From HL7 Templates to Topic Maps for Clinical Activity Representation

2nd International Conference on the Clinical Document Architecture (CDA)
October 20-22, 2004 - Acapulco, Mexico

Grace Paterson, MSc (CIHR Trainee in Health Informatics) & Zhihong Wang, BSc (Masters in Health Informatics student), Dalhousie University, Nova Scotia

Andriy Moshyk, (CIHR Trainee in Health Informatics) & Andrew Grant, MD PhD FRCPC, Université de Sherbrooke, Quebec

Canada
Aim

- CDA-aware system to support improving professional skills
Goal #1

- Produce HL7 Templates to improve outcomes of data collection in the clinical setting of a teaching hospital
  - Objective 1.1 Author HL7 Template for Discharge Summary using Microsoft Office InfoPath
  - Objective 1.2 Implement HL7 Template for Chronic Kidney Disease Discharge Summary
Goal #2

- Create Archetypes to facilitate data entry and browsing of clinical information.
  - Objective 2.1 Bind Primary Renal Diagnosis values to multiple coding schemes needed for information reuse
  - Objective 2.2 Design Febrile Neutropenia Archetype based on published algorithm
Goal #3

- Transform information accumulated for clinical purposes into information for medical education
  - **Objective 3.1** Validate Templates and Archetypes by transformation from CDA to Topic Maps
  - **Objective 3.2** Validate Templates and Archetypes by querying for similar cases in clinical data store
HL7 Template and Archetype Model

GOAL #1: CDA for Clinical Communication

GOAL #2: CDA Augmented with Background Knowledge

GOAL #3: CDA Transformation to Topic Maps to Index Cases

MEDICAL EDUCATION

CLINICAL PRACTICE

KNOWLEDGE MANAGEMENT
Template Lifecycle

The Discharge Summary provides a complete story of a medical episode *

- Problem/Situation Description
- Solution/Clinical Management Plan
- Outcome

Story is told by the attending physician in a teaching hospital using ‘language data’*

* N. Sager, C. Friedman, M. S. Lyman. Medical Language Processing: Computer Management of Narrative Data, 1987:p28-29
Current System

- Purpose of Discharge Summary is to bridge care between current and next caregiver
- Constructed and dictated by members of the resident staff, transcribed by clerical staff
- Few examples from experienced physicians
- Discharge summaries lack key elements for abstracting for registries and research
- Difficult for residents to produce discharge summaries for complicated Chronic Kidney Disease patients
## Communicative Structure of Discharge Summary Genre

<table>
<thead>
<tr>
<th>Form</th>
<th>Conform to Dalhousie University’s <em>Discharge Summary Training Manual</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Content</td>
<td>Lookup feature for structured data (diagnoses, labs, hospital formulary) plus text</td>
</tr>
<tr>
<td>Function</td>
<td>Consider reuse of information for medical education; utilize boundary objects (e.g., classification systems and digital libraries) for background knowledge</td>
</tr>
</tbody>
</table>
Structured and Narrative Content

- Thesauri Discovery Tools—What is said now?
  1. SNOCODE from MEDSIGHT Informatique Inc. transforms sentences and phrases into SNOMED International; supports interactive use
  2. MMTx from National Library of Medicine identifies medical concepts according to the knowledge embedded in UMLS

- Semantic interoperability for core concepts such as Renal Topics in Cochrane Library—neither too specific nor too generic
Goal is to facilitate the follow-up care

Automatic tasks, e.g., the calculation of Chronic Kidney Disease stage

Residents requested prompts
  - What is the essential data for this component?
  - What are the composites of the essential data?
  - What is the scope for this component?
Clinical Practice Research

- Design study to test hypothesis that Discharge Summaries produced from CDA system are
  - more complete
  - contain more essential data elements than those completed without the use of a template
Dx Categorization Archetype

