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Patti Brooks
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patti.brooks@avera.org

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Standards and Interoperability in Healthcare Information Systems: Current Status, Problems, and Research Issues

Patti Brooks
Avera Health
patti.brooks@avera.org

ABSTRACT

Data interoperability is a key ingredient for modern health information technology. Interoperability of healthcare information systems is essential for the communication of critical data, as well as for leveraging the vast amounts of data gathered to conduct research, analyze trends, improve safety, and reduce healthcare costs. One of the critical components for enabling interoperability is the availability of data standards. This paper presents, from a practitioner's perspective, a broad overview of the current status of healthcare data standards and an analysis of the problems with current standards including gaps, redundancies, and varying data exchange requirements that prevent seamless data exchange between healthcare information systems. This paper concludes by identifying problems related to healthcare information systems standardization and interoperability and potential issues for future research that can address the given problems.

Keywords

Data exchange, data standards, electronic health records, health information exchange, interoperability, standards development organizations

INTRODUCTION

Over the last few years, there has been an increasing awareness by both the private and public sectors of the ability to improve the quality and safety of healthcare with interoperable healthcare information technology (IT) systems (Markle Foundation, 2003). Some of these health information technologies include electronic health records, personal health records, health information exchanges, evidence-based medicine, and comparative effectiveness research (Hersh, 2009). As healthcare systems are increasing the adoption of health IT, a growing amount of data is being gathered. One of the ultimate goals in using health information technology is to evaluate and provide information to providers and patients on the most appropriate treatment options based on scientific comparisons of the effectiveness of treatments, including factors such as quality, risk, benefit, and cost (Congressional Budget Office, 2007). Data standards and interoperability are currently a bottleneck for seamless exchange and use of data to derive the maximum benefits of health IT.

In order to be able to share health information, interoperability across software from multiple vendors is critical (California HealthCare Foundation, 2005). When interoperability is lacking, it impedes access to data, which in turn leads to inefficiencies, increased cost, and poor quality (Stiell, Forster, Stiell, and van Walraven, C. 2003; Smith, Araya-Guerra, Bublitz, Parnes, Dickinson, Van Vorst, Westfall, and Pace, 2005; Shapiro, Kannry, and Kushniruk, and Kuperman, 2007). A core requirement for interoperability is the need for both data and messaging standards. Interoperability of healthcare information systems and the lack of consistent data standards has been a problem in healthcare for many years. Interoperability problems in healthcare include gaps in data standards, several overlapping standards, multiple data standard development organizations, and no overarching mechanism for ensuring the development and usage of data standards.

In this paper we will discuss the interoperability and standards problem by describing the underlying data collection and exchange processes in the context of the key functions of a healthcare organization. We then present an overview of current standards, the problems associated with it, and a discussion of research issues. Specifically, the contributions of this paper include (1) a description of the current drivers for healthcare IT needs and an overview of the data collected within a healthcare organization, (2) a description of the typical data exchanges between healthcare and other organizations, (3) a review of the most common healthcare data standards, and (4) an analysis of the problems with current data standards and potential issues for future research.

TYPES OF DATA COLLECTED BY A HEALTHCARE ORGANIZATION

The primary types of information contained in a patient's medical record can be categorized as either administrative or clinical (Johns, 2007). At a very broad level, clinical information includes a patient's problem list, medication record, history

and physical, progress notes, consultation reports, physicians' orders, nurses' notes and interventions, rehab and other clinical documentation, imaging and x-ray results, lab results, immunization record, operative report, pathology report, and a discharge summary. Administrative information includes demographic information about the patient, consents for treatment and surgery, authorizations, pre-authorization, scheduling, insurance eligibility, billing, and diagnosis and procedure codes (Wager, Lee, and Glaser, 2009).

While an electronic medical record (EMR) is the record of health-related information maintained for each patient within one healthcare organization, an electronic health record (EHR) has a broader definition in that it implies a longitudinal collection of information about a patient across more than one healthcare organization (Wager, et al., 2009). Implementing electronic records is increasing rapidly, although widespread implementation will still take years to complete.

