# Technologies for Enhancing Clinical Information Systems

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### Our Strategic Objectives

- 1. Deliver NLP Enhancement Technologies for intelligent support and processing.
- Build generic, compact, customisable Clinical ISs to enhance existing clinical processes.
- 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, HOSREP.
- Partners: RPAH, SEALS, NCCH, SWAHS, Childrens Westmead, SWAPS, and more

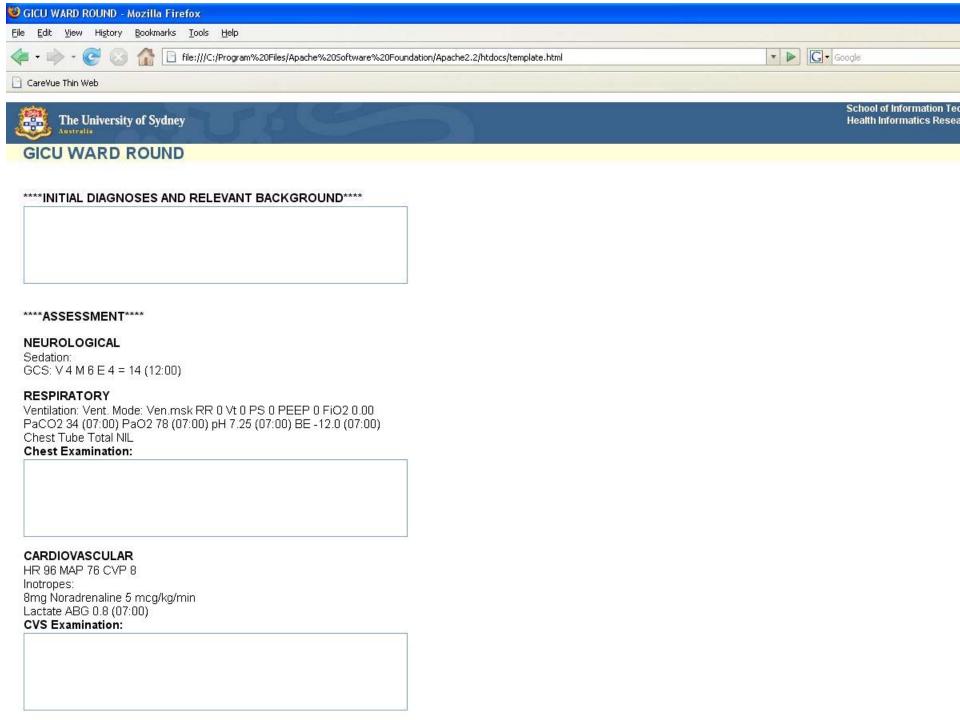
## Enhancment Technologies Active Projects

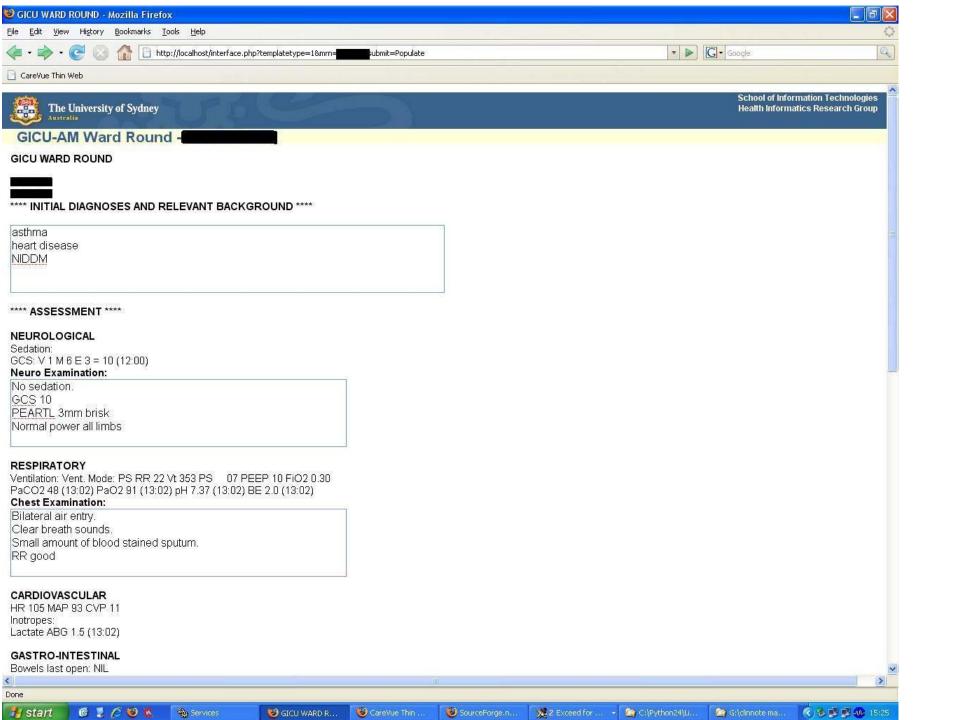
- 1. Ward Rounds Information Systems
- 2. Clinical Data Analytics Language
- Structured Reporting Pathology+ Imaging
- 4. Handovers Information System

## 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







ref	Extract		SNOMED-CT	Correct
A	asthma	195967001	Asthma (disorder)	OY ON OU
A	disease	64572001	Disease (disorder)	OY ON OU
Α	NIDDM	44054006	Diabetes mellitus type 2 (disorder)	OY ON OU
Α	power	73618007	Power saw, device (physical object)	OY ON OU
٨	limbs	66019005	Limb structure (body structure)	OY ON OU
		243996003	Entire limb (body structure)	OY ON OU
Α	air	15158005	Air (substance)	⊙Y ON OU
n		417696007	Medical air (product)	OY ON OU
٨	breath sounds	52653008	Respiratory sounds (observable entity)	OY ON OU
۸	blood	32873005	Bloods (ethnic group)	OY ON OU
		87612001	Blood (substance)	⊙Y ON OU
	stained	45389009	Tissue stain (substance)	OY ON OU
Α		61789006	Dye (substance)	OY ⊙N OU
		397165007	Stain (substance)	OY ON OU
٨	sputum	45710003	Sputum (substance)	⊙Y ON OU
٨	No bowel (absent of) *	87042004	Bowel sounds (observable entity)	OY ON OU
Α	sounds	87042004	Bowel sounds (observable entity)	OY ON OU
Α	drainage	75823008	Discharge (morphologic abnormality)	OY ON OU
		122462000	Drainage procedure (procedure)	OY ON OU
٨	sepsis	91302008	Systemic infection (disorder)	⊙Y ON OU
٨	bowel obstruction	81060008	Intestinal obstruction (disorder)	OY ON OU
٨	intuhated	52765003	Intubation (procedure)	OV ON OH,





















### 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

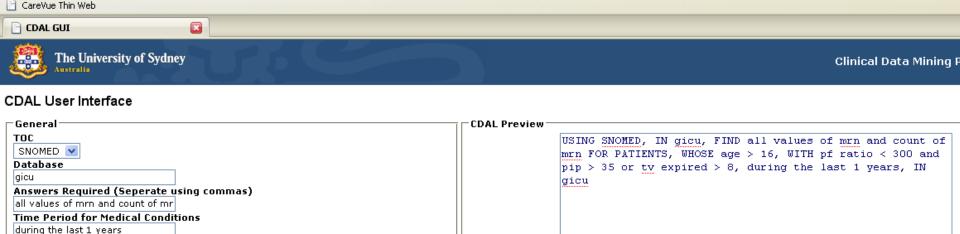
- Can express all questions that are answerable from the database including from narrative content
- Can compute all questions that can be expressed
- Is transportable across all CISs

### 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 <3<sup>rd</sup> 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



**Location for Medical Conditions** 

Medical criterias

**Current diagnosis** 

expired > 8

pf ratio < 300 and pip > 35 or tv

Demographic criterias

Diagnosis Information Previous diagnosis

gicu Criterias

age > 16

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: Pa 22/Fi 22 = PF Ratio; Paw = PIP; Delivered Vt = Vt Expired Piper Financing Technologies for

**Clinical Information Systems** 

## 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
  - Thromboebolic\_prophylaxis: 6
- Total: 981



#### Hypothesis Testing

riypourioolo room	.8
-General	_
Perform	
2 means t-test 💌	
TOC	
SNOMED V	

#### Database gicu answer Required

#### MAP Confidence Interval 0.95

#### **Test Type** Mean 1 = Mean 2 V

#### Criterias for Patient 1

#### Demographic Criterias sex = male

#### **Medical Criterias** Time Period

### Location

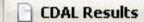
- **Medical Criterias** Time Period

Location

- Demographic Criterias | sex = female
- gicu Criterias for Patient 2
  - during the last 24 hours

gicu

during the last 24 hours







#### 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

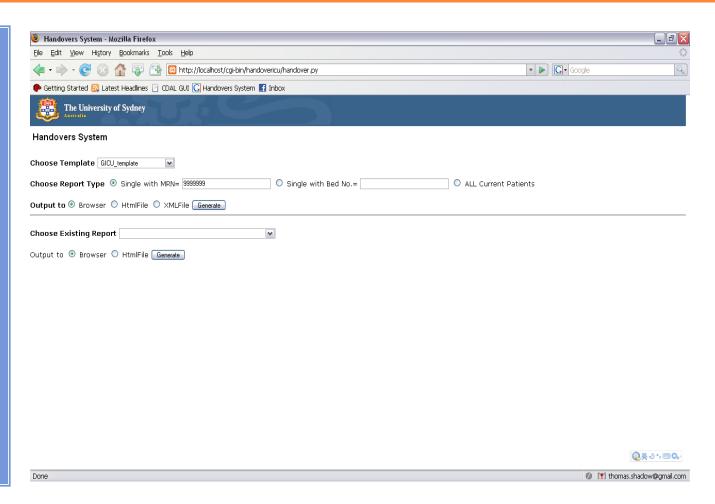
- Populate a structured report by information extraction from a narrative report
- SRs exist of breast, colorectal, and skin cancer
- Need to verify design against actual reports
- Need to convert historical reports for research
- Adds efficiency and completeness to reports
- Minimises call backs on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

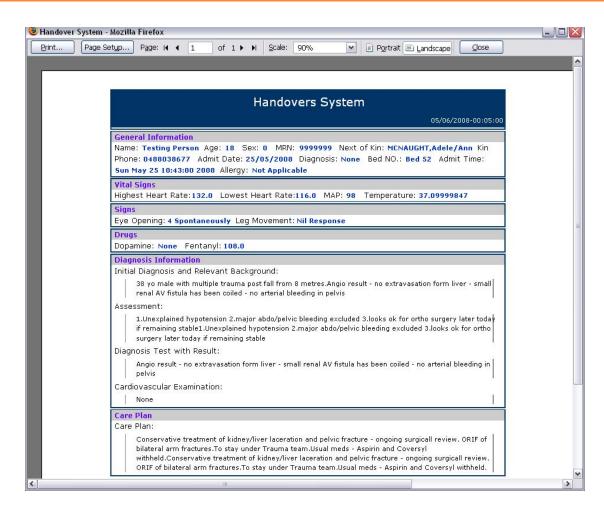
User Interface 2 functions: generating new report and retrieving existing report 4 templates 3 report type 3 report output format



Handovers report for general purpose

19 attributes and 5 progress notes

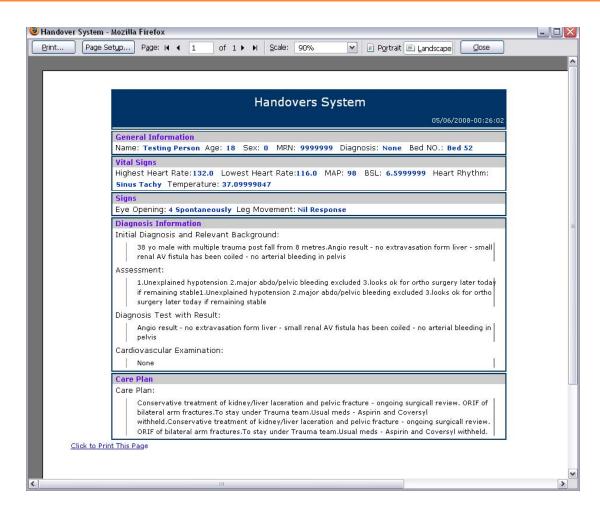
Around
4mins to
generate this
report



Handovers report for Doctor usage

14 attributes and 5 progress notes

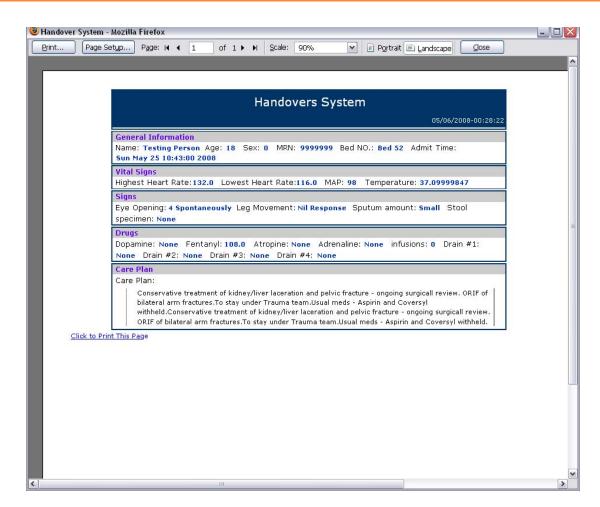
Around 3Mins and 37 Secs to generate this report



Handovers report for Nurse Usage

23 attributes and 1 progress notes

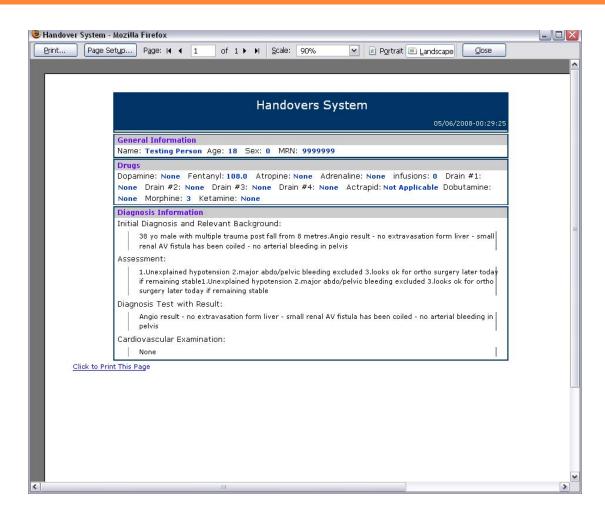
Around 5Mins and 38 Secs to generate this report



Handovers report for Pharmacist Usage

17 attributes and 4 progress notes

Around 3mins and 9Secs to generate this report



# 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

