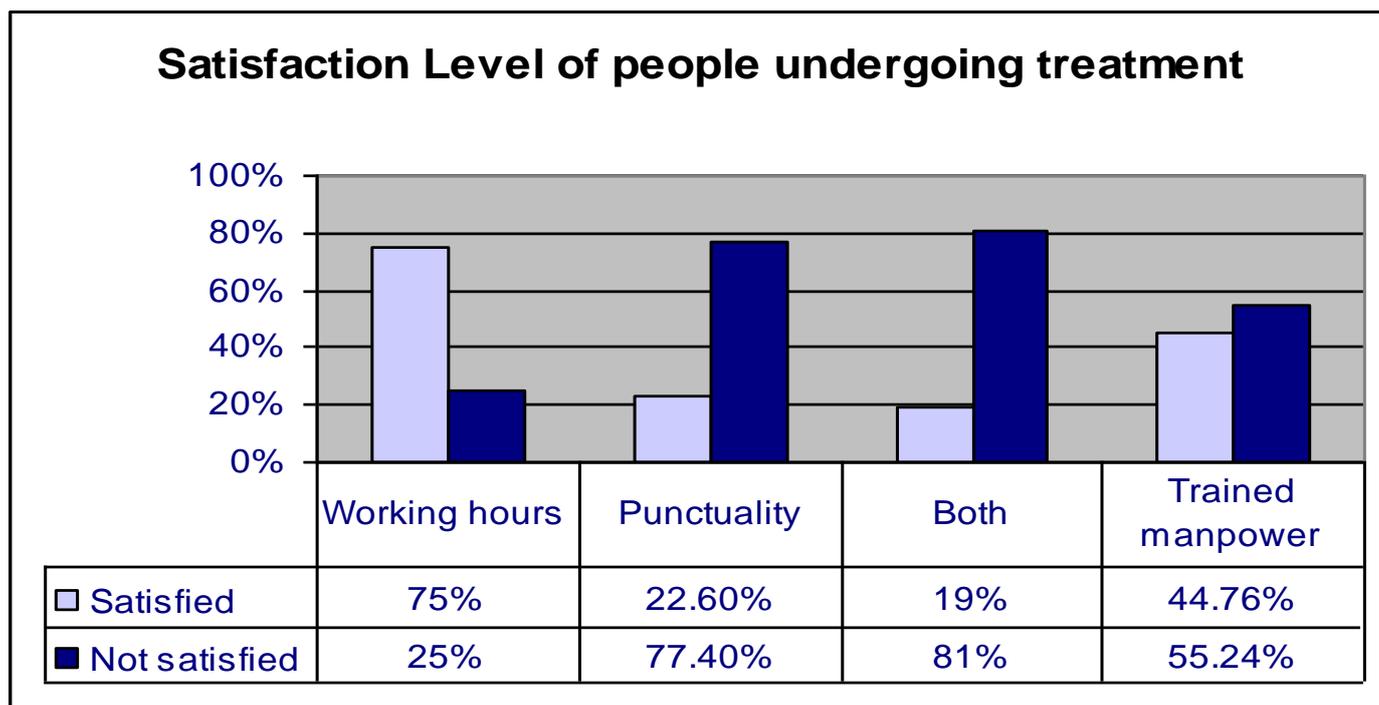
Table 3 Public-health infrastructure in Rajasthan

Institution	2011	2012	2016
Hospitals (Excluding Medical Colleges)	108	108	114
Dispensaries	196	195	194

PHCs – Rural	1528	1612	2080
PHCs – Urban	37	37	52
CHCs	380	428	571
Maternity and Child welfare centres	118	118	118
SCs	11487	12701	14409
Inpatient beds	35442	37417	46767

As per the observations, most of the people in the state are dependent upon the Sub Centres and Primary Health Care Centres for treatment of minor diseases and for major diseases they avail the facilities of main stream hospitals.