- **Primary Renal Diagnosis List**
  - 70% of codes from Canadian Organ Replacement Registry (CORR)
  - 30% of codes from physician community – not all diagnoses are treated with replacement therapy
  - ICD9 and ICD10 do not reflect Nephrology care
  - “Categorization work”* of physicians, medical records, care team, and physicians-in-training

Dx Code Bindings

- Multiple Coding Schemes Needed for Diagnosis
  - ICD9 for Communication with Family Medicine
  - ICD10 for Hospital Administration
  - Canadian Renal Replacement Therapy Registry Codes
  - SNOMED International for encoding narrative text
  - SNOMED CT for clinical statements
  - UMLS for Digital Library interoperability
Draft HL7 Template* for starting point

Collaboration with Director, Bone Marrow Transplant Program, Nova Scotia, on research ethics

Management of patients who become febrile despite fungal and bacterial prophylaxis is a difficult challenge
  - guided by individual aspects of the patient
  - institution’s experience

SNOCODE encoding of >90 discharge summaries

*via Email from Amnon Shabo, IBM Haifa, Israel, February 18, 2004
Post BMT Course

Acute GVHD:
  Date: BMT-POST-BMT_COURSE-ACUTE_GVHD-DATE_OF_ONSET-DATE_OF_PHENOM
  Stage at Diagnosis: BMT-POST-BMT_COURSE-ACUTE_GVHD-OVERALL_AGVHD_SCORE-AT_DIAGNOSIS
  Peak Stage: BMT-POST-BMT_COURSE-ACUTE_GVHD-OVERALL_AGVHD_SCORE-AT_PEAK
    Skin: BMT-POST-BMT_COURSE-ACUTE_GVHD-SKIN_INVOLV._at_PEAK
    Intestine: BMT-POST-BMT_COURSE-ACUTE_GVHD-INTEST.INVOLV.at_PEAK
    Liver: BMT-POST-BMT_COURSE-ACUTE_GVHD-LIVER_INVOLV.at_PEAK
    Oral: BMT-POST-BMT_COURSE-ACUTE_GVHD-ORAL_INVOLV.at_PEAK
    Ocular: BMT-POST-BMT_COURSE-ACUTE_GVHD-OCULAR_INVOLV.at_PEAK
    Lungs: BMT-POST-BMT_COURSE-ACUTE_GVHD-LUNG_INVOLVEMENT
    BM: BMT-POST-BMT_COURSE-ACUTE_GVHD-BM_INVOLVEMENT

  Treatment:
    BMT-POST-BMT_COURSE-ACUTE_GVHD-SPECIFIC_THERAPY-MEDICATION
    BMT-POST-BMT_COURSE-ACUTE_GVHD-SPECIFIC_THERAPY-ANTIBODIES
    BMT-POST-BMT_COURSE-ACUTE_GVHD-SPECIFIC_THERAPY-PHOTO_RX
    BMT-POST-BMT_COURSE-ACUTE_GVHD-SPECIFIC_THERAPY-AUTO CELLS
    BMT-POST-BMT_COURSE-ACUTE_GVHD-SPECIFIC_THERAPY-OTHER

  Outcome: BMT-POST-BMT_COURSE-ACUTE_GVHD-AGVHD_OUTCOME

CMV:
Infectious Complications:
Liver Complications:
Renal Complications:
Pulmonary Complications:
Cardiac Complications:
Febrile Neutropenia Algorithm


**temperature** ≥38.3°C X 1 or ≥38°C for ≥1 h

**HISTORY** - Type of cancer – immunologic defect (likely pathogen):

- Neutrophil dysfunction – *E. coli*, *Klebsiella* spp., *Pseudomonas aeruginosa*, *S. aureus*, *S. epidermidis*, *Candida*

- B cell dysfunction – *S. pneumoniae*, *H. influenzae*

- T cell dysfunction – *Listeria*, *Mycobacterium*, *Legionella*, *Cryptococcus*, ...

