Technologies for Enhancing Clinical Information Systems

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Our Strategic Objectives

1. Deliver **NLP Enhancement Technologies** for intelligent support and processing.
2. Build generic, compact, customisable **Clinical ISs** to enhance existing clinical processes.
3. Position Natural Language Processing as the base technology for processing the **EMR**

“all clinical data has to be turned into language”
Our HIT Activities

- 60+ Projects in 3 Years
- Language Analysis of clinical texts
- Data Analytics for Clinical ISs
- Text to SNOMED CT to ICD 10AM
- Generating subset of SNOMED CT
- Clinical Information Systems - WeBCIS
- Rescuing data from abandoned and decaying ISs - OMNI-LAB, HOS-LAB, CARDS, BS, HOSREPO.
- Partners: RPAH, SEALS, NCCH, SWAHS, Childrens Westmead, SWAPS, and more
Enhancement Technologies
Active Projects

1. Ward Rounds Information Systems
2. Clinical Data Analytics Language
3. Structured Reporting - Pathology+ Imaging
4. Handovers Information System
1. Ward Rounds Information System (WRIS)

• Needs
  – Make an extract of the current medical measurements into a pro forma report
  – Congregate at patient bedside
  – Determine next course of action
  – Record those actions in the medical record
  – Complete an analysis of the narrative content for indexing
**INITIAL DIAGNOSES AND RELEVANT BACKGROUND**

**ASSESSMENT**

**NEUROLOGICAL**
Sedation
GCS: V 4 M 8 E 4 = 14 (12.00)

**RESPIRATORY**
Ventilation: Vent. Mode: Ven. mask RR 0 Vt 0 PS 0 FEEP O FIO2 0.00
PaCO2 34 (07:00) PaC2 78 (07:00) pH 7.25 (07:00) BE -12.0 (07:00)
Chest Tube Total NLL
Chest Examination:

**CARDIOVASCULAR**
HR 96 MAP 76 CVP 6
Inotropes:
8mg Noradrenaline 5 mcg/kg/min
Lactate ABG 0.8 (07:00)
CVS Examination:
### Initial Diagnosis and Relevant Background

- Asthma
- Heart disease
- NIDDM

### Assessment

#### Neurological

**Sedation**
- GCS: V1 M1 E3 = 5/12

**Neuro Examination**
- No sedation.
- GCS 10
- PEARTL, 3 mm brisk
- Normal power all limbs

#### Respiratory

**Ventilation**
- Vent: Mode: PS RR 22 Vt 353 PS 07 PEEP 15 FiO2 0.30
- Paco2 49 (13.02) Paco2 91 (13.02) pH 7.37 (13.02) Be 2.6 (13.02)

**Chest Examination**
- Bilateral air entry.
- Clear breath sounds.
- Small amount of blood stained sputum.
- RR good

#### Cardiovascular

- HR 106 MAP 93 CVP 11
- Inotropes:
  - Lactate ABG 1.5 (13.02)

#### Gastro-intestinal

- Bowels last open: NIL
Abdo Examinations:
- No bowel sounds.
- Abdo tender, distended.
- Not free drainage with small output.

**Current Problem List:**
- Rectal bleeding.
- Bile output.
- Altered bowel habit.

**Plan:**
- Remain nil per os (NPO).
- Allow to resolve.
- Trial small amount of NG tube, 2 cal 20mL.

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<th>ref</th>
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<th>SNOMED-CT</th>
<th>Correct</th>
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<td></td>
<td>Asthma (disorder)</td>
<td>Y ON ON</td>
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<td></td>
<td></td>
<td>Disease (disorder)</td>
<td>Y ON ON</td>
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<td></td>
<td>Diabetes mellitus type 2 (disorder)</td>
<td>Y ON ON</td>
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<td>Power saw, device (physical object)</td>
<td>Y ON ON</td>
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<td></td>
<td></td>
<td>Limb structure (body structure)</td>
<td>Y ON ON</td>
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<td></td>
<td></td>
<td>Entire limb (body structure)</td>
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<td></td>
<td>Air (substance)</td>
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<td>Medical air (product)</td>
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<td>Respiratory sounds (observable entity)</td>
<td>Y ON ON</td>
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<td>Bloods (ethnic group)</td>
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<td>Blood (substance)</td>
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<td>Sputum (substance)</td>
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<td>Bowel sounds (observable entity)</td>
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<td>Discharge (morphologic abnormality)</td>
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<td>Intestinal obstruction (disorder)</td>
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<tr>
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<td></td>
<td>Intubation (procedure)</td>
<td>Y ON ON</td>
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</table>
Use of SCT Encoding of Clinical Notes

- Indexes notes for SNOMED codes
- Operational Information Retrieval
- Research Information Retrieval
- Data Analytics
- Audit of Care
- Clinician training for stable terminology
- Extension to Customisable Handovers ISs
2. A Clinical Data Analytics Language - CDAL

• Principles
  – Can express all questions that are answerable from the database including from narrative content
  – Can compute all questions that can be expressed
  – Is transportable across all CISs
Clinical Data Analytics Language (CDAL)

- Practicals
- Need for general purpose Information Extraction
  - Over aggregated data
  - Constrained by many variables
  - Over the text notes in the patient record
  - From a wide range of Information Systems
  - Using a wide range of health dialects
CDAL Request Basic Structure

