Day In The Life Of eHealth Technologies

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Overview

‣ eHealth Principles and Strategies
‣ eHealth Architectures
‣ Clinical Information
  ‣ Clinical Documents and Data
‣ Clinical Terminologies
  ‣ SNOMED
‣ eHealth Solutions
  ‣ ePrescriptions
  ‣ National eHealth Record Systems
‣ Towards Semantic eHealth
  ‣ The future path
eHealth Strategy

- Foundations
  - Core foundations for information exchange
- eHealth Solutions
  - Stimulate the delivery of priority solutions by the marketplace
- Change and Adoption
  - Foster consumer and provider adoption with training, tools, and services
- Governance
  - Effective leadership, coordination, accountability and oversight of the eHealth program

eHealth Principles

- eHealth architecture principles that can be used to guide architecture developments and solution implementations in an eHealth environment

  - eHR development should be government-led and leverage HA's systems and know-how
  - Data privacy and system security of the eHR Sharing System should be accorded paramount importance and given legal protection
  - Participation in eHR sharing should be compelling but not compulsory for both patients and healthcare providers
  - eHR Sharing System should be based on open, pre-defined, and common technical standards and operational protocols
  - Development of eHR Sharing System should be based on a building block approach, involving partnerships with the private sector


- Improve the safety and quality of healthcare
- Improve the efficiency of healthcare services
- Ensure eHealth solutions support interoperability
- Ensure solutions are fit for purpose
- Support services-based approaches
- Comply with legislative and policy requirements
- Re-use eHealth components
- Adopt pragmatic approaches
- Engage with all relevant stakeholders
- Maintain security
- Assess whole-of-life costs
- Use common terminologies and data definitions
- Manage information quality
- Manage information assets
- Ensure information consistency in distributed environments
- Express policy compliance as business rules
- Support loose coupling
- Express policy in technology-independent terms
- Observe standards
- Ensure supportability, sustainability and continuity
- Govern change
- Manage technical diversity
eHealth Architecture

- eHealth is a complex sector and ICT environment
  - Huge Stakeholder base
  - Serious consequences from failures
- eHealth Architecture design
  - Requirements Driven approaches
    - Use cases and Scenarios
  - Community & Capability Models
  - Capture Current-State and Target-State Architectures
    - Conceptual, Logical, Implementable Views
    - Information and Services
  - High-Level System Architecture
- Architecture Design Authority

eHealth Solution Capability Model
Clinical Information

- HL7 Reference Information Model (RIM)
  - A universal model covering the entire healthcare domain
  - Grammar for messages, permitted relationships, data types

Information Model

Conceptual

Logical

Implementable

Use Case Driven + Business Req

System/Platform Driven

Document Encodings

Prescription CDA (XML)

Prescription [HL7 V2]

Prescription [FHIR]
Clinical Document Architecture (CDA) is a mechanism to encode the HL7 RIM in machine format (XML)
  - Typically for message payload
Follows the “Document paradigm”
  - Header - Who, Where, When
  - Body - What
  - Human-readable parts
    - Render as HTML
  - Coded Entries (from Terminologies)

Fast Healthcare Interoperability Resources (FHIR)
FHIR solutions are built from a set of modular components called Resources
  - Can easily be assembled into working systems that solve real world clinical and administrative problems
Strong focus on implementation
  - Simple XML, JSON, RESTful interfaces
Evolutionary development from HL7 Version 2 and CDA
Interoperability – base resources can be used as is - can also be adapted for local requirements
“Backed by solid ontologies and rigorous formal mapping for correctness”
Clinical Terminologies

