Clinical Interoperability to Improve Quality and the Point-of-Care of EHR

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ABSTRACT

We think about interoperability only in today's terms. Looking ahead, the demands that future technologies will make on health information exchange could be large, as could the health because of interoperability. This paper would present the description on Healthcare Information System organizations and communities as a standard to underpin clinical information exchange. A number of significant problems results are directly from the way the computable entries in clinical documents exchange represented currently. In this paper, the information exchange with other system and also supporting communication of electronic healthcare records across organization boundaries. The CCD is an XML-based specification for exchange of clinical summary information. The HL7 Reference Information Models expressed in the Clinical Document Architecture Release 2 (CDA R2), an information exchange specification generic to any type of clinical information. Hence, the patient's health information is easily communicated points of care and improves quality services.

Keywords: Clinical Interoperability, HL 7 v3, Clinical Document Architecture (CDA), Continuity of Care Record (CCR), Continuity of Care Document (CCD), EHR, Reference Information Model (RIM)

General words: XML, HIS

I. INTRODUCTION

In this paper the Clinical Interoperability is a fundamental requirement of ensuring that widespread electronic medical adoption gives us the social and economic benefits that we want. Without interoperability, EHR further strengthen the information silos that exist in today's paper-based medical files & other systems. Interoperable systems can exchange information and a percentage of the information can be put to coded, productive use. Thus, the main objective of clinical interoperability is to support the electronic exchange of patient summary information among caregivers and other authorized parties via potentially disparate EHR systems to improve the quality, safety, efficiency, and efficacy of care delivery [1]. The Continuity of Care Document is an electronic clinical document exchange standard for sharing patient summary information among providers and within personal health records. The HL7 Clinical Document Architecture (CDA) is a document markup standard that specifies the structure and semantics of 'clinical documents' for the purpose of exchange that would improve quality and the point-of-care of EHR.

II. MATERIALS AND METHODS

A. Clinical Interoperability

The Clinical Interoperability relationship is represented to support the electronic exchange of patient summary information and also defined in the Certification Commission for Healthcare Information Technology [2] has defined interoperability as "the high fidelity exchange of information between an EHR system and other healthcare IT systems."[3] Interoperability aims to support clinical documents:

- Integration with clinical and non-clinical applications
- Data transfer and sharing on much more than a local or enterprise-wide scale
- Knowledge transfer and integration
- Medical terminology transfer, mapping and integration Image transfer

Coupled with the rise of consumer-directed healthcare, advancements in patient safety, and the call for greater transparency in cost and quality measurement, are new requirements for security, privacy, and connectivity. Clinical Interoperability Solutions offerings help healthcare organizations to improve the patient health and safety in Fig 1.

1. Providing secure access and exchange of patient-centric data to authorized personnel, at the point of care
2. Delivering medication history, prescriptions & formulary information to clinicians on demand

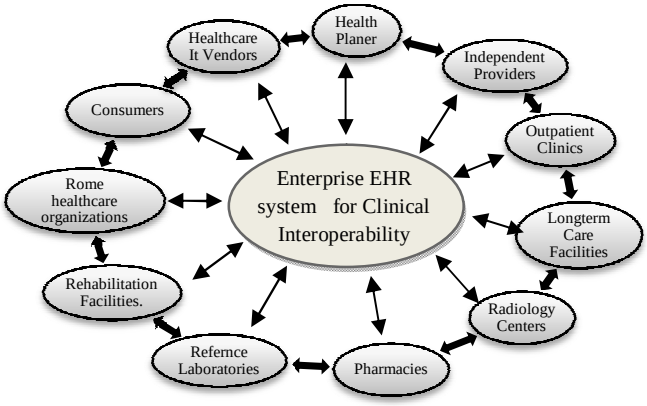


Figure 1.Enterprise connected EHR system for Clinical Interoperability

B. CCD – Continuity of Care Document

The Continuity of Care Document is an electronic of clinical documents to allow physicians to send electronic medical information to other providers without loss of meaning, which will ultimately improve patient care. [16]

