**INTEROPERABILITY IN HEALTHCARE INFORMATION TECHNOLOGY AND ROLE OF DATA STANDARDS**

**INTRODUCTION**

According to HIMSS, interoperability is exchanging data and communication among prevalent information technology (IT) systems and programming applications and, to use the exchanged information to facilitate the effective delivery of healthcare for everyone within an organization or with other organizations.1 This secure and standard-based exchange of healthcare will help in reducing resources required for expansion of interfaces and thereby reducing implementation costs.2

Health information exchange (HIE) facilitates secured electronic sharing and easy access of a patient’s vital medical information with physicians, nurses, chemists, health care providers and patients, thereby improving the quality, safety, pace and cost of patient care.3

HIE relies on interoperability and institutions want a precise, secure, effective, consistent and reasonable information exchange. Lately, there has been an increase in the demand for access to the Electronic Health Record (E.H.R.) by patients and by physicians. Consumers and clinicians are looking for seamless access to this information. To make this a reality, various government organizations and agencies have developed standards for data sharing. The HITECH has a meaningful use specification which outlined the criteria for the methodology in which clinical patient data should be exchanged between healthcare providers, insurers and with patients according to U.S. government standards for EHR. 4 This paper is going to describe the importance of data standards, their history and the policy and legislation that drove E.H.R. adoption and specifically, stage 2 of meaningful use which forced the transfer of data between clinical information systems in a federally-specified secure structure for greater interoperability. The paper will also describe organizations involved with developing and implementing standards, types of standards in HIE and their features, data governance and lastly how far we have come in the goal of achieving interoperability in healthcare.

**ANALYSIS**

**Background**

Health Institutions have become reliant on IT to computerize almost everything in patient care (Larsen, Haubitz, Wernz, & Ratwani, 2016). Healthcare systems are struggling with unstable health care access, affordability, inaccurate results, and a surge in demand for facilities due to longer life span among population. Health information (HI) and electronic technologies are developed to help fight these challenges, improving the consumer experience, support public health goals and develop awareness for health conditions.5

For making this a reality, standards are required to achieve faultless, secured information exchange to achieve interoperability. Data standards are the fundamental concepts in informatics, essential for information flow through the foundation of national HI. 6

The main goals for Data standardization are: 6, 7

* Promote interoperability and health information exchange.
* Encourage consistent nomenclature, common coding terminology for individuals, events, diagnoses for seamless communication.
* Support making of decision support tools using assimilated knowledge, such as alerting the physicians of the latest drug adverse event profile to improve delivery of care. 6
* Let constructive use and reuse of patient care data for quality assurance, public health and research.
* Promote technical innovation using adopted standards such as SMART mobile applications and wearable technology.2
* Encourage participation and acquiescence by vendors and stakeholders. Vendors must be encouraged to provide constructive feedback that will help improve the quality of standards.
* Keep implementation costs as low as rationally possible by efficient electronic data interchange used for reducing administrative costs, increasing accuracy.
* Prevents unnecessary work for the healthcare industry and regulators to optimize the path to customize reports, including data preparation, transmission, and data set analyses. 6

Interoperability is becoming so important that a strategic roadmap titled, "Connecting Health and Care for the Nation: A Shared Nationwide Interoperability Roadmap" was published by the Office of the National Coordinator (ONC) for Health Information Technology in 2015.This road map defined a pathway to interoperability that set the following goals for the respective time periods:8

• From 2015-2017 it was about the transmission and retrieval from these domains to enhance the output quality and speed.

• Between 2018-2020 the focus is to intensify both the collection and usage of interoperable health IT ecosystem, to help optimize the costs and quality of care.

• From 2021-2024 it is to achieve nationwide cross-functional applicability to enable continual improvement in care through real-time data access thereby improving public health and science.

The current focus of the Roadmap is to leverage available standards for greater standardization consistency in implementation, and invention of new technology. It summarizes the integration of the ecosystem to optimize per the policy and requirements set forth by ONC’s vision 9.

Standards and certification processes from ONC helps to – 9

* Create standard vocabularies and data structures to organize key information
* Helps to detect and solve problems relating to the source, quality, and validity of data to partner with patients to enhance quality and to re-harvest this data for secondary analyses
* Design a framework by addressing privacy, security, and business policy.