- **ICD-10** - classify diseases and other problems for payment, management, and research/statistical purposes
- **LOINC** - laboratory and other clinical observations
- **SNOMED** - Systematized Nomenclature of Medicine - Clinical Terms (CT)
  - Comprehensive multilingual clinical healthcare terminology
  - Collection of about 400,000 clinical concepts, associated with about 800,000 description terms, and a hierarchy consisting of about 1,200,000 relationships
  - Can be profiled into smaller “Reference Sets” for specific domains
SNOMED CT provides a compositional syntax that can be used to create expressions that represent new clinical ideas. For example, there is no explicit concept for "third degree burn of left index finger caused by hot water." Using the compositional syntax, it can be represented as:

```
284196006 | burn of skin | :
  116676008 | associated morphology | = 80247002 | third degree burn injury |
  272741003 | laterality | = 7771000 | left |
  246075003 | causative agent | = 47448006 | hot water |
  363698007 | finding site | = 83738005 | index finger structure
```

SNOMED is based on a formal model that is extensible and still preserves semantics (can infer outcomes).
eHealth Solutions - ETP

- Medication errors cost the public hospital system approximately $380 million each year (Australia)
- ETP - manage prescriptions and dispense via PES
- The complete Electronic Medication Management (EMM) will cover plans, schedule, order, notification, administration

![Diagram of medication management process]

National eHR Systems

- Electronic Health Record (eHR) provides:
  - Improved continuity of care for consumers accessing multiple providers
  - Access to consolidated information about an individual’s medicines
    - Reductions in avoidable medication-related adverse events
  - Enabling individuals to participate more actively in their healthcare
  - Improved diagnostic and treatment capabilities through enhanced access to health information
- Supported by National Legislation and Regulations
**Hong Kong eHR System**

### Problem / Diagnosis Summary

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
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<tbody>
<tr>
<td>26-Oct-2011</td>
<td>Colonic polyp</td>
</tr>
<tr>
<td>12-Aug-2011</td>
<td>Cancer of Colon</td>
</tr>
<tr>
<td>12-Jan-2011</td>
<td>Follow-up examination following surgery</td>
</tr>
<tr>
<td>05-Sep-2008</td>
<td>Postmenopausal bleeding</td>
</tr>
<tr>
<td>01-Aug-2008</td>
<td>No abnormality detected</td>
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</table>

### Laboratory Summary

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-Feb-2013</td>
<td>Hb A1c</td>
<td>PWH</td>
</tr>
<tr>
<td>18-Feb-2013</td>
<td>Albumin, Spot, Urine, Alb...</td>
<td>PWH</td>
</tr>
<tr>
<td>08-Feb-2013</td>
<td>CEA</td>
<td>PWH</td>
</tr>
<tr>
<td>30-Nov-2012</td>
<td>CEA</td>
<td>PWH</td>
</tr>
<tr>
<td>30-Nov-2012</td>
<td>LFT, RFT</td>
<td>PWH</td>
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</tbody>
</table>

### Encounter Summary

<table>
<thead>
<tr>
<th>Start Date</th>
<th>Specialty</th>
<th>Institution</th>
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<tbody>
<tr>
<td>04-Apr-2014</td>
<td>Ophthalmology</td>
<td>PWH</td>
</tr>
<tr>
<td>22-Oct-2013</td>
<td>Surgery / General surgery</td>
<td>PWH</td>
</tr>
<tr>
<td>24-Jul-2013</td>
<td>GQP</td>
<td>PWH</td>
</tr>
<tr>
<td>03-Jun-2013</td>
<td>Clinical Oncology</td>
<td>PWH</td>
</tr>
<tr>
<td>16-Apr-2013</td>
<td>GQP</td>
<td>PWH</td>
</tr>
</tbody>
</table>

**Singapore NEHR**

### Mark Looi, 64 yrs, Male, Chinese

**NRIC:** S12345678A  | **Care Provider:** Dr. Alvin Tan (SGH)  | Dr. Daniel Wong (Merlin) (Cinc)  | **Good Afternoon! Welcome to EHR v8.8s**

**Allergies:** Paracetamol, Aspirin

### Recent Events

<table>
<thead>
<tr>
<th>Date</th>
<th>Institution</th>
<th>Specialty</th>
<th>Event Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>01/05/2009</td>
<td>Merlion Hospital</td>
<td>Haematology</td>
<td>Discharge</td>
</tr>
</tbody>
</table>

