

suite applications, NIC has touched around 1000 hospitals. During the implementation process, it was realized that the existing monolithic architecture based e-Hospital suite would not be able to scale up, so a Next-Gen microservices based architecture e-Hospital suite in the container environment has been initiated to keep future integrations and simplified user interface and user Experience.

e-Hospital HMIS

The e-Hospital HMIS is a cloud based application that takes care of internal workflows of any tertiary, secondary and primary hospitals. It has 11 modules, namely, Patient Registration (OPD and Emergency), Admission, Discharge and Transfer (IPD), Billing, Lab Information System (LIS), Radiology Information System (RIS), Clinics,

Store and Inventory, Pharmacy, Dietary, Laundry and OT Management. The e-Hospital HMIS has been developed based on the global healthcare standards like HL7, SNOMED-CT, ICD10 and LOINC, and MetaData and Data Standards (MDDS) recommended and published by the Ministry of Health & Family Welfare (MoHFW).

Through these modules, the healthcare information of patients is being captured by hospi-

King George Medical University, Lucknow is the largest residential Medical University in India with a large hospital of nearly 4000 beds. It also has one of the biggest IT based healthcare infrastructure powered by hospital information software "e-Hospital" from NIC that caters to an patient load of 20-25lac per annum, providing full online facility with bi-directional lab information system that provides online pathology reports even up to patients mobile through ORS portal of NIC.

KGMU also manages appointments, diet, laundry, stores, pharmacy and other patient related services through the HMIS.

KGMU is also digitized with human resource software - 'manav sampada' as well as 'eOffice' - an Office digitization portal of NIC, making KGMU the single largest implementation medical site of NIC bouquet.

This sheer transaction volume and load of KGMU implementation itself highlights the kind of support and infrastructure that NIC is capable of providing. I hope this HIS achieve even greater levels of implementation with the upcoming Ayushman Bharat Digital Mission.



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tals under one umbrella and is being utilized for record, statistics and planning purposes. It has helped in streamlining the internal processes and services for the patients.

Implementation of e-Hospital starts with onboarding and configuration of any Hospital. Every module has its configuration also. Counter based OPD and Casualty Registration is the first module, which is implemented by any hospital, and facilitates in basic reporting and classification of new and follow-up patients. In case hospital implements ORS, then appointments taken online by patients are reflected in e-Hospital HMIS for registration purposes. Counter based appointments are facilitated through this module for follow-up. As of now, patients can do the registration

by submitting PM-JAY ID or ABHA ID, which is authenticated from respective platforms and basic demographics are captured. The data is then used for further integration as well. Counter based QR Code OPD registration has been tested which will further facilitate fast and validated registration and will strengthen the crowd management.

In-Patient Department (IPD) Module has various sub-modules like Admission, Doctors Visit, Orders, Nursing Station, Ward Management (Bed Allocation, Transfer), Discharge Services, and interfaces with Dietary, Laundry, Stores, Labs and Radiological Services. e-Hospital HMIS IPD Module includes Admission, Discharge and Transfer (ADT) Services. However, all other services have been integrated with it to facilitate the in-patients.

Billing is another important module of e-Hospital HMIS. Billing is the process of generating an invoice to recover services provided to patients. The billing process is the final step in the hospital which is directly proportional to patient satisfaction. Billing plays a vital role in the discharge process. Billing documents are important for any hospital, its operations enclose clinical aspects, financial aspects and administration for better functioning and decision making. Hospitals can define the services and configure normal as well as subsidized rates. It handles all types of billing workflows and facilitates cashier and billing operators for managing billing functions related to billing receipts, advances and refunds.

Maintenance of EHR is one of the prime objectives of bringing IT enablement to hospital operations. ePrescription during OPD and eOrders during IPD by doctors are the prime source for EHR. This is where healthcare standards like SNOMED-CT, LOINC, ICD, Drug Registry and other directories come in picture. e-Hospital HMIS captures vitals, history, symptoms, diagnosis, medication, orders diagnostics tests of the patients as a part of ePrescription and eOrders. e-Hospital HMIS has been developed using HL7 development platform and standards as recommended by MoHFW.