**What is a Standard?**

The International Standards Organization defines the standard as a process or procedure per a standardized document finalized by consultation, input and approval of an accredited organization for routine and repeated use setting forth the guidelines and specifications relating to all process steps, and/or documentation and outcomes to optimize the order in a specific setting.7

Regarding healthcare standards are a set of agreed-upon guidelines to connect systems. It may pertain to the data format, transport, security, structure, or interpretation of codes or terms. 10

**What are Data Standards in healthcare?**

Data Standards integrate terminologies, procedures, conventions and provisions for the compilation, conversion, stocking, and information retrieval from PHRs (Patient Health Records) including diagnostic imaging, insurance claims information, various interventions. Standardizing healthcare data involves the following: 6

* Data Elements which determine what data can be gathered and exchanged.
* Data Interchange Designs, which are standardized formats for digital coding, sequencing and error handling of the data elements (Hammond, 2002).
* Standardization of terminologies to describe, code and classify data to enable statistically significant standard analyses to explain interoperability between hypotheses.
* Knowledge Depiction are methods used for electronically representing medical literature, clinical guidelines, and decision support systems.

## **Policy and legislation responsible for Development and Formulation of Data Standards-**

For two decades, a lot of efforts are made to establish HIE in the United States. In 1990, a centralized data repository was created by the Hartford Foundation through the Community Health Management Information Systems (CHMIS) program to develop interoperable data sources and a strong political support which was overtook by Community Health Information Networks (CHINs) in mid- 1990’s easing the process involved in data-sharing process between providers with a focus on cost-efficiency.11

Health Insurance Portability and Accountability Act of 1996 (HIPAA) guidelines mandate safeguarding the privacy per the “Standards for Privacy of Individually Identifiable Health information”. The security Standards for the Protection of Electronic Protected Health Information sets forth the rules for all electronically stored, transferable data. 12

“To Err is Human,” a report from Institute of Medicine recognizes medical errors as a factor contributing to significant inaccuracies in the overall health data of Americans, and established new Federal programs aiming to mitigate these risks by a employing better strategies to harness information technology (IT). A $166 million fund from the Agency for Healthcare Research and Quality (AHRQ) Health IT to support improved healthcare decision making to improve safety and quality of patient centric care.12

The 111th US Congress signed into law a stimulus package enacted by the American Recovery and Reinvestment Act of 2009 (ARRA) to provide federal tax relief, more comprehensive unemployment benefit provision and additional social welfare schemes to boost domestic expenses in the education, healthcare and other infrastructure sectors.13

Additional provisions of the act include a grant of $19 billion to the Health Information Technology for Economic and Clinical Health (HITECH) Act, to encourage an extensive use of Electronic Health Records (EHRs) in the US healthcare system via the Office of the National Coordinator for Health Information Technology (ONCHIT) and HIT Policy and Standards Committees to enable the development, review and promotion of HIT architecture to maximize the impact of certified EHR systems at a hospital level. Certification Commission for Health IT (CCHIT) was the certifying authority for software to ensure compliance with these standards.14

As soon as ARRA and HITECH acts in February 2009 got passed, a new funding and incentives for the adoption of EHR and HIE was created. 11

The Medical Access and Children’s Health Insurance Program (CHIP) Reauthorization Act (MACRA) in April 2015 drove the shift of “meaningful use” of EHR data to “value-based payment” in addition to incentives promoting interoperability.15

On December 13, 2016, Cures Act was passed by Congress. This act promotes and funds the research for preventing and curing serious diseases, accelerates drug and medical device development; attempts to address the opioid abuse crisis, and tries to improve the delivery of mental health services. The Act provisioned for greater interoperability, adoption of electronic health records (EHRs) and support for human services programs. 16

This act hoped to realize 3 features specific to interoperability: 10

* Enabling a secure and low effort use of EHR information by the user from other HITs.
* Allowing full access, use and exchange of all EHR for pre-approved usage in accordance with applicable local and national laws.
* De-rooting of information blocking.

**Table1. Organizations involved with making and implementing standards**

|  |  |  |
| --- | --- | --- |
| S.No | Name of Organization/Agency | Functions/ Responsibilities |
|  | Health Level 7 (HL7) 17 | HL7 International emphasizes on messaging standards to provide a comprehensive framework and standards for the exchange, integration, sharing and retrieval of electronic health information that supports clinical practice and the management, delivery and evaluation of health services. |
|  | Agency for Healthcare Research and Quality (AHRQ) 7 | - lead by Federal agency and responsible for improving the quality, safety, efficiency, decision making and effectiveness of health care for all Americans.  - supports health services research.  -Facilitates healthcare information technology (HIT) modernization and innovation via various grants. |
|  | National Council for Prescription Drug Programs (NCPDP) 18 | NCPDP is a non-profit organization whose purpose is to standardize the exchange of health care information, improve outcomes, and decrease the costs. |
|  | Integrating Healthcare Enterprise (IHE) 19 | IHE promotes the coordinated use of DICOM and HL7 to address specific clinical needs for optimal patient care. |
|  | International Health Terminology Standards Development Organization (IHTSDO) 20 | IHTDSO is a non-profit organization that supports safe, accurate, and effective health information exchange. SNOMED International is the trading name of IHTDSO. |
|  | International Standard Organization (ISO) 21 | ISO is a non-profit international standard making organization which make standards in healthcare for individuals and communities to receive better quality of care. |

**Types of Standards as specified by ONC roadmap**

1. Vocabulary and Code/Semantics standard sets (ICD10, CPT, Snowmed CT, RXNorm, LOINC, DICOM, NDC)
2. Format and Content-based standards (HL7, CDA, FHIR)
3. Transport standards
4. Security Standards
5. Services

**Vocabulary and Code/Semantics standard sets**

For ‘normalization’ of clinical data, we need a reliable and consistent terminology to group patient data to support meaningful clinical assessments in both real-world and clinical settings in a format understandable to both humans and computers. This is why nomenclature is standardized in diagnosis, lab testing, drugs, adverse events etc7.

1. **International Classification of Diseases (ICD-10)**: ICD-10 is the revised version of the [International Statistical Classification of Diseases and Related Health Problems](https://en.wikipedia.org/wiki/International_Statistical_Classification_of_Diseases_and_Related_Health_Problems) (ICD), a [medical classification](https://en.wikipedia.org/wiki/Medical_classification) list by the [World Health Organization](https://en.wikipedia.org/wiki/World_Health_Organization) (WHO). It consists numerous codes, such as for diseases, abnormal findings, medical procedures, signs and symptoms, complaints, social circumstances, and external causes of injury or diseases. 22 Presently, ICD is majorly used in coding diagnoses for health insurance claims. Therefore, data collections with ICD codes is also known as claims data. ICD-10-CM (CM stands for clinical modifications) was implemented in United States in October 2015, after discontinuation of ICD-9. There are 69,000 ICD-10-CM codes and it consists of seven characters compared to five for ICD-9-CM. In ICD-10-CM, the first three characters in the code represent the category, and next three details the etiology, anatomical site, or other clinical aspect. There is an extra seventh character in ICD-10-CM, called as an extension which provides additional extensible information”.7

There is a massive variance between ICD-9-CM and ICD-10-CM because of the additional level of detail in the latter. Many ICD-9-CM codes represent a unique disease or condition, whereas ICD-10 enables additional configuration, making the code more descriptive. For example, an ICD-10 code for adverse drug event is: 7

“T360X5A Adverse effect of penicillin, initial encounter.”

1. **Logical Observation Identifiers Names and Codes (LOINC)**: This standard is a common language that is used to identify health measurements, observations, and documents for laboratory tests. It is a collection of laboratory measurements, clinical measures, standardized survey instruments, and codes for collecting these items. It enables the sharing of clinical results for care delivery, outcomes management, and research by providing a set of universal codes and structured names to unambiguously identify things you can measure or observe. 23

LOINC is a collection of observation of various elements, the main one being the analyte that is being measured with the help of a qualitative, quantitative, ordinal, or nominal scale.

Regenstrief LOINC Mapping Assistant (RELMA) is a Windows programming tool to search and map local codes to LOINC codes. An example of LOINC code: 7, 23

“Blood glucose GLUCOSE:MCNC:PT:BLD:QN:”

1. **Current Procedural Terminology (CPT-4):** It helps physicians and health care professionals in customizing treatment options along with an ICD-10 code. 24 CPT-4 is reported by physicians for reimbursement of their services paid for both by public and private payers. There are two forms of CPT codes called evaluation and management (E&M) codes, available for documentation of clinical encounters and their severity. American Medical Association is responsible for the maintenance and currently holds copyrights to this. 7
2. **Systemized Nomenclature of Medicine (SNOMED)**: SNOMED determines standards for a codified language that represents classes of clinical terms also known as SNOMED Clinical Terms (SNOMED CT). With SNOMED CT, users can record patient data more accurately and comprehensively – and use tools and analytics to provide better patient care and health management. 25 SNOMED was originally developed by the College of American Pathologists (CAP). SNOMED CT is currently available in 7 languages with the provision of translation. SNOMED CT is allowed for use only by US public and private entities to enable public health, educational or research use after being licensed to use. SNOMED CT classifies and describes several observations in the clinical setting by usage of standard terminology and attributes to categorize and interpolate connections to enhance the outcome quality.7
3. **RxNorm**: This is a repository of regulatory nomenclature of clinical interventions and maps them to routine pharmacy management and drug interaction software like GoldSpan, First Databank etc without the need to synchronize between software and vocabularies on the user’e end.

The National Drug File – Reference Terminology (NDF-RT), which is a resource from Veterans Health Administration is a part of RxNorm which is used to code drug properties that comprise of safety and efficacy profile, mechanism of action and therapeutic categories.26

1. **National Drug Code Directory (NDC)**: NDC, a universal product identifier for drugs and drug products, identifies and reports drugs using a unique, three-segment number. “FDA publishes the listed NDC numbers and the information submitted as part of the listing information in the NDC Directory which is updated daily. the NDC number, and the NDC Directory are used in the implementation and enforcement of the Drug Listing Act.” 27
2. **Imaging Standard, DICOM:** It was developed by the American College of Radiology and the National Electrical Manufacturers Association to facilitate digital diagnostic image transfer. The interface enables the data transfer of medical imaging including but not limited to: (a) image acquisition equipment (e.g., computed tomography, magnetic resonance imaging, computed radiography, ultrasonography, and nuclear medicine scanners); (b) image archives; (c) image processing devices and image display workstations; (d) hard-copy output devices (e.g., photographic transparency film and paper printers). DICOM is an all-encompassing description of information content, organization, encoding, and communications protocols for electronic exchange of diagnostic and therapeutic images and image-related information.(Bidgood et al., 1997). 28 A DCICOM message consists of two parts, a header which stores patient information and the actual medical image. Picture archiving and communication systems (PACSs) enable the usage of these transmitted images to various healthcare applications.

BENEFITS 29

* 1. Enable improved patient communication
  2. Increased rates of accuracy in coding of diagnoses, reimbursements, and reduced rejections of claims
  3. Increased decision making and treatment speeds

**Format and Content-based standards - Messaging standards**

Various message exchange standards with focus on different types of messages and data, developed by HL7 International –

1. **Health Level Seven (HL7) Version 2 and Version 3:** HL7 is named from the OSI 7- layer model of network communications. Some of its features are: 7, 30, 31

* It is widely used.
* Enables centralized patient care based on data located in various localized departmental systems for an extensive reach.12
* HL7 V2 is a syntactic standard and HL7 V3 wants to achieve semantic interoperability.
* These are adopted by many vendors of HIS for sharing of data.
* HL7 V2 messages are in segments, where each segment has a three-character identifier followed by values that denote the following:
* Message header (MSH)
* Event type (EVN)
* Patient identifier (PID)
* Results header (OBR)
* Result details (OBX)
* Both sender and receiver, must know the syntax of the message because of small number of semantic definitions in HL7 V2, which is one of its limitation.
* There is a consistent meaning in every system that is using HL7 V3 messaging, designed on the basis of Reference Information Model (RIM). RIM is an object-oriented model of entities with five abstract classes namely, Entity, Role, Participation, Act and Act relationship that pass messages.
* HL7 V3 is a complex and incoherent version.7

HL7 V2 messages offer a lot of operationality and flexibility but HL7 V3 addresses individual needs through implied methodology and predefined implementation guide which makes it more adaptable to all systems used. The targeted market for HL7 V2 and HL7 V3 is all US and International Healthcare Industry Organizations and Companies.31

BENEFITS OF HL7 V3 over HL7 V2- 31

* Semantic interoperability is emphasized by postulating the information in the clinical context that guarantees synchronization of information interpretation across sender and recipient systems.
* Designed to maximize global reach via unification in approach and application.
* Consistent models that interpolate data both laterally and longitudinally to adapt to novel fields of clinical interest.
* Consistent development and the capacity to store is ensured to make specific changes in data repositories.

HL7 implementations are being used by most Healthcare vendors and providers, NHS (Nation Health System, UK), Netherlands, Canada etc.