The CCD is a joint effort of HL7 and ASTM to foster interoperability of clinical documents to allow physicians to send electronic medical information to other providers without loss of meaning, which will ultimately improve patient care. **[16].**It summarizes the most commonly needed pertinent information about current and past health status in a form that can be shared by all computer applications, from web browsers to electronic medical records [2]. The Continuity of Care Document CCD is a set of constraints on CDA that define is the "The HL7 Clinical Document Architecture (CDA) is a document markup standard that specifies the structure and semantics of 'clinical documents' for the purpose of exchange." [CDA 1.1] The CCD template is following the Healthcare Information Technology Standards Panel (HITSP) standards as the harmonized format for the exchange of clinical information, including patient demographics, problems, medications and allergies. These patterns of constraints, or templates, support interoperability between CCD documents and other document types defined as constraints on CDA that reuse the same patterns or templates defined by CCD, such as emerging HL7, IHE and HITSP specifications.

The CCD is a CDA implementation of ASTM's Continuity of Care Record (CCR). It is intended as an alternate implementation to the one specified in ASTM ADJE2369 for those institutions or organizations committed to implementation of the HL7 Clinical Document Architecture. The CCD represents a complete implementation of CCR, combining the best of HL7 technologies with the richness of CCR's clinical data representation, and does not disrupt the existing data flows in payer, provider, or pharmacy organizations. The CCD is an XML-based standard that specifies the structure and encoding of a patient summary clinical document. The CCD is the Clinical Statement pattern, which is comprised of the CDA entries and associated participations and references. Clinical statements are the most general patterns for clinical content based on the HL7 RIM. To bring these patterns to a level of specificity required for exchange, CCD introduces templates at the section, clinical statement, and entry or supporting (subclinical statement) level. These templates reduce optionality and bind patterns to vocabulary as required for semantic interoperability.

III. FRAMEWORK

All EMRs and EHRs import, manage, and export clinical documents. CCD and all CDA documents are designed for this type of exchange and integration. Thus, documents of all types imported as conformant CDA documents contain data that can be readily integrated into document management systems [1]. CDA is at the heart of every standards are based health information exchange architecture and The CCR is a core data set of the most relevant administrative, demographic, and clinical information facts about a patient's healthcare, covering one or more healthcare encounters. The CCD framework provides a means for one healthcare practitioner, system, or setting to aggregate all of the pertinent data about a patient and forward it to another practitioner, system, or setting to support the continuity of care.

CCD aims to give priority to documents generated by clinicians in order to:

- Standardize the format of the many thousands of types of clinical documents
- To support exchange of clinical information for human readability, and information processing;
- To promote longevity of information by separating the data from the systems that store it (to avoid obsolescence as occurs with technological processes and by being computer platform independent;
- Allow appropriate local adaptation of the standard to meet national or specific user requirements.

The resulting specification, known as the Continuity of Care Document (CCD), is developed as a collaborative effort between ASTM and HL7 [7]. The document consists of 17 modules; shown in Table. 1 A module contains multiple patient data elements in template.

Table 1. CCD template structure components

Template Modules	
1. Header	10. Medications
2. Purpose	11. Immunizations
3. Problems	12. Medical equipment
4. Procedures	13. Vital signs
5. Family history	14. Functional stats
6. Social history	15. Results
7. Payers	16. Encounters
8. Advance directives	17. Plan of care
9. Alerts	

