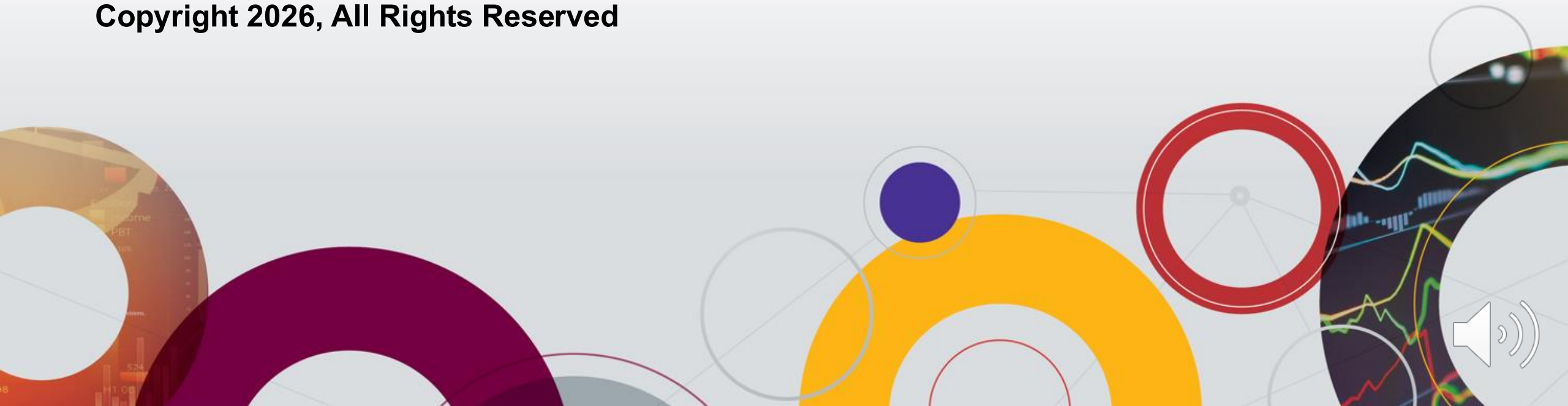


4.3 Message Exchange Standards

10x10 – Introduction to Biomedical Informatics & Artificial Intelligence
William Hersh, MD, FACMI, FAMIA, FIAHSI
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Message exchange standards

Health Level 7 (HL7): V2, V3, Fast Healthcare Interoperability Resources (FHIR), and Clinical Document Architecture (CDA)

Images: Digital Imaging and Communications (DICOM)

ePrescribing: NCPDP and SCRIPT

Patient summaries: Continuity of Care Document (CCD)

Health Level 7 International (HL7)

Major standards development organization for healthcare

Name based on OSI seven-layer model of network communications

HL7 messaging standards

- Version 2 widely used and syntactic-oriented
- Version 3 still minimally adopted; aims for semantic interoperability
- FHIR may solve reconciliation of these

Documentation less than ideal but

- Standards documents on Web site with voluminous detail
- Overview book (Benson, 2021)
- [Case studies and white papers](#)

HL7, version 2

(Henderson, 2007; Bhagat, 2015; Benson, 2021)

Current versions (2.X) supported by most vendors for interchange of data

Implemented by bar-delimited ASCII files

Is mostly a syntax, where sender and receiver must understand meaning of messages, but subsequent versions adding more semantics (meaning)

Each message has segments consisting of three-character identifier and values, e.g.,

- MSH – message header
- EVN – event type
- PID – patient identifier
- PV1 – provider identifier
- OBR – results header
- OBX – result details

HL7 version 2.5 example (Benson, 2021)

MSH ^~\& ^123457^Labs 200808141530 ORU^R01 123456789 P 2.4	Report from Lab123457, 15:30 14-Aug-2008, Ref 123456789
PID 123456^^^SMH^PI MOUSE^MICKEY 19620114 M 14 Disney Rd^Disneyland^^^MM1 9DL	Patient: MICKEY MOUSE, DoB: 14-Jan-1962, M, Address: 14 Disney Rd, Disneyland, MM1 9DL
PV1 5N G123456^DR SMITH	Provider: Dr. Smith (G123456), Ward: 5N
OBR 54321 666777^CULTURE^LN 20080802 S W^^^FOOT^RT C987654	Specimen: Swab, FOOT, Right, Requested By: C987654
OBX CE 0^ORG 01 STAU F	Organism: STAU (Staphylococcus aureus)
OBX CE 500152^AMP 01 R F	Susceptibility:
OBX CE 500155^SXT 01 S F	AMP R
OBX CE 500162^CIP 01 S F	SXT S
	CIP S

