Health Information Systems
Architecture and Interoperability

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My background

Current role

• Medical Director, Information Technology Services, UW Medicine
• Medicine inpatient attending 1 month a year
• General Internal Medicine Center ½ day per week

Training

• Medicine internship residency
• Fellowship in Medical Information Science 1987-1989

Experience in clinical computing (as ~CMIO)

• Group Health Cooperative 1989-1997
• VA Puget Sound Healthcare System 1997-2000
• UW Medicine 2000-current
UW Medicine, Seattle

- Hospitals
  Harborview Medical Center
  UW Medical Center
  Seattle Cancer Care Alliance
  949 beds, 51,000 admissions

- Clinics
  1.4 million outpatient and ER visits

- Physicians
  1,200 attending physicians
  1,100 residents
  800 medical students
Objectives

• Describe the components and rationale for interoperable health information systems design for improving health systems.

• What are some key types of standards important for ensuring interoperability?

• Describe the basic components and principles for building a national health information system.
Topics for today

• Interoperability
  – Definition
  – Why it is important

• Standards used in healthcare

• Components and principles for building a national health information system
  – Architecture
  – Use of standards
  – Working toward interoperability
What do we mean by interoperable?

- Able to communicate, and *exchange data* with another system or device
- The ability of diverse systems and organizations to *work together*
- Interoperability is the ability of two or more systems or components to *exchange* information and to *use* the information that has been exchanged. (GAO)
- An alternative to interoperability is to enter the same information into several systems repeatedly, which is more expensive and prone to error
Methods to achieve partial interoperability between HIT systems

1. Interfaces (HL7, other)
2. Communicate results in paper; scan into foreign EMR
3. Reciprocal access
4. Embedded applications
5. Context sharing (CCOW, other)
6. Build separate application with data from both
1. Interfaces between HIT systems

![Diagram showing interfaces between HIT systems](image)

Lab → HL7 → System A → HL7 → System B → HL7 → Lab

Integrated
2. Incorporation of clinical information via scanning of paper documents
3. Reciprocal access

2 organizations wish to share data concerning a patient for whom they both provide care. Rather than create an electronic interface, they grant access to their EMR to providers in the 2nd organization.

Organization 1 uses EMR A

Providers in organization 1 are granted access to web view, Citrix session, or EMR client to EMR B

Organization 2 uses EMR B

Providers in organization 2 are granted access to web view, Citrix session, or EMR client to EMR A

Issues:

• Username password
• Patient identification
• Training
• Time requirement to access 2nd EMR
• Not easily generalizable to multiple organizations
4. EMR mixes many approaches to interoperability

5. Context sharing
6. Build separate application with data from both systems
Embedded web view
Assume one EMR is used in clinics and another in the hospital. If a patient is to be admitted to the hospital from the clinic:

- In which systems are orders entered?
- If they are entered in the outpatient EMR, are they communicated to the inpatient EMR?
- If some orders are to be completed in the clinic and others in the hospital (e.g. start IV antibiotics), how are all providers aware of all orders?
- Do providers need to receive training in both EMR systems?
- Will paper orders be honored if the provider is unfamiliar with CPOE in one or the other EMRs?
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Types of standards

Purpose

• Coding standards
• Messaging standards
• Application standards
• Knowledge standards

Development process

• Standards from standard development organizations
• Standards from dominant vendor
• Ad hoc standards
Coding standards

- Clinical terminologies, such as SNOMED CT, ICD10, DSM3, LOINC, RxNorm, VA NDF-RT, CPT
- May be used within messages to succinctly and unambiguously transmit a finding, observation, or other information
Messaging standards:

- EDIfact (EDI For Administration Commerce and Transport)
- CEN TC251
- ISO TC215
- HL7
- X12N (claims)
- EEG7
- DICOM
- NCPDP (prescriptions)
- OASIS (business)
Application standards

- Clinical Context Object Working Group (CCOW)
- UK Common User Interface CPOE application standard
- Integrating the Healthcare Enterprise IHE
Sample HL7 message

MSH|^~\&\|ORCAFLEX|UWMC|||ORU^R01|arich_U6999999_1927106_20050808143527_1_1|P|2.3|
PID|1||U6999999^^^^UWMC||TEST^PATIENT^FUNNY^|
PV1|1|L|^^^UWMC||L|219968|||20050608113800||
ORC|RE|
OBR|1||arich_U6999999_1927106_20050808143527_1|UPULPFT|3BBAB350|||2005060800000000000000^Alberts^Marco^A^^^Dir^\||

OBX|1|RP|930000|1|arich_U6999999_1927106_20050808143527_1_1^OTG^PDF|20050808143537
Relationship between coding and messaging standards

“Technical interoperability also supports coded information using standard classifications such as ICD-10/OPCS, early forms of Read Codes etc. which may be sent using early messaging standards such as HL7 v2 and EDIFACT.”