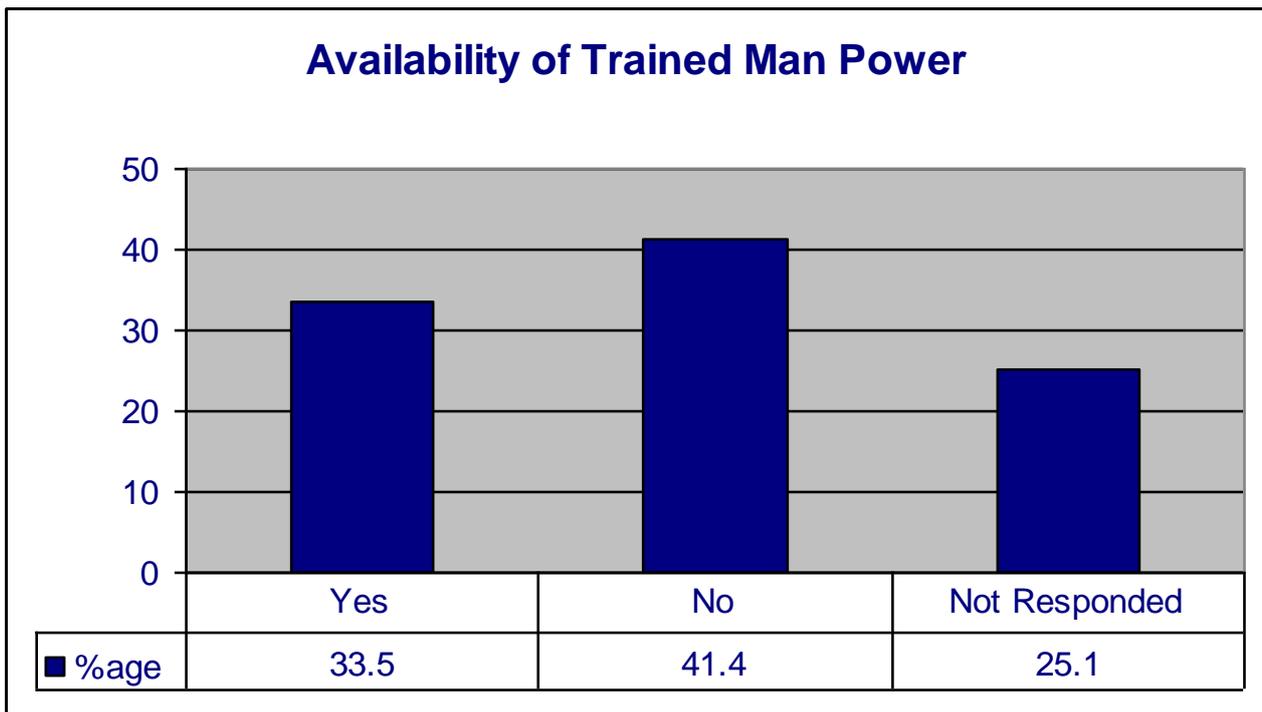
Satisfaction Level of People about Working hours and Punctuality of Staff



75% people were found satisfied with working hours of the Doctors and Nurses and 22.6% about the punctuality. Only 19% were satisfied about both working hours and punctuality of the staff. There could be reasons for dissatisfaction of the people, like lack of manpower, absence

of protocols indicating clear responsibility of each and every person in the hospital. Almost all the hospitals are facing the problems of shortage of the doctors and nursing staffs which impact their efficiency due to over burden of the work.

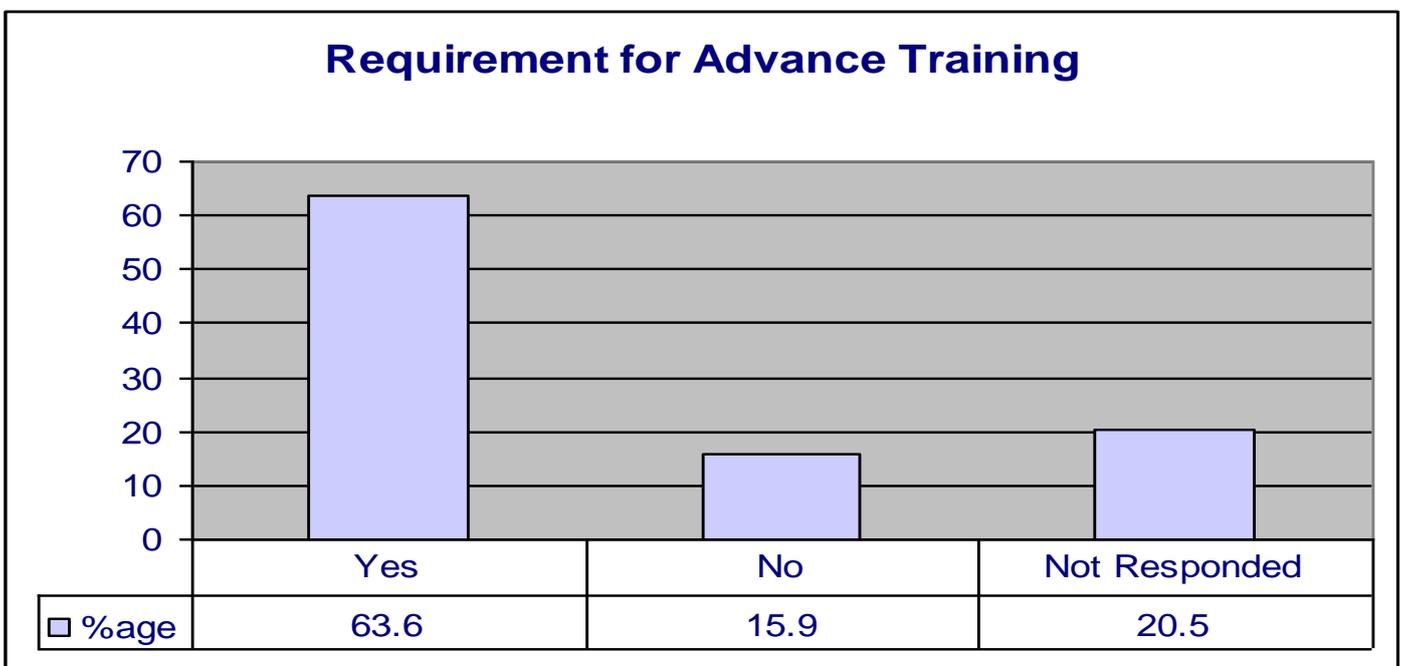
Opinion of Public about the Availability of Trained Manpower and Requirement of Advanced Training