A comprehensive hospital information system (HIS) contains hundreds of tables or data dictionaries. Vendors have allowed the flexibility for facilities to create their own naming conventions for data elements such as drug names, lab tests, x-ray procedures, and nursing diagnoses, to name a few. This is because in some cases there have been no data standards and in other cases there have been no enforcement of the use of standards. Where proprietary naming conventions cause a problem is when data needs to be exchanged or interfaced from one system to another. The systems do not share the same test or drug names, so without a considerable amount of time and effort mapping the names, the data cannot be exchanged. An essential building block of interoperability is the adoption and use of terminology and messaging standards that are agreed upon (Harris, Harvell, and White, 2003). As stated by Harris et al., 2003, terminology standards will provide an unambiguous, machine-readable meaning of specific terms and messaging standards permitting the electronic exchange of information in a consistent manner. Together, they will allow the interoperable use and exchange of healthcare information.

Patient medical records are used in a healthcare organization as a documentation tool for patient care, as a communication tool for those involved in patient care, and as a support for reimbursement and research (Wager, et al., 2009). Healthcare providers need access to tools that allow them clinical decision support capabilities and access to the latest relevant research findings, reminders, alerts, and other knowledge databases. Departmental systems may be separate systems that are interfaced or be part of a totally integrated healthcare information system. Figure 1 shows a schematic of typical departmental data functions within a hospital.

Financial: Billing, HR, MM	**Administrative:** Registration, Scheduling, Abstracting, Coding	**Clinical:*** Laboratory, Radiology/PACS, Physician Ordering, Clinical Documentation, and Pharmacy *These components with some data elements from the other two areas make up the EMR

Figure 1. Typical Departmental Functions at a Healthcare Organization

DATA EXCHANGES IN A HEALTHCARE ORGANIZATION

One of the central components of the US healthcare information technology strategy is to further the adoption of interoperable EHR systems. Creating a better functioning healthcare system requires a comprehensive electronic health record (EHR) available at the time and point of care. The EHR is created by aggregating and sharing data with all the sites where a patient receives care (Hammond, 2005). Figure 2 displays a list of typical external entities that receive and/or share patient information with a healthcare organization. Data is shared in many ways including faxing reports; sending paper copies; manually or electronic submitting claims; providing data downloads; or electronically sharing data, especially if the patient belongs to the same healthcare integrated delivery network or if the healthcare organization is part of a health information exchange (HIE). An HIE is the exchange of health information for patient care across traditional business boundaries in healthcare (Hersh, 2009).