Another HL7 version 2.5 example (Hammond, 2014)

```
MSH|^~&\\DHIS|OR|TMR|SICU|199212071425|password|ADT|16603529|P|2.1<cr>
EVN|A02|199212071425||<cr>
PID|||Z99999^5^M11||GUNCH^MODINE^SUE|RILEY|19430704 |F||C|RT. 1, BOX
97^ZIRCONIA^NC^27401 |HEND|(704)982-1234|(704)983-1822||S|C||245-33-9999<cr>
PV1|1||N22^2204||OR^03|0940^DOCTOR^HOSPITAL^A||SUR||||A3<cr>
OBR|7|||93000^EKGREPORT|R|199401111000|199401111330||RMT||||1994011111330
|?|P030||||199401120930||||88-126666|A111|VIRANYI^ANDREW<cr>
OBX|1|ST|93000.1^VENTRICULAR RATE(EKG)||91|/MIN|60-100<cr>
OBX|2|ST|93000.2^ATRIAL RATE(EKG)||150|/MIN|60-100<cr>
...
OBX|8|ST|93000&IMP^EKG DIAGNOSIS|1|^ATRIAL FIBRILATION<cr>
```

Releases of HL7 V2

V2.1 (1990): First implemented version - very basic, but still used

V2.2 (1994): Basic enhancements

V2.3 (1997): Scheduling and Finance messages added

V2.3.1 (1999): Pathology, Allergies, Referral as Scheduling

V2.4 (2000): Clinical Focus - Referrals and Discharge Summaries

V2.5 (2003): Data field lengths standardized

V2.5.1 (2007): Four data items added due to US regulatory requirements

V2.6 (2007): Data type changes

- Coded Element (CE) → Coded With (No) Exceptions (CNE/CWE)
- Time Stamp (TS) → Date/Time (DTM)

V2.7 (2011): Collaborative Care Message

V2.7.1 (2012): Lab Orders/Results features added for US “Meaningful Use”

V2.8 (2014): Authorization and Ordering information added

V2.9 (2019): Adds security labeling

HL7 version 3 (Hinchley, 2005)

Attempted to introduce semantics (meaning, also termed computable semantic interoperability) beyond syntax of version 2

- Differences demonstrated in (Spronk, 2007)

Based on Reference Information Model (RIM), an object model of entities that pass messages (Mead, 2005)

- Implemented in eXtensible Mark-Up Language (XML)

Thought by many to be overly complicated, never achieved widespread adoption

- Some aspects have been called “incoherent” (Smith, 2006)

Fast Healthcare Interoperability Resources (FHIR)

Response to complexity of HL7 V3, but maintaining compatibility with other HL7 standards, e.g., Clinical Document Architecture (CDA) (Benson, 2016; Braunstein, 2022)

Uses “modern” application programming interface (API) approach but less detailed semantics than HL7 V3

Key component is Resource, which defines and represents data elements

More in 4.5

Additional activities of HL7

Clinical Context Management Specification (CCOW)

Clinical Decision Support Workgroup

(many more)

Clinical Document Architecture (CDA)

Clinical Document Architecture (CDA) (Boone, 2011; Benson, 2021)