It can be interpreted from the above table that 25.1% respondents not responded about the above question. 33.5% of the responded respondents agreed that trained manpower

is available in the state, whereas 41.4% of the responded respondents agreed that trained manpower is not available in the state.

Requirement of Advance Training to the Healthcare Staff



20.5% of the total did not respond when asked about the requirement of advanced training to the staff. Whereas 63.6% of the responded respondents agreed that the advanced training is required to the healthcare staff.

Opinion of Public of Rajasthan state about the Healthcare System in the Neighbouring States

Table 4

STATE	FRQUENCY	PERCENTAGE
GUJARAT		
YES	287	89.4
NO	34	10.6
DELHI		
YES	285	86.4
NO	45	13.6
PUNJAB		
YES	45	23.7
NO	145	76.3
HARYANA		
YES	67	34.2
NO	129	65.8

From the data collected, it is analyzed that most of the people think that outside in the neighbouring states there is a better healthcare system as compared to the state of Rajasthan. It can be assessed that most of the people prefer

the Gujarat and Delhi are states for medical treatment as compared to Rajasthan for major diseases.

Treatment outside the State

Table 5

Treatment For			
Middle Income Group	93	16	109
High Income Group	147	88	235
Total	240	104	344

Let us take hypothesis that middle income group does not prefer the treatment outside the state even for major disease. If X represents the ‘middle income group’ and Y represents the ‘treatment outside the state’, then

The expected frequency of the persons of middle income group vis-à-vis treatment outside the state would be:

Expectation of XY = (X * Y) / Total

X = 109, Y = 240

Expectation of XY = (109*240)/344 = 76.05 = 76

Using this expectation of XY, we can write the tables of expected values as

Table 6

Income Group / Treatment For	Major Disease Y	Minor Disease y	Total
Middle Income Group X	76	33	109
High Income Group x	164	71	235
Total	240	104	344

Table 7 Calculation of Chi Square

Group	Observed Frequency O _{ij}	Expected Frequency E _{ij}	(O _{ij} – E _{ij})	(O _{ij} – E _{ij}) ²	(O _{ij} – E _{ij}) ² / E _{ij}
XY	93	76	17	289	3.802
Xy	16	33	-17	289	8.758
xY	147	164	-17	289	1.762
Xy	88	71	17	289	4.070

Chi Square = $\sum (O_{ij}-E_{ij})^2 / E_{ij} = 18.392$

Degree of Freedom in this case = (r-1)(c-1) = (2-1)(2-1) = 1

The table for Chi Square for degree of freedom at 5 percent level of significance is 3.841 which is much lesser than the calculated table value. Thus it can be concluded that in most of the cases in middle income group, people prefer to go outside the state for the treatment of major illness.

Table 8 Improvement in Healthcare Due to Information Technology

Improvement	Age below 15	Age 15-50	Age above 50
Without ICT	83	40	48
With ICT	99	126	62

Personal interviews were conducted to know the penetration of IT in healthcare system and improvements in the system due to IT. The analysis of data received through questionnaire and personal interview has been analyzed in

this section. From the above data it has been analyzed whether IT is good for health sector or not.