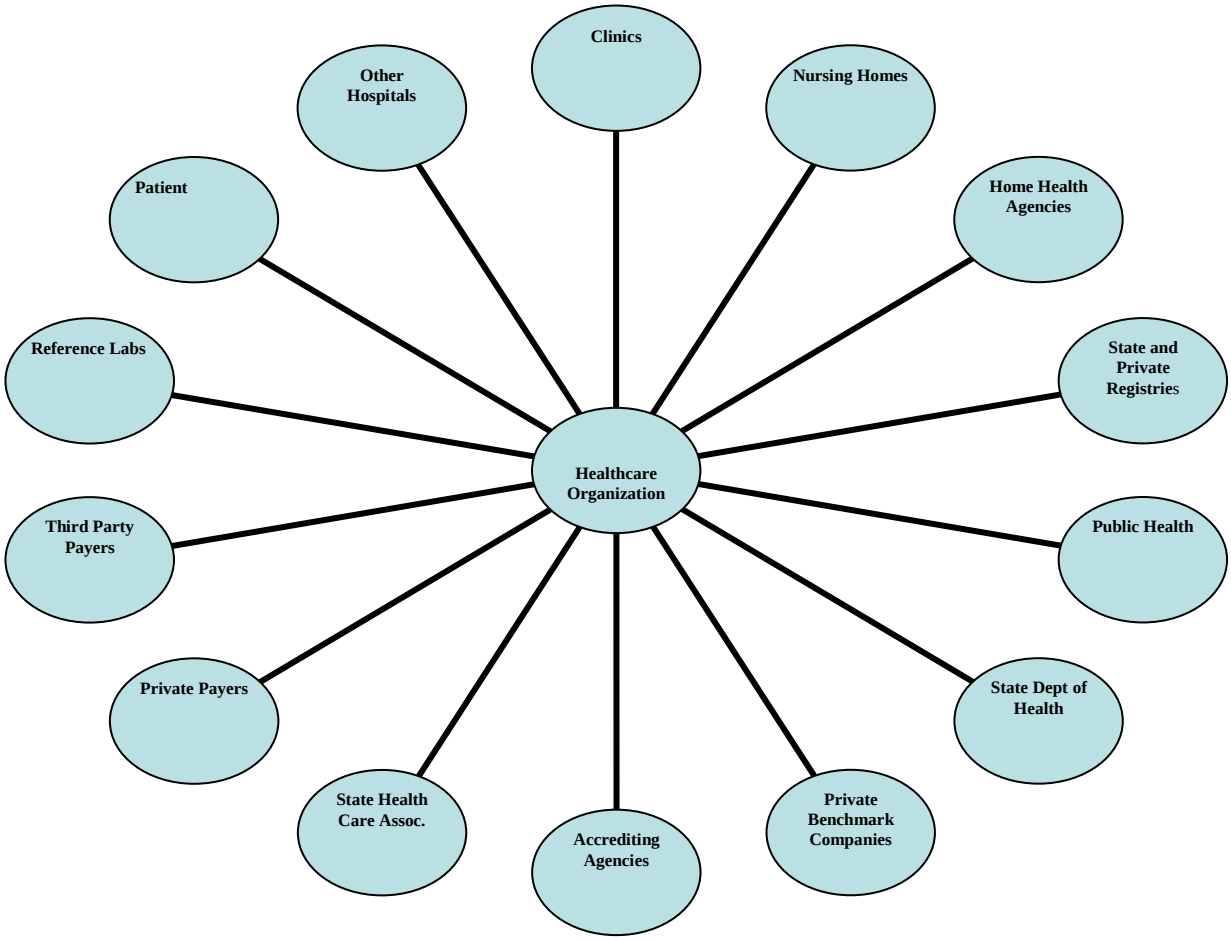

Figure 2. Healthcare Data Exchanges

OVERVIEW OF HEALTHCARE DATA STANDARDS

In order to share and use data from multiple institutions, data must be built upon common words (data elements and terminology), structures, and organization. This requirement is called interoperability. Functional interoperability means that the groups participating support common functions and procedures. Semantic interoperability means that the language of communication must be understandable by a computer at the receiving end of the communication.

Interoperability requires the use of standards. In Wager, et al., (2009), standards are categorized into three main categories: (1) Classification, vocabulary, and terminology standards; (2) Data interchange standards; and (3) Health record content standards. Standards for healthcare information systems have been predominantly established through four mechanisms (Hammond and Cimino, 2001). The four methods are: (1) Ad hoc – when a group of interested people or organizations agree on a certain specification; (2) Defacto – when a vendor or other commercial enterprise controls such a large segment of the market that its product becomes the recognized norm; (3) Government mandate – when the government mandates a standard; and (4) Consensus – when representatives from interested parties work together and reach a consensus.

There are a number of recognized standards development organizations (SDO's) working to achieve interoperable standards internationally (Hammond, Bailey, Boucher, Spohr, and Whitaker, 2010). Table 1 provides a list of the most common standards development organizations.

TYPE OF STANDARD	EXAMPLE STANDARDS	SDO CREATING THE STANDARD
General standards	XML, TCP/IP, 802.11, Web services, security, wireless, GPS	W3C, IETF, IEEE, OMG, HL7
Data components	Reference Information Model (RIM), data elements, data types, terminology, templates, clinical statements, clinical document architecture	HL7, CEN, ISO, openEHR, IHTSDO, LOINC, RxNorm, UMLS, WHO
Data interchange	Structured and free-form documents, images	HL7, ASTM, DICOM, IEEE 1073, NCPDP, X12N, CEN, ISO
Knowledge representation	Guidelines and protocols, decision support algorithms	HL7, ASTM
Electronic health record (EHR)	Functional requirements, EHR models, Continuity of Care Record (CCR), patient summary record, personal health record	HL7, ASTM, openEHR, CEN
Application level support	Identifiers, resource registries, disease registries, tool sets, conformance requirements, implementation manuals	HIPAA, HL7, ASTM, ISO, CEN

Table 1. An overview of standard development organizations (adapted from Hammond, 2005)

In addition to the Standards Development Organizations, the growing need for integrated electronic health records prompted the Department of Health and Human Services, through the Office of the National Coordinator for Health IT (ONC) to develop a process for harmonizing standards. In order to achieve this goal, the Healthcare Information Technology and Standards Panel (HITSP), a partnership between the public and private sectors with a neutral and inclusive governance model administered by the American National Standards Institute has been set up to provide the process within which affected parties can identify, select, and harmonize standards for communicating healthcare information (HITSP Technical Committees, 2007).

PROBLEMS WITH STANDARDS AND DATA EXCHANGE

In this section, some of the problems that organizations face due to inconsistencies with data standards are identified and point to potential issues for future research that can address the given problems.

(1) Need for multi-purpose standards and terminologies: Some of the problems with data standards and exchange arise due to the fact that standards and terminologies are not designed to serve multiple purposes thus resulting in significant overhead and inefficiencies. For example, administrative code sets such as ICD-9-CM and CPT work well for research and payment systems, but fall short of granular terminology needed in an EHR (Giannangelo and Fenton, 2008). Standard clinical terminology and classifications will need to map in order to achieve interoperability and the benefits of a national health information infrastructure (Bowman, 2005). SNOMED CT and ICD-9-CM (and soon to be ICD-10-CM) actually complement each other because they serve different purposes. There is a map available which correlates between SNOMED CT concepts and the closest ICD-9-CM target code/s. However, the mapping is not intended to be accurate enough to be used for billing or reimbursement without an additional review. The SNOMED CT scope of content is much broader than ICD-9-CM; therefore, less than 30 percent of SNOMED CDT can be mapped to ICD-9-CM (Bowman, 2005; Imel and Campbell, 2003; and Imel, 2002).

(2) Lack of content in terminology standards: A standard representation of the full meaning of patient medical data requires integrating terminology models with models of context and other structural relationships. As an example, the coded representation of "myocardial infarction" has different clinical significance when it appears in the context of "current diagnosis," "past medical history," or "family history." Without contextual information, the full meaning may remain ambiguous, leading to incorrect reporting or decision-support behavior (National Committee on Vital and Health Statistics, 2002).

(3) Gaps in data standards: Despite the fact that there are many standards, there are still a few gaps that have been identified. For example, there is a lack of named standards for the structuring of questions and case report forms, especially for physical exam, medical history, family history, and eligibility criteria. SNOMED CT is being used, but how the terminology is used as far as metadata and question modeling is lacking, and it is an important component for standards. Other areas of significant gaps in standards include deficiencies in LOINC standards in some areas of lab results and question attributes (Richesson and Krischer, 2007), medication management with regard to interoperability information on when a medication was stopped, modified, or put on hold, and gaps in nursing documentation, such as nurses' notes (HITSP, 2010).

(4) Overlapping standards: There are overlaps in standards where multiple standards have been named by one or more authoritative body. An example is the list of nursing terminology standards (See Appendix A). Focused research in each area is necessary to really identify overlaps. There also some overlapping named standards in the area of physical exam observations and findings and among many research and clinical variables, including lab, physiological, and patient assessment variables (Richesson and Krischer, 2007). HL7 and ASC X12 have some duplication in standards used for reporting of clinical data associated with the claims process.

(5) Different requirements from different agencies when exchanging data: There are different types of examples that can be shared as far as difficulties with data standardization. One area can be with the use of electronic prescribing. There are standard codes for the retail pharmacy component, which typically need to be mapped to a standard drug formulary name, and if the hospital drug formulary does not use a standard drug naming component in its formulary, another mapping needs to occur between the standard drug formulary name and the hospital drug formulary name (Simonatis, Belsito, and Overhage, 2008). In addition, data mapping is consistently necessary when submitting data externally. There are several minimum data sets used for billing, registries, external benchmarking companies, and accrediting agencies, to name a few. Most of these sources come with different requirements for data downloads to meet their specifications, thus requiring additional data mapping.

(6) Changes in standards: Evolution of standards represents a major problem for the healthcare industry as it requires major retooling and significant new investments. For example, there are two important changes to existing standards that add complexity to the existing challenges related to interoperability. The first is the transition from the ICD-9-CM coding classification system to ICD-10-CM. The ICD classification system is the primary system used for diagnosis and procedure coding and billing and is one of the major classification systems for coding for quality initiatives, public health reporting, and research initiatives (Abdelhak, Grostick, Hanken, and Jacobs, 2007). The format of the ICD-10-CM system is quite different from ICD-9-CM and will require massive changes for computer systems across the country. The second standard that causes challenges is the HL7 versions 2 and 3, which are the messaging standards. While HL7 version 2 is a legacy standard for electronic messages between different healthcare applications, HL7 version 3 messages are based on XML encoding syntax and has a broader scope of healthcare workflows.

Even though there has been considerably more attention given to the matter of data standards and interoperability over the last few years, there are still issues and challenges. There needs to be better understanding of the actual constructs, activities, and inter-relationship flows of clinical research data (Richesson and Krischer, 2007.) Further research could explore the need for consensus on where standards are needed, which standards will be used for different components of data interoperability, and how the standards will be enforced. Research and evaluation of existing vendor capabilities would be very helpful. There is a significant challenge with vendor products, because vendor source systems often use proprietary concept identifiers and translation services are not readily available (Kuperman, Blair, Franck, Devaraj, and Low, 2010). Efficient mapping tools and products to assist with data integration across different data sources need to be further researched and developed. In addition, reference models, semantic web, standards, ontology, and other techniques can enable fast and efficient merging of heterogeneous data and should be explored further to assist with data standardization and interoperability (Brazhnik and Jones, 2007; Lopez and Blobel, 2009).

CONCLUSION

The need for standardized terminologies and data standards in healthcare has long been recognized. The growing urgency to share electronic health records and the establishment of health information exchanges will continue to escalate the need. If the data standards can be determined and enforced, interoperability will become a reality much quicker. Many are recognizing that healthcare information technology can make a positive impact on healthcare reform, and data standards and interoperability are two of the keys to making that happen.

REFERENCES

1. Abdelhak, M., Grostick, S., Hanken, M., and Jacobs, E. (2007). Health information: Management of a strategic resource, AHIMA, Chicago.
2. Bowman, S. (2005) Coordination of SNOMED-CT and ICD-10: Getting the most out of electronic health record systems, *Perspectives in Health Information Management*, Spring.
3. Braznik, O. and Jones, J. (2007) Anatomy of data integration, *J Biomed Inform*, 40, 3, 252-269.
4. California HealthCare Foundation (2005) *Clinical data standards in health care: Five case studies*, Retrieved March 4, 2010 from http://www.chcf.org/documents/healthit/ClinicalDataStandardsInHealthCare.pdf
5. Congressional Budget Office (2007) Research on the comparative effectiveness of medical treatments: Issues and options for an expanded federal role, December, 2007.
6. Giannangelo, K., and Fenton, S. (2008) SNOMED CT survey: An assessment of implementation in EMR/EHR applications, *Perspectives in Health Information Management*, 5, 7.
7. Hammond, W. (2005) The making and adoption of health data standards, *Health Affairs*, 24, 5, 1205-1213.
8. Hammond, W. and Cimino, J. (2001) *Standards in medical informatics*, in E. Shortliff and L. Perrault (Eds), *Medical informatics computer applications in health care and biomedicine* (pp. 212-256), Springer-Verlag, New York.
9. Hammond, W., Bailey, C., Boucher, P., Spohr, M., and Whitaker, P. (2010) Connecting information to improve health, *Health Affairs*, 29, 2, 284-288.
10. Harris, M., Harvell, J., and White, A. (2003) U.S. Department of Health and Human Services, Toward a national health information infrastructure: A key strategy for improving quality in long-term care, Retrieved from http://aspe.hhs.gov/daltcp/reports/toward.htm
11. Hersh, W. (2009) A stimulus to define informatics and health information technology, *BMC Medical Informatics and Decision Making*, 9, 24.
12. HITSP/IS01 (2010) *HITSP electronic health records laboratory results reporting interoperability specification*, Reference No. 20080827 V3.1.
13. Imel, M. (2002) A closer look: The SNOMED clinical terms to ICD-9-CM mapping, *Journal of AHIMA*, 73, 6, 66-69.
14. Imel, M. and Campbell, J (2003) Mapping from a clinical terminology to a classification. AHIMA 75th Anniversary National Convention and Exhibit Proceedings, October, 2003.
15. Johns, M. (2007) Health information management technology, second edition, AHIMA, Chicago.
16. Kuperman, G., Blair, J., Franck, R., Devaraj, S., and Low, A. (2010) Developing data content specifications for the nationwide health information network trial implementations, *Journal of the American Medical Informatics Association*, 17, 6-12.
17. Lopez, D. and Blobel, B. (2009) Enhanced semantic interoperability by profiling health informatics standards, *Methods Inf Med*, 48, 2, 170-177.
18. Markle Foundation. (2003) *Connecting for health: A public-private collaborative. The Data Standards Working Group*, Retrieved March 4, 2010 from http://www.connectingforhealth.org/resources/dswg_report_6.5.03.pdf
19. National Committee on Vital and Health Statistics (2000) *Report to the Secretary of the US Department of Health and Human Services on uniform data standards for patient medical record information*,. Retrieved March 1, 2010 from http://www.ncvhs.hhs.gov/hipaa000706.pdf
20. National Committee on Vital and Health Statistics (2002) *Patient medical record information technology analysis reports*, available at http://www.ncvhs.hhs.gov
21. Ozbold, J. (2003) Nursing terminologies, Vanderbilt University, May.
22. Richesson, R. and Krischer, J. (2007) Data standards in clinical research: Gaps, overlaps, challenges and future directions, *Journal of the American Medical Association*, 14, 6, 687-696.
23. Shafer, D. (2006) How do CCR and CDA compare? Retrieved from http://www.hl7standards.com

24. Shapiro, J., Kannry, J., Kushniruk, A., and Kuperman, G. (2007) Emergency physicians' perceptions of health information exchange, *Journal of the American Medical Informatics Association*,, 14, 700-705.
25. Simonatis, L, Belsito, A, and Overhage, J. (2008) Enhancing an e-presribing system by adding medication histories and formularies: the Regenstrief medication hub. American Medical Informatics Association Symposium Proceedings.
26. Smith, P., Araraya-Guerra, R., Bublitz, C., Parnes, B., Dickinson, M., Van Vorst, R., Westfall, J., and Pace, W. (2005) Missing clinical information during primary care visits, *Journal of the American Medical Association***,** 293, 565-571.
27. Stiell, A., Forster, A., Stiell, I., and vanWalraven, C. (2003) Prevalence of information gaps in the emergency department and the effect on patient outcomes, *CMAJ*, 169, 1023-1028.
28. Wager, K., Lee, F., and Glaser, J. (2009) Health care information systems: A practical approach for health care management, Jossey-Bass, San Francisco.