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Research Article

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Improving Healthcare through Standardizing Information Supply Chain

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Abstract The United States healthcare system is characterized by its unparalleled complexity, stemming from its multifaceted structure that includes a vast array of providers, payers, and regulatory frameworks. This complexity is further exacerbated by the system's reliance on both public and private sectors for health insurance coverage and care provision, leading to significant disparities in access, quality, and cost of care. A prominent challenge within this intricate network is the efficient and secure transmission and exchange of health data. Despite the widespread adoption of Electronic Health Records (EHRs) and Health Information Exchanges (HIEs), issues with interoperability, data privacy, and standardization hinder seamless communication between different healthcare entities. These obstacles not only impede the coordination of care and compromise patient safety but also contribute to escalating healthcare costs by fostering inefficiencies. Moreover, the stringent regulations governing data privacy, notably the Health Insurance Portability and Accountability Act (HIPAA), while crucial for protecting patient information, can sometimes limit the fluid exchange of critical health data necessary for informed decision-making and public health monitoring. Addressing these challenges requires a concerted effort to enhance system interoperability, adopt uniform data standards, and balance the need for data privacy with the imperative for efficient health information exchange.

Keywords Healthcare, Healthcare Information Standards, HL7, Medicaid, Medicare, HIE, Healthcare Data Terminology

1. Introduction

The United States healthcare system is an intricate and diverse structure, combining elements of private and public sectors to deliver and finance healthcare services. It is distinguished by its lack of uniformity, with health insurance coverage provided through a mixture of private companies and government programs. Key public programs include Medicare, for those aged 65 and older; Medicaid, for low-income individuals and families; and the Children's Health Insurance Program (CHIP), for children in families who do not qualify for Medicaid but cannot afford private insurance.

In the private sector, employer-sponsored health insurance is the most common form of coverage, benefiting from tax incentives to lower its cost. The Affordable Care Act (ACA), enacted in 2010, significantly impacted the system by establishing health insurance exchanges, expanding Medicaid in some states, and implementing insurance mandates and protections for individuals with pre-existing conditions.

Despite these provisions, the U.S. remains the only developed country without universal health care, leading to a significant number of uninsured and underinsured citizens. High healthcare costs are a defining characteristic of the system, driven by factors such as technological advancements, prescription drug prices, administrative expenses, and the fee-for-service model that compensates providers based on quantity rather than the quality of care.

The U.S. healthcare system is also marked by its excellence in research, innovation, and the quality of care provided in its leading hospitals and medical institutions. However, it faces challenges in terms of health

outcomes, such as average life expectancy and rates of chronic conditions, which lag behind those of other developed nations.

Efforts to reform the healthcare system continue to be a central issue in American politics, with ongoing debates about how to expand access, reduce costs, and improve the overall quality of care. The system's complexity is further compounded by the need to balance competing interests among stakeholders, including insurance companies, healthcare providers, patients, and government agencies, each with their own perspectives on how the system should operate and evolve.

Data management and technology play crucial roles in the system's operation, aiming to improve efficiency and patient outcomes through electronic health records (EHRs), telehealth services, and other digital health innovations. However, challenges related to data privacy, interoperability, and the digital divide persist, affecting the seamless exchange of health information and equitable access to healthcare services.

As the U.S. healthcare system continues to evolve, it remains a subject of intense scrutiny, debate, and reform efforts aimed at addressing its complexities, reducing its costs, and making high-quality healthcare accessible to all Americans.

2. Healthcare Information Exchange Standards

Standardization in the United States healthcare system is a critical component aimed at improving the quality, safety, and efficiency of healthcare delivery. It involves creating and implementing uniform standards and practices across healthcare processes.