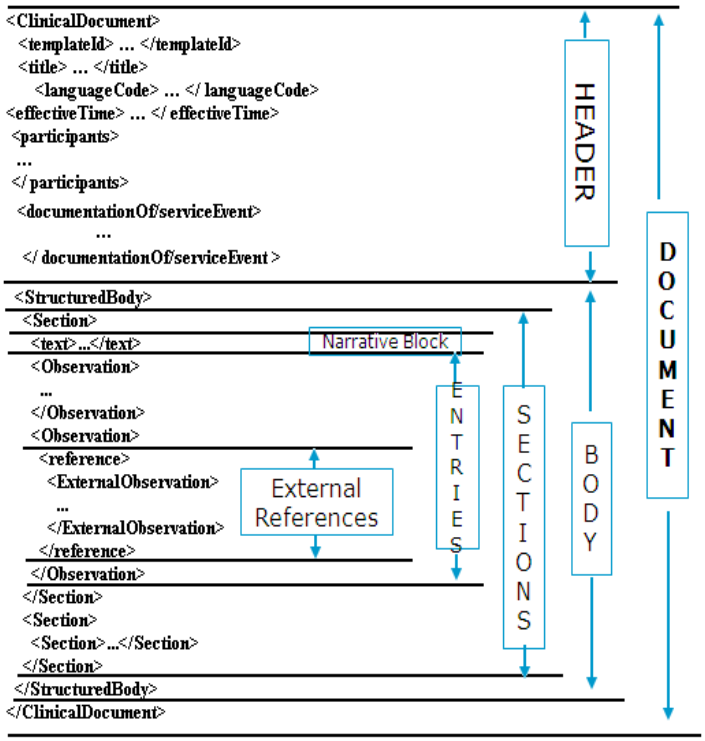


Figure 2. CCD document structure of components

Healthcare continues to march steadily towards the use of XML for data communication needs. CCD follows this trend by encouraging the implementation of XML for clinical Document exchange. It also keeps pace with the introduction of XML in HL7 V3 – the wave of the future for healthcare information exchange. The template structure defines how to use CDA elements to communicate clinical data [8]. The scope of the clinical data itself, within the templates, is set the Header and body part elements define in the clinical interoperability.

From the CDA header and body defines the document itself (document ID, document type classification, version, et cetera), the participants (e.g., care providers, authors, patients), and the document's relationships to other documents. In the Figure 2 shown require a minimal set of elements and defines that is used for these CCD template elements in XML syntax and the seamless transformation of clinical and administrative data between the two standards to improve the point-of-care in EHR.

CDA is an XML document structure introducing templates at the section, clinical statement, and entry or supporting (subclinical statement) level [9]

1. Level One – the root hierarchy and the most unconstrained version of the document. Level One supports full CDA semantics, and has limited coding ability for the contents. An example of a level one constraint on document type would be "Discharge Summary."
2. Level Two – additional constraints on the document via templates at the "Section" (free text) level. An example of a level two constraint on document type would be "Emergency Department Discharge Summary."
3. Level Three – additional constraints on the document at the "Entry" (encoded content) level, and optional additional constraints at the "Section" level.

The CCD constraints on CDA are expressed in a technology-neutral formalism that defines conformance requirements for CCD instances. Using a W3C schema (.sad) [11].and in the case of CCD, using Path statements compiled into a Schematron schema. Schematron is "a language for making assertions about patterns found in XML documents" [12].

Vocabulary and Datatypes

Vocabulary domains represent value sets for coded CDA components. These domains can include HL7-defined concepts or can be drawn from HL7-recognized coding systems such as LOINC [13] or SNOMED [14]. Data types define the structural format of the data carried within a RIM attribute and influence the set of allowable values an attribute. Every attribute in the RIM is associated with one and only one data type. CDA, Release Two uses the HL7 V3 Data Types, Release One abstract and XML-specific specification.

Templates, Conformance, and Validation

Templates define patterns at the document, section, clinical statement, and entry level. These patterns include required, optional, and allowable structures and vocabulary that further constrain CDA. Templates are identified by a templateId with a valid OID which indicates that the identified document, section, clinical statement, or entry not only conforms to the requirements of CDA, but also conforms to the pattern of constraints identified by the template. By convention, the HL7 SDTC uses only OID roots, not OID extensions, for template identifiers.

Context Propagation

Implementers should be thoroughly familiar with CDA context rules and how to use them to efficiently and precisely convey author, informant, language, subject, confidentiality, participant, and other parameters within the document. These rules state that contextual parameters defined at the document header apply to the entire document unless overridden and they define which parameters can be overridden at the body, section, and entry level. CCD leverages these rules to assert the source. In the example that follows, an informant element in the Medications section indicates that the patient is the source of the information in this section [15].

Within a document section, an informant element in mediacation section represents content to be rendered, whereas CCD entries represent structured content provided for further computer processing (e.g., assignedEntity, patient ID extension). CCD entries typically encode content present in the narrative block of the same section. Figure 3 shows two < informant > in CCD entries and a < assignedEntity >.

Entry containing a nested <representedOrganization> entry, although several other CCD entries reddened.

```
<Clinical Document>
  <templateId root="2.16.840.1.113883.10.20.1.8"/>
    <!-- Medications section template -->
  <code code="10160-0" codeSystem="2.16.840.1.113883.6.1"/>
  <title>Medications</title>
  <text>
    ...
  </text>
  <informant>
    <assignedEntity>
      <representedOrganization>
        <name>Good Health Clinic</name>
      </representedOrganization>
    </assignedEntity>
  </informant>
</Clinical Document>
```

Figure 3. An example of Section Informant Context

CCD Header

The CDA header defines the document itself (document ID, document type classification, version), the participants (e.g., care providers, authors, patients), and the document's relationships to other documents. CDA R2 requires a minimal set of elements and defines others that may be used.

CCD provides additional constraints or guidance on these header elements:

- templateId
- languageCode
- code (document type)
- effectiveTime
- documentationOf/serviceEvent
- header participants: next of kin, emergency contact, caregiver

CCD instances should include the <templateId> at the document root level which asserts that the document conforms. CCD requires the <languageCode> be present and take the form *nn*, or *nn-CC*. The *nn* variables are drawn from ISO-639 and are lowercase. The CC variables are from ISO-3166 country code and are in uppercase. At the document root (header) level, <code> is defined as the document type code used to categorize and classify types of CDA documents. CCD requires that the <ClinicalDocument/code> element. <EffectiveTime> represents the time the summary document was created.

CCD Body

This section contains a chapter on general patterns within the CDA body, then describes the general structure of templates defined in CCD. These chapters assume knowledge of the general form for section-level templates and therefore provide only those variables specific to each section <code> and title string.

The XML CDA body consists of one or more <section> that can nest and that are related through a <component> relationship. Within the <section>, the <title>, and <text> elements constitute the narrative block that must be rendered. Also, <section> may contain <entries> that convey the machine-computable semantics of the section and links to related information. Collections of entries are called "clinical statements."

a. The section template specifies required elements and attributes that establish an unambiguous context for each section and purpose of context CCD template . In this example <entry> elements, excluding the wrapping <component>, <section>, section-level <templateId>, and required <code>, < title>, and <text> elements. The purpose is represented by an act with the SNOMED CT code for "documentation procedure."[14].
b. Clinical Statement Templates specify key component of the Clinical Statement is the entryRelationship and entryRelationship@typeCode, which create relationships between the entries. Clinical statement templates describe patterns that can be used within one or more sections of the plan for activities of CCD templetes. Thus, a problem template may also be used in a family history section, possibly with addition constraints for that section.
c. Entry Templates are used for recurring concepts such as status, age, product, and reaction observation. In the example that follows, the reaction observation template is the target of an alert observation. Taken together, they assert that hives is a manifestation of an allergic reaction to penicillin. Supporting templates may be used within clinical statement templates.

IV. DEVELOPMENT AND RESULTS

The design of the CCD module for the Interoperability of clinical documents , not just a record, and is congruently designed for the same type of exchanges as those performed in an EMR for including import, management, and export of information in the XML format. Because of its small fixed XML tag set, CCD can be universally rendered as HTML or PDF or print. No specialized communication efforts or tedious changes to existing processes are required.

A. Implementation Specification of the CCD Module:

Platform: Microsoft visual studio 2008
Language: VB.Net, XML
XML stylesheet: CCD.xsl
Web Browser: Microsoft visual studio 2008 – toolbox web browser component
Supporting Files [18]:

1. Clinical Interoperability.dll
2. POCD_HD000040.xls
3. datatypes.xsd
4. datatypes-base.xsd
5. datatypes-base.xsd
6. NarrativeBlock.xsd
7. voc.xsd
8. CDA.xsd

9. SampleCCDDocument-QSG-level-3.xml
10. ccd_qsg.Ver1.Nov12007.doc

Validation Tool for CCDDoc.xml file: Online Tool: http://xreg2.nist.gov/cda-validation/validation.html [17]

B. Implemented Design of Module:

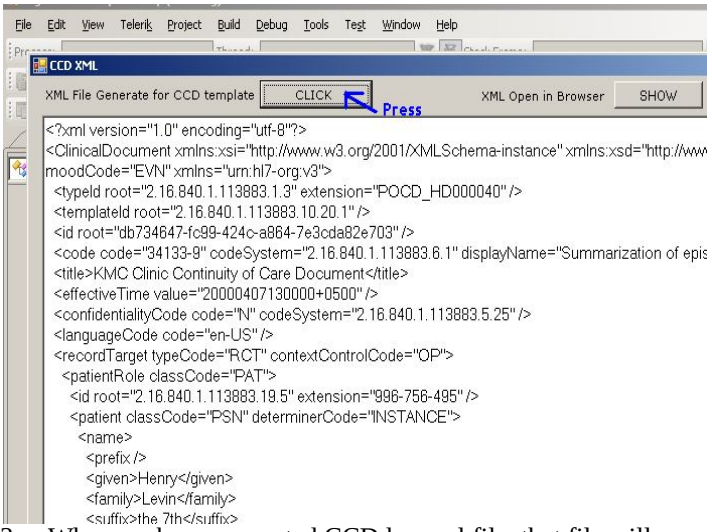
In CCD module, there exist system used the parameters and states as mention in the implementation specification.

1. In this implementation, the parameters and classes are provides function for convenient access to design the Clinical document's XML format of CCD Header and Body part. The Clinical document's of CCD templates parameters and class are used for Clinical Interoperability.dll and followed the POCD_HD000040.xls of CDA R2 POCD_HD000040 Hierarchical Description. The StreamWriter method is instantiated and the file "myfile.txt" is opened for writing. This file is located in the same directory as the application. And **StreamReader** method to try to read a text file that contains extended characters; the extended characters are removed from the line that is being read of XML-based specification for exchange of clinical summary information. That is shown below Figure 4.of CCD module coding.

```
Imports Interoperability
Imports System.Xml.Serialization
Imports System.Xml
…..
Public class CCDTemplate
        Dim objSerialization As New
XmlSerializer(GetType(POCD_MT000040ClinicalDocument))
        Dim oStreamWriter As StreamWriter
        Dim objClinicalDocument As New POCD_MT000040
ClinicalDocument
        Private Sub XML_Click()
        'To Generate the CCD template in XML standards
        Call GenerateCCDHeader()
        Call GenerateCCDBody()
        End Sub
        Private Sub GenerateCCDHeader()
        ……..
        End Sub
        Private Sub GenerateCCDBody()
        ……..
        End Sub
        'To open the webrowser, and read the XML contentens of CCD
template
        Private Sub BrowserClick()
        ……
        End Sub
End Sub
```

Figure 4 Implemented coding of Module

2. After execution of the CCD module program it will display the CCD XML Form. To click on the XML file gererate for CCD then show then Clinical document structred appearance XML tags I Firure 5.



3. When we have generated CCDdoc.xml file, that file will use to read in webbrowser in new browser. We need the xml-stylesheet can be used to allow a document to contain its own stylesheet. The URI reference uses a relative URI with a fragment identifier to locate the xsl:stylesheet element. In the same xml file it append the line "<?xml-stylesheet type="text/xsl" href="CCD.xsl"?>" and CCD.xls file if XSL specifies the styling of an XML clinical document would be display as per the CCD Document. On CCD Xml window screen, click on button for CCDDoc.xml read in web browser then in file append the line of xml-stylesheet type line of CCD.xls. According to that designed stylesheet, it will display the CCD clinical documents in Figure 6.

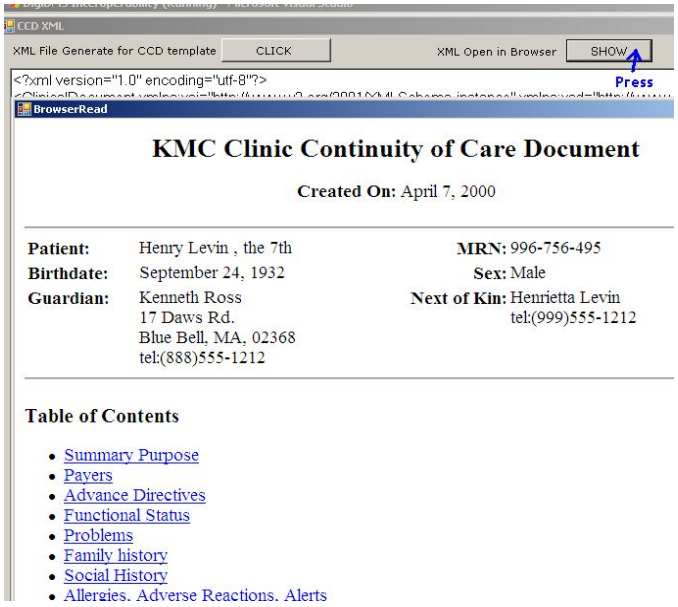


Figure 6. CCDDoc.xml file read in web browser

4. The validation tools are designed to be used by HIT developers and implementers during the development of software that implements CDA/CCD-based specifications. These tools can be used for self-testing to

Firure 5. XML file of CCDDoc.xml

determine if an XML instance document is correct with respect to the specifications.
In this online tool "CCDDoc.xml" file upload for validation of CCD of clinical documents in figure 7.

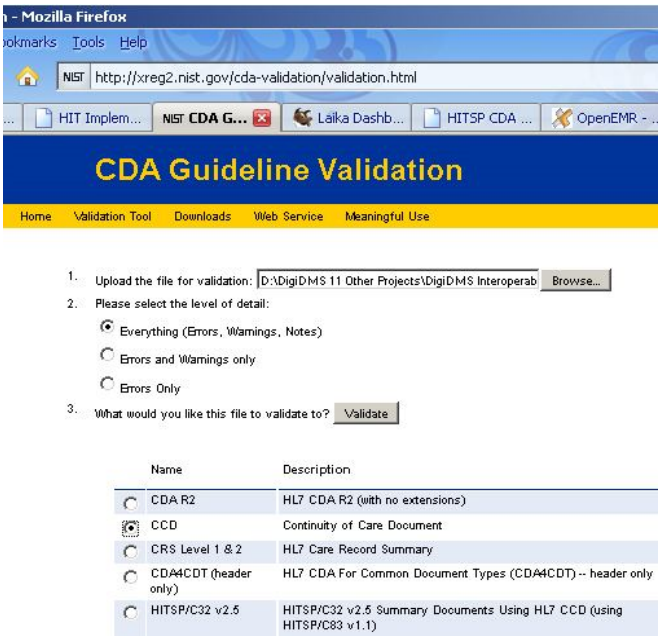


Figure 7. "CCDDoc.xml" for validation online of CCD

V. CONCLUSION AND FUTURE SCOPE

The Continuity of Care Document is an electronic document exchange standard for sharing patient summary information among providers and within personal health records. It summarizes the most commonly needed pertinent information about current and past health status in a form that can be shared by all computer applications and electronic medical records. The HL7 CDA RIM-based specifications that form the base of CCD are widely compatible with existing applications, browsers, EMRs and legacy systems.
Clinicians use other specialized clinical documents, including the History & Physical, Consultation Note, Pathology and Discharge Summary. These include new types of public safety reports, Because of its small fixed XML tag set, CCD can be universally rendered as HTML, PDF or print.

As future work, the objective of interoperability is to support the electronic exchange of patient summary information among caregivers and other authorized parties via potentially disparate EHR systems and other aspects of interoperability: "plug and play" and extensibility. "Plug and play" addresses the issue of making it easier and less costly for different EHR systems to exchange patient summary information reusing CCD templates for problems, medications, alerts, procedures, and other fundamental constructs. Extensibility focuses on establishing a standard that will provide near-term benefits as well as support more complex requirements for data exchange in the future.

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