

# Encyclopedia of Healthcare Information Systems

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# IT–Standards and Standardization Approaches in Healthcare

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## INTRODUCTION

E-health basically comprises health services and information delivered or enhanced through the Internet and related technologies (Eysenbach, 2001). The future healthcare system and its services, enabling e-health, are based on the communication between all information systems of all participants of an integrated treatment. Connecting the elements of each healthcare system (general practitioners, hospitals, health insurance companies, pharmacies, and so on)—even across national borders—is an important issue for information systems research in healthcare. Current developments, such as upcoming or already-deployed electronic healthcare chip cards (that are to be used across Europe), show the need for Europe-wide standards and norms (Schweiger, Sunyaev, Leimeister, & Krcmar, 2007). In this article, we first outline the advantages of the standards, and then describe their main characteristics. After the introduction of communication standards, we present their comparison with the aim to support the different functions in the healthcare information systems. Subsequently, we describe the documentation standards, and discuss the goals of existing standardization approaches. Implications conclude the article.

## BACKGROUND

The advantages of generally accepted standards for the processes in healthcare and the medical market can be summarized as follows (CEN/TC 251 European

Standardization of Health Informatics, <http://www.centc251.org/>; Wirsz, 2000):

- Standards increase competition and reduce costs;
- Standardized products could easily be replaced or updated;
- Standardized products of various suppliers could easily exchange medical information;
- Healthcare institutions are able to iteratively extend their offers/capabilities;
- Standardized products could reduce errors and make healthcare services safer.

Several national and international committees, German as well as European or American (CEN/TC 251 European Standardization of Health Informatics; DIN, <http://www.din.de>; Integrating the Healthcare Enterprise (IHE), <http://www.ihe.net>; Integrating the Healthcare Enterprise-Europe (IHE-E), <http://www.ihe-europe.org>; World Health Organization (WHO), <http://www.who.int>), have been founded to ensure unified standardization of national and international healthcare systems. Accordingly, there are numerous standardization attempts, which partly correspond to, but also disagree with, each other (Märkle & Lemke, 2002). Two main objectives of these committees can be distinguished: the development of standards for communication, and standards for documentation in healthcare. The former focuses on enabling an efficient and effective combination of medical information systems, in order to enable the exchange of data between

different medical information systems (refer to IHE). The latter are supposed to ensure the right interpretation of the content of electronically exchanged information (Haas, 2005).

### IT-STANDARDS IN HEALTHCARE

The transmission of data between heterogeneous and isolated medical information systems requires interoperability of systems and data (Hasselbring, 1997). The interoperability on its side is composed of norms, interfaces, and standards—the basis for data exchange and communication between participating applications (refer to World Health Organization (WHO), <http://www.who.int>). For an overview of common interoperability standards in the healthcare sector, and the graphical classification of its relations, see Figure 1.

### Communication Standards

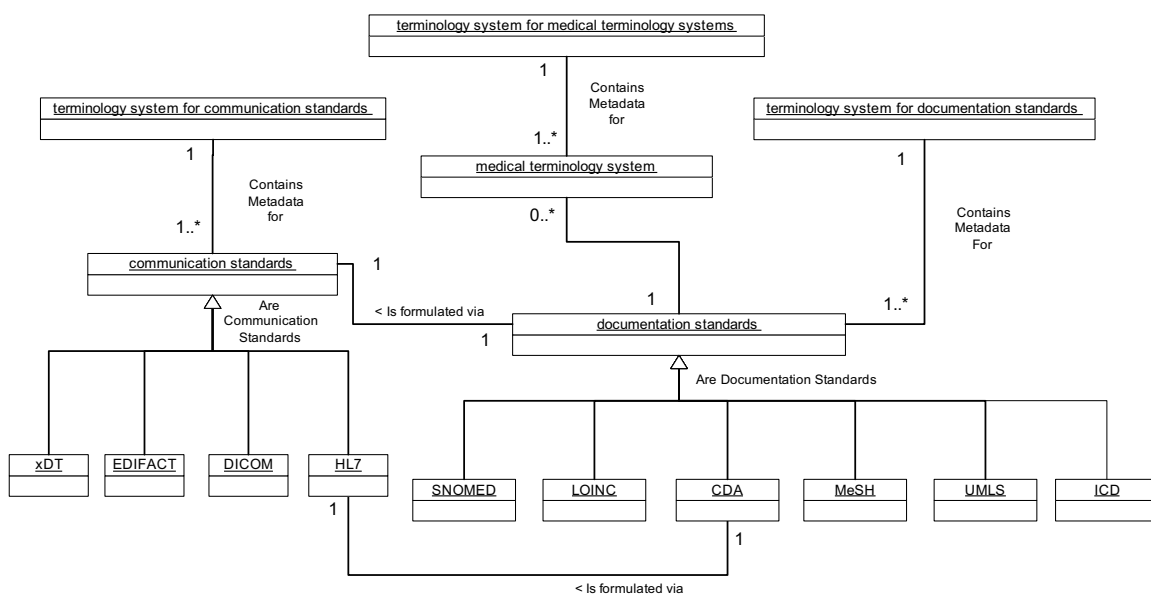
Communication standards, also called syntactical standards, ensure a correct transmission of medical and administrative data between different information systems. In the clinical area, one can distinguish them worldwide, mainly between the established standards of Health Level 7/Clinical Document Architecture, (HL7/CDA), Digital Imaging and Communications in

Medicine (DICOM), and Electronic Data Interchange for Administration, Commerce and Transport (EDIFACT) (Pedersen & Hasselbring, 2004). The reason for their acceptance is mainly the openness of these standards.

Health Level 7 is an international, vendor-independent, and main communication standard in healthcare for the exchange of information between systems and institutions. The Version 2 family of this standard is based on events that trigger the exchange of data. Beginning from Version 3 XML<sup>1</sup>, data structure is supported, alleviating the integration of data into information systems, since adequate libraries for XML handling are available. HL7 operates at the application layer of the ISO/OSI reference model (ISO7498-1, International Organization of Standardization (ISO), 2006). The Clinical Document Architecture (Health Level Seven Inc., <http://www.hl7.org/>) amplifies the HL7-standard with the description of the structure and the contents of clinical documents (e.g., discharge summaries and progress notes), based on an XML-format. HL7/CDA also offers a model for the exchange or the common use of information, and the option to individually reuse this information (Dolin, Alschuler, Boyer, Beebe, Behlen, & Biron, 2006).

Digital Imaging and Communications in Medicine (National Electrical Manufacturers Association (NEMA), <http://medical.nema.org>) is an open standard

Figure 1. Medical communication and documentation standards



for the exchange of images in healthcare. Besides the image, it can also contain additional meta-information, such as the patient's name, date of admission, device parameters, or attending physician. The standard lists the data fields (e.g., images, diagnosis, patients, studies, series, and so on), functions of network services, as well as syntax and semantics for the commands and messages. DICOM can store the images with or without loss of information, in accordance to TIFF and JPEG formats, and enables electronic archiving of images in all medical information systems.

Electronic Data Interchange For Administration, Commerce and Transport (EDIFACT, 2006) standardizes the formats for the electronic exchange of administrative data amongst others in healthcare information systems. Orders, calculations, and payment orders in the health service are often based on it. EDIFACT is, unlike the other introduced communication standards, not specifically designed for the healthcare field—it is used globally by business partners of different kinds of business areas to exchange accounting-relevant data.

In the sector of general practitioners in Germany, there are additionally specific standards, so called xDT-standards (KBV, 2006). xDT is a set of several German standards, which are supposed to simplify the communication and the data exchange between healthcare providers (i.e., physician's offices, hospitals, and so on) and health insurance companies. As a result, xDT aims at the reduction of waste of paper by applying information technology using the following data formats:

- **ADT:** AbrechnungsDatenTransfer (invoice data for medical services)
- **AODT:** AmbulantesOperierenDatenTransfer (securing the quality of out-patient surgery)
- **BDT:** BehandlungsDatenTransfer (for the communication between general practitioners)
- **KVDT:** KassenaerztlicheVereinigungDatenTransfer (standard for communication between physician's offices and health insurances)
- **LDT:** LaborDatenTransfer (communication with laboratories)
- **GDT:** GeraeteDatenTransfer (communication with medical devices)
- **ODT:** OnkologischerDatenTransfer (oncological data carrier for the documentation of tumor information)

Even though all of these xDT-standards serve different purposes, they are structured according to the same basic rules and principles.

There are currently efforts to harmonize the introduced communication standards on an XML-basis: HL7/CDA incorporates already the XML-format for structuring clinical documents; additionally, there are also XML-based specifications for the DICOM standard (refer to NEMA), for the xDT-standards (Bundesministerium für Gesundheit und Soziale Sicherung, 2004), and for EDIFACT (EDIFACT, 2006). The advantages of introducing XML-based data structures can be described as follows:

- Automatic processing can be simplified when using established XML programming libraries.
- XML is an open and platform-independent standard.
- XML can be read and understood by users.

The introduced communication standards support different functions in healthcare information systems (Table 1: “x” connotes that the standard supports the function, “-” connotes the opposite case). Such a use of miscellaneous standards in several healthcare service sectors is the most current problem in electronic communication in medicine (Lenz, Beyer, Meiler, Jablonski, & Kuhn, 2005).

## **Documentation Standards and Standardization Approaches**

For the right interpretation of the content of the electronically exchanged messages between different medical information systems, there are terminology and documentation standards, called semantic standards (see also Figure 1). The semantic standards are responsible for the conversion of encoded medical data, in order to, for example, correctly identify the diagnosis. Logical Observation Identifiers Names and Codes (LOINC®, <http://www.regenstrief.org/loinc>) offers a multidimensional terminology system for clinical laboratories. It allows detailed descriptions of medical circumstances for almost each clinical problem to be solved automatically.

Classifications are medical systems of concepts that are used for medical documentation. In comparison to terminology systems, classifications are less complicated, and thus mostly one-dimensional. “International

Table 1. Communication standards and their functions

<b>Medical communication standards</b>				
<b>Functions in health care</b>	DICOM	xDT	EDIFACT	HL7/CDA
HIS	x	x	x	x
RIS	x	-	-	x
PACS	x	-	-	x
MPI (Master Patient Index)	-	x	-	x
graphical diagnosis	x	-	-	x
archiving	x	x	-	x
diagnosis comments	-	x	-	x
image documentation	x	-	-	x
report comments	-	-	-	x
video documentation	-	-	-	x
patient registration	-	x	-	x
ERP (Electronic Health Records)	x	x	x	x
invoicing	-	x	x	x
prescriptions	-	-	-	x
data transformation	-	x	-	x
emergency data	-	-	-	x
physician's practices	-	x	x	x

HIS - Hospital Information System,  
PACS - Picture Archiving and Communication System,  
RIS - Radiology Information System.

Classification of Diseases” (ICD) (DIMDI, <http://www.dimdi.de>; refer also to WHO) is an example for such a classification of illnesses and related health issues.

Systemized Nomenclature of Medicine (SNOMED, <http://www.snomed.org/index.html>) is a nomenclature. Nomenclatures are combinations of terms that are based on determined concept orders. SNOMED CT covers the arrangement of a unified terminology for expressions in the medical field, and supports the languages English, German and Spanish.

The thesaurus Medical Subject Headings (MeSH) (United States National Library of Medicine, 2006) is an extension of a nomenclature. MeSH mainly enables indexing international publications—such as journals,

articles, and books—for the United States National Library of Medicine (NLM). Enriching a thesaurus with semantic and linguistic information yields a metathesaurus. The “Unified Medical Language System” (UMLS, <http://www.nlm.nih.gov/research/umls>) is a metathesaurus that tries to integrate all important medical terms in only one term, and to represent all possible term relations accordingly.

Because of the existence of different documentation standards, a lot of incompatibilities occur, such as if different users use different terminology systems for the documentation (McDonald, 1997). The complete interoperability, the consent identification concerning the meaning of the medical data and meaningful

## IT-Standards and Standardization Approaches in Healthcare

Table 2. Overview of current standardization approaches in healthcare

Standardization approaches in healthcare	Characterisation and Goal	Approach and assignment of internationally accepted standards
Integrating the healthcare enterprise (IHE) (Hornung, Goetz, & Goldschmidt, 2005)	IHE is an international initiative, driven by healthcare professionals and industry, to improve the communication of medical information systems and the exchange of data.	IHE's approach for the information integration is based on the propagation and integration/usage of HL7 and DICOM standards. IHE promotes and advances these standards as a suggestion for standardizing bodies.
Professionals and citizens network for integrated care (PICNIC) (Danish Center for Health Telematics, 2003)	PICNIC is a European project of regional healthcare providers in a public-private partnership with industry to develop new healthcare networks, and to defragment the European market for healthcare telematics.	The development is an open source model, an open and interoperable architecture with exchangeable components (aim is an easy and simple integration of external products). All components must be based on established standards, such as HL7/CDA.
Distributed healthcare Environment (DHE, <a href="http://www.gesi.it/dhe">http://www.gesi.it/dhe</a> )	DHE has been created as a part of previous development projects (e.g., HANSA-Project ( <a href="http://www.ehto.org/ht_projects/initial_project_description/hansa.html">http://www.ehto.org/ht_projects/initial_project_description/hansa.html</a> ) for the integration of clinical information systems) to build a platform to both integrate legacy healthcare systems, and support the development of new ones.	DHE is an open middleware, which is based on the "Healthcare Information System Architecture" (HISE, CEN/TC 251 European Standardization of Health Informatics) (Scherrer & Spahni, 1999). DHE tries to specify generic healthcare services, which are based on predefined database-schemata, and offers them on a common platform (e.g., with HL7-interfaces).
Open electronic health record (The openEHR foundation, <a href="http://www.openehr.org">http://www.openehr.org</a> )	The openEHR foundation is dedicated to develop an open specification and implementation for the electronic health record (EHR). openEHR advances the experiences of Good European Health Record-Projects (Blobel, 2006; GEHR, <a href="http://www.chime.ucl.ac.uk/work-areas/ehrs/GEHR/">http://www.chime.ucl.ac.uk/work-areas/ehrs/GEHR/</a> ) in England and Australia.	The project works closely with standards (e.g., HL7). However, it does not adopt them verbatim, but tests, implements, and improves their integration and application, while giving feedback to the standardizing bodies.
Standardization of communication between information systems in physician's offices and hospitals using XML (Gerdson, Müller, Bader, Poljak, Jablonski, & Prokosch, (2005); SCIPHOX, 2006)	SCIPHOX is a German initiative with the aim to define a new common communication standard for ambulant and inpatient healthcare facilities.	The basis for the information exchange is the XML-based HL7/CDA standard. SCIPHOX adapts and improves this global standard for local (German) needs.
<a href="http://www.akteonline.de">www.akteonline.de</a> (Schwarze, Tessmann, Sassenberg, Müller, Prokosch, & Ückert, 2005; Ückert, Görz, Ataian, & Prokosch, 2002)	<a href="http://www.akteonline.de">akteonline.de</a> is German state-funded project to develop a Web-based electronic healthcare record.	<a href="http://www.akteonline.de">akteonline.de</a> developed dynamic Web pages, which can be accessed via Internet, and look similar to physicians and hospital software. The project is based on the common communication standards (DICOM and HL7/CDA).
All introduced initiatives, with the exception of SCIPHOX, defined and developed an "Electronic Healthcare Record" (EHCR) (Tang, Ash, Bates, Overhage, & Sands, 2006)		

cooperation of functions, are the primary ones of the main challenges for the near future of development of healthcare information systems (Frist, 2005). There are many different approaches to standardize the electronic communication and documentation in healthcare to achieve the interoperability. Some of the promising standardization initiatives are summarized in Table 2.

The analysis described in Table 2 shows that the existing standardisation approaches for interoperability in healthcare can be divided in two opposing groups (Märkle & Lemke, 2002). On the one hand, there is basically industry that propagates and adopts proprietary standards like HL7 and DICOM. On the other hand, there are generally university- and state-funded initiatives which use and support open standards as initiated by European Committee of Standardization (CEN/TC 251 European Standardization of Health Informatics). This difference is also based regionally—the former are mainly located in the U.S., whereas the latter initiatives come from Europe. For the future healthcare system, it remains to be aspired that both camps learn from each other and may grow together, and with it, the vision of complete interoperability in the healthcare sector can become true. Nevertheless, they all provided important issues and contributed indispensable knowledge in attaining the present status.

## IMPLICATIONS

Standards in healthcare are supposed to enable an efficient and effective communication of distributed and isolated medical information systems. Unfortunately, the current situation is not satisfying in terms of interoperability. Until there is no generally accepted standardization for syntactic as well as semantic standards in the healthcare sector, all advantages of standardized solutions listed in the introduction cannot be exploited (Haux, 2006). To improve health services and reduce costs, the problem of interoperability (standardized software solutions) has to be solved. Such interoperable information systems can influence the quality of healthcare services and the adjunctive costs very positively (Berger & Partner GmbH, 1997; Warda & Noelle, 2002).

The issue of interoperability as major driver for efficiency in healthcare requires efforts as to harmonization of standards, especially on the semantic

level. The existing and introduced communication standards are able to deal with and connect different medical information systems. But a great percentage of the potential benefits still remain useless without prior harmonisation of standards on a semantic level. Future efforts from research and practice should focus on this topic.

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## KEY TERMS

**Classification:** Given representation of abstract concepts, which are assigned to a set of categories.

**Communication (Syntactic) Standards:** Communication standards ensure a correct transmission of electronic data between different information systems, in terms of a particular syntactical format.

**Documentation (Semantic) Standards:** Documentation standards ensure the right interpretation of encoded medical data.

**Interoperability:** Denotes the ability of different, independent, and heterogeneous information systems to exchange electronic data for their further processing.

**Metathesaurus:** A thesaurus enriched with additional semantic and linguistic information.

**Nomenclature:** An accumulation of principles for the consistent naming of objects.

**Thesaurus:** A given vocabulary with related terms.

## ENDNOTE

<sup>1</sup> The standard extensible mark-up language XML, as defined by the World Wide Web Consortium (W3C), is used for the creation of machine- and human-readable documents in the shape of a tree structure, and is hereby defining the structure of these files. An actual document requires the definition of several details, particularly the definition of elements of structure and their arrangement within the document tree.

XML is a subset of the Standard Generalized Mark-up Language (SGML). It is also a metalanguage, which is capable of defining numerous amounts of different mark-up languages, which are still closely related in their basic structure. In order to describe the structure of XML documents, a so-called “scheme language” is used. The two most important scheme languages are the Document Type Definition (DTD) and the XML schema.