Table 9

Age Group	Before X_i	After Y_i	Difference $D_i=X_i-Y_i$	D_i^2
Below 15	83	99	-16	256
15-50	40	126	-86	7396
Above 50	48	62	-14	196
Total n=3			$\sum D_i = -116$	$\sum D_i^2 = 7848$

$$D_m = \sum D_i/n = -116/3 = -38.667$$

$$\text{Standard Deviation of Difference} = \sqrt{\{(\sum D_i^2 - D_m^2 * n)/n-1\}} = 41.004$$

$$\text{Therefore } T = (-116-0)/(41.004/\sqrt{3}) = -4.89996$$

$$\text{Degree of Freedom} = n-1=2$$

Using the table of T distribution for 2 degree of freedom

$$R: T < -2.920$$

The observed Value of T is -4.899 which falls in the highly rejection region and it is concluded that the Information Technology in health care system is very important.

From the above data it is also clear that the age group between 15-50 years seems to have much knowledge about Information Technology in health care than the other two groups.

IV. PROPOSED HEALTH CARE SYSTEM DESIGN

Healthcare services are usually provided in collaboration between hospitals and primary healthcare centres. There are, in addition to these two main actors, a number of other organizations that need to collaborate with municipal or private home care operators, diagnostic laboratories, pharmaceuticals, providers of housing and daily services including relatives and ICT suppliers etc. Traditionally, many knowledge transactions take place informally when the health care personnel talk or leave messages on paper to one another. With increasing number of collaborators, the difficulties inherent in the informality of this are likely to increase, as people continually need to keep in communication to update them. A major disadvantage of these local systems is that the communication channels often are only partially documented. They are thus not available to all individuals who need the knowledge and not in the situations where they are needed. This gives rise to both symmetry of knowledge and an insufficient inters organizational integration [1].

A Planning and implementation

The aim of the research is to study of Health care system in Rajasthan and possible improvement in system by using ICT and ICT tools, particularly Government Health Institutions which covers the major areas of the State and provide medical support almost free of cost to the most of the population. The proposed electronic health communication model is like the waterfall model in which the next phase will not be initiated unless the previous phase gets fully completed. Overall networking is the key features of the model.

Phase I	Managing patient and doctors' data Creating Remote Consultation Centres
Phase II	Making all Government health centres including medical colleges ICT enabled and networking of RCCs and health centres
Phase III	Networking of all important private and charitable hospitals, private blood banks and diagnostic laboratories

A) Managing patient and doctors' data

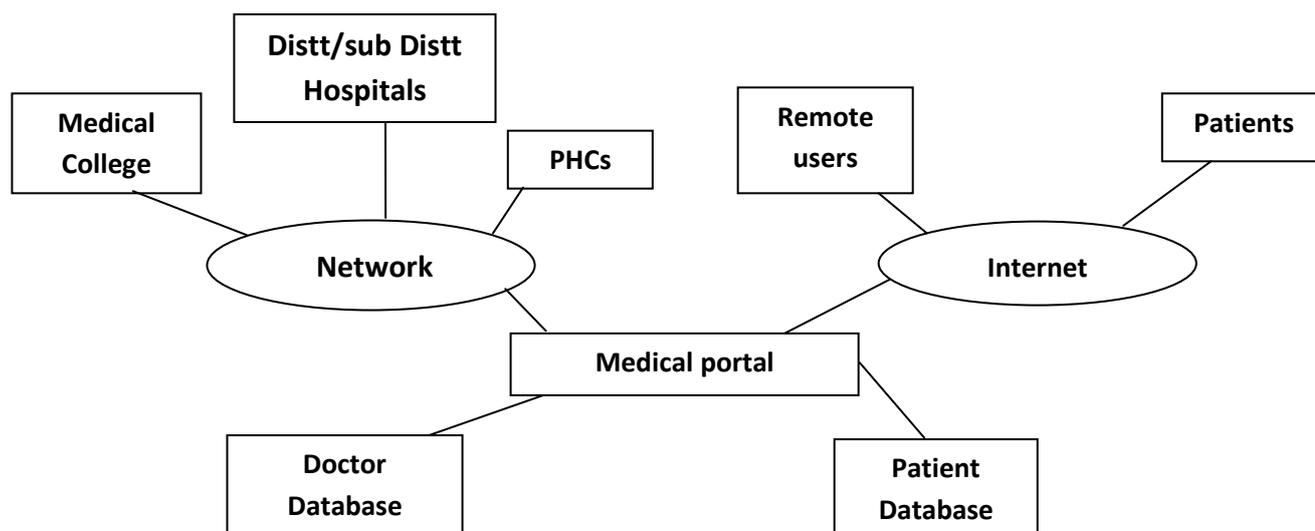
A medical portal in the form of electronic health record (EHR) has to be developed which will record the patient data completely from admission to till being relieved. The system will be initially stand alone at all levels. The system will be effective later on when the phase of networking will be carried out. At the admission of the patient, the software will tack care of patient's identification number (pin) will be allotted to each Patient in outpatient department (OPD) or emergency as the case may be, which will also indicate to identity of the health centre where received. In the similar way the doctors' database will also be made the part of the portal.