Orders by doctors are issued for diagnostic tests. It involves laboratory services or radiological services. e-Hospital HMIS has Laboratory Information System (LIS) and Radiological Information System (RIS). LIS module automates the ordering of tests and procedures on patient specimens, collection and accessioning of specimens into the laboratory database, processing and analysis in the appropriate department or work areas, review and verification of results, reporting of results and/or diagnoses for clinical treatment. In many hospitals, LIS has been integrated with Lab Analyzers using the HL7 interface, which pushes the output directly to e-Hospital HMIS. However, the RIS module automates the ordering and scheduling of tests and procedures, review and verification of results, and reporting of results and/or diagnoses for clinical treatment.

Two more services, which are important from an IPD patient's services perspective, Dietary and

NIC e-Hospital & ORS application is running smoothly in AIIMS, New Delhi. The new requirements during COVID era were swiftly taken care of by this application. Also, the Queue Management System developed and running at new RAK OPD building is proving beneficial for patients.

We are able to deliver effective and efficient health care services to patients as per AIIMS standards.



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Under the Digital India Initiatives, NIC, MeitY developed a standard-compliant, state-of-the-art ABDM ready e-Hospital platform aimed at public hospitals of all levels, with varying facilities and sizes, where the immediate need is to deploy and adopt an EHR solution that is robust, interoperable, and integrated with medical vocabularies that conform to global standards – to reduce treatment costs by empowering citizens with EHR in line with the National Health Policy, 2017. The e-Hospital platform is an end-to-end solution for managing hospital processes and services, including telemedicine. It's simple to onboard, scale able, and is used by more than 650 public hospitals across the country.



CK Dhar
Deputy Director General & SIO
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Government Medical College & Hospital, Chandigarh is one of the leading medical institutions in Punjab and India. It has an attached hospital of 975 beds. It offers many undergraduate courses and post-graduate courses including MBBS. To meet ever-increasing ICT demands, GMCH opted for e-hospital in 2014. Over the years, almost all modules of e-hospital have been activated and made functional to provide critical information for the management of patients and other related activities. It has improved the efficiency and accessibility to critical information, which in turn, has improved the healthcare services. It has provided easy access to patients reports online. Most of the activities have become paperless.

Through e-hospital, GMCH is also running Online Registration System (ORS) with its unique features of scheduling an appointment at a chosen time with a chosen consultant.

Recently, NIC has integrated e-hospital with ABDM which will further help in improving the healthcare services.

NIC has provided timely support for implementation, upgradation and troubleshooting if needed.



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Laundry. The objective of the dietary module is to make provision for clean, hygienic and nutritious diet plans for the patient as per their nutritional requirement. The dietary module automates the functions of dietary services provided to the patients in the hospitals. Its functioning includes capturing patient wise dietary requirements, their consolidation, generating the diet sheet and using it for planning and distribution.

The laundry module automates the functions and workflows of laundry services in hospitals. It facilitates the laundry service in providing a safe, clean, adequate, and timely supply of linen and laundry to different units of hospitals. Its functionality includes indent generation, verification, returns and declaring not-for-use.

Stores and Pharmacy are another important

back-end module of e-Hospital HMIS for managing the hospital resources. The concept of the main store and sub-stores have been implemented. The main store prepares indents to purchase department and receive items and further distribute them to sub-stores and maintain stores. Sub-stores, Pharmacy and Departments, raise indent to the main store and receive items from the main store and distribute them to patients, internal staff.

The OT Management module automates the functions and workflow of operation theatres, which include pre-operation and post-operation notes. In addition, OT supports the recording of anaesthesia notes, OT checklist, ward checklist and so on.

During the COVID-19 pandemic, e-Hospital HMIS was enabled to capture data items related to it so that better monitoring can be done. A separate COVID-19 e-Hospital HMIS was carved out for dedicated COVID-19 Hospitals to take care of their end-to-end operations with integration with COVID-19 Lab Information System from ICMR. The COVID-19 version of e-Hospital HMIS module was implemented in Sardar Patel Covid Care Centre and Hospital (SPCCCH), Chhatarpur, Delhi facilitating end-to-end digitization of registration, admission, treatment, transfer and discharge processes of COVID-19 patients. The Government of Puducherry also implemented the same solution at Indira Gandhi Medical College and Research Institute (IGMCRI).