- CNS dysfunction – anaerobes, *Enterobacteriaceae*

- Obstruction – GI – *Enterobacteriaceae* + anaerobes;
  - GU - *Enterobacteriaceae*
  - Lung – *S. pneumoniae*, *H. influenzae*, *Moraxella catarrhalis*, ...

**Iatrogenic procedures** – surgery;

**Chemotherapy administration & timing**
Abstract Knowledge from NCI Thesaurus
Medications and Renal Function

- Different concept relationships available:
  - National Library of Medicine
  - Drug database perspective
  - SNOMED Description Logics
- Analogous to parable of *Six Blind Men and the Elephant*
- NCI Terminology Browser example for Drug Database from Veterans Affairs
**VA_NDFRT Root Concepts**

- Active Ingredients
- Cellular or Molecular Interactions
- Clinical Kinetics
- Diseases, Manifestations or Physiologic States
- Pharmaceutical Preparations
- Physiological Effects
- Proposed HL7 Drug Dose Forms

**Advanced Search**

- Relationship to other concepts: CELECOXIB PREPARATION
- Code: C12398

**Relationships to other concepts:**

- **CI_with**
  - Drug Hypersensitivity
- **CI_with**
  - Pregnancy
- **has_Ingredient**
  - celecoxib
- **has_MOA**
  - COX-2 Inhibitors
- **has_PE**
  - Decreased Prostaglandin Production
- **has_PK**
  - Fecal Excretion
- **has_PK**
  - Hepatic Metabolism
- **has_PK**
  - Renal Excretion
- **may_treat**
  - Adenomatous Polyposis Coli
- **may_treat**
  - Arthritis, Rheumatoid

---

[Link: http://nciterms.nci.nih.gov/NCIBrowser/Startup.do]
Template Lifecycle*

Knowledge Resources and Design

- Algorithms can inform data collection design
- Chapter 103: Infections in the Cancer Patient*
  - Physical examination
  - Investigations and evaluation
  - Drug regimens, risk assessment, and evaluation
- Discharge summary states the path taken through the Algorithm
- Does not require HL7’s “SubstanceAdministration” level of detail

Microsoft Office InfoPath for authoring template

**Pros**
- Learn by Examples
- Easy Access – part of the Professional Edition of Microsoft Office
- Graphic XML authoring tool
- Conforms to designated XML schema

**Cons**
- Not flexible dealing with CDA schema. To reduce programming workload, CDA schema has to be transformed
- Limits on dropdown menus
- Not Web-based. Requires local installation

*Design*
### Discharge Summary Help

The ABC's of a discharge summary are **Accuracy**, **Brevity**, and **Clarity**.

Three important characteristics of a discharge summary are:

1. It succinctly summarizes what happened to the patient during the hospital stay.
2. That it highlights the relevant findings.
3. It helps to direct future care and follow-up visits, if required.

### InfoPath Help

1. To insert a row/paragraph at the end of the list, click "Insert item" at the left bottom of the list/paragraph (e.g., Diagnosis/Co-morbidity list, Lab test list, Social paragraph), and then type in the content. For a row of a list, type "Unknown" for an unknown code.
Educate at time of data entry.
Microsoft Office Tools

- Provides alerts
- System Maintenance Tasks
The form you are opening has the same form ID as a form already on your computer.

You should replace the form on your computer if the form you are opening is an updated version from a trusted source. If you are not sure of the source or the content, you should keep the form already on your computer.

Form on your computer

**Junev11**

Version: 1.0.0.641

**Opened From:**
file:///C:/unzipped/Junev11/Junev11

**Access Path:**
file:///C:/unzipped/Junev11/Junev11

**Form ID:**
urn:schemas-microsoft-com:office:infopath:Junev11:urn-hl7-org-v3

Conflicting form

**Junev11**

Version: 1.0.0.641

**Opened From:**
file:///C:/Documents%20and%20Settings\Grace\My%20Documents\cda\workshop\Junev11\manifest.xsf

**Access Path:**
file:///C:/Documents%20and%20Settings\Grace\My%20Documents\cda\workshop\Junev11\manifest.xsf

**Form ID:**
urn:schemas-microsoft-com:office:infopath:Junev11:urn-hl7-org-v3

[Keep Form on Your Computer] [Replace Form on Your Computer]
Java/XSLT for authoring