PID|1|U6999999^^^UWMC||TEST^PATIENT^FUNNY^|
Messaging and coding standards

Messaging standard specifies how the train is built.

Coding standard specifies what goes in the train.
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Analogy of Building Architecture

Minimal Architecture

Architecture Essential
How can Enterprise Architecture Help?

• The goal of our Enterprise Architecture approach is to provide a coherent whole of principles, methods and models that are used in the design and realization of a country’s organizational structure, health policies and processes, health information systems and infrastructure.

• An open enterprise architecture framework provides a superset of generalized principles, methodologies and artifacts that can be customized by a country.

• The architecture and models form the basis for reasoning about the elements of the system and define a process for harmonizing the elements to converge on design goals.

Slide courtesy of Chris Seebregts
ICU rounding uses mobile wireless computers
Transmitting laboratory data

[Diagram showing the flow of laboratory data from Laboratory to EMR through Application router, with error queue and acknowledgement points.]
Clinical computing system architecture

- What do we mean by ‘architecture’?
- Is it important?
- Interfaced versus integrated architecture
- Examples
Interfaced versus integrated architecture

- **Integrated** systems: Those in which patient data exist in the same database used by all clinical applications.

- **Interfaced** systems: Those in which data are communicated between separate applications with different databases, usually by means of an interface using HL7 protocol.

In practice most organizational clinical computing systems are a mixture, with varying degrees of both.
Interfaced versus integrated architecture
Connections between systems
Point-to-point model

\[ \frac{n(n-1)}{2} \]

Metcalf’s Law
Connections between systems

Interface engine model

n
Why use an Interface Engine?

Point to Point Architecture
Why use an Interface Engine?

Engine architecture

Slide courtesy of Jim Hoath
Architecture example 1
University of Washington
1987
Architecture example 2
Columbia Presbyterian Medical Center

- Laboratory
- Pharmacy
- Radiology

Patient Database

Data Dictionary

Medical Logic Modules

Billing & Financial

Data Entry Applications

Results Review

Data Analysis

Distributed Applications

Common Results Interface

Common Database
Architecture example 3
VA Puget Sound Health Care System

2,200 client workstations

Remote users via dial-up (RAS)

Clinical event monitor

Enterprise network (TCP/IP)

VA Intranet

Internet

Patient/Pharmacy Interface

CORI (endoscopy)

Pulm. Function

Transcription

Laboratory devices

DDP

HL7

HL7

Serial

VISTA

VISTA Imaging interface managers

Dicom

Magnetic storage

Optical storage

Lab, inpatient pharmacy, outpatient pharmacy, radiology, ADT, other clinical and administrative systems

Radiology modalities

Visible light capture stations

Muse ECG
Value of integration

• Interfaces are expensive, time-consuming, add complexity.
• Interoperability between different systems is extremely difficult to achieve in important areas.
• For real-time decision support, single data source is essential.
• Time for clinicians to gather data is limited. Simplicity helps.
Building on the architectures: Clinical computing systems commonly used in hospitals (examples)

- Foundational systems
  - ADT
  - Registration
  - Master Patient Index

- Departmental systems
  - Laboratory
  - Radiology
  - Pharmacy
  - Pathology
  - PACS

- Financial
  - Facility billing
  - Professional fee billing

- Electronic medical record system
  - Results review
  - Documentation
  - CPOE
  - Decision support
  - Messaging
Clinical computing system components

- Radiology system
- Laboratory system
- Pathology system
- Admission/Discharge/Transfer
- Interface engine
- Master patient index
- EMR
- Clinical data repository
- Pharmacy system
- Terminal server
National health system components

- National health ministry
- Laboratory system
- Public health department
- Hospital 1
- Hospital 2
Summary and questions