• Nominates
  – TOCs
  – Databases
  – Statistical/Record Expression
  – Patient Classes
  – Medical Expressions
  – Time constraints
  – Location Constraints

• {Using <SNOMED>}* in {<ICU-db>}#
  Find <AVG (Stay)> of <children under 12>+ {with <3rd degree burns to the torso treated with penicillin>}*
  {<during the last 2 years>}# from {<postcodes 2300-2999>}#

*, # - parameters need to be domain consistent
+ - classes needs to be computable; Group/Computed functions
Screenshot of a CDAL query: **ARDS SNIFFER**: Find all patients’ medical record number (and the number of records retrieved) for patients with age > 16, [AND] arterial blood gas analysis (PaO2 / FiO2) < 300 AND Tidal Volume Peak Pressures (Paw) > 35 OR Delivered tidal volume (Vt) > 8mL IN the GICU (over the last year).

Note that: PaO2 / FiO2 = PF Ratio; Paw = PIP; Delivered Vt = Vt Expired.
Accessible attributes in ICU-CDAL - CareVue

- Chart_events (total): 786
  - Chart_events (numeric): 734
  - Chart_events (categorical): 52
- Medication_events: 52
- Patient_events: 6
- Lab_events: 63
- Group_events (total): 74
  - Sedation: 8
  - Inotropes: 14
  - Antibiotics: 46
  - Thromboembolic_prophylaxis: 6
- Total: 981
**Hypothesis Testing**

**General**

**Perform**
- 2 means t-test

**TOC**
- SNOMED

**Database**
- gicu

**Answer Required**
- MAP

**Confidence Interval**
- 0.95

**Test Type**
- Mean 1 = Mean 2

### Criterias for Patient 1

- **Demographic Criterias**: sex = male
- **Medical Criterias**: 
- **Time Period**: during the last 24 hours
- **Location**: gicu

### Criterias for Patient 2

- **Demographic Criterias**: sex = female
- **Medical Criterias**: 
- **Time Period**: during the last 24 hours
- **Location**: gicu
Hypothesis Testing Results

Two-sample t-test
Null Hypothesis: mean of map for group 1 = mean of map for group 2
Alternate Hypothesis: mean of map for group 1 ≠ mean of map for group 2

mean for group 1: 76.6575
sd for group 1: 13.3675
size of group 1: 73
mean for group 2: 82.8824
sd for group 2: 11.2181
size of group 2: 85
degree of freedom: 156
pooled sd for both groups: 12.2571
observed test statistic: -3.1826
p-value: 0.0018

Evidence against the Null Hypothesis in favour with the Alternate Hypothesis.
3. Structured Reporting
Pathology & Radiology

- Populate a structured report by information extraction from a narrative report
- SRs exist of breast, colorectal, and skin cancer
- Need to verify design against actual reports
- Need to convert historical reports for research
- Adds efficiency and completeness to reports
- Minimises call backs on reports
4. Handovers ET

- Generated from an underlying IT infrastructure
- Can be readily varied - regenerated at will
- Particular structure for staff roles
- Extracts from the legacy IS
Handovers Screenshots

User Interface

2 functions: generating new report and retrieving existing report

4 templates

3 report type

3 report output format
Screenshots

Handovers report for general purpose

19 attributes and 5 progress notes

Around 4mins to generate this report

9/1/2008
Handovers report for Doctor usage

14 attributes and 5 progress notes

Around 3Mins and 37 Secs to generate this report
Handovers report for Nurse Usage

23 attributes and 1 progress notes

Around 5Mins and 38 Secs to generate this report
Handovers report for Pharmacist Usage

17 attributes and 4 progress notes

Around 3mins and 9Secs to generate this report

9/1/2008
5. Future Work

Intensive Care Real-time Audit IS

• Build a computer model for the patient case
• Build a model of the care guidelines
• Fold the two against each other to create an audit
Front End to Hospital Systems
Compact Customisable ISs

- Store data to serve a specific function - e.g. WRIS
- Provide rich retrieval functions - CDAL
- Serve an operational purpose
- Can fetch and deliver from other systems
- Add productivity to existing systems
- Tailored and managed to suit a local clinical needs
Strategic Directions

- Continuous support for handovers for the whole patient journey
- Analytics on all Clinical Info Systems
- Patient tracking from entry to exit
- Automatic conversion of Text to Medical Codes - SNOMED, ICD 10AM, DRGs
- Compute SNOMED subsets from clinical content
Proposed Developments

• Expand WRIS into a Handovers system
• Make CDAL more portable
• Expand CDAL’s Hypothesis testing capacity
• Expand the language processing in both systems
• Continue developing the GCIMS model
• Add workflow to GCIMS
• ICRAIS - Intensive Care Real-time Audit IS
• Compact Nursing ISs using NIC & NOC
• Information Exchange fetching and delivering information from all hospital ISs
Features of Enhancement Technologies

• None is mission critical, but all give
  – High productivity,
  – Enhanced patient safety and outcomes, and
  – Unheralded access to data especially text
  – Bolt on technologies
  – Removable at any time to allow return to original processes
THE END