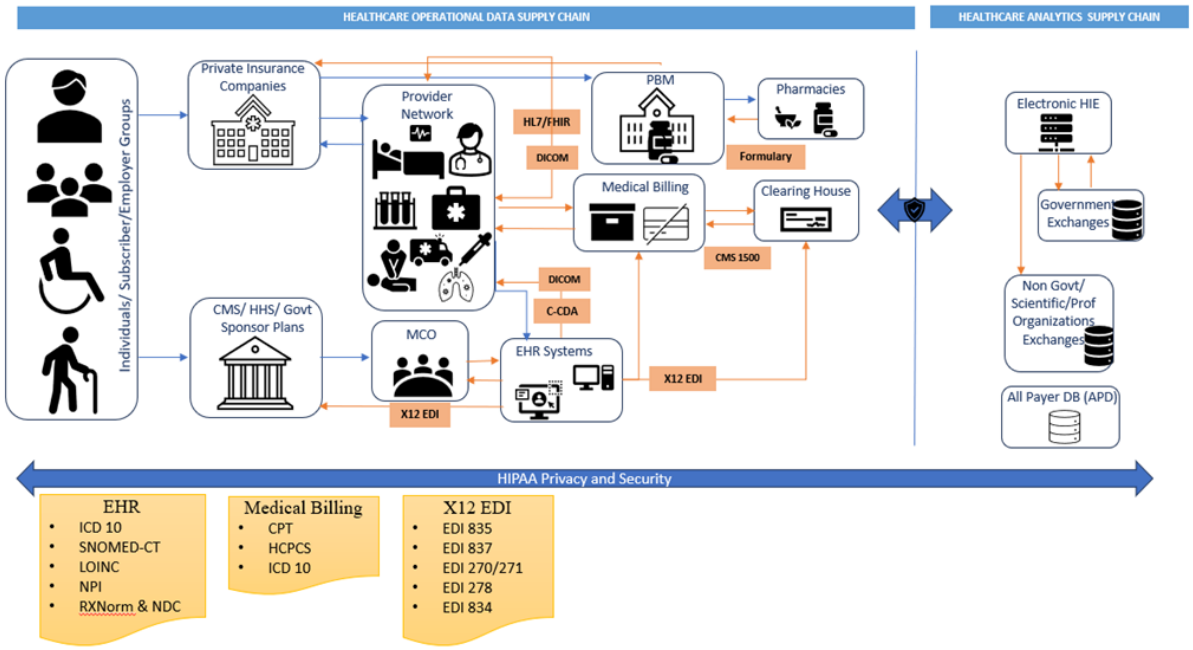

Figure 1: US Healthcare Information Exchange Standards

Healthcare Standards play a pivotal role in the seamless and secure exchange of healthcare information across different healthcare systems and settings. These standards ensure that electronic health records (EHRs), clinical data, financial data, and other health-related information can be shared and understood across various platforms and institutions, enhancing interoperability and supporting coordinated patient care. By establishing a common language and framework for data exchange, these standards facilitate improved healthcare delivery, enable better clinical decision-making, and contribute to the overall goal of achieving a more efficient and effective healthcare system.

Vocabulary/Terminology standards OR Coding Systems: Vocabulary standards determine how individual data elements are structured when they are recorded in software system and represented in a transmission. Standardized coding systems such as the International Classification of Diseases (ICD) for diagnoses, Current Procedural Terminology (CPT) for medical procedures and services, the Healthcare Common Procedure Coding

System (HCPCS) for Medicare/Medicaid billing, Logical Observation Identifiers Names and Codes (LOINC®); a universal code system for identifying health measurements, observations, and documents. LOINC codes can be grouped into laboratory and clinical tests, measurements, and observations. National Drug Code (NDC), maintained by the FDA. NDC provides a list of all drugs manufactured, prepared, propagated, compounded, or processed for commercial distribution. RxNorm is a terminology used to normalize names for clinical drugs and links its names to many of the drug vocabularies commonly used in pharmacy management and drug interaction software. SNOMED-CT, Systematized Nomenclature of Medicine – Clinical Terms; A comprehensive clinical health terminology, it enables the consistent, processable representation of clinical content in EHRs. These systems ensure accurate and consistent documentation and billing across healthcare patients, providers, and insurers.

Format Standards: Electronic Health Records (EHRs), the standardization of EHRs, including formats and data exchange protocols like Health Level 7 (HL7) and Fast Healthcare Interoperability Resources (FHIR), facilitates the secure and efficient sharing of patient information among healthcare providers, enhancing care coordination and patient outcomes. Consolidated Clinical Document Architecture (C-CDA) standard, which specifies a pre-defined summary of care document templates like continuity of care document or discharge summary. CDA - An XML-based document markup standard that specifies the structure and semantics of "clinical documents" for the purpose of exchange between healthcare providers and patients.

Transport Standards: Digital Imaging and Communications in Medicine (DICOM) is the standard for the communication and management of medical imaging information and related data. Direct Standard™: Defines a set of standards and protocols to allow participants to send authenticated, encrypted health information directly to known, trusted recipients over the internet**.**

Identifier Standards: These identifier standards are used to uniquely identify providers or patients. National Provider ID (NPI) is a unique 10-digit number for a healthcare provider. Medical Record Number (MRN) is used as a systematic documentation of a patient's history and care during a hospital stay. This is an organization-specific code.