### Diagnosis

<table>
<thead>
<tr>
<th>Last Entry</th>
<th>Description</th>
<th>Risk</th>
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<tbody>
<tr>
<td>11/05/2009</td>
<td>Diabetes Mellitus (x5)</td>
<td>☐</td>
</tr>
<tr>
<td>20/05/2009</td>
<td>Colon Cancer (x2)</td>
<td>☐</td>
</tr>
</tbody>
</table>

### Procedures

<table>
<thead>
<tr>
<th>Date</th>
<th>Procedure</th>
<th>Summary of Procedure</th>
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<tbody>
<tr>
<td>12/05/09</td>
<td>Revision of central/other intravascular line</td>
<td>Revision of Hickmann Line</td>
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</tbody>
</table>

### Investigations

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>13/09/08</td>
<td>Full Blood Count</td>
<td>SGH</td>
</tr>
<tr>
<td>15/09/08</td>
<td>Lipid Panel</td>
<td>Tan Clinic</td>
</tr>
</tbody>
</table>

### Current Medications

<table>
<thead>
<tr>
<th>Date</th>
<th>Name</th>
<th>Dose</th>
<th>Frequency</th>
<th>Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>18/05/09</td>
<td>Metformin</td>
<td>850 mg bd</td>
<td>x3</td>
<td>Oral</td>
</tr>
<tr>
<td>18/05/09</td>
<td>Losartan</td>
<td>50 mg om</td>
<td>x1</td>
<td>Oral</td>
</tr>
<tr>
<td>18/05/09</td>
<td>Simvastatin</td>
<td>20 mg om</td>
<td>x1</td>
<td>Oral</td>
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</table>

### Care Plan

<table>
<thead>
<tr>
<th>Category</th>
<th>Service</th>
<th>Details</th>
<th>Adm Date/Time/Time Interval</th>
</tr>
</thead>
</table>

**Recent Referrals/Discharges**

<table>
<thead>
<tr>
<th>Date</th>
<th>From</th>
<th>To</th>
<th>Purpose</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/05/08</td>
<td>SGH FMCC</td>
<td>SGH Endocrine</td>
<td>Referral</td>
<td>Hypertension</td>
</tr>
<tr>
<td>13/05/08</td>
<td>SGH Endocrine</td>
<td>Discharge</td>
<td>Diabetes mellitus</td>
<td></td>
</tr>
<tr>
<td>15/05/08</td>
<td>SGH FMCC</td>
<td>OP</td>
<td>Referral</td>
<td>Congestive heart failure</td>
</tr>
</tbody>
</table>
Towards Semantic eHealth

- RIM Modelled as a “closed system”
  - Designed for “constraint”-based modelling (not common)
  - Scope of Acts very large and overwhelming
  - CDA produces very complex XML
- The independent layers (conceptual/logical/implementable) causes interoperability issues - No Connections or Linkages
- The same information can be expressed in different ways using SNOMED and HL7 CDA structures
  - BUT modelled fundamentally different
- The W3C Semantic Web is a collection of standards for modelling and representing information (open-world assumption)
  - Based on formal model so can guarantee reasoning outcomes

Case Study: Medications

Health Summary

ePrescription

Value Domain

Value Domain

<code code="292954005" codeSystem="2.16.840.1.113883.6.96" codeSystemName="SNOMED CT-AU" displayName="Penicillin adverse reaction (disorder)" />

<code code="6162011000036107" codeSystem="1.2.36.1.2001.1004.100" codeSystemName="Australian Medicines Terminology (AMT)" displayName="Moxacin (amoxycillin (as trihydrate) 500 mg)" />

No Relationship
EHealth has many complex information standards
- HL7 CDA v FHIR for the immediate future
- Challenge now to preserve semantics between closed info models (eg RIM) and open terminology models (ie SNOMED)
- Move towards the information model based on the same model as terminologies
- Semantic eHealth can achieve a level of functionality that current methods/technologies cannot provide
  - Decision support can have guaranteed outcome and hence reduce clinical errors
- Benefits will be significant - by improving provider decisions and consumers healthcare outcomes - in the long term