**Pros**
- Flexible
- Easy access
- Web-based so no installation required on users’ computers

**Cons**
- Difficult as a starting point
- Heavy programming workload
PART I: ON ADMISSION

Admission Diagnosis (Fill in ONLY when it is different from Discharge Diagnosis)
Chronic Kidney Disease  
GFR Calculation

On Stage  
secondary to:

Reason for Diagnosis (If NOT for renal failure)

Health Status
- Fully active, able to carry on all pre-disease performance without restriction
- Restricted in physically strenuous activity but ambulatory and able to carry out work of a light or sedentary nature.
- Ambulatory and capable of all self-care but unable to carry out any work activities. Up and about more than 50% of waking hours.
- Capable of only limited self-care, confined to bed or chair more than 50% of waking hours.
- Completely disabled. Cannot carry on any self-care. Totally confined to bed or chair.
- Dead

History of Present Illness

Relevant Past Medical and Surgical History

Allergies and Adverse Reactions

Add Another
Integrate Archetypes

- Implemented as Pop-Up Window in CDA form
- Evaluate Ocean’s Clinical Archetype Editor*
- Open Source Environment of great interest in academic setting
- Thanks to all those who provide these tools!

*http://www.oceaninformatics.biz/archetype_editor/ArchetypeEditor_download.html
Inpatient Therapy - Vancomycin Not Needed

- IV Combination antipseudomonal beta-lactam + aminoglycoside
- IV monotherapy with ceftazidime, imipenem-cilastatin, meropenem or cefepime
- IV double beta-lactam therapy piperacillin or piperacillin-tazobactam + ceftazidime

Re-evaluate at 72 h
Role of Université de Sherbrooke in this work

- Dalhousie University and Université de Sherbrooke are partners in CIHR Health Informatics PhD/Postdoc Strategic Training Program
- Dalhousie investigator is Michael Shepherd (my supervisor)
- Sherbrooke investigator is Andrew Grant (Andriy’s supervisor)
- Validation activity planned for end of October
Clinical Datawarehouse

• Data coding
  – Snomed, ICD, DRG,
  – HL7
• Data mining
• Data modeling
  – Prostate cancer
  – Acute coronary syndrome
CDA Transformation to Topic Maps

- Topic Maps provide an alternate view of CDA content
- Define Topic “CrossDefinition” for mappings of concepts to different vocabularies
- Define associations as relations between topics
- Use Topic Maps to visualize conceptual representation of clinical problem and learn what was done in past cases (the solutions to the problem situation) and what were the patient outcomes
- Evaluate whether Topic Maps augment learning?
- Topic Maps Software is Omnigator from www.ontopia.com
Template mining of Clinical Data Warehouse

- Validate that HL7 Template and Archetypes prepared in Nova Scotia are meaningful in Quebec.
- This work should lead to templates that are more complete and contain more of the essential data elements than those generated without the use of a data warehouse.
Summary

- Work-in-progress

- Integrates background knowledge available from ontological resources to support reuse

- Leverage CDA as way to improve professional skills

  - Data entry of discharge summary

  - Homogenous data entry for reuse in research, administration, and education

  - Topic Maps for Indexing Discharge Summaries
Acknowledgements

- Dr. Steven Soroka, Director, Chronic Kidney Disease, Capital District Health Authority, NS
- Dr. Stephen Couban, Director, and Cara Melvin, Bone Marrow Transplant Program, CDHA, NS
- Janet Cooper, Canadian Pharmacists Association
- Dr. Michael Shepherd, Director, Health Informatics and PhD Supervisor, Dalhousie
- Ron Soper, Systems Developer, Medical Informatics, Dalhousie University
Thanks, any questions?