B) Creating remote consultation centres

Since the maximum population is residing in remote villages connected by improper roads, telemedicine method of operation can strong bone to the Health care system patients particularly living in rural areas need medical advice for the proper medical treatment and they don't find an equipped health centre very nearby, fail to take any decision in crucial moments. A patient rushed to nearest primary health centre can be taken care of even by an RMP by making a simple consultation with expert sitting in the network if these primary health centres are

equipped with ICT facilities. As internet has approached to every remote area of the country, proper infrastructure can be set to make some of the primary health centres ICT enabled and to call them as remote consultation centre (RCC). These RCCs are intended to serve the maximum population residing in remote villages connected by improper roads by providing consultation which in turn will help them in decision making for right kind of treatment. In its primary stage it doesn't involve lot of efforts, manpower and budget and the station could be established with minimum efforts and very few hurdles.

RCCs in state should be connected to district health level hospitals which contains a group consisting of one to two experts whom other staff available for expert opinion to the queries received from their subsequent RCCs. These experts from district level centres/ hospitals will also have links with different experts of the system as per schedule for any kind of assistance as and when required. They can seek an opinion from a specialist from any other hospital in the network if needed.



Phase II- Making all government health centers ICT enabled and networking of RCCs and health centres

Through online communication, the patient related opinion can be obtained, resources can be shared and above all the burden on lower level hospitals can be eased. At this stage it is presumed that RCC are completely functional now. A doctor from a sub district hospital can send all the parameters available to an expert for special opinion. The query can be posed through one RCC to the other RCC up to district level. The district level RCC can forward the query to concerned specialist and collect the feedback. The query can be directly replied by the doctor or through RCC. Video conferencing can be used to watch the patient on the digital monitors and have discussion with each other and decide the treatment.

senior doctors of the hospital through RCC unit; on the other hand government hospitals would like to send the blood samples of a patient for cross examination and confirmation of results. Similarly a private agency can arrange blood for the Government Hospital and provide ambulance and other manpower support as and when required.

Phase III-Networking of all important Private Hospitals, Charitable Health Centres, Private Blood Banks, Pathology and Radio diagnostic Labs.

However, to begin with only the well known health centres and institutions which are functioning under Govt license should be covered in the proposal. Requests as and when necessary will be made within the terms and conditions of MOU. E.g. the private hospitals may seek opinions from the

The development of this proposed system can be made effective with the help of one central agency which will prepare a common data Bank of all the health institutions, Nursing Homes, Private clinics etc out of which some can serve as service centre for RCC and will be online with different Hospitals and will have access to their reception/registration counters. Similarly, the private clinic doctors who desire to be in the net should also be linked.

V. CONCLUSION

Rajasthan is making progress in the health sector adequately. The people of the state of rural background have limited knowledge of the use of IT/ICT in the Health Care System. In urban area doctors and paramedical staff engaged for saving the precious lives are using the technology and its role in improving Health Care System. There is a need of improvement in the existing Health Care Structure of the state particularly in relation to the use of ICT in the system. The new techniques in

the field of Health system due to introduction of ICT like e-health, telemedicine and other ways of resource sharing would be highly beneficial for the people living in scattered area.

A new system has been proposed which recommends the implementation of the system in phases. It is always desirable to carry out the projects in phases; the proposed system has been divided into five different phases. Main emphasis has been given on the establishment of Remote Consultation Centres (RCC) which are mainly targeted for rural areas of the state. Networking of all the health institutions has been proposed up to the Sub Centre level and to the process has been split into different phases keeping in view the present position of Health sector in the state and the requirement of finance, manpower, technology and time.

VI. FUTURE SCOPE

The proposed system has touched almost all the issues pertaining to ICT in Health Care System. All the issues pointed out have a scope of detailed study and can serve as a model for any other state and system. More data can be collected on similar lines and analyzed to get a clearer picture. The proposal is designed in such a way that different teams can be involved and given separate jobs which will be almost independent of each other.

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