e-Hospital HMIS also supports the external systems, which are part of the ecosystem. Mera Aspataal captures patient feedback on the services received from both public and empanelled private health facilities. It works through multiple communication channels, including Short Message Service (SMS), Outbound Dialing (OBD), a mobile application, and a web portal. e-Hospital HMIS has been integrated with Mera Aspataal for 198 hospitals. It has also been integrated with ABDM Building Blocks as well to the support registration of authenticated patients and sharing of their electronic health record by taking electronic consent. Over 100 hospitals have been integrated with Health Facility ID of ABDM and more than 20,000 ABHA IDs have been linked with health records in e-Hospital HMIS. LIS module of e-Hospital has been integrated with the Lab Analyzers in major hospitals like AIIMS Delhi, Dr. RML Hospital Delhi, KGMU Lucknow, NIMHANS Bengaluru and NDMC Charak Palika Hospital Delhi and many such hospitals. Similarly, e-Hospital HMIS has been integrated with Uttarakhand CM Dashboard, Central Dashboard of MoHFW and eRakatkosh application in Dr. RML Hospital.

Implementation of e-Hospital HMIS requires lots of effort on the hospital end also. It includes ICT infrastructure in terms of personal computers, Local Area Network (LAN), and dual internet connectivity from different Internet Service Providers (ISPs). The hospital administrator needs to depute a Nodal Officer, who can identify Doctors, Nurses and other staff for the purpose of training

Dr. RML Hospital has a robust IT infrastructure of extensive LAN with 1500 users spread over 13 buildings. The e-hospital HMIS has been in place in Dr. RML Hospital since 2014. It has multiple modules encompassing all essential hospital functions viz OPD, Ward, Casualty, Lab, Radiology, Inventory, Laundry, Dietary, Online payment and blood bank. The e-hospital suite is a cloud based user friendly software that can be accessed through any browser.

Since its inception, e-hospital has made the hospital function smooth and time efficient. The OPD registration is fast and linked to the Online Registration System. During the Covid pandemic, telemedicine was started on this platform and has been a boon to a lot of patients.

There has been regular improvement by NIC in the e-hospital modules driven by needs of the hospital. To name a few, the inventory module has included provision of department and patient specific demands. We are also collaborating with NIC to develop an Equipment Management System in the inventory module.

e-hospital has made patient data archival and retrieval easy and secure. It has made inventory management efficient and paperless.

Recently with the initiative of NIC, e-hospital suite of Dr. RML Hospital has got integrated with ABDM which will benefit patients in OPD registration and digital maintenance of patients' health records.

We are on a path of making the hospital paperless and our collaboration with NIC will definitely lead us to that end, in line with the mission of Digital India.



Prof. (Dr.) Sameek Bhattacharya
Chairman, eGovernance
ABVIMS & Dr. RML Hospital, New Delhi

and capacity building, and providing the master data for the purpose of basic and module wise configuration.

Over 740 hospitals have onboarded on e-Hospital HMIS and about 631 hospitals have already started to offer this facility across the country. Major States/UTs who have onboarded on e-Hos-

Government Multi Specialty Hospital, Sector-16, Chandigarh has a robust IT infrastructure of extensive LAN network with 300+ users spread across the entire campus of the hospital. The e-Hospital HMIS – a Hospital Management Information System, has been in place in the hospital since April, 2017. The multiple modules of e-Hospital has been implemented in GMSH-16 encompassing all essential hospital functions viz OPD, Casualty, IPD Registration, Billing, Store and Inventory Module, and e-BloodBank. Also we are in process of implementing Clinic and LIS modules very soon.

e-hospital is a cloud based user friendly software that can be accessed through any internet browser from anywhere anytime. Since its implementation in GMSH-16, e-Hospital has made the hospital function smooth and time efficient. The OPD registration is fast and linked to the Online Registration System (ORS) due to which patients are getting benefited a lot.

NIC has improved the software over the years and most of the modules are customized as per the needs of the hospital. Many MIS reports were also developed during these five years as desired by the higher authorities of Health Department.

