

# Big Data in Medical Informatics

## Assignment #2

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## Problem 1

### Solution

The Grammar of the given HL7 message is as follows:

MSH EVN PID {NK1} PV1 [PV2] ROL {OBX} DG1 GT1 IN1

## Problem 2

### Solution

The HL7 message can be constructed as follows:

```
MSH|^~\&|LIS|GOODHEALTHHOSPITAL|HIS|GENERALHOSPITAL|201603101230|
|ORU^R01|||2.3
PID|||111222||BLACK^JOE|BROWN|19800126|M|||||English|||
30934|982493|||SOUTHDAYTON^BUFFALO||UK|
OBR||2495|49034|^55399-0^^D01^DiabetMonitor||201603281700||
||||201603290800||
3439^KLEIN^JANE^M^^DR||||||F|
OBX|1||CE^4548-4^^A334^AICTest||6.7||H||F|
```

## Problem 3

### Solution

- Message Structure

The Message Structure of the CDA message is illustrated in **Figure 1**:

- Applied Template

The templates applied in this CDA message are given below in **Table 1**.

- Applied Constraints

Some of the applied constraints in this CDA document are shown in **Figure 2 and Figure 3**. The full list of constraints applied in this template on this website: <http://ccda.art-decor.org/> by searching for the desired Template ID.

Template Code	Name of Template	Type
2.16.840.1.113883.10.20.22.1.1	US Realm Header Template	Document Level
2.16.840.1.113883.10.20.22.1.2	ContinuityofCareDocumentCCD	Document Level
2.16.840.1.113883.10.20.22.2.1	MedicationsSectionentriesoptional	Section Level
2.16.840.1.113883.10.20.22.2.1.1	MedicationsSectionentriesrequired	Section Level
2.16.840.1.113883.10.20.22.4.16	MedicationActivity	Entry Level
2.16.840.1.113883.10.20.22.4.23	MedicationInformation	Entry Level
2.16.840.1.113883.10.20.22.4.24	DrugVehicle	Entry Level
2.16.840.1.113883.10.20.22.4.19	Indication	Entry Level
2.16.840.1.113883.10.20.22.4.17	Medication Activity	Entry Level
2.16.840.1.113883.10.20.22.4.20	Instructions	Entry Level
2.16.840.1.113883.10.20.22.4.18	MedicationDispense	Entry Level
2.16.840.1.113883.10.20.22.4.25	PreconditionforSubstanceAdministration	Entry Level

Table 1: Templates Used in the CDA Document

## Problem 4

### Solution

1. A simplified data exchange model is illustrated in **Figure 4**. The basic concept idea behind the model is to have a centralized server and data storage facility for the hospital to coordinate the data exchange among the different departments. The server should in turn have access to the internet in order to facilitate data exchange over the network with other hospitals, payers and continuity of care providers.
  - (a) **Telephone Call to Care Team:** The care team needs to quickly get access to summarized medical continuity-of-care data from the hospital that the patient currently gets treatment from. This should be in a human-readable format.
  - (b) **Within the work group:** Within the work group (e.g. Orthopedic Department or Radiology Department), the communication should be facilitated by the server of the work group or the centralized server. This data exchange should be in a machine-readable format.
  - (c) **Requests (orders) and reports between clinicians and diagnostic and treatment departments:** When the Emergency department needs to order a Radiology report, it should be able to make a request with the centralized server, which can then pass on the request to the Radiology Department. This communication should be in a machine-readable format.
  - (d) **Across organization boundaries between hospital, GP, and community staff, to ensure continuity of care:** This should be facilitated by the the

central server, using the internet and firewall security. The data exchange format should be machine-readable and interoperable, e.g HL7. E.g. The endocrine department of Hospital Y will be able to communicate with the Emergency department of Hospital X via their respective Central Servers over the internet.

- (e) **From the care provider to payers and regulatory agencies, for revenue and accountability:** This includes the insurance company, employer(s), and/or government bodies. This should also be facilitated by the central server, and the final data should be human-readable. A standard such as CDA can be used for this.