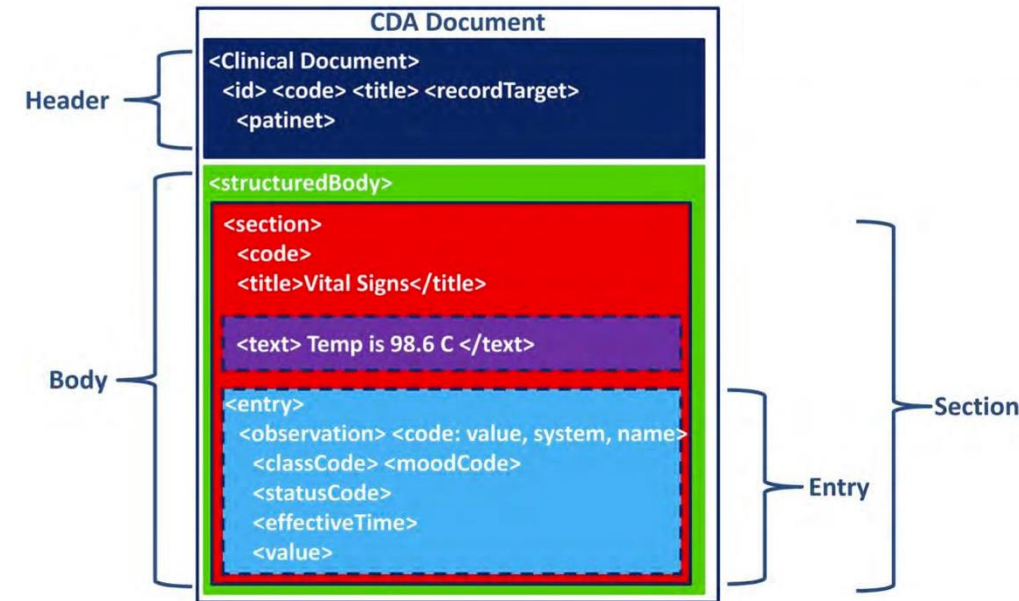
Much healthcare information is in “documents” required for human reading, but still want computable structure

CDA defines XML-based standard structure and elements for clinical documents

- Templates are reusable, computable components of CDA documents
- “Unstructured” documents can be “wrapped” in CDA framework

CDA documents contain

- Header – metadata about patient, author, type, date, etc.
- Body – one or more sections composed of
 - Narratives – human-readable entries (unstructured)
 - Entries – structured data



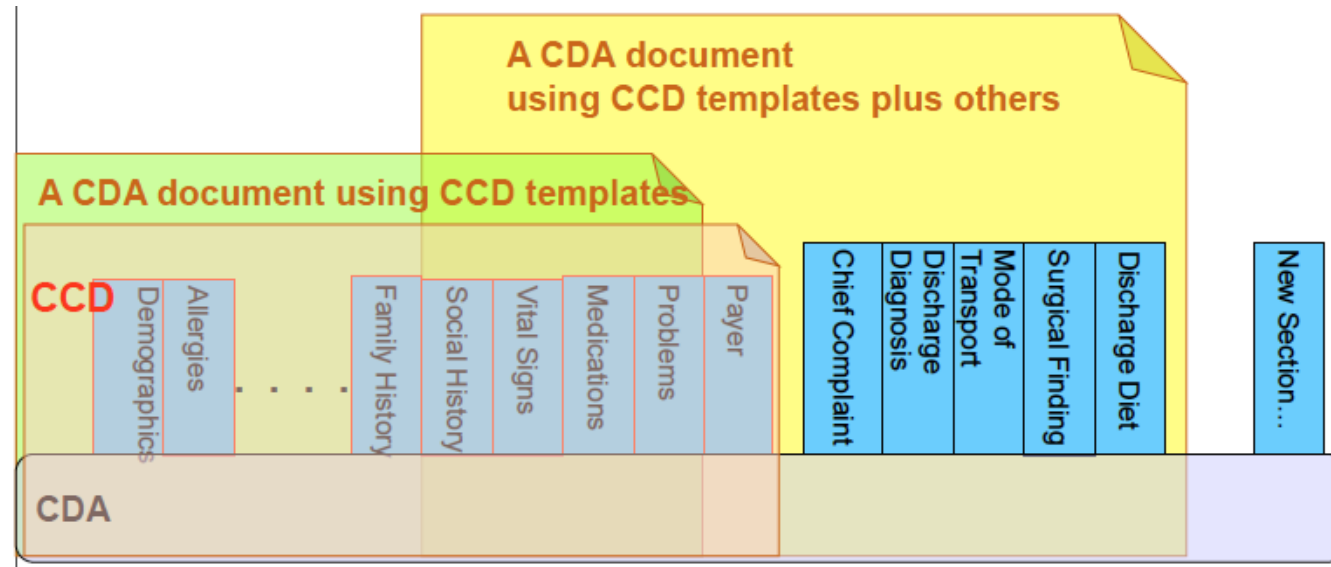
Consolidated CDA (C-CDA)