e-Hospital Software has improved the efficiency and accessibility

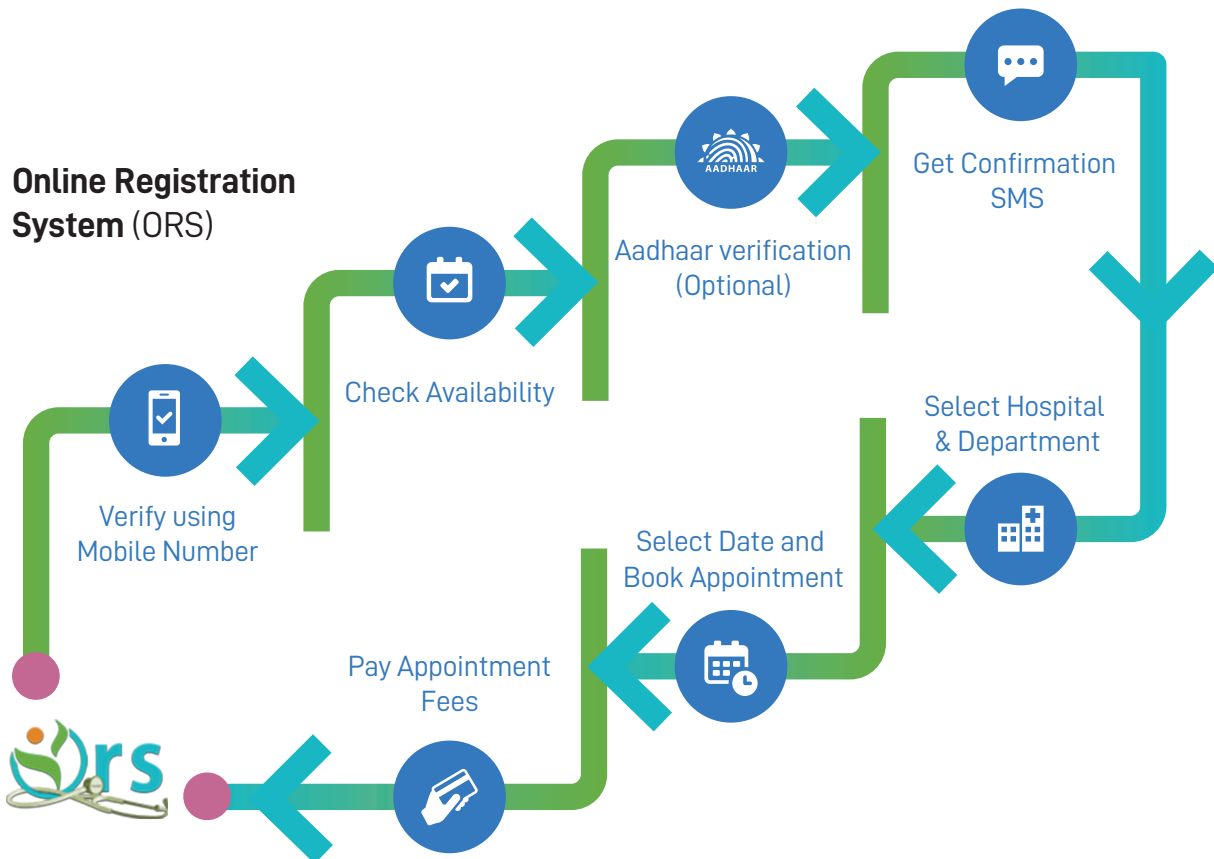
to critical information which has improved the healthcare services. It has provided fast and easy access to patients for the lab reports just at one click of mouse sitting in the comfort of their homes and made several activities paperless.

