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Electronic Discharge Letters Using the Clinical Document Architecture (CDA)

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Abstract

Communication between hospitals and general practitioners is often restricted to paper-based discharge letters. In order to meet the growing need for improved data communication between various actors in the healthcare domain, it is necessary to overcome the barriers of software heterogeneity and lack of standards. HL7's clinical document architecture (CDA) is a new tool to exchange clinical documents. In this paper we show how CDA can be used to share electronic discharge letters generated in the hospital information system with general practitioners. Ease-of-use and data security and integrity were the main design principles. Although there still remain technical and organizational issues to be solved, this is a promising method in order to enhance data exchange between hospital and primary care and to move towards an electronic patient record (EPR) crossing institutional borders.

Keywords

Hospital Information Systems; Physicians, Family; Telecommunications; Electronic Mail; Computer Communication Networks

Introduction

Although information technology has become an important component of primary care as well as of hospital care, communication of patient related data between hospitals and general practitioners is mostly restricted to paper-based documents, e.g. discharge letters or faxes. In Germany, two different types of discharge letters can be identified:

- Short discharge letters are mostly concise, hand-written documents with an epicrisis and some follow-up prescriptions. They are given to the patients on discharge. These short letters do not always contain all relevant information, sometimes they are hardly legible.
- Long discharge letters contain comprehensive information about the patient's hospitalisation, but often they arrive too late at the physician's office.

Direct electronic data exchange between the different actors in the healthcare domain can certainly ease this situation by improving transmission speed and quality of discharge letters. Unfortunately, structured electronic information exchange is still difficult due to lacking technical infrastructure, missing organizational frameworks and rigorous legal constraints. The heterogeneity of available software products with neither a common interchange standard nor an easy-to-use protection of data confidentiality is a major barrier which has to be overcome ihomer1n order to meet the growing need for improved data communication.

The Scottish Immediate Discharge Project [1] uses the eXtensible Markup Language [2] as a message format to send and receive discharge letters within the National Health Services (NHS) secure private network. The XML Format has the advantage of transferring human readable clinical information between computer systems giving the receiving general practitioner (GP) the choice of decoding and saving clinical and administrative data into his or

her practice system. The Document Type Definitions (DTD) have been developed and standardized by the NHS.

In 2000, Health Level 7 [3], a standards-setting organization accredited by the American National Standards Institute (ANSI), released a standard for the representation of clinical documents: The XML-based HL7 Clinical Document Architecture (CDA) [4] is a promising approach to a standardized information exchange which fills the gap between different software systems [5]. The CDA is a document markup standard that specifies the structure and semantics of clinical documents. A "clinical document" has different characteristics: It continues to exist in an unaltered state (*Persistence*), being maintained by a person or an organization (*Stewardship*). It is a human readable (*Human readability*) assemblage of information that is intended to be legally authenticated as a whole (*Potential for Authentication*, *Wholeness*). The CDA is part of the HL7 version 3 family of standards, which derive their semantic content from the shared HL7 Reference Information Model (RIM) and are implemented in XML.

Over the last two years, at Münster university hospital a comprehensive hospital information system (HIS) has been introduced to provide the basis for a institution-wide, full electronic medical record (EMR). We see our hospital as one partner within a regional healthcare network comprising other hospitals, general practitioners and specialists. In order to move towards an electronic patient record (EPR) which crosses institutional borders we wanted to establish an exchange of standardized clinical documents among the regional healthcare partners using the CDA standard. As a starting point, electronic discharge letters shall be exported from the HIS and then securely being mailed to general practitioners and follow-up specialists, who can import them into their physician office systems. Minimizing the technical barriers to both clinicians and GPs was the main guiding principle: This implies an automatic export of CDA Documents and a comfortable but secure data encryption and mailing.

Materials and Methods

Our hospital information system provides very sophisticated programming tools for defining forms and interactions among them, allowing the design of comprehensive clinical workflows [6]. In earlier projects [7, 8] we gained extensive experience in designing complex forms with data exchange functionalities and in embedding them in the clinical context.

