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Interoperability of Electronic Health Record

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Abstract: ***We are creating interoperability of health record from the perspective of Indian Medical care system, patients visit several doctors, throughout their lifetime right from visiting a primary health center to community health. Health records get generated with every clinical meet during the inpatient or emergency visits. However, as it is paper based most of the health records or EHR. But there are certain barriers to it. The idea behind any technology or a invention is to make things simple and easy for everyone. To Store the health record of patients to digital system and accessing the record whenever required and it will be so simple that even people in rural area can run it and can achieve interoperability of that record without affecting the security and privacy of the user.***

Keywords: Interoperability, International classification of disease, Electronic health record, Snomed, Health Level 7

I. INTRODUCTION & THE INTEROPERABILITY PROBLEM

Healthcare is far more behind many other high risk-industries in its attention of ensuring basic patient care. An Electronic Health Record Systems (EHR) is the central information system of a hospital. Generally, EHR system incorporates various other subsystems such as patient management systems, financial and personnel departments as well as communications and user's capabilities in order to process and manage all patient services effectively. The EHR system of a Hospital should be able to process patient information from various departments, such as radiology, pathology, admissions, wards etc. Different departments have various formats, and models of information which make it difficult for the interoperability of an EHR. The patient care is poorly achieved due to incorrect or inefficient exchange of patient records between different users, which also hampers the privacy and confidentiality of medical information resulting in redundant use of resources. There exist many terminologies, due to which the problem of interoperability becomes difficult to solve. Safe transfer and interpretation of medical data can be ensured only with the use standardizations. WHO (World Health Organization) has developed a standard known as ICD "International Classification of Diseases". The ICD is originally designed as a healthcare classification system, providing a system of diagnostic codes for classifying diseases, including nuanced classifications of a wide variety of signs, symptoms, abnormal findings, complaints, social circumstances, and external causes of injury or disease. This led to the development of standards, such as HL7 which is a message-oriented framework used for the interoperability of EHRs by standardizing and automating hospital information processes. HL7 is now an accepted standard in many countries, for the interoperability of medical data. This project has combined HL7 standards to illustrate a stable framework for the interoperability of EHRs in the evolving field of modern hospital environments..

II. STANDARDS

A. ICD

ICD is a medical classification list by the World Health Organization (WHO), which contains codes for diseases, signs and symptoms, abnormal findings, complaints, social circumstances, and external causes of injury or diseases. Work on ICD-10 began in 1983,became endorsed by the Forty-third World Health Assembly in 1990, and was first used by member states in 1994. Currently, 11th revised version of the ICD codes is being used by countries which was released in June 2018. Its development has taken place on an internet-based platform that is still being used as the maintenance platform for discussions, and proposals for updates of ICD. Users can submit an evidence based proposal. The updation proposals are processed in an open transparent way with reviews for scientific evidence, usability and utility in the various uses of ICD. It is presumed, that no need will arise for national modifications of ICD-11, due to its richness and flexibility in the reportable detail.

Common complaints the about the ICD-10 were, the long list of potentially relevant codes for a given condition which were confusing and reduced it's efficiency. In ICD-11 WHO tried to overcome this problem.ICD-11 invokes a more advanced architecture than it's former versions, consistent with its generation as a digital resource. ICD-11 comes with an implementation package that includes transition tables from and to ICD-10, a translation tool, a coding tool, web-services, a manual, training material, and more. All tools are accessible after self-registration from the maintenance platform.

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B. SNOMED-CT-

Being the most exhaustive international terminology, SNOMED CT is presently available and used in varied domains of the healthcare industry. In this industry, SNOMED CT is considered to be the most multilingual healthcare terminology. It is a group of medical terms which provides codes, synonyms and definitions used in clinical documentation and reporting.

The paramount aim of SNOMED CT is to cipher the meanings that are used in medical data and to considerably improve patient care. Clinical findings, symptoms, diagnoses, procedures, body structures, organisms and other etiologies, substances, pharmaceuticals, devices and specimens are all covered by SNOMED CT. The International Health Terminology Standards Development Organization (IHTSDO) distributes the standard. Currently, SNOMED CT has more than 300,000 medical concepts which are classified into various hierarchies, which are as diverse as body structures, medical finding, geographic location and biological product. Each of those concepts are represented by an individual number and several of those concepts can be simultaneously used to to simplify and describe any given condition.

SNOMED CT consists of four core components

1) *Concept Codes:* These are numerical codes which help in identifying clinical terms (primitive or defined) organized in hierarchies.
2) *Descriptions:* They are textual descriptions of the Concept Codes
3) *Relationships:* It describes the relationships between Concept Codes that have a related (similar) meaning
4) *Reference Sets:* They are used to group Concepts or Descriptions into various sets, including reference sets and cross-maps to other classifications and standards.

SNOMED CT is a constant means to index, store, retrieve, and aggregate medical data across hospital and sites of care. Organizing the content of electronic health records systems by reducing the variation in the way data is captured, encoded and used for the care of patients and medical research is a major use of the SNOMED CT. It also provides the user with a number of linkages to healthcare pathways, shared care plans and other knowledge resources, which helps them in making informed decisions, and support long-term care of the patient.

C. HL7

Health Level-7 is an international standard used to transfer healthcare industry data such as medical and administrative between various software applications used by hospital, clinics and research institutes. These standards emphasize on the application layer, i.e, "layer 7" in the OSI model. The HL7 standards are produced by the Health Level Seven International, and are adopted by other standards issuing bodies such as American NAtional Standards Institute and International Organization of Standardization.

Hospitals and other healthcare providers have many software systems which are catered according their specific requirements and used for everything from billing records to patient tracking. Such systems should be able communicate with each other when they are updated with new information, or when they wish to retrieve information, but not all systems do so.

HL7 International has given a number of guidelines, and methodologies by which various healthcare systems can communicate with each other. These guidelines are a set of rules that allow data to be shared and processed in a consistent and uniform manner. These data standards allow healthcare organizations to easily share clinical information. The goal of HL7 standards is to help in minimizing minimize the tendency for medical care to be geographically isolated and highly variable.

HL7 International considers the following standards to be its primary standards – the standards that are most commonly used and implemented:-

1) Version 2.x Messaging Standard – It is an interoperability specification for health and clinical transactions.
2) Version 3 Messaging Standard – Current version of an interoperability specification for health and medical transactions
3) Clinical Document Architecture (CDA) – This is an exchange model for clinical documents, based on HL7 Version 3.
4) Continuity of Care Document (CCD) – This is a specification used by US for the exchange of medical summaries, based on CDA.
5) Structured Product Labeling (SPL) – This is the information published that accompanies a medicine, based on HL7 Version 3
6) Clinical Context Object Workshop (CCOW) – It is an interoperability specification for the visual integration of user applications

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III. PURPOSE

From the perspective of Indian Medical care system, patients visit several doctors, throughout their lifetime right from visiting a primary health center to community health. Health records get generated with every clinical meet during the inpatient or emergency visits. However, as it is paper based most of the health records are either lost by the patients or remain in the supervision of health care providers and gets destroyed. As per the maintenance period of medical records generally followed by hospitals is 5 years for out-patient records and 10 years for in patient records. Medical records are however retained permanently. In India we have some intention of EHR. But there are certain barriers to it. The idea behind any technology or a invention is to make things simple and easy for everyone. To Store the health record of patients to digital system and accessing the record whenever required and it will be so simple that even peoples in rural area can run it and can achieve interoperability of that record without affecting the security and privacy of the user.

IV. APPROACH

A. Technical Functionality

The EHRS website uses PHP 5.6.25 and MySQL 5.7.14.We are using Apache 2.4.23 web server software. The website is made using WordPress 5.1.0 which is the most widely used CMS (Content Management System).WordPress is a free and open-source content management system based on PHP & MySQL. Features include a plugin architecture and a template system.In order to enable the functionality of different levels of logins for different levels of access based on designations, we have made use of the SMP 3.7.7 plugin which stands for Simple Membership Plugin which allows web developers to seamlessly create an environment where people with different levels of accessibility can register and login in a common flow and still be able to see only what they are allowed to.To accept data from the users we are using Caldera forms 1.8.1 which enable us to design responsive forms that provide a huge deal of features like conditional logic, calculation fields, multi-part forms, file uploads and column layouts out of the box.For managing all of this data in an efficient manner, we make use of TablePress 1.9.2 that allows us to edit data in a spreadsheet-like interface. Tables can contain any type of data, even formulas that will be evaluated. An additional JavaScript library adds features like sorting, pagination, filtering, and more for site visitors. Tables can be imported and exported from/to Excel, CSV, HTML, and JSON files.In the end, in order to convert the patient records to HL7 format, we use HL7 Maker 2.1.0.1 which was adapted from the work of Gabriel Worley of New Mexico Department of Health. HL7 Maker allows us to import data in .csv and .xlsx formats and then we can directly get an output after mapping the columns appropriately and executing the convert command.

B. System Flow

When a patient will visit a hospital for the purpose of diagnosis, the doctor or the hospital staff will make an entry of the same by logging into the EHRS. The content of this entry will include the personal information of the patient along with details of the visit and the diagnosis data. The diagnosis data may consist of any medical test results, reference ranges of the same, ICD / SNOMED CT code or any other relevant medical standard code based on the ailment of the patient.

Now when a patient would want their data to be shared with another medical establishment, the patient / authorized hospital staff can approve sharing of data. To enable seamless sharing of data, the visit / medical info from the first system will be converted first to HL7 format and then further converted to XML file for sharing across systems. This XML file will get converted back to HL7 format in the receiving system. HL7 files have message headers which help in identifying / classifying the data to relevant fields in the new system. Older entries of patient data can be accessed by the patient, doctor, and authorized hospital staff. These records will be accessible only if they have their respective login credentials of the system. In this manner we can enable the Interoperability function of the whole system. As far as the conversion of ICD code to any other format is concerned, it can be done by mapping the terms of each entry in different standards, with each other. As of now, the expertise and processing power required to achieve the said conversion functionality, is enormous and not acquirable for us resulting in a limitation in EHR system designed by us.

V. CONCLUSION

From recent analytics it is estimated that the healthcare industry could save billions by adopting interoperable systems in hospitals and clinics for Health Records, Insurance claims, Prescription order, Clinical studies, Government reports and Lab results. Analytics also plays a very important role in the healthcare industry. It is majorly used to systematically review clinical data to provide decision based on the available data. Interesting thing is that instead of seeing only 20 patients a day doctors are available to see 75 to 100 people and get ahead of the wave. The main future of interoperability in healthcare is to provide such physician support tools. Also, to concentrate on areas such as to develop programs to prevent falls by patients in the hospital, predict the

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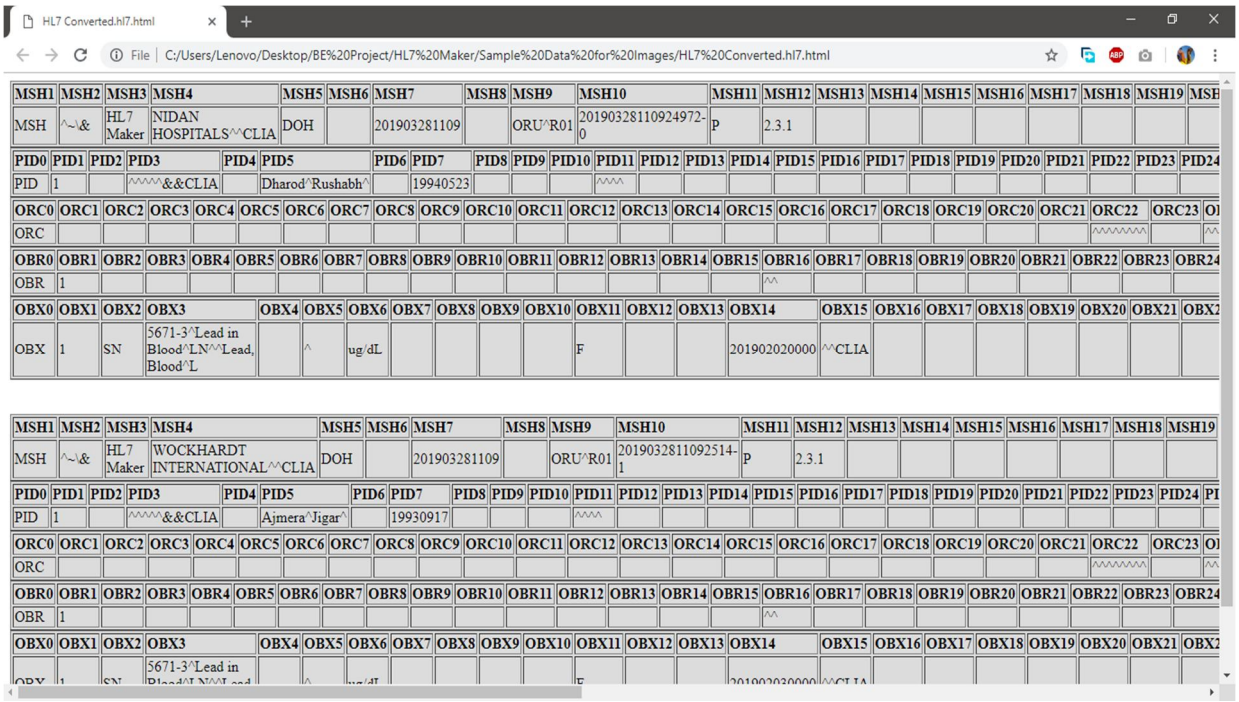
length of hospitals stays, create early warning system to spot complications after a procedure and reduce the number of people being readmitted for the same condition. The work is carried out to standardize the health record of the people for India. This work aims to promote interoperability of Electronic Health Records for India which has many merits such as patient treatment cost will be reduced, patient data are managed efficiently, authentication of data is provided, indexing the authentication using cloud etc. Only the authorized experts can view the patient's details, since the data is very sensitive.

We have used to HL7 maker tool to demonstrate how the medical data can be shared, if we can design our own HL7 parser we will be able to achieve more precise and user centric results.

Figure 1:- This Image shows the data of various patients in the CSV format.

	A	B	C	D	E	F	G	H	I
1	Submmited	Patient ID	First Name	Last Name	Age	Sex	Diagnosis / Observations	ICD Code	Doctor ID
2	2018-05-19 18:18:07	286-50-1450	Janelle	Esland	56	Female	Injury of digital nerve of left little finger, sequela	S64497S	4956
3	2018-08-30 22:34:18	483-21-9135	Gale	Swyer-Sexey	96	Male	Displaced articular fracture of head of unspecified femur	S72063	9061
4	2018-06-12 4:24:10	260-49-5902	Annabella	Hillum	43	Female	Unspecified subluxation of right foot, initial encounter	S93301A	5075
5	2019-04-12 10:12:24	384-23-9350	Guinna	Lukasik	67	Female	Nondisplaced transverse fracture of shaft of left femur, subsequent encounter for closed fracture with routine healing	S72325D	3763
6	2019-02-13 0:25:30	711-55-0497	Alberto	Hearsey	28	Male	Toxic effect of lacrimogenic gas, assault	T593X3	6299
7	2018-12-31 21:47:14	755-58-3481	Dyann	Parradye	74	Female	Laceration of muscle, fascia and tendon of other parts of biceps, right arm, sequela	S46221S	2252
8	2019-04-01 6:02:29	131-92-8211	Calli	Soloway	55	Female	Laceration without foreign body of unspecified front wall of thorax with penetration into thoracic cavity, subsequent enco	S21319D	1277

Figure 2:- This image shows the data that is converted into HL7 format.



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[10] Medical Information System based on EHR.https://ieeexplore.ieee.org/document/5520713/metrics#metrics
[11] Interoperability of Hospital Information Systems.https://ieeexplore.ieee.org/document/1218723

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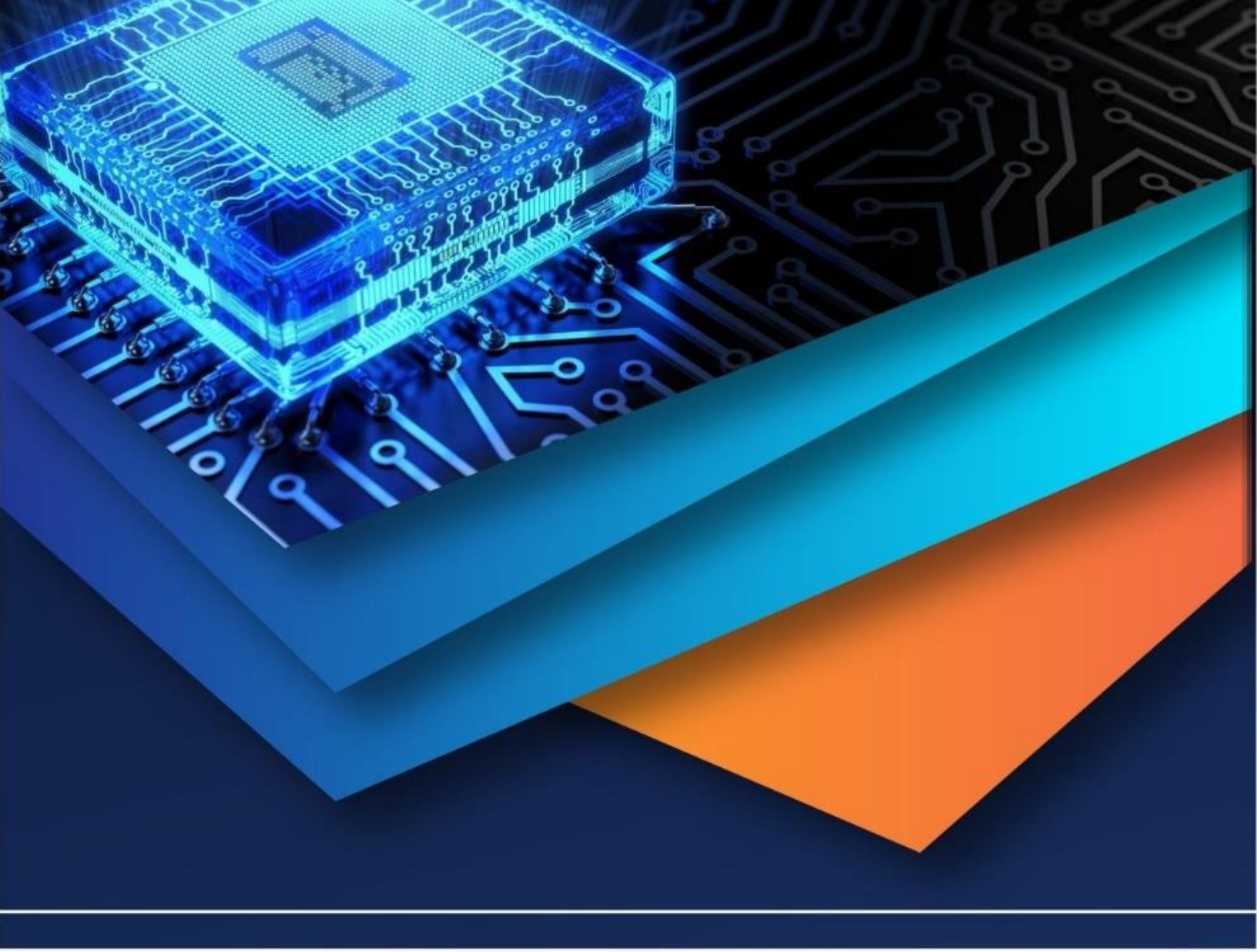

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