CDA R2 based document repository: a true Swiss Army Knife. Functionality: contingency support

Fernando Campos[1,2], **Matias Blanco**[1], **Daniel Luna**[1], **Fernán González B. de Quirnós**[1]

[1] Health Information Department, Hospital Italiano de Buenos Aires, Argentina

[2] HL7 Argentina

Abstract

The pervasive use of electronic records in healthcare increases the dependency on technology due to the lack of a physical support for the records. Downtime in the EHR system is unavoidable, due to software, infrastructure, energy failures or even natural disasters, so there is a need to develop a contingency plan ensuring patient care continuity and minimizing risks on health care delivery. To mitigate these risks, an application was developed allowing healthcare delivery providers to retrieve medication prescriptions for inpatient or emergency care patients using the CDA R2 document repository as information source. In this paper we describe the strategy and the implementation results.

Keywords

Electronic Health Record, CDA repository, contingency plan.

Correspondence to:

Fernando Campos
Health Information Department,
Hospital Italiano de Buenos Aires, Argentina
Address: Juan D. Perón 4190 (C1199ABD) Buenos Aires, Argentina
E–mail: fernando.campos@hospitalitaliano.org.ar

EJBI 2015; 11(2):en3-en6
received: October 12, 2014
accepted: January 8, 2015
published: January 20, 2015

1 Introduction

There is an increasing use of the HL7 CDA R2 (Clinical Document Architecture Release 2) in implementations requiring document level exchange, being interoperability the main goal [1, 2, 3]. There is also an increasing use of the electronic health record, specifically the replacement of the paper based health record to the use of Electronic Health Records (EHR) [4]. Therefore, every healthcare delivery process relies on information systems to ensure patient care. One of the biggest documented risks for continuity of patient care are mistakes in medication administration [5].

Revising all the Hospital Italiano own experiences and pertinent literature, it has been observed that when all 'redundancy' and 'control' instances designed as support to business continuity are exhausted, alternate ad-hoc methods are triggered for the protection of information which is considered crucial [6, 7].

The goal of this paper is describe the implementation of an architecture based on the CDA R2 document repository which allows physicians and nurses retrieval of the patient EHR in the case of partial system downtime, and medication prescriptions for inpatients in case of total system downtime.

2 Materials and Methods

The Hospital Italiano of Buenos Aires (HIBA) is a non-profit health care academic center founded in 1853. HIBA has a network of two hospitals with 750 beds (250 for intensive care), 800 home care patients under care, 25 outpatients care centers, and 41 surgery rooms. There are more than 2800 healthcare agents, and 1900 administrative and support staff. During 2013-2014 there were 45,000 inpatient episodes, 3,000,000 outpatient visits annually, and 45,000 surgeries (half of them for outpatients).

Since 1998 HIBA began the gradual implementation of a Healthcare Information System (HIS) based on an 'in-house' development, from capture to analysis. It includes a web based, modular, problem oriented and patient centered EHR. This EHR is known as ITALICA and allows inpatient, outpatient, domiciliary and emergency care records. ITALICA also allows ancillary services order, medication prescription, and results visualization including Imaging through a PACS (picture archiving and Communications system)

The EHR has a relational database record and also a CDA R2 document based repository, which is digitally signed by professionals participating in healthcare delivery. This repository is used to interoperate with payers, other EHRs and to make information portable for patients or other external healthcare providers. Currently there are 36.400.000 CDAs. In the document repository [8].

This kind of repository allows the organization to operate without the need for a paper record, because information exchange between actors or systems is facilitated by these documents.

For instance, for ancillary systems like Imaging or Laboratory, the order is no longer paper based but a digitally signed CDA R2. Likewise, result reports are not printed, but reviewed directly in the EHR through a CDA R2 sent by the ancillary service.

Since 2012, and based on this implementation, all the procedures and communications for business continuity while systems recover from a meaningful interruption where redesigned, mainly for the inpatient setting.

```
Document Date:
/ClinicalDocument/effectiveTime/@low
Document Type:
/ClinicalDocument/code/@code
Service:
/ClinicalDocument/legalAuthenticator/assignedEntity/representedOrganization/id/@extension
/ClinicalDocument/legalAuthenticator/assignedEntity/representedOrganization/id/@assigningAuthorityName
Patient
id:  /ClinicalDocument/recordTarget/patientRole/id/@root
root:  /ClinicalDocument/recordTarget/patientRole/id/@extension
First Name:  /ClinicalDocument /recordTarget/patientRole /patient /name/@given [1]
```

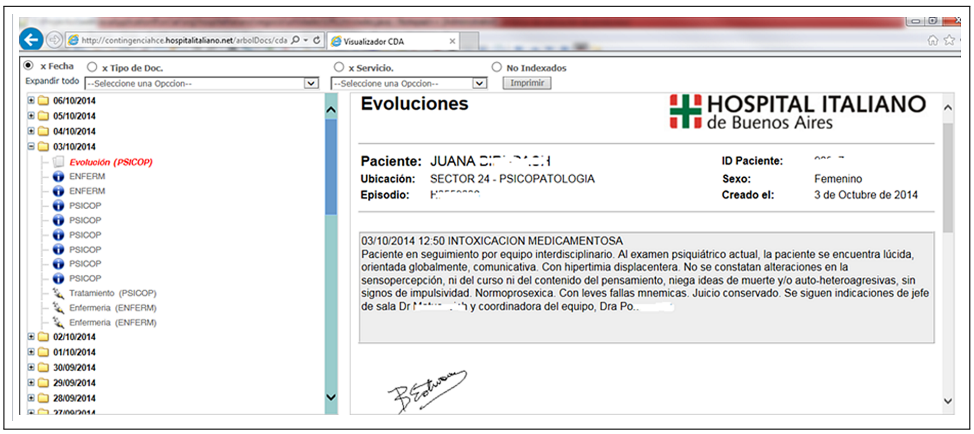

Figure 1: CDA Navigator.

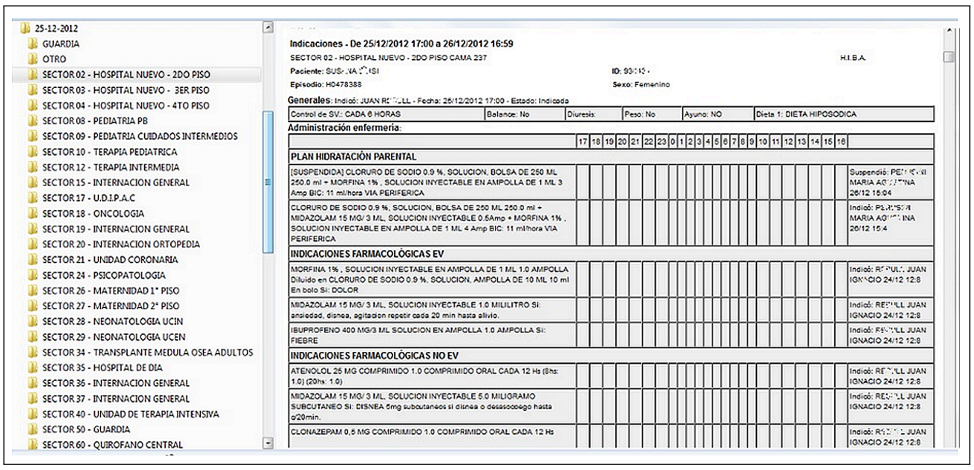

Figure 2: File Explorer for Level 2 Contingency.

Table 1: Downtime record and contingency use.

Date	Month	Year	Class	Motive	Begin Time	End Time	Total Time	Contingency level
08	March	2012	unplanned downtime	EHR Bug	9:15 AM	3:10 PM	5:55	Level 1
05	April	2012	unplanned downtime	database issues	11:10 PM	1:10 AM	2:00	Level 2
07	April	2012	planned downtime	Database maintenance	8:00 PM	10:00 PM	2:00	Level 2
27	April	2012	unplanned downtime	EHR Bug	9:50 AM	4:05 PM	6:15	Level 1
12	May	2012	planned downtime	Upgrade Database version	10:40 PM	6:30 AM	7:50	Level 2
09	June	2012	planned downtime	Increase Server memory	10:00 PM	5:00 AM	7:00	Level 2
29	December	2012	unplanned downtime	EHR Bug	5:30 AM	10:00 AM	4:30	Level 1
23	April	2013	unplanned downtime	Shutdown power server energy	5:30 AM	6:31 AM	25:01	Level 2
26	April	2013	unplanned downtime	Router down. Areas without networking	12:30 PM	1:30 PM	1:00	Level 2[1]
27	April	2013	planned downtime	Server Maintenance	6:00 PM	9:00 PM	3:00	Level 2
25	May	2013	planned downtime	Server Maintenance	4:00 PM	9:05 PM	5:05	Level 2
15	June	2013	planned downtime	Server maintenance	5:00 PM	12:38 AM	7:38	Level 2
26	July	2013	planned downtime	Install new database cluster	8:00 PM	9:30 AM	13:30	Level 2
14	September	2013	planned downtime	Upgrade switches firmware	6:00 PM	8:00 PM	2:00	Level 2
11	January	2014	planned downtime	Upgrade switches firmware	2:00 AM	6:30 AM	4:30	Level 2
24	June	2014	unplanned downtime	Database issue	12:10 PM	1:20 PM	1:10	Level 2

`Last name: /ClinicalDocument /recordTarget/patientRole /patient/name/@family`

Two levels of contingency were identified.

First, at an application level. In this level, only the EHR is not available. Causes may be a problem in a new version deployment or server issues. The entire infrastructure is available: database, networking, electric energy etc.

The second level is total impact. Usually this level of contingency occurs when the database server is down or halted during upgrades or maintenance work, data center problems affecting the server farm or storage, network outages or natural disasters.

The decision was to leverage the redundancy generated by the documentary repository to support contingency processes.

In order to mitigate the first level of contingency, a CDA navigator was developed, having as indexes some of the elements in the CDA header (metadata)

Using this index, a tree is generated, and this tree is accessed based on the patient information. From the tree root (target patient) the timeline for the inpatient (day by day) can be navigated. After selecting a specific date, the caregiver can access all the documents for the visit grouped by document type and service.

This application is deployed in a distinct server from the EHR, and with a different and redundant database. If by any-chance the EHR is not available, the document based EHR at least can be retrieved.

The second level of contingency assumes total lack of database support, application server support, energy or network connections.

In this extreme case, and only for inpatient and emergency care (average 720 beds) it was evaluated which information is essential for healthcare delivery without risks for the patient.

In this regards, two elements were key: access to the patient's prescriptions: medications, doses, indications, and diets, and proper labeling for samples or patient elements.

Based on this requirement, an application was designed. The application access every 30 minutes to the last indications for each inpatient.

Based on the documents, each computer running the application stores in a local disk a folder tree organized by service and inpatient location, where there is every indication CDA for each location.

Two folders are alternatively used for this repository. This application runs redundantly in several computers in locations strategically selected, and can only be used in contingency. These computers have a local printer and connection to the backup energy line, with UPS and printer paper stock.

In the case of natural disasters, application server downtime, database downtime, or any other contingency, these computers can be used to print the indications, and deliver health care continuity for all the inpatients in the hospital

[1] affected areas only

3 Results

Creating this backup querying the relational system generates an average of 18 queries involving 44 tables for patient. Since there are an average of 720 beds, 12960 queries would be needed every 30 minutes, and then the composition of the HTML to render for the user in screen.

Using the CDA repository, only 1 query is needed, involving a snapshot of the current active inpatients or emergency care episodes, and the query to the document repository for the URL for the last indications CDA for the patient. Rendering the information only requires transformation of the XML using an XSLT stylesheet.

Since implemented, usage record is presented in Table 1.

As an example, when there was a change of servers and database servers' operating system migration, there was a downtime for 13.30 hours. In this episode, all indications were printed. 1250 paper sheet were used, printing 759 indications in 1 hour 15 minutes.

The printing process has a predefined sequence, prioritizing critical care units, emergency care, pediatric care, and then other services and locations.

4 Discussion

This architecture allowed information to be available from all delivery care locations, and allows every actor requiring the information to access it. Portability was achieved because every record in the EHR can be shared with any individual or organization requiring access to the information.

The alternate folder strategy was required because in one of the tests if networking or energy were interrupted when the folder was being generated, its structured could be corrupted. If this happens, the other folder can be accessed.

No other experience in creating this kind of repository was found in the literature, used as redundant repository or contingency.

References

[1] Jun Liang et al. Increasing the Meaningful Use of Electronic Medical Records: A Localized Health Level 7 Clinical Document Architecture System. (2010) China: Springer Berlin Heidelberg.

[2] Kussaibi H, et al. HL7 CDA implementation guide for structured anatomic pathology reports methodology and tools. Studies in Health Technology and Informatics. (2010). 160(Pt 1):289-293.

[3] Gomes, A; Campos F et al. Implementación del Clinical Document Architecture Standard en un sistema de información. (2006). Presentación en CBIS'2006 - X Congresso Brasileiro de Informática em Saúde. Florianopolis, Brasil.

[4] Wright, S. Henkin, J. Feblowitz, A.B. McCoy, D.W. Bates, D.F. Sittig, Early results of the meaningful use program for electronic health records, N. Engl. J. Med. 368 (February (8)) (2013) 779–780, http://dx.doi.org/10.1056/NEJMc1213481.

[5] Hanuscak TL, Szeinbach SL, Seoane-Vazquez E, Reichert BJ, McCluskey CF. Evaluation of causes and frequency of medication errors during information technology downtime. Am J Health Syst Pharm. 2009 Jun 15;66(12):1119-1124.

[6] P. Kilbridge, Computer crash – lessons from a system failure, N. Engl. J. Med. 348 (March (10)) (2003) 881–882.

[7] J. Merrick, 'Serious' computer crash hits hospital trusts, Daily Mail (July 31, 2006) 3984, Available at: http://www.dailymail.co.uk/news/article-77/Serious-crash-hits-hospital-trusts.html

[8] Campos F, Plazzotta F, Luna D, Baum A, de Quirós FG. Developing and implementing an interoperable document-based electronic health record. Stud Health Technol Inform. 2013; 192 1169. PubMed PMID: 23920943.