Quality Measures: The development and implementation of quality measures, such as those from the National Quality Forum (NQF) or the Healthcare Effectiveness Data and Information Set (HEDIS), provide a standardized way to evaluate healthcare services' effectiveness, safety, and patient satisfaction.

Clinical Practice Guidelines: Evidence-based clinical practice guidelines offer standardized recommendations on the diagnosis and treatment of specific conditions, helping to ensure patients receive the most effective care based on the latest research and consensus among healthcare professionals.

Patient Safety Protocols: Standardization of patient safety protocols, including infection control practices, medication administration, and surgical procedures, aims to minimize errors and improve patient outcomes.

Health Information Exchange (HIE): Standards for health information exchange ensure that different healthcare information technology systems can communicate and exchange data effectively, supporting coordinated patient care across various settings.

Accreditation and Certification: Accreditation standards for healthcare organizations and certification criteria for healthcare professionals and facilities, established by bodies such as the Joint Commission or the American Board of Medical Specialties, ensure adherence to high-quality care and operational standards.

Drug and Device Approval: The Food and Drug Administration (FDA) sets standards for the approval and monitoring of pharmaceuticals and medical devices, ensuring they are safe and effective for public use.

Privacy and Security Standards: Regulations like the Health Insurance Portability and Accountability Act (HIPAA) provide standardized rules for the protection of patient health information, ensuring privacy and security in the handling of medical data.

Interoperability Standards: Standards that promote interoperability among different healthcare technologies and platforms ensure that systems can work together seamlessly, sharing and utilizing health information to support comprehensive, patient-centered care. The CCD (Continuity of Care Document) standard, part of the HL7 family, is designed to improve the continuity of care by making patients' clinical information available electronically. It benefits healthcare by providing a comprehensive summary of patient data, which can be shared across different healthcare settings, ensuring that healthcare providers have access to relevant patient information when making treatment decisions.

These standardization components work together to streamline healthcare processes, enhance patient care, and improve the overall performance of the healthcare system in the United States.

3.Who sets the Standards

The U.S. healthcare system is vast and involves a multitude of institutions that play various roles in delivering, regulating, financing, and improving healthcare. Here's an overview of some of the key institutions that are tasked to set the standards for the healthcare system and their roles:

Government Agencies:

Centers for Medicare & Medicaid Services (CMS): Administers the nation's major healthcare programs like Medicare, Medicaid, and the Children's Health Insurance Program (CHIP) and sets standards for healthcare providers and manages health data through initiatives like the Hospital Compare and Nursing Home Compare websites.

Food and Drug Administration (FDA): Responsible for protecting public health by ensuring the safety, efficacy, and security of human and veterinary drugs, biological products, medical devices, and the nation's food supply.

Centers for Disease Control and Prevention (CDC): Works to protect public health and safety through the control and prevention of disease, injury, and disability and conducts research and provides information on health threats.

National Institutes of Health (NIH): One of the world's foremost medical research centers, conducting research in its own laboratories; supporting the research of non-federal scientists in universities, medical schools, hospitals, and research institutions throughout the country and abroad.

Agency for Healthcare Research and Quality (AHRQ): Aims to produce evidence to make healthcare safer, higher quality, more accessible, equitable, and affordable, and to work within the U.S. Department of Health and Human Services and with other partners to ensure that the evidence is understood and used.

Health Resources and Services Administration (HRSA): Provides direct healthcare to people who are geographically isolated, economically or medically vulnerable.

Office of National Security (ONS):

ONS manages Department-wide programs and provides oversight, policy direction, standards, and performance assessments in the areas of intelligence, counterintelligence, insider threat, cyber threat intelligence, information security, national personnel security, homeland security, and the safeguarding of classified information.

Office of the National Coordinator for Health Information Technology (ONC):

ONC provides counsel for the development and implementation of a national health information technology framework.

Non-Profit Organizations and Advocacy Groups

National Quality Forum (NQF): Works to catalyze improvements in healthcare by setting national priorities and goals for performance improvement, endorsing national consensus standards for measuring and publicly reporting on performance, and promoting the attainment of national goals through education and outreach programs.

