INTEGRATION OF HEALTHCARE INFORMATION SYSTEMS: STEPS TOWARDS COMMON CLINICAL DOCUMENTS

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ABSTRACT

The process of transmitting patient medical information between the departments of a health care organization and between healthcare practitioners involves dealing with interoperability issues within a hospital information system infrastructure (HIS) as well as harmonising documents to be exchanged. The 2nd Regional Healthcare Authority of Central Macedonia (RHA) is in the process of implementing a major information technology infrastructure under the 3rd Community Support Framework (CSF) funding. In that context, a pilot system was developed to achieve data integration and record synchronisation using Health Level 7 (HL7) as the basic protocol for data exchange. One of the next steps is to determine clinical documents data to be used in order to achieve a "basic medical communication level" within the RHA. This paper presents the methodology used to sort and achieve a common understanding in handling clinical documents between different healthcare practitioners and institutions by using the Clinical Document Architecture (CDA) proposed by HL7 organization.
Key words: Regional Information Systems, Clinical Documents, Clinical Document Architecture

INTRODUCTION

In 2001 a reform of the Greek National Healthcare System was introduced in order to enhance the performance and control of healthcare provision in Greece. One of the main changes was the division of the country in 17 autonomous Healthcare Regions where the Regional Healthcare Authorities (RHA) are responsible for the regional healthcare strategy [1, 2]. In order to support this reform and with the substantial financial aid of the EU funded third community support framework, a series of information and communication technology oriented interventions will be introduced. After a period of analysis and design the Greek Government started issuing a number of Requests for Proposal (RFP) for the information system of each RHA [3].

The proposed information system consists of a series of subsystems covering the information and data workflow management in a regional healthcare system. The system is innovative in the sense that it required the design and implementation of a complete and integrated information system at a regional level that comprises all types of healthcare levels (primary care, secondary care, home care, etc), that included interoperability issues (proposing the use of the HL7 protocol) [4] that covered most of the needed components (Enterprise Resource Planning - ERP, Hospital Information Systems - HIS, Laboratory Information Systems - LIS, etc) and that could be able to work efficiently in a secure wide area network (Virtual Private Network - VPN) to ensure data privacy and confidentiality. Furthermore, envisioning the complexity of the required integrated regional healthcare information system, it should be made possible to ensure high service provision and business continuity by establishing a service level agreement with the vendors.

The integration of existing information systems represents one of the most urgent priorities of the health information systems in order to meet the increasing clinical, organizational and managerial needs. A pilot system was developed in the 1st and 2nd RHA of Central Macedonia, to achieve data

integration and record synchronisation using the Health Level 7 protocol between the existing HIS of two Hospitals of Thessalonica and the headquarters of the RHAs [5]. Current practice shows that the most promising approaches to achieve a regional Electronic Health Care Record (EHCR) is to use a message-based communication system. One of the next steps towards hospital information systems integration is to determine clinical documents and consecutive data to be used in order to achieve a "basic medical communication level" within the 2nd RHA of Central Macedonia.

The Health Level 7 Clinic Document Architecture (CDA) is an XML-based document mark-up standard that specifies the hierarchical structure and semantics of clinical documents for the purpose of information exchange [6]. CDA documents derive their meaning from the HL7 Reference Information Model (RIM). CDA is a three-layer architecture implemented in XML, where each level is defined by a DTD. Level One is the root of the hierarchy and specifies the semantics of the header, codes for the document type and sections within the body of the document. It consists of three technical specifications: the CDA header, the CDA Level One Body and the HL7 Version 3 data types. Level Two uses the same codes as Level One for the document type and sections but allow further constraints to be imposed. Level Three will define observations and services within the document body. Level One is the basic formula for our study. In order to achieve a shared health information system across various HIS and other information systems and reduce interface interoperability problems is to determine and classify clinical and all other documents. The proposed study is based upon empirical knowledge gathered by key users within their daily operations in healthcare institutions and from the existing bibliography on clinical document processing [7 – 11].

MATERIALS and METHODS

The Pilot project

The pilot project for the integration of Health Information System using the HL7 messaging standard included the design and implementation of two scenarios to integrate two different Hospital Information Systems from the two Hospitals and the central headquarters (HQ) using asynchronous message communication architecture. The implementation processes took a month, while the pilot system was kept operational for another month for validation and evaluation purposes. The scenarios were formulated by the IT department of both RHA and are:

Scenario A - Treatment and diagnostics progress:

The hospital charges the patient for the 'package SEKN', on a certain medical treatment provision. This causes an event to the HIS, which transmits an update of managerial data to the management information system (MIS) of the RHA. Each amount of money charged to a patient for treatment included in 'package SEKN' is forwarded to the central RHA system as costing and financial data. All data accumulated at the RHA HQ is input to the MIS that breakdowns data according to the following criteria: (i) Treatment costs broken down per hospital, (ii) a calculation of treatment frequency is made and (iii) all received or expected cash flow from this package is grouped by the Insurance company. For the implementation of scenario A the following HL7 messages have been used: ADT event A01 for admission of patient, event A02 for patient transfer, event A03 for discharge of patient. The segments that were used were MSH, EVN, PID, and PV1.

Scenario B -Synchronizing patient records:

The scenario implements a regional patient unique identifier (RPID) production engine that can be contacted by hospital information systems and obtain this patient identifier. The RPID can be attached to the patient record in each HIS. An HL7 based "hand-shake" (request/response) message interchange was implemented between a Patient Identification Application, which was developed in this pilot project and the HIS of the two involved hospitals. An HL7 message with the patient data from the hospital system activates the identification algorithm at the RHA HQ and results in a response, from RHA to hospital, containing the RHA patient identifier and the new version of patient data to synchronise the communicating systems (hospitals and RHA). If the patient does not have any previous registration in the RHA database a new record is created for him. A satisfactory heuristic to match patient records is assumed and from that it is possible to determine with a high likelihood that the two records describe the same patient. Then the RHA system is capable of taking the decision to hand out a new RPID, or to send one of an existing RHA patient record. The search algorithm is based on an exact match of values in a predefined set of patient required and descriptive data fields. The patient identification data stored in the hospital database is exchanged through the segment PID of the appropriate HL7 message. The fields of segment PID are: *Patient ID*, which may also contain national identification number, tax payer identification number, *Patient Name, Birth Date, Gender* and

Address fields. The algorithm results in a 100% association under the condition that national identification or tax payer identification numbers are valid in hospital's databases.

The **architecture** adopted for the functional pilot system fulfils at least the following three requirements: (i) Existing systems do not need to be altered, (ii) No significant extra (hence unanticipated) load on existing systems is introduced, (iii) Connecting existing systems is an economical viable activity with limited time and budget. The three requirements are met by an asynchronous message based information exchange infrastructure defining a uniform interface for any system that exchanges information with the polling method. All systems are connected, through a uniform interface, to a common communication infrastructure (CCI).

The pilot system confirmed the initial approach that HL7 enables information exchange between HIS and the RHA HQ and patient record synchronisation at a regional level. The pilot system showed that disparate patient records can be synchronised and kept synchronised in real-time. The message-based approach with the HL7 integration approach approved to be pragmatic and achieves data integration.

Analysing Document needs

The next steps were implemented by determining the processes that are in place in each department of the healthcare institutions that administratively belong to the RHA. In order to achieve that task, a series of interviews with decision makers and other key users took place for a period of three months. As a result, the RHA had in hand an updated "as is" report, that was the base for the design of the RFP (with represents the "to be" analysis). During that process all major documents that are created and handled during daily routine in the healthcare settings were identified and a list of mega-processes was established as depicted in Table I.

Table I Mega – processes categories

Category	Number of established mega-processes
Primary Care	24
Hospital's Administrative Sector	21
Hospital's Financial sector	18
Hospital's Engineering/Technical Department	7
Hospital's Medical Sector	9
Hospital's Nursing Sector	7

The processes that involve documents **in use which are in an electronically stored form** for patient care are shown in Table II. The processes were collected empirically and by the method of interviews with the personnel. The results are from 12 hospitals of 2nd RHA and 81 Primary Care Units.

Table II Mega – processes categories and number of documents processed per hospital per day

	District Hospitals		General Hospitals		University Hospitals		Special Care Hospital	
	Number of Hospitals	Number of Docs	Number of Hospitals	Number of Docs	Number of Hospitals	Number of Docs	Number of Hospitals	Number of Docs
Administrative Sector								
1 Admission of patient	4	102	2	90	1	90	3	25
2 Patient Record - Medical Notes	3	137	1	40	2	210	2	42
Totals	7	239	3	130	3	300	5	67
Medical Sector								
1 Referrals for laboratory tests	3	1070	2	700	1	700	2	200
2 Referrals for surgery, medical operation	3	25	2	70	1	15	1	1
3 Lab and RIS test	3	4645	2	2930	1	896	3	1743
Totals	9	5740	6	3700	3	1611	6	1944
Nursing sector								
1 Diet Documents								
2 Drug prescription			Not used					
3 Nursing Patient Record								

No work has been done to classify the document names and types in the health care organisations and homogenise them. The diversity of clinical documents and the lack of standardisation of document names imply weakness to achieve the document information exchange and harmonization. Inevitably the next step is the standardization of clinical documents in the regional system. The standardization will be based on Clinical Document Architecture (CDA) proposed by HL7 organization as mentioned above.

The scope of CDA is the standardisation of clinical documents for exchange. CDA does not model clinical content, but does standardise the mark-up of the structure and semantics needed for exchange of clinical documents. CDA documents can be transmitted in HL7 messages designed to transfer clinical documents.

The goals that govern the work for the basic communication at document level for the regional system and consequently the standardization of document names-types:

- Install the base for Virtual Patient Record in the healthcare organisations in the regional system
- Allow cost effective implementation across for the integration of a wide range of already existing systems.
- Support exchange of human-readable documents between users, including those with different levels of technical sophistication and especially documents concerning the medical care of patient.
- Be compatible with a wide range of document creation applications.
- Prepare the design for the regional information system reasonably quickly.
- Enable policy-makers to control their own information requirements without extension to this specification.

The design principles that will govern the standardisation of document names based on HL7 CDA at Regional Level are:

1. The Correlation of processes, mega – processes and clinical documents.
2. The (empirical)definition of clinical documents and the distinction between clinical notes and hospital summaries
3. The fact that document classes do not define document contents but should be a sufficient predictor for human understanding.
4. Names have a definite relationship to an activity of the process being documented, but the document name may not be completely specified by the name of the activity.
5. The extension of the above steps at national level by sorting the processes and document classes between the RHAs'.

The above goals and principles can be described through the Four logical components of CDA Headers: (1) Document information (Document identification, Document time stamps, Document confidentiality, Document relationships) (2) Encounter data (3) Service actors such as People responsible for a clinical document, Authenticators, Intended recipients, *Originators (Originating person*, originating organisation), Transcriptionist, Healthcare providers, Other service actors And (4) Service targets (patients, Originating device, and other service targets) are the components that should be standardised. The document identification in the CDA header is the first process that should govern the efforts according to the already mentioned design principles and as there is no previous work so far.

The proposed formula for classifying the clinical documents in order to define the document identification in the CDA header is based on the formula proposed by the Document Ontology Task Force of HL7 [12] and is as below:

Document-name: health-care sector+, service+, health-care provider?, clinical category?, practice setting?

The formula means that a document-name is defined by one or more sectors (as mentioned in table II), one or more services, zero or one health-care provider, zero or one clinical category and by zero or one practice setting. Services are the business processes that would be collected as mentioned in the above paragraphs, health-care provider could be hospital names, general practitioners etc, clinical

category is the domain of practice (does not apply for the administrative sector) and practice setting is the type of facility (home health, emergency room etc) and not the physical location.

The polyhierarchy of the documents according to the HL7 CDA as described in the formula for the ontology to generate the document names is intended for use in the following of situations:

1. Document organization: represents the health care organizations in the regional health system
2. Document l ocation: s hould m ake p ossible r etrieval of i nformation t hrough a d ocument of a specified department in a health sector (e.g. pathology etc).
3. Document structure: should make possible the categorization of information according to underlying structure, reflect the contents of documents.

RESULTS

The first pilot attempt towards the standardisation of clinical documents, as mentioned above, w as introduced in the largest hospital in the 2nd RHA of Central Macedonia, the General Hospital of Thessalonica "G.Papanikolaou". O ne c linic f rom t he pathological s ector w as s elected t o g ather t he different document-types regarding the patient record in the clinic. The document-types that were collected from the flow of administrative and medical processes concerning the Patient Record are the following in Table III.

Table III Document-types in Pathological Sector

Cod e	(proposed/common usage name)	Proposal Document-name, health-care sector+, service+, health-care provider?, clinical category?, practice setting?				
		Health-Care Sector	Service	Health-Care Provider	Clinical Category	Practice Setting
AN	Admission note	Administrative	management-of-patient, hospital-admission	GENERAL HOSPITAL PAPANIKOLAOU	PHATOLOGY CLINIC	Hospital
DN	Discharge note	Administrative	management-of-patient, patient discharge			
TN	Transfer note	Administrative	management-of-patient, patient transfer			
CE	Charge Order (medical expenses /charges)	Administrative	management			
PN	Prescription notes	Nursing	management			Hospital Clinic
MO	Medical Orders	Nursing	evaluation-AND-management			
BM	Bulletin of issuing of medicines	Nursing	management			
NR	Nursery Delivery Record	Nursing	evaluation-AND-management, hospital admission			
MI	Medical Record Informative Note (on discharge)	Medical, Nursing	Evaluation-AND-management, summation			
DP	Disease Progress Note	Nursing	follow-up-evaluation			
LR	Leaf of Re-entry	Nursing	Consultation, hospital admission			
HT	Hospital (Nursing) Treatment Note	Nursing	Treatment procedure			
MR	Medical record (Total)	Medical	evaluation and management			
HP	History and Physical Notes (Narrative)	Medical, Nursing	History-taking AND physical examination			
HH	History of (e.g.) Hematology Record (Narrative), (Medical Note relative to the current diagnosis)	Medical	History-taking, history-taking-by-self administered questionnaire			
FB	Familial Background	Medical, Nursing	Consultation			
CR	Clinical Examination Results	Nursing	evaluation and management			
LE	Laboratory Exams Record	Laboratory	Laboratory procedure, observation, evaluation			
DF	Diagram of Follow-up	Nursing, Laboratory	follow-up-evaluation			
DM	Debits of materials during hospitalization	Administrative, Nursing	management			
NA	Nursing account (report)	Nursing	management			
RE	Referrals for Exams	Nursing, Laboratory	Laboratory procedure, operative procedure, procedure-on-body part			

The name of the services' column is a result of the work mentioned above regarding the standardisation of mega-processes in the RHA in the phase of analysing the document needs. The document class is identified by the fully-specified name as it resulted from the interviews with nursing and administrative personnel. The column code is an assigned code thus a non-semantic identifier -. The results in Table III are a first level analysis of clinical documents in order to elaborate it in future work.

DISCUSSION

Open issues for the work of specifying the document names for the regional health information system can be summarized to the following:

- Documents regarding medical and nursing sector are mostly within the scope of this effort.
- The clinical category domain should be developed and maintained at regional and at national level.
- Education in Information technology and communication is a Medical and Nursing staff is a crucial factor to succeed the clear categorization
- Principles of Virtual Patient Record are not yet widely implemented in the commercial products for the health information system
- Existing applications and information system are often legacy systems and vendors are not willing to cooperate
- Existing products' architecture does not have the principles of workflow management systems (notion of process, activities) in order to define the services.
- Common communication at a document names level implies that a reform at organisational level should take place in health providers
- Private health service providers are not included in the regional health information system

The proposed stages for document names standardization are time-consuming and the efforts should be harmonized at national level. The next step of the effort will be the standardization of the context of the documents. Assumptions should be made without jeopardizing the quality of the IT projects in health care

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