The implementation of the CDA export, encryption and mailing functionality, however, has been done in two principal steps:

- First, a discharge letter form had to be generated using the hospital information system's form designing tool. The discharge letter combines pre-existing administrative and clinical data (like radiology or laboratory results) with the information entered by the clinician. The form collects this information and transforms it into a CDA compliant string, which can be exported and sent to the GP. A major challenge was the mapping of these different data fields to the corresponding CDA items. Due to the complexity of this task, a mapping engine was developed in Microsoft Excel, which – basing on corresponding HIS/CDA items – automatically generates source code for the designing and programming tool in development mode. A level one CDA document typically consists of a header and a body. The header conveys the text in which the document was created (administrative data like document information, encounter data, service actors, service targets), the body contains the actual content of the document, which is represented by the clinical information in the form. Figure 1 shows an example of the resulting CDA string.

```
<?xml version="1.0" encoding="iso-8859-1" ?>
- <levelone>
  - <clinical_document_header>
      <id EX="a123" RT="2.16.840.1.113883.3.933" />
      <version_nbr V="1" />
      <document_type_cd V="11490-0" S="2.16.840.1.113883.6.1" DN="Kurzarztbrief" />
      <origination_dttm V="2002-07-22" />
      <confidentiality_cd ID="CONF1" V="N" S="2.16.840.1.113883.5.10228" />
    - <patient_encounter>
        <id EX="000001" RT="UKMGWI" />
        <practice_setting_cd V="GACH" S="2.16.840.1.113883.5.10588" DN="General acute care hospital" />
        <encounter_tmr V="905" />
      - <service_location>
          <id EX="Klinik und Poliklinik für Urologie" RT="UKMGWI" />
        - <addr>
            <STR V="Albert-Schweitzer-Str. 33" />
            <CTY V="Münster" />
            <ZIP V="48149" />
          </addr>
        - <local_header>
            <local_attr name="Fax" value="0251 83-49739" />
            <local_attr name="Email" value="urologie@uni-muenster.de" />
            <local_attr name="Internet" value="http://urologie.uni-muenster.de" />
          </local_header>
        </service_location>
      </patient_encounter>
```

Figure 1: CDA document (patient encounter section)

- Second, on users' request during execution of the form, the string has to be exported, encrypted, signed, and finally mailed to the intended recipients. These tasks were not supported by the development tool – an external process had to be created, which is invoked out of the form receiving all relevant information (e.g. CDA string, recipients) using Dynamic Data Exchange (DDE). This process was written in Borland Delphi [9] and uses GnuPG, an open source project aiming to provide tools for secure communication and data storage [10] for signing and encryption of the CDA document.

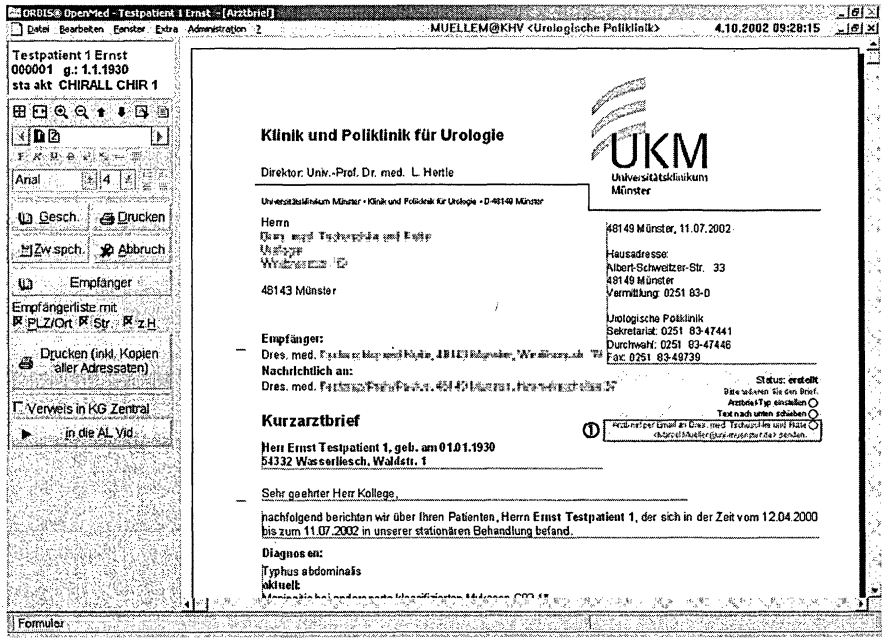

Figure 2: HIS data entry form for discharge letter

Results

Figure 2 shows a screenshot of the data entry form for discharge letters inside the hospital information system. This is used to compose a short discharge letter, which is normally printed and handed to the patient.

If the intended recipient participates in the project, an additional button for sending the discharge letter via email ① is presented automatically. With a click on that button, a cascade of processes will be initiated (Figure 3):

- After the CDA string is generated within the form, the external Delphi application is launched ①, setting up a DDE server for data exchange. The form pushes the CDA string and recipient information to the application through a DDE channel ②. Since at present no primary care information system can handle pure CDA documents, the CDA string has to be converted to a better readable format like hypertext markup language (HTML). The application triggers an Extensible Stylesheet Language (XSLT) processor, which transforms the XML formatted document to HTML using a predefined XSLT style sheet ③. This HTML file will then be signed and encrypted with the recipient's public key and signed with the hospital's private key using GnuPG ④, and emailed as an attachment to the recipient ⑤. Finally, a status information will be sent to the form and the DDE channel will be closed by the server ⑥.
- On the recipients' side, the attachment has to be decrypted with the respective private key and can then be integrated in the physician office system ⑦.

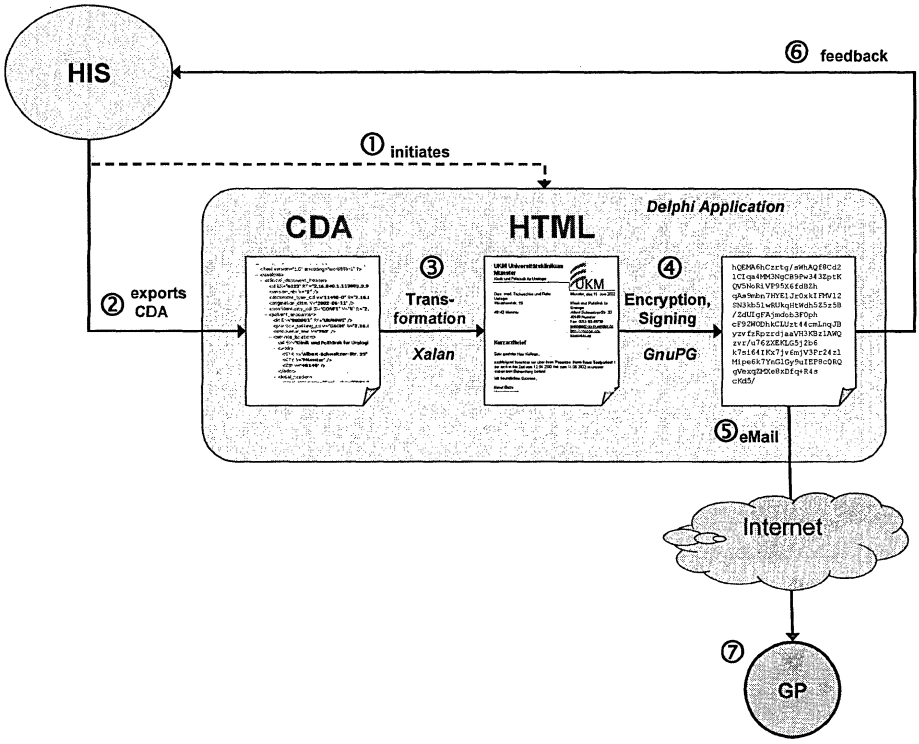

Figure 3: communication pathways

Discussion

We have proposed an easy-to-use and point-to-point interface for exchanging discharge letters. It is integrated in both the clinical and the practice workflow so doctors on both sides benefit from it without additional effort. The presented use of cryptographic software provides a secure data exchange. Currently we are introducing the system in the urology department and several GP offices – users' acceptance is encouraging but has to be evaluated in the future.

The clinical document architecture proved to be a valuable and flexible standard for electronic data exchange among different actors in the healthcare domain. CDA level one has some limitations in the granularity of the clinical content, but this will be ameliorated in coming versions. Since at present no commercially available information system can handle native CDA documents we were forced to reduce the CDA document to an unstructured but better readable HTML file. So it is highly desirable that software vendors start adopting CDA technology in order to establish a structured data exchange which crosses institutional and software borders.

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