

An aerial photograph of a winding road through a mountainous landscape. The road is paved and curves through a valley with steep, forested hillsides. The sky is overcast and hazy. The overall scene is scenic and rugged.

# EMRs and ICUs – A User's Perspective

## The Long and Winding Road

Assoc Prof Graeme Hart MB BS FANZCA FCICM FACHI

Senior Staff Specialist in Intensive Care

Chief Medical Information Officer – Austin Health

Associate Professor Health and Biomedical Informatics Centre, UoM

*TravelerFolio.com*

# Crossing the Quality Chasm (IOM II),

Institute of Medicine.  
*Crossing the Quality Chasm:  
A New Health System for the 21st Century.*  
National  
Academy Press, Washington DC, 2001;3

1. Care based on  
continuous healing  
relationships.

2. Customization  
based on patient  
needs and values.

3. The patient as  
the source of  
control.

4. Shared  
knowledge and the  
free flow of  
information.

5. Evidence-based  
decision-making.

6. Safety as a  
system property.

7. The need for  
transparency.

8. Anticipation of  
needs.

9. Continuous  
decrease in waste.

10. Cooperation  
among clinicians.



# Safety and Quality Imperative for EHR/CDSS

- Public and Funders are losing patience with the frequency and cost of mistakes
- Many errors are preventable
  - 190,000 pa potentially preventable deaths in hospital (USA)
  - Adverse treatment effects cost \$US75-100 billion
  - 945,520 safety incidents reported 2009 (NHS) (73%in hospitals)
  - 10,000 coded as deaths or severe harm
  - Legal claims costs 650million pounds 2009/10 NHS
    - 10% annual incremental cost



# Avoidable costs of error

- The cost of care is bankrupting societies
  - “ assumption we will need to release unprecedented levels of efficiency savings between 2011-14: between 15 and 20 billion pounds” *NHS CEO Annual Report 2008/9*
  - \$US 700 billion and \$US 2.2trillion annually is wasted – unwarranted treatment, redundant, inappropriate or unnecessary tests, over use of antibiotics (*Thomson Reuters, PWC*)
  - 2.2billion pound annual savings in UK (*Nuffield Trust*)
- Variations in Practice documented in US and UK
  - Substantial over use or under use in many regions



# Confluence of Capability

Analytics

Wireless /  
Mobility

Battery

Devices

Standards

SMART on  
FHIR

Cloud  
Services

DATA  
governance

The advent of EMR opens options for **impacting health care delivery** through **targeted interventions** at individual patient level. The **tools** for implementing such interventions are available today but optimising their **impact** requires a change from reactive to **pro-active patient centred** thinking and changes to **culture at clinical and funder level**.



# Data Cascade

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Clinically captured data may reