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Turkey's National Health Information System (NHIS)

İlker KÖSE[1], Nihat AKPINAR[1], Murat GÜREL[1], Yakup ARSLAN[1], Hakan ÖZER[1], Nihat YURT[1], Ahmet ÖZÇAM[1], Soner KIRICI[1], Erdinç SABUR[1], Yıldıray KABAK[2] , Mustafa YÜKSEL[3] and Asuman DOGAC[2,3]
[1] *Dept. of Information Processing, Ministry of Health, Ankara, 06434, Turkey*
Tel: +90 312 5851000, Fax: +90 (312) 430 01 44, Email: Nihat.Akpinar@saglik.gov.tr
[2]*Software Research, Development and Consultancy Ltd.,*
METU-KOSGEB Tekmer, Ankara, 06531, Turkey
Tel: +90 312 2102076, Fax: + 90 312 2105572 Email:, yildiray@srdc.com.tr
[3] *Dept. of Computer Engineering, Middle East Technical University,*
İnönü Bulvari, Ankara, 06531, Turkey
Tel: +90 312 2405598, Fax: + 90 312 2101259,Email: asuman@metu.edu.tr

Abstract: Turkey's National Health Information System (NHIS) provides a nation-wide infrastructure for efficient sharing of electronic health records. The system is implemented based on HL7 v3 messages, HL7 Web service Profile is used for transportation and the clinical document format is HL7 v3 CDA Release 2. In order to provide common coding/classification systems that are available to all healthcare players, MoH Department of Information Processing developed the Health Coding Reference Server (HCRS) which encapsulates all the international and national coding systems used in Turkey. Furthermore, the National Health Data Dictionary (NHDD) is developed to enable the parties to share the same meaning of data, and use them for the same purpose which currently, contains 261 data elements. The data groups used for data collection are called Minimum Health Data Sets (MHDS) and are formed from the NHDD. Currently, the system is at its test phase and the healthcare information systems send CDA documents using 25 Web services available.

1. Introduction

The current version of the NHIS, Turkey provides 25 Web Services, each of which is specialized to a specific Minimum Health Data Set Transmission as described in [1]. In order to guarantee the interoperability, the MoH, Turkey published an Implementation/Integration/Interoperability Profile for vendors of Family Medicine Information System (FMISs) and Hospital Information Systems (HISs). This profile is based on the following national and international standards and specifications:

- For transport protocol, HL7 Web Services Profile is used. For security, WS-Security Username Token over SSL is required for conformance.
- The "Transmission Schemas" are HL7 CDA R2 compliant EHRs and each HL7 CDA section is a Minimum Health Data Set (MHDS) which is formed from the data elements specified in National Health Data Dictionary (NHDD).
- Health Coding Reference Server (HCRS) [8] serves all coding systems in use in Turkey which is used in the data elements within the Minimum Health Data Sets.
  Currently, the system is at its test phase and the healthcare information systems send CDA documents using 25 Web services available. This testing will end by September

2008 and by January 2009, all of the healthcare organizations in Turkey are obliged by law to send patient data through NHIS.

2. Technology Description – National Health Information System (NHIS)

The NHIS is built on the eHealth network ("Saglik-Net") connecting these components:

- The National Health Data Dictionary and the Minimum Health Data Sets Server
- The Health Coding Reference Server
- The digital security mechanisms

As shown in Figure 1, all the servers, that is, the National Health Data Dictionary Server (Ulusal Saglik Veri Sozlugu, USVS) [4]; the Minimum Health Data Sets Server (Minimum Saglik Veri Setleri, MSVS) [5] and the Health Coding Reference Server (Saglik Kodlama Referans Sunucusu) [6] are available from the Saglik-Net network. Telemedicine applications and the more comprehensive digital security mechanisms on top of the current WS-Security are about to be connected. Among the users of the network, currently only the Family Medicine information is connected, the other types of users (primary, secondary, tertiary healthcare providers, payer institutions, family physicians, etc.) will be connected by 2009.The software companies in Turkey have to comply with these standards developed by the Ministry of Health. In this way, interoperability among NHIS servers and various Hospital/Lab/Clinic/etc. information systems are provided. The EHRs are based on HL7 Clinical Document Architecture (CDA) [7] and uses the National Health Data Dictionary, the Minimum Health Data Sets and the relevant coding systems.

In the following sections, the major components of the Saglik-Net will be described.

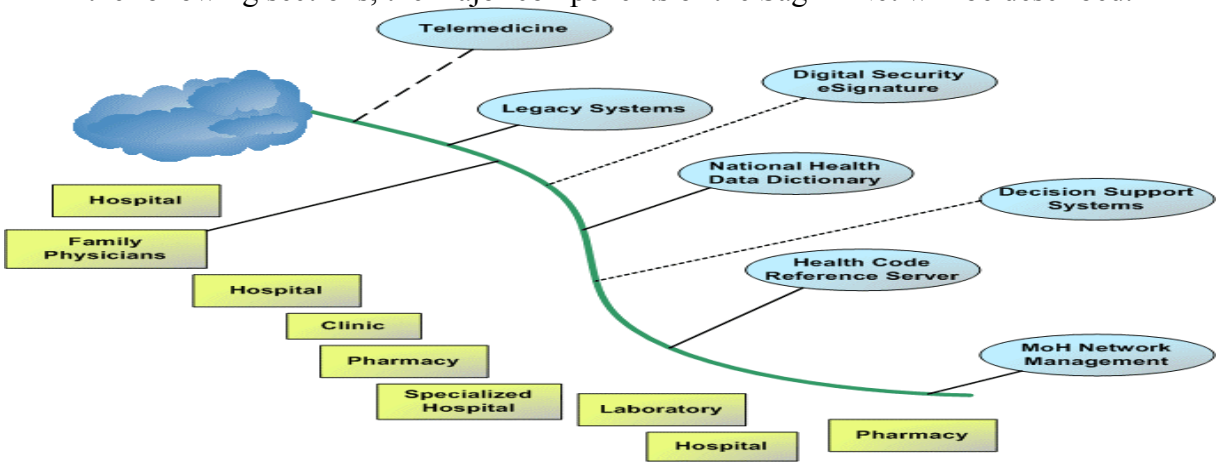

Figure 1: Saglik-Net as of July 2007

2.1 The Health Coding Reference Server (HCRS)

In order to provide common coding/classification systems that are available to all healthcare players, MoH Department of Information Processing developed the Health Coding Reference Server (HCRS), which encapsulates all the international and national coding systems used in Turkey within a publicly accessible server.

Some of the coding systems available from HCRS are ICD-10 [8], Drugs, ATC (Anatomic, Therapeutic, and Chemical Classification System), Associations, Clinics, Specialization, Careers, National Health Tarrifs, Health Application Instructions, Supplies, Vaccines, Baby Monitoring Calendar, Pregnant Monitoring Calendar, Child Monitoring Schedule and Parameters.

The HCRS is shared online through Web Services (through SOAP [9] requests and responses) that are available at the address: http://aile.saglik.gov.tr/sbrs/service.asmx. A tabular form that allows querying through Web browsers is also available at the address: http://sbu.saglik.gov.tr/SKRS2_Listesi/.

The concept of Health Coding Reference Server (HCRS) is similar to the "vocabulary domain/ value set" mechanism of HL7 v3. All the software companies doing business for Turkish health market are obliged to use the HCRS in their software and to design their products for fast adaptation to the latest updates in the HCRS, latest in 7 days from the date of update. For this purpose, the software vendors should follow a modular approach. It is clear that the content of the HCRS is also provided as a package for fast offline usage within the information systems.

2.2 National Health Data Dictionary and the Minimum Health Data Sets (MHDS) Server

The National Health Data Dictionary (NHDD) is developed to enable the parties to share the same meaning of data, and use them for the same purpose. The data whose definition and format determined within the NHDD establishes a reference for the information systems used at health institutions. Thus, the content interoperability among different applications is provided through the NHDD. The stable versions of NHDD will be annually revised to include improvements as comments are received from the field.

NHDD is composed of data sets and data elements conforming to ISO/IEC 11179-4 Standard [10]. Currently, there are 46 Minimum Health Data Sets and 261 data elements. Some example data elements are:

- Address
- Name
- Main Diagnosis
- Vaccination
- Treatment Method
- Diastolic Blood Pressure
- Healthcare Institution
- Marital Status

The data groups used for data collection are called Minimum Health Data Sets (MHDS) and are formed from the NHDD as shown in Figure 2. In other words, MHDS define the data sets that emerge at the time of presenting a certain service, for example, Infant Monitoring Data Set, or Pregnant Monitoring Data Set. Currently Health MHDSs are completed and work is in progress for developing the other two sets, namely, Administrative and Financial.

Currently, it covers the most critical health data but in the future, these data sets will be extended to the full Electronic Health Record schemas. Some example MHDS are:

- Citizen/Foreigner Registration MHDS
- Medical Examination MHDS
- Prescription MHDS
- Pregnant Monitoring MHDS
- Cancer MHDS
- Inpatient MHDS

MHDS has a changing and updateable structure. In other words, as more data is collected from the field, MHDS will be updated in certain periods to meet the new needs.

Currently, the MHDS are being used for the National Decision Support System that enables the analysis of health data with methods such as data mining to determine the health policies of the MoH, Turkey.

The data elements within the Minimum Health Data Sets are mostly coded with coding systems and all these coding systems are available at the Health Coding Reference Server (HCRS). If a data element is defined in the National Health Data Dictionary as coded or classified, then the related coding/classification system is given both within the definition of the data element and in the "HCRS System Code" field. There are two possibilities for a

coded element: either the value is gathered from a coding system (e.g. ICD-10, healthcare institutions, specialities, etc.) or it is of parametric kind such as gender, or marital status.

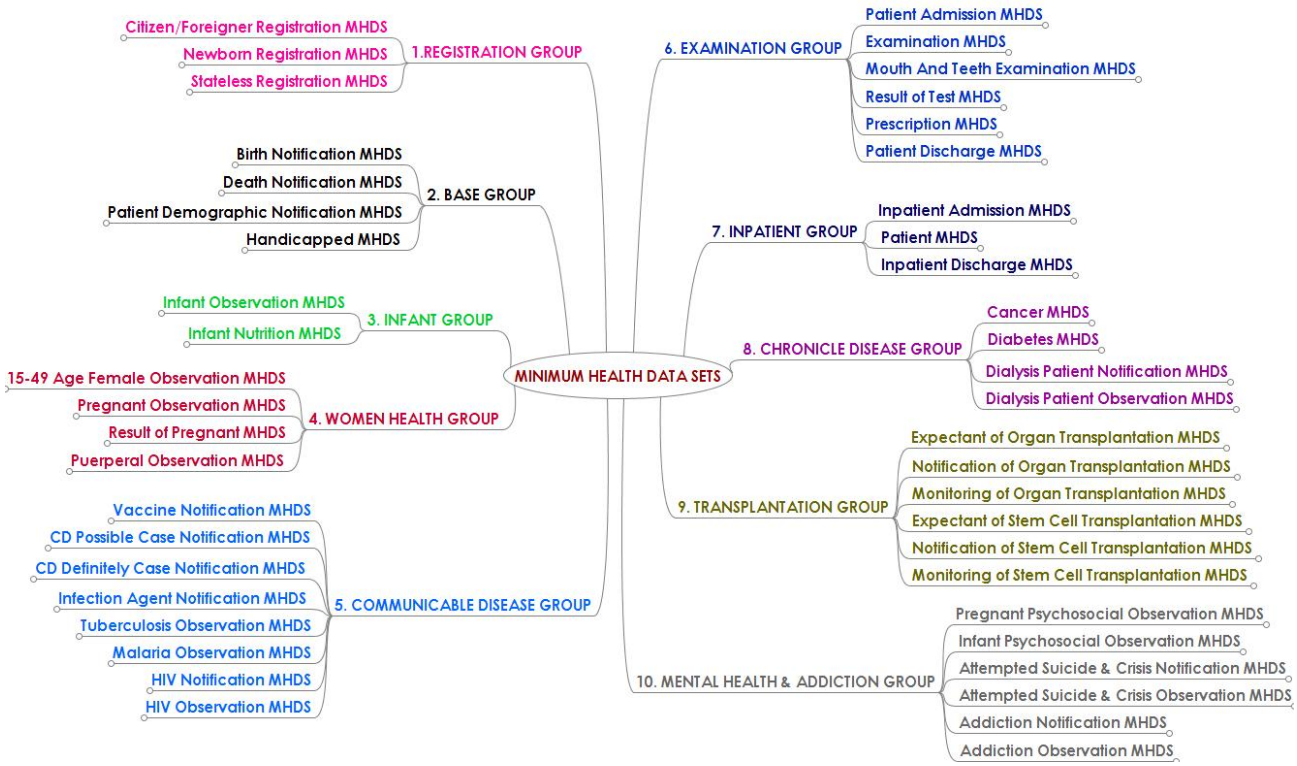

Figure 2 Minimum Health Data Sets

Data sets are transported conforming to the Data Set Transport Schemas which describe the groupings of data sets for reporting a certain activity. For example, for reporting "infectious diseases", the Data Set Transport Schema contains the "Patient Admission", the "Patient Examination", the "Prescription" and the "Patient Discharge" data sets. In other words, all these data sets must be grouped and sent for reporting "infectious diseases".

2.3 Digital Security

The Technical and Scientific Research Council (TUBITAK) [11] is the authorized body for providing solutions in Digital Security in Turkey. For this purpose, TUBITAK is developing the National Electronic Identity Verification System and the Smart Identity Card. These solutions will be available for both individuals and institutions.

In Turkey, digital signatures are legislated in 2004 and mobile signatures are legislated in 2006 and the integration of Family Medicine Information Systems (FMIS) [12] with digital signatures has already been realized.

2.4 Healthcare Professional Registry

Ministry of Health is authorized to provide the work licenses to physicians in Turkey. The diploma/specialty information of the medical professionals is recorded with their Turkish citizenship numbers in the Doctor Data Bank (DDB). As of October 2007, there are 162,446 registered doctors in the data bank. The Doctor Data Bank is served by the Health Coding Reference Server (HCRS) [6].

The Doctor Data Bank, that is, the Healthcare Professional Registry serves two purposes: The first one is that most of the payment providers control the health service and the prescriptions according to the physicians' specialty. For example, when a rule indicates that only the physicians with a certain specialty can prescribe certain medicines, it becomes possible to check whether the doctor who has signed the prescription has the required specialty. The relevant institutions signed an official protocol and started their

implementations based on DDB in the last quarter of the year 2006. The second use of the DDB will be for authorizing access to the EHRs of the patients.

3. Developments

In this section, the implementation of the National Health Information System is described together with the experiences gained in the process.

The National Health Data Dictionary, the Minimum Health Data Sets and the Health Coding Reference Server data sets provide the information space used in the messages to be exchanged between the peripheral systems and National Health Information System. It should be noted that these data sets do not have a wire format and the most important decision to be taken at such nation-wide projects is whether to use a standard format. Most of the time, standards do not cover all of the identified information requirements in a project; therefore, the implementers choose to develop their own proprietary format instead of a standard format. However, this decreases interoperability. In the National Health Information System, HL7 v3 is selected because of the following reasons:

- HL7 is the most widely used electronic healthcare standard. Although, National Health Information System is to be used locally in Turkey, when it comes to communicate with other countries, the systems should be ready.
- After the completion of the NHIS, all of the medical information systems used in the nation-wide healthcare institutes should be adapted to communicate with the NHIS. Being based on a widely-used standard will facilitate interoperability to a large extent.
- HL7 v3 provides mechanisms to extend the messages according to project requirements.
- Specifically, the version 3 of the HL7 standard is selected rather than HL7 v2.x because of optionality problems of v2.x. Additionally, HL7 v3 is a standard whose conformance can be tested. In other words, it becomes possible to test the software clients running on the peripheral medical institutes that provide data to the NHIS servers. This is not possible in the v2.x versions of HL7.

The messages are developed based on HL7 v3 Clinical Document Architecture (CDA) Release 2 (R2) standard [7] with the following characteristics:

- Persistence: The information continues to exist in an unaltered state in NHIS.
- Stewardship: The information is maintained by Ministry of Health.
- Potential for authentication: The information is legally authenticated by the originator physician.
- Wholeness: The authentication of the information applies to the whole of the document.

In the following sections, the details of the implementation are presented.

3.1 Development of the Message Schemas

In the current version of the NHIS implementation there are 23 messages. These are: “15-49 Age Female Observation”, “Mouth and Teeth Examination”, “Vaccine Notification”, “Infant Feeding”, “Infant Observation”, “Infant Psychosocial Observation”, “ CD Definite Case Notification”, “CD Possible Case Notification”, “Diabetes”, “Birth Notification”, “Pregnant Observation”, “Result of Pregnant”, “Pregnant Psychosocial Observation”, “Patient Demographic Notification”, “Cancer”, “Puerperal Observation”, “Examination”, “Death Notification”, “Result of Test”, “Citizen/Foreigner Registration”, “Stateless Registration”, “Inpatient Admission” and “Newborn Registration”.

For all of these messages, the CDA R2 Refined Message Information Model (R-MIM) [13] is constrained based on the Refinement, Constraint and Localization process (http://www.hl7.org/v3ballot/html/infrastructure/conformance/conformance.htm) and the Hierarchical Message Descriptions (HMDs) [14] and XML Schemas are produced. All the schemas and R-MIM diagrams are available at:

http://www.sagliknet.saglik.gov.tr/portal_pages/notlogin/saglikcilar/saglikcilar_teknikstandart_hl7.htm

3.2 Development of the Communication Infrastructure (HL7 WS Profile)

HL7 v3 recommends three transport mechanisms to exchange HL7 messages:

1. Web Services Profile [15]
2. ebXML Messaging Profile [16]
3. TCP/IP based Minimum Lower Layer Profile (MLLP) [17]

In these profiles, HL7 provides detailed guidelines on how to implement a messaging infrastructure from four perspectives: Basic, Addressing, Security and Reliability. Among them, Web Services Profile is the most promising, as it is based on widely-used Web Services Technology. Therefore, in the National Health Information System implementation, Web Services Profile is used for the communication infrastructure.

In the implementation, the addressing and reliability requirements of the profile has not been addressed, as there are no intermediary systems and the messages are not expected to be too large to require splitting into several parts. Basically, for each of the message described in Section 5.1, a Web Service Endpoint is implemented.

3.3 Guidelines for Clients

As mentioned before, after the completion of the NHIS Project, all of the software systems running in the medical institutes in Turkey are obliged to be updated to have the ability to send messages to NHIS. For this update purpose, a comprehensive guideline is prepared for the software vendors that develop client software [18]. The guideline includes the following:

- The HL7 Storyboards
- The HL7 Interactions used in the NHIS
- The HL7 Application Roles
- The R-MIMs, HMDs and XSD for the messages
- The WSDL documents for the Web Services
- Constraints and Rules to be applied to the messages

The guidelines are available at:

http://www.sagliknet.saglik.gov.tr/portal_pages/notlogin/saglikcilar/saglikcilar_teknikstandart_hl7.htm

3.4 HL7 Turkey Constraint/Localization Profile

Once an HL7 specification has been balloted and formally published, it may be further constrained for a variety of purposes, including realm-specific localizations by an HL7 Affiliate. For this purpose, a constraint profile is an expression of local constraints applied to an HL7 standard RMIM, HMD, or Message Type. In other words, it documents how HL7 artefacts are used in an implementation. As mentioned before, in the implementation of NHIS, HL7 v3 CDA R2 is used. Therefore, the “HL7 Turkey Constraint/Localization Profile” is also developed. In addition to be a report to the HL7 standard, the document is also useful cross country communication.

The HL7 community does not specify a formal structure for constraint profiles. However, HL7 expects the followings to exist in the document:

- A storyboard or use-case
- The realm(s) in which the application is intended to be used
- A description of all trigger events associated with the interactions and how the events are bound to the system
- The interactions that the system sends based upon identified trigger events;

- The interactions that the system is capable of receiving;
- For each interaction, the subset of attributes and associations the system supports;
- For each domain, the supporting value set the system supports;
- Data type specializations the system supports;
- Any extensions - conformant and conflicting – the system supports; and
- The transport(s) supported.

3.5 Validation of Incoming Messages

As mentioned before, the information in the NHIS is persistent in nature. In other words, it should be stored in unaltered state in the repositories of the NHIS. Before storing the information to the repositories, the messages are validated and a two-phase validation technique is used for this purpose. In the first phase, structure validation is performed. In this phase, an incoming message is validated against the XML Schema it is expected to conform. If it validates, the message is passed to the second state where the semantics is tested. In this phase, the codes in the messages are validated against the codes maintained in the Health Coding Reference Server. Furthermore, some business rules are also controlled. For example, considering the "Examination" message, the admission date should be prior than the examination start date. Only after the message is passed the second phase, it is stored in the repositories.

4. Conclusions

NHIS, Turkey is operational now and it is expected that it will be possible to collect data from 90% of the field (primary, secondary, tertiary healthcare providers, family physicians, etc.) by year 2009.

The data flow in NHIS is not always one-way, that is from the healthcare institutions to NHIS servers. The authorized parties can also query and retrieve the healthcare records from the NHIS servers. Hence, the sharing of medical records among healthcare providers will be possible in the future when the necessary legislations are passed. Currently the work is going on determining legal ground about the access rights of all types of users.

Another future plan is the use of the "Doctor Data Base (DDB)" to develop an advanced privacy consent mechanism for authorizing physicians' access to the EHRs of the patients based on their roles. The patients will able be restrict access to the parts of their EHRs based on the specialty of the physicians. For example, mental disorders of a patient will be accessed only by psychologists if the patient specifies so.

Finally, an eAppointment system is being developed on Saglik-Net which will allow the General Practitioners using the Family Medicine System to arrange appointments for their patients in the hospitals.

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