Series of “reusable templates” consisting of

- Document templates for specific types of common clinical notes, based on
 - Section templates – describe basic elements of notes, which are based on
 - Entry templates – contain the actual data

Many document, section, and entry templates now available in Version 2.1 – [can be searched](#)

Being integrated into FHIR standard (Levy, 2022)



Digital Imaging and Communications (DICOM)

(Pianykh, 2012)

Developed by American College of Radiology (ACR) and National Electrical Manufacturers Association (NEMA)

Defines how images and associated data are moved between electronic devices, including information systems

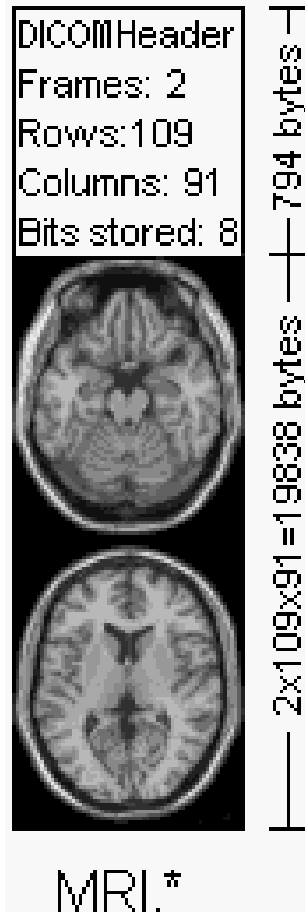
Used in most radiology picture and archiving systems (PACS)

Growing transfer of radiology images digitally leads to viewing problems when DICOM not used (Kalia, 2011)



DICOM format files

Overall



Header

First 128 bytes: unused by DICOM format
Followed by the characters 'D','I','C','M'
This preamble is followed by extra information e.g.:

0002,0000,File Meta Elements Group Len: 132
0002,0001,File Meta Info Version: 256
0002,0010,Transfer Syntax UID: 1.2.840.10008.1.2.1.
0008,0000,Identifying Group Length: 152
0008,0060,Modality: MR
0008,0070,Manufacturer: MRicro
0018,0000,Acquisition Group Length: 28
0018,0050,Slice Thickness: 2.00
0018,1020,Software Version: 46\64\37
0028,0000,Image Presentation Group Length: 148
0028,0002,Samples Per Pixel: 1
0028,0004,Photometric Interpretation: MONOCHROME2.
0028,0008,Number of Frames: 2
0028,0010,Rows: 109
0028,0011,Columns: 91
0028,0030,Pixel Spacing: 2.00\2.00
0028,0100,Bits Allocated: 8
0028,0101,Bits Stored: 8
0028,0102,High Bit: 7
0028,0103,Pixel Representation: 0
0028,1052,Rescale Intercept: 0.00
0028,1053,Rescale Slope: 0.00392157
7FE0,0000,Pixel Data Group Length: 19850
7FE0,0010,Pixel Data: 19838

Transfer Syntax UID
reports structure and
compression of image,
e.g., JPEG and amount
of compression

NCPDP and SCRIPT

[National Council for Prescription Drug Programs \(NCPDP\)](#) has developed family of standards for pharmacy claims benefits

[SCRIPT](#) is NCPDP standard for electronic communications between prescriber and pharmacy

Continuity of Care Document (CCD)

Based on Continuity of Care Record (CCR), a “set of basic patient information consisting of the most relevant and timely facts about a patient’s condition”

Goal was for use when patient was referred, transferred, or discharged among healthcare providers and/or facilities, containing basic information for providing continuity of care

Original CCR was not compatible with existing standards, so HL7 and vendors created CCD, which was based on HL7 V3 and CDA (D’Amore, 2011)

CCD has resulted in more standard use but errors and allowable variation from standard have limited semantic interoperability (D’Amore, 2014; D’Amore, 2018)

CDA templates in CCD required data set

Allergies and Intolerances

Medications

Problem

Procedures

Results

Advance Directives

Encounters

Family History

Functional Status

Immunizations

Medical Equipment

Payers

Plan of Treatment

Social History

Vital Signs

Mental Status

Nutrition