2. Following Health Data Exchange Standards can be utilized in this use case:

- (a) **Central Repository and PACS System:** HL7, DICOM, LOINC, SNOMED-CT compliant
- (b) **Continuity of Care Record:** HL7, CDA compliance
- (c) **Radiology Department:** HL7, DICOM compliance
- (d) **Ambulance/Emergency Care Team:** HL7, CDA compliance

- CDA HEADER
- CDA BODY
  - SECTIONS
    - ADVANCE DIRECTIVES
      - Entries
    - ALLERGIES, ADVERSE REACTIONS, ALERTS
      - Entries
    - ASSESSMENT
      - Entries
    - ENCOUNTERS
      - Entries
    - FAMILY HISTORY
      - Entries
    - FUNCTIONAL STATUS
      - Entries
    - IMMUNIZATIONS
      - Entries
    - INTERVENTIONS
      - Entries
    - MEDICATIONS
      - Entries
    - PAYERS
      - Entries
    - PLAN OF CARE
      - Entries
    - PROBLEM LIST
      - Entries
    - PROCEDURES
      - Entries
    - RESULTS
      - Entries
    - SOCIAL HISTORY
      - Entries
    - VITAL SIGNS
      - Entries

Figure 1: Message Structure of the CDA Document



















Item	DT	Card	Conf	Description	Label
cda:ClinicalDocument					(USRealmHea
└ cda:realmCode		1 .. 1	M	SHALL contain exactly one [1..1] realmCode="US" (CONF:16791).	conf-16791
└ cda:typeId		1 .. 1	M	SHALL contain exactly one [1..1] typeId (CONF:5361).	conf-5361
└ @root		1 .. 1	F	2.16.840.1.113883.1.3	
└ @extension		1 .. 1	F	POCD_HD000040	
└ cda:templateId		1 .. 1	M	SHALL contain exactly one [1..1] templateId (CONF:5252) such that it	conf-5252
└ @root		1 .. 1	F	2.16.840.1.113883.10.20.22.1.1	
└ cda:id		1 .. 1	M	SHALL contain exactly one [1..1] id (CONF:5363).	conf-5363
				This id SHALL be a globally unique identifier for the document	
└ cda:code		1 .. 1	M	SHALL contain exactly one [1..1] code (CONF:5253).	conf-5253
└ cda:title		1 .. 1	M	SHALL contain exactly one [1..1] title (CONF:5254).	conf-5254
				can either be a locally defined name or the display name corresponding to clinicalDocument/code	
└ cda:effectiveTime		1 .. 1	M	SHALL contain exactly one [1..1] effectiveTime (CONF:5256).	conf-5256
				The content SHALL be a conformant US Realm Date and Time (DTM.US.FIELDDED) (2.16.840.1.113883.10.20.22.5.4)	
	Schematron assert	role	error		
	test			string-length(cda:effectiveTime/@value)>=8	
	Message			The content SHALL be a conformant US Realm Date and Time (DTM.US.FIELDDED) (2.16.840.1.113883.10.20.22.5.4)	
└ cda:confidentialityCode		1 .. 1	M	SHALL contain exactly one [1..1] confidentialityCode, which SHOULD be selected from ValueSet HL7 BasicConfidentialityKind 2.16.840.1.113883.1.11.16926 STATIC 2010-04-21 (CONF:5259).	conf-5259
	CONF			The value of @code shall be drawn from value set 2.16.840.1.113883.1.11.16926 HL7 BasicConfidentialityKind (DYNAMIC)	
└ cda:languageCode		1 .. 1	M	SHALL contain exactly one [1..1] languageCode, which SHALL be selected from ValueSet Language 2.16.840.1.113883.1.11.11526 DYNAMIC (CONF:5372).	conf-5372
	CONF			The value of @code shall be drawn from value set 2.16.840.1.113883.1.11.11526 Language (DYNAMIC)	
└ cda:setId		0 .. 1		MAY contain zero or one [0..1] setId (CONF:5261).	conf-5261
				If setId is present versionNumber SHALL be present	
	Schematron assert	role	error		
	test			count(..//cda:versionNumber   ..//cda:setId)=2 or count(..//cda:versionNumber   ..//cda:setId)=0	
	Message			If setId is present versionNumber SHALL be present	
└ cda:versionNumber		0 .. 1		MAY contain zero or one [0..1] versionNumber (CONF:5264).	conf-5264
				If versionNumber is present setId SHALL be present	
	Schematron assert	role	error		
	test			count(..//cda:versionNumber   ..//cda:setId)=2 or count(..//cda:versionNumber   ..//cda:setId)=0	
Item	DT	Card	Conf	Desc	Label
cda:ClinicalDocument				The component/structuredBody SHALL conform to the section constraints below	conf-737
 cda:templateId	II	1..1	M		conf-9441
 @root		1..1	F	2.16.840.1.113883.10.20.22.1.1	
 cda:templateId	II	1..1	M		conf-8450
 @root		1..1	F	2.16.840.1.113883.10.20.22.1.2	
 cda:code	CD	1..1	M		conf-8451
 @code		1..1	F	34133-9	
 @codeSystem		1..1	F	2.16.840.1.113883.6.1	
 @displayName		1..1	F	Summarization of Episode Note	
 cda:documentationOf		1..1	M		conf-8452
 cda:serviceEvent		1..1	M		conf-8480
 @classCode		1..1	F	PCPR	
 cda:effectiveTime	IVL_TS	1..1	M		conf-8481
 cda:low	TS	1..1	M		conf-8454
 cda:high	TS	1..1	M		conf-8455
 cda:performer		0..*	R	serviceEvent/performer represents the healthcare providers involved in the current or pertinent historical care of the patient. Preferably, the patient's key healthcare providers would be listed, particularly their primary physician and any active consulting physicians, therapists, and counselors	conf-8482
 @typeCode		1..1	F	PRF	
 cda:assignedEntity		0..1	O		conf-8459
 cda:id	II	1..*	M		conf-8460
	Schematron assert	role	error		
	test			@root=2.16.840.1.113883.4.6'	