National Committee for Quality Assurance (NCQA): Provides accreditation and certification for healthcare organizations and manages the Healthcare Effectiveness Data and Information Set (HEDIS) and the Consumer Assessment of Healthcare Providers and Systems (CAHPS) survey, which measure and report on health plan performance.

The Joint Commission: An independent, not-for-profit organization that accredits and certifies nearly 21,000 healthcare organizations and programs in the United States, focusing on improving healthcare quality and safety.

American Medical Association (AMA): The largest association of physicians and medical students in the U.S., which works to promote the art and science of medicine for the betterment of public health, advance the interests of physicians, and improve public health.

ICD-10 codes were developed by the World Health Organization (WHO). ICD-10-CM codes were developed and are maintained by CDC's National Center for Health Statistics under authorization by the WHO. ICD-10-PCS and HCPCS codes were developed and are maintained by the Centers for Medicare and Medicaid Services (CMS).

Current Procedural Terminology, or CPT is published by AMA (American Medical Association). Health Level-7 (HL7) and FHIR were created by Health Level Seven International, a non-profit organization dedicated to developing standards for the exchange of electronic healthcare data. SNOMED CT was originally developed and maintained by the College of American Pathologists (CAP). Indianapolis-based Regenstrief organized the LOINC Committee to develop a common terminology for laboratory and clinical observations. FDA maintains NDC codes, whereas CMS maintains NPI numbers. C-CDA, CCD, and CCR are developed by HL7. HEDIS is developed by NCQA, whereas PQRS (Physician Quality Reporting System) is developed by CMS. In 1979, the American National Standards Institute (ANSI) chartered the Accredited Standards Committee (ASC) X12 to develop uniform standards for inter-industry electronic exchange of business transactions, namely electronic data interchange (EDI). DICOM was originally developed by the National Electrical Manufacturers Association (NEMA) and the American College of Radiology (ACR).

4. Benefits

These standards and initiatives significantly benefit healthcare interoperability by:

Enhancing Patient Care: They enable more coordinated and integrated care by ensuring that patient data is timely, accurate, and available to healthcare providers when needed.

Improving Efficiency: By automating the exchange of information, they reduce manual data entry, minimize errors, and save time.

Supporting Decision-Making: Access to comprehensive and standardized data improves clinical decision-making and patient outcomes.

Facilitating Compliance: They help healthcare organizations meet regulatory requirements for data exchange and patient privacy.

Enabling Innovation: Standards provide a foundation for developing new technologies and applications that can further enhance healthcare delivery and patient engagement.

5. What is Missing

Although the current Healthcare system is using the state-of-the-art available data and information exchange standards and international nomenclature, something is missing. Although the current healthcare system has been distributed, in the past few years Healthcare has improved to bring the pieces together through achieving high-level standards in standards implementation. However, something is still missing. The current healthcare system still fails to give conclusive information of the healthcare episodes of a patient. Also considering that healthcare information is segregated and distributed at many locations, into many systems, and with many stakeholders, the lag in collecting the whole information is considerably high. There is standardization in silos but need uniqueness and standardization in very important pieces that connect all silo information as Patient ID or Subscriber ID. Since each system is unique, a lot of validation efforts need to be spent identifying and establishing an association of silo information to connect the dots and prepare one whole health record. So ID standardization (globally) for each patient/subscriber like SSN, faster availability of information is still missing.

6. Conclusion

The standardization of health information has significantly benefited the healthcare industry by enhancing data interoperability, improving patient care quality, and reducing costs. Standardized data formats and terminologies have enabled seamless communication between different healthcare systems and providers, ensuring that patient information is accurate, complete, and accessible when needed. This interoperability facilitates better clinical decision-making and more coordinated care, leading to improved patient outcomes. Moreover, standardization has streamlined administrative processes, reducing the time and resources spent on data management and allowing healthcare providers to focus more on patient care.

Despite these benefits, there remain opportunities for improvement. The continued evolution of healthcare technology calls for ongoing updates to standards to accommodate new data types and sources, such as wearable health devices and genomic information. Ensuring the privacy and security of standardized health information in an increasingly digital and interconnected world presents ongoing challenges. There is also a critical need to enhance the security and privacy of health information, especially in an era of increasing cyber threats. Additionally, achieving true interoperability across all healthcare systems and providers requires further efforts to ensure that existing standards are universally adopted and properly implemented. Addressing these challenges will further enhance the benefits of standardization in health information, ultimately leading to an even more efficient, effective, and patient-centered healthcare system.

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