1. **Fast Healthcare Interoperability Resources (FHIR):** The intricacy of HL7 led to the implementation of FHIR by HL7 International, which is not as complicated as HL7 V3.Resources is a key component in FHIR, the basis of its content and design paradigms that define the exchange patterns in real-time RESTful interface form along with messaging and Documents.32

There are 6 types of resources: 7

* Clinical: clinical record content
* Identification: identifying auxiliary care providers
* Workflow: that manages the process
* Financial: Assist with insurance, payer and claims processes
* Conformance: Development, testing and configuration of FHIR
* Infrastructure: Capabilities and assets available to carry out internal FHIR requirements

FHIR’s cloud sharing and information exchange provided a viable platform for the healthcare industry’s need for data-driven decision making to accelerate patient-centered care to healthcare providers. The targeted market for FHIR are Public and Clinical Health Laboratories, immunization registries, quality reporting agencies, Standards Development Organizations (SDOs), regulatory agency, payors, pharmaceutical and equipment vendors etc.32, 33

BENEFITS 33

* Provides a common protocol to enable healthcare participants to exchange information
* Enables creation of applications that are vested in making high-quality information in a format easily accessible by the users
* Aids in enhancing healthcare delivery via new initiatives like Value Based care32.
* FHIR based tools aim to achieve a more integrated and seamless experience for patients with a focus on making greater insights and information available
* Data aggregators, care planning apps and patient engagement tools enable streamlined communication between providers and admin staff. Risk score calculators and clinical decision support systems offered a practical perception of conditions to providers at the point of care.

FHIR is implemented by major vendors like EPIC, CERNER and is being used by companies like Apple, Google and Microsoft.

FHIR-based APIs like Blue Button 2.0 allow patients, including Medicare recipients to retrieve personal health date directly from CMS for simple viewing or to share with their providers. This data can be used for secondary analysis by developers, researchers and even providers to improve care, and treatment quality34, 35

1. **Clinical Document Architecture (CDA)**: CDA is a document profitable standard that stipulates the clinical document semantics and organizational structure that are intended to be shared between healthcare providers and patients. This clinical is characterized by the following six attributes:36
   * 1. Persistence, B) Context, C) Potential for authentication, D) Stewardship, E) Completeness and F) Human readability.

In recent years consolidated CDA (C-CDA) is developed which allows building of documents from standardized components and hence contains standardized information. The most popular use of CDA document is for inter-organizational data transfer, as it is intended for a US Health Information Exchange (HIE). 36

There are templates which can be re-used and that occur across different documents wrapped in the CDA framework. According to HL7 implementation guide for CDA, there are 9 documented Templates. These are: 7

* Continuity of care document (CCD)
* Consultation Note
* Diagnostic Imaging Report (DIR)
* Discharge summary
* History and Physical (H & P)
* Operative Note
* Procedure Note
* Progress Note
* Unstructured Document

The targeted market for CDA is Healthcare IT Vendors, EHR and PHR systems and Healthcare providers.

BENEFITS 36

* Supports exchange of clinical documents between healthcare organizations.
* Supports clinical data re-utilization to facilitate for public health reporting, patient safety, quality monitoring, and clinical trial conduct.
* Enables reprocessing of data to enable decision support, single source proof of concept etc.
* Provides a mature and proven architecture for structured and unstructured documents that integrates with HL7 FHIR.

CDA is being implemented by countries where HIE is established completely such as Finland, Greece, and Germany. 36

1. **Direct:** Direct standard’s development began in 2010 by a public-private collaboration, with the backing of ONC. Direct is email that, instead of being maintained by an employer or email provider (eg, Google), is maintained by a Health Internet Service Provider (HISP). The HISP carries out the encryption/decryption and digital signing of each message and attachment. 37

**Transport Standards**

* 1. **Prescribing Standards, SCRIPT**: SCRIPT, developed by the NCPDP, is the standard to transmit prescription information between healthcare providers, drug stores, insurance companies and other involved stakeholder for new prescriptions, prescription refills, cancellations etc. NCPDP SCRPT V10.6 inclusion as the industry standard addition to 2017071.18

SCRIPT is being used in the ‘Meaningful Use’ criteria and helped in the extensive electronic prescribing implementation.