Figure 2: Applied Constraints for the CDA Message - Part 1

Item	DT	Card	Conf	Desc	Label
cda:section					conf-639
 cda:templateId	II	1..1	M		conf-7568
 @root		1..1	F	2.16.840.1.113883.10.20.22.2.1.1	
 cda:code		1..1	M		conf-7569
 @code		1..1	F	10160-0	
 @codeSystem		1..1	F	2.16.840.1.113883.6.1	
 @displayName		1..1	F	History of medication use	
 cda:title	ST	1..1	M		conf-7570
 cda:text	ED	1..1	M		conf-7571
 cda:entry		1..*	M	If medication use is unknown, the appropriate nullFlavor MAY be present (see unknown information in Section 1)	conf-7572
Contains an element with template id 2.16.840.1.113883.10.20.22.4.16 with overridden cardinality 1 .. * mandatory					
Item	DT	Card	Conf	Description	Label
cda:substanceAdministration				Medication Activity SHOULD include doseQuantity OR rateQuantity	(MedicationActivity)
└ @classCode		1 .. 1	F	SBADM	
└ @moodCode		1 .. 1	R		
			CONF	The value of @moodCode shall be drawn from value set 2.16.840.1.113883.11.20.9.18 MoodCodeEvnInt (DYNAMIC)	
└ cda:templateId		1 .. 1	M	SHALL contain exactly one [1..1] templateId (CONF:7499) such that it	conf-7499
└└ @root		1 .. 1	F	2.16.840.1.113883.10.20.22.4.16	
└ cda:id		1 .. *	M	SHALL contain at least one [1..*] id (CONF:7500).	conf-7500
└ cda:code		0 .. 1		MAY contain zero or one [0..1] code (CONF:7506).	conf-7506
└ cda:text		0 .. 1	R	SHOULD contain zero or one [0..1] text (CONF:7501).	conf-7501
└└ cda:reference		0 .. 1	R	The text, if present, SHOULD contain zero or one [0..1] reference (CONF:15977). This reference/@value SHALL begin with a '#' and SHALL point to its corresponding narrative (using the approach defined in CDA Release 2, section 4.3.5.1)	conf-15977
└└└ @value		0 .. 1			
			Schematron assert	role error	
			test	count(cda:text/cda:reference[@value])=0 or starts-with(cda:text/cda:reference/@value, '#')	
			Message	This reference/@value SHALL begin with a '#' and SHALL point to its corresponding narrative (using the approach defined in CDA Release 2, section 4.3.5.1)	
└ cda:statusCode		1 .. 1	M	SHALL contain exactly one [1..1] statusCode (CONF:7507).	conf-7507
└ cda:effectiveTime		1 .. 1	M	SHALL contain exactly one [1..1] effectiveTime (CONF:7508) such that it	conf-7508
└└ cda:low		1 .. 1	M	SHALL contain exactly one [1..1] low (CONF:7511).	conf-7511
└└ cda:high		1 .. 1	M	SHALL contain exactly one [1..1] high (CONF:7512).	conf-7512
└ cda:effectiveTime		0 .. 1	R	SHOULD contain zero or one [0..1] effectiveTime (CONF:7513) such that it SHALL contain exactly one [1..1] @xsi:type="PIVL_TS" or "EIVL_TS"	conf-7513
└└ @operator		1 .. 1	F	A	
			Schematron assert	role error	
			test	count(cda:effectiveTime) = 2 and cda:effectiveTime[@operator='A'][@xsi:type='PIVL_TS' or @xsi:type='EIVL_TS']	