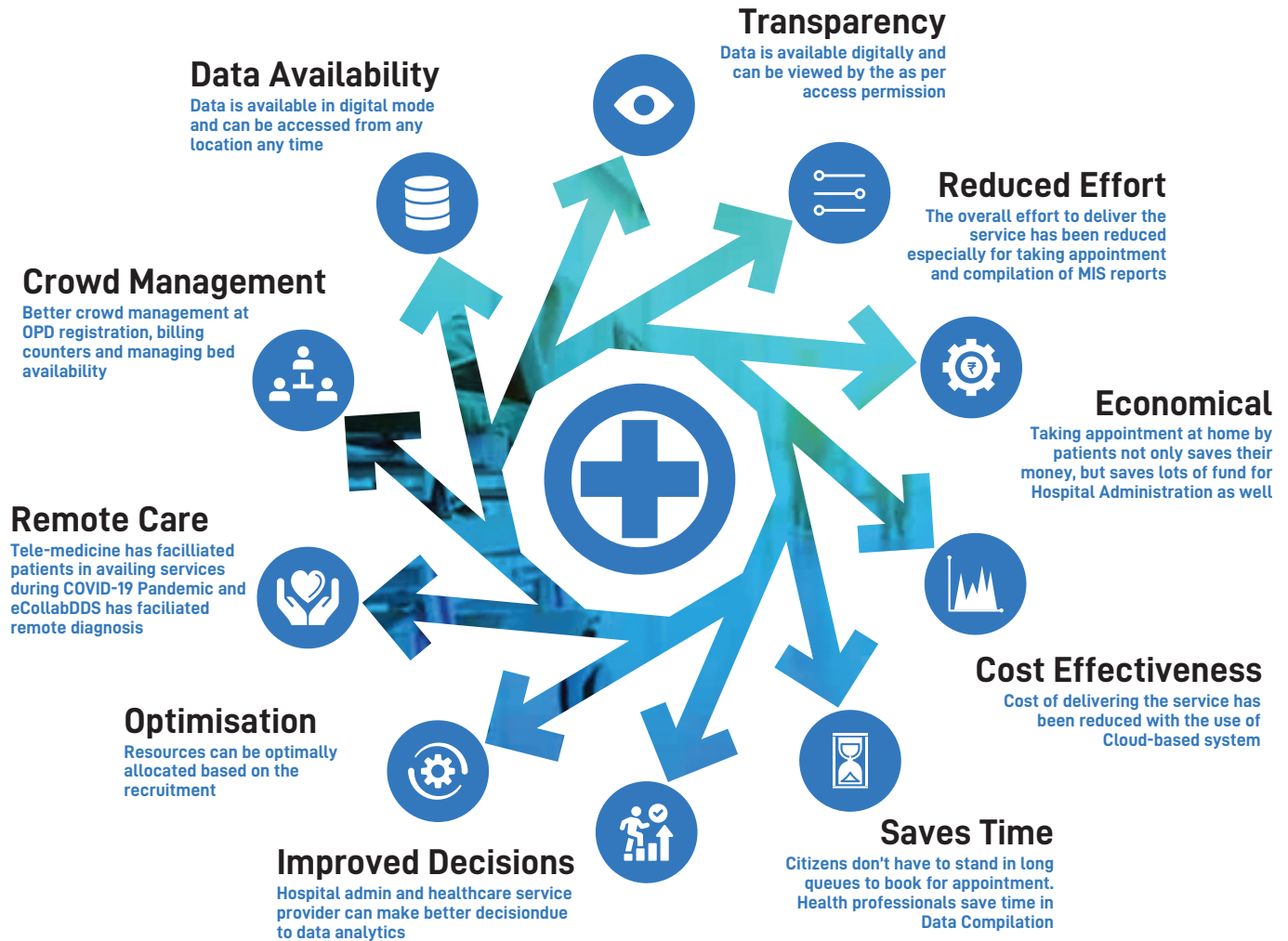
From the past 7-8 months, hospital has started the integration of e-Hospital with Ayushman Bharat Digital Mission with the technical support of NIC, which is providing lots of benefits to patients during OPD registration and maintenance of health records of patients in Digital form.

With the technical guidance and constant support from the NIC, GMSH-16 is progressing towards the paperless hospital tag and is moving very fast to achieve the purpose and aim of Digital India.



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e-Hospital Suite | IMPACT

pital HMIS include Karnataka, Uttar Pradesh, Madhya Pradesh, Chandigarh and Andhra Pradesh. Since September 2015, over 24 crore transactions have been done using e-Hospital HMIS. There is a Dashboard, with data for both National and State levels, has been provided for monitoring purposes.

Online Registration System

With an objective to make patient services available on a common platform, Online Registra-

tion System (ORS) was launched in July 2015 by the Hon'ble Prime Minister Shri Narendra Modi during 1st Digital India Week. ORS is an online interface where the patients can book online appointments with or without Aadhaar using his/her mobile number from the hospital based on their preference of location and department. Apart from this, patients can also access their lab investigation reports online and check the blood availability status and make payments online in the hospitals. ORS is ABDM enabled and patients

can register and create ABHA ID and also book appointments using ABHA ID. ORS is also available on the UMANG platform for facilitating patients to book appointments using the mobile app. Online Payments have been enabled for the hospitals for taking registration fees and donations. A hospital needs to sign the MoU with the Payment Gateway Provider for enabling it on ORS.

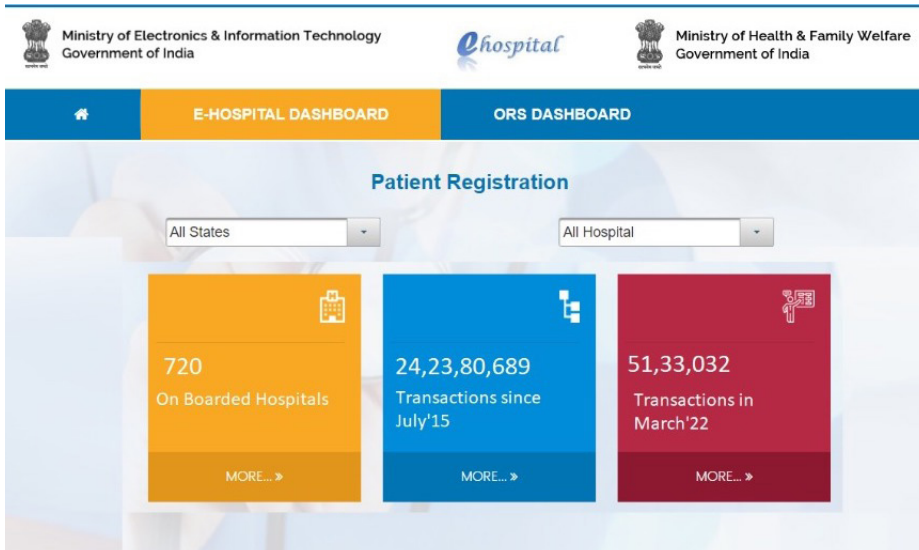
ORS is a platform that can be integrated with the OPD Registration Module of any Hospital Management Information System (HMIS) like

NIC has developed and implemented the cloud-based e-Hospital Suite of 10+ modules under digital India programme of Ministry of Electronics and Information Technology (MeitY). The e-Hospital suite being offered to public health facilities in Software-As-a-Service (SaaS) mode and is compliant with ecosystem of Ayushman Bharat Digital Mission (ABDM) and integrated with PM-JAY. 700+ hospitals in 29 states/UTs across the country have been onboarded on e-Hospital platform, providing comprehensive support to the hospital administration to

provide multiple services to the patient and monitor them efficiently. For the citizen the e-Hospital suite, provide the interface to digitally book the appointment and view the health records, thus citizens can escape the long queue for appointment and report collection. I hope that implementation of the e-Hospital Suite has effectively reduced the turn-around time for number of services, enabling responsive governance.



Dr. Neeta Verma
Director General, NIC



▲ e-Hospital Dashboard by MoHFW and MeitY

▼ Online Registration System Dashboard by MoHFW and MeitY



e-Hospital and it also facilitates its functioning in any hospital without any HMIS solution. Similarly, On-Boarded Hospitals, which have automated Lab reports, can also push it to ORS using Application Programming Interface (API) for public view using OTP and Blood Banks can push blood type-wise availability to ORS using API for public view. On-boarded hospital declares Nodal Officer, who can configure ORS as per requirement and monitors using Dashboard.

As of now, 476 hospitals have been on-boarded to ORS and 54.5 Lakhs+ appointments have been taken since July 2015. About 4000 appointments are taken on average using ORS.

e-BloodBank

e-BloodBank facilitates the implementation of operations for internal workflows of blood banks. e-BloodBank has all modules required for a blood bank like Donor Registration, Checking of Donors, Blood Collection, Component Preparation, Blood Issue, Blood Transfer and Receive from other Blood Banks. From successful donor screening to optimal blood distribution in the field, e-Blood-Bank application can compile diverse data into readable reports to strengthen decision making. e-BloodBank application also facilitates organizing the Blood Camps. Blood Banks, already implementing e-BloodBank are integrated with ORS for making blood availability status to public. e-BloodBank has been implemented in 65 Blood Banks across the country and more than 2 Lakhs Blood Donors have been registered on this. 2522 Blood Camps have been arranged using the e-BloodBank application.

Telemedicine

Telemedicine application of e-Hospital suite is an initiative to bring health care service to the location & time that suits patients. The telemedicine application is integrated with e-Hospital HMIS. During follow-up teleconsultation, the EHR of existing patient of a hospital helps doctor to provide better treatment. For new patients, service to create an EHR during

e-Hospital Suite has been strengthening the patient's and hospital back-end services in public hospitals in India since 2010. Services like Online Appointment, Registration, Viewing of Lab Reports, IPD (ADT) and Billing had left significant mark in the hospitals like KGMU, Lucknow, AIIMS, New Delhi, NIMHANS, Bengaluru, Dr RML Hospital, New Delhi and about 200 district hospitals across the country.

I congratulate State Governments, Hospital Administrators, Nodal Officers and NIC officers, who worked tirelessly to bring e-Hospital tool implementation to this level.



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first teleconsultation is also available, which can be accessed during subsequent follow-up consultations. During COVID-19 pandemic, more than 17,000 teleconsultations have been done in 44 hospitals/institutions across the country.

CollabDDS

CollabDDS (Collaborative Digital Diagnosis System) is a teleradiology application by which health facilities, not having radiologist, can upload the x-ray images and radiologist sitting at the remote location can visualize image data online and prepare the report. Such reports and images are also visible to doctor, who uploaded it, for further diagnosis and prescription.

Different modules of the CollabDDS are hospital and user registration, role-based authentication and authorization, Collaboration/Reviewer, and DICOM/Image viewer with functionality to image manipulation and annotations. CollabDDS is also integrated with external applications like telemedicine for uploading of images from application side.

Artificial Intelligence (AI) enabled CollabDDS has been envisaged during COVID-19 pandemic to detect COVID-19 through Chest X-Rays. In CollabDDS, an interface has been developed to upload an image from the health center which is sent to the AI model for prediction. The AI model

returns the probability of COVID-19 infection with a confidence score which is sent to the Radiologist for validation. Once the validation is done by the Radiologist, the result is sent back to the requested health facility for further action. Similar work has been done for detection of Tuberculosis (TB) through Chest X-Rays.

CollabDDS has been implemented in Karnataka and more than 1700 cases have been diagnosed by remote radiologists.

Development Stack & Architecture

e-Hospital Suite has been developed using open source technologies with Linux as Operating System, Apache as Web Server, Tomcat as Application Server, PostgreSQL as database, Java as Programming Language. HL7 Development Framework has been used as per recommendation of MoHFW. Health Standards for EHR including SNOMED CT, ICD, LOINC and DICOM have been used.

Coverage of e-Hospital Suite

The e-Hospital suite has touched upon all the states implementing one or more of its applications. But some of the implementation has left major impact and come up after facing lots of challenges. Major hospitals which implemented e-Hospital HMIS includes AIIMS - Delhi, Rishikesh, Bhopal; NIMHANS Bengaluru; Dr. RML Hospital, Delhi; Safdarjung Hospital, Delhi; King George's Medical University, Lucknow; NDMC Charak Palika Hospital, Delhi; Silchar Medical College, Assam; RIMS Manipur; NEIGRIHMS, Meghalaya; Lady Hardinge Medical College, New Delhi.

Major hospitals, which implemented ORS includes AIIMS - Delhi, Rishikesh, Bhopal, Patna, Jodhpur, Bhatinda; RIMS Jharkhand; NIMHANS Bengaluru; IGIMS Patna; Dr. RML Hospital, Delhi; Safdarjung Hospital, Delhi; PGIMER Chandigarh; Lady Hardinge Medical College, New Delhi; Sports Injury Centre, New Delhi.

Karnataka and Tripura have been able to implement e-BloodBank effectively in their states covering most of their Blood Banks. Karnataka state has implemented CollabDDS in effective manner however tele-medicine has been implemented in Uttarakhand effectively during Covid-19 era.

Training and Capacity Building

Once a hospital takes the decision to implement any of e-Hospital suite's application, the request for training and capacity building is immediately received and hospital identifies officials for the training. Mostly, training is provided to Nodal Officer, Doctor, Nurses, Hospital Staff, Data Enter Operators. The training is customized as per the plan of implementation based on ICT infrastructure and staff availability. Mostly, training is imparted module by module on the training server. Handholding is done during the practice sessions. User Manuals are made available to the end-users. 474 Training Sessions have been conducted so

that and 7549 officials have been trained on different applications and their modules.

Way Forward

It has been realized that Healthcare delivery requires every healthcare professional to leverage technology. To bring fast implementation, provide scalability and better UI/UX, Next-Gen e-Hospital Suite has been initiated and agility has been brought into development. CollabDDS is being enhanced with the support of Artificial Intelligence (AI). It will help radiologists to find anomalies that could escape the human eye or are simply missed because of overworked experts. Patient Services will be further strengthened on ORS so that patients get more services at their homes. Solutions around AI based disease-specific analysis especially to end TB are being developed. Big Data Analytics is required as lots of patient data has already been accumulated. IoT based wearable devices integration with e-Hospital HMIS is another area where exploration is.

There are immense possibilities to integrate numerous applications, devices and platforms with e-Hospital Suite to realize the dream of electronic health records of every citizen of India.



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