**Security Standards**

**ISO 27001/ ISO 27799:** ISO 27001 is a security standard that sets forth requirements for information security management, and ISO 27799 is a set of best practices and a list of threats that must be tackled in order for security management systems to be compliant. These are international standards and can be implemented in conjunction to implement sensitive health information protection. 38

**Identifier Standards**

Identifiers Standards facilitate universal standardization of names to enable recognition of names pertaining to the various stakeholders in the healthcare system (consumer, prescriber, payer, hospitals and clinics, payers etc.).39

Patient Identifiers - The benefit of having a single standardized patient identifier is an easy linkage of records to the same patient for whom many records exist and to avoid duplicity. This enables streamlined exchange of health information when patients change their providers, also reducing errors and making the process cost-efficient by avoiding duplication and merging.

Patient identifier attribute standards per ONC include:7

* Full legal name
* Suffix (if applicable. Ex.: Jr./Sr. etc.)
* Date of birth (YYYYMMDD)
* Addresses (current and previous)
* All known phone numbers
* Gender as defined in the HL7 value set (M/F/UN)

This standardization handles changes in these attributes across the whole healthcare system, for example, address, name or a phone number change as well as advocated the need of research in improved algorithms. 7, 39

Several national and international standard identifiers like the ones developed by SDO and ISOs have been adopted in healthcare.39

**Transaction Standards**

Transaction standards are critical for to conduct the healthcare business. ASC X12N, authorized by HIPAA is a set of transaction standards for healthcare to reassure eCommerce for health claims. 5010 is a new version of ASC X12, released in 2012. 5010 transaction standards are used by government healthcare transaction and private insurance companies for payment purposes. Here are a few important transactions in 5010 with their identifier numbers: 7, 40

* Eligibility for a health plan (request 270/response 271)
* Enrollment and disenrollment in a health plan (834)
* Health claims and equivalent encounter information (837)

**Standards and Data Governance**

In any organization, implementation of standards is important but more important is its management within the system. Data governance encompasses data management and influence of data collection and utilization in an organization. Data is now being considered as the top strategic asset in healthcare and it is important to develop data governance strategy. 41 Therefore, it is recommended that every organization should be doing analytics to safeguard data.

One of the essential practices for data governance committee is master data management where Data Governance Committee will handle all defining, utilization, and conflicts in data management. This role will cover most of the conventional data standards (facility codes, department codes, etc.), as well as regional and industry standards (CPT, ICD, SNOMED, LOINC, etc.). This committee also uses algorithms to utilize the data into analytic algorithms for consistent use throughout the organization.42

Data governance strategies should accomplish the complex needs of modern healthcare and help them formulate and provide reliable data to the intended users in the appropriate format to ensure right timing to optimize costs. Simultaneously, data governance ensures safeguarding private data, proactive regulatory compliance, and enhanced collaborations between cross-functional data teams.42

**Recommendations**

We have already established the need for standards in achieving faultless, secure and relevant interoperability through this paper. But big, useful and reusable data is available in plenty and needs to be leveraged for improved patient safety, quality, and health outcomes and for secure exchange among healthcare institutions and, with patients. Therefore, data governance committee needs to be formed in organizations to manage the data and improve proficiency in connecting financial, operational, clinical and patient-centered data to maintain competitiveness and to achieve top performance and positive outcomes (e.g. patient engagement, staff engagement, quality, safety, interoperability, seamless care transitions, cost reduction, and cost containment).

Currently, providers and vendors are not doing much because of competing priorities, lack of financial incentives and penalties for delivering more than the basics. To overcome this, new incentive programs that promote interoperability should be considered. 44

Also, I believe that these standards should be globalized to benefit the healthcare system around the world. This will help in achieving the highest level of interoperability.

**Conclusion**

It can be concluded that interoperability is more than just sending records. Data exchange standards are critical in maintaining interoperability. Both private sector and the state and federal governments are working actively to improve interoperability and have numerous harmonizing rules in place to fulfill the common goal.44 Health care regulations and standards are essential to incorporate compliance, to provide safe health care to all operating on the system and hence, to achieve interoperability. In turn, the health care regulatory agencies supervise practitioners and facilities, provide information about industry changes, promote safety and help ensure quality services and legal compliance.

Balanced data governance function will help healthcare organizations to maximize the value of data to deliver the best possible care and provide health, at the lowest price. Health IT and EHR enables to share data between providers and patients, and hence lead to an improved quality of health care. The errors are reduced by the clarity of the shared information and, the delays in lab testing and reporting are significantly lesser.43 This has a huge impact on treatment and diagnostic decisions made by the physicians as both patients and providers have access to the right information at the right time in the goal to achieve interoperability. Interoperability has come a long way since the inception of its concept in healthcare, but it still needs to go a long way.

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