Figure 3: Applied Constraints for the CDA Message - Part 2

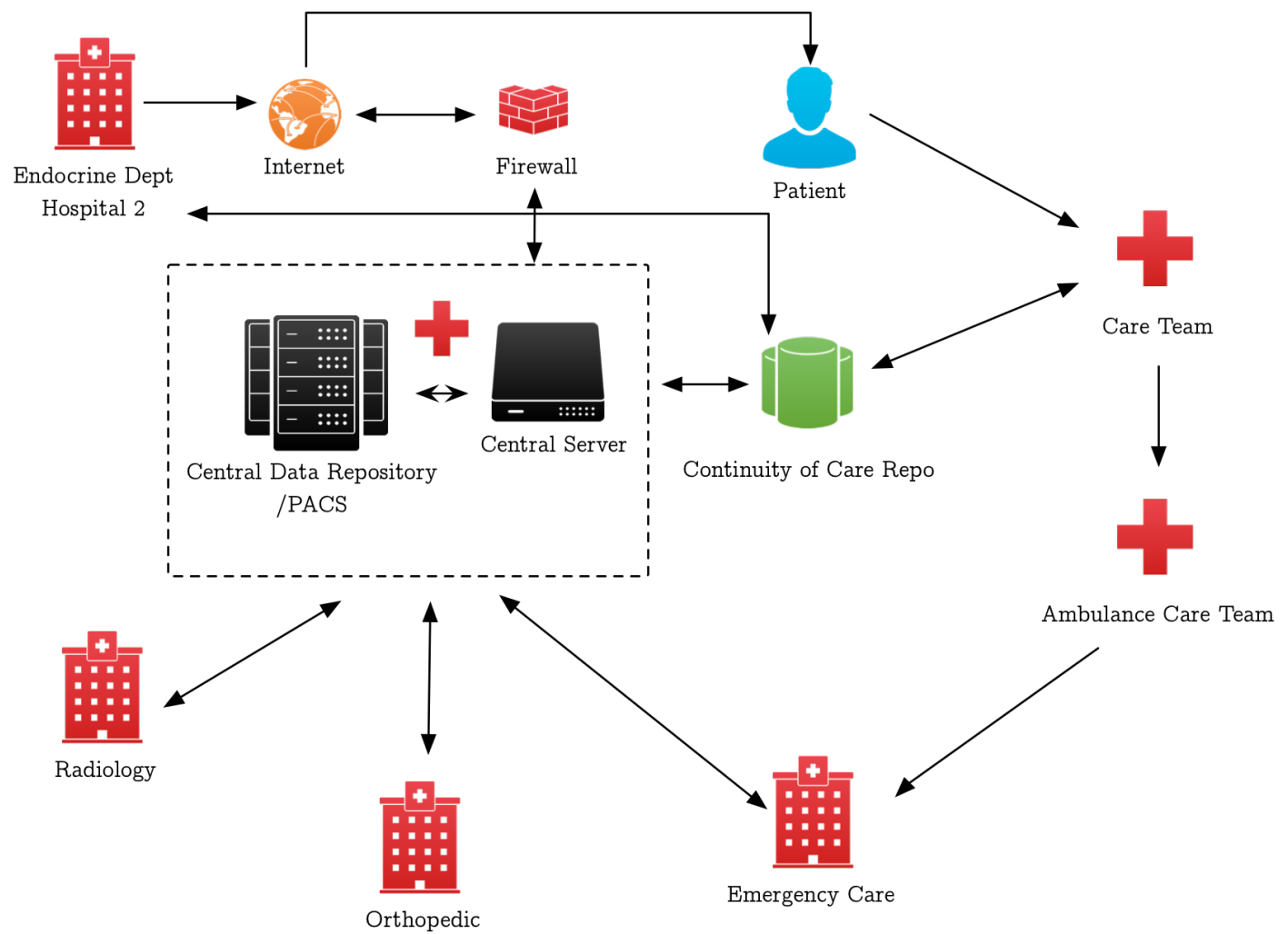


Figure 4: Concept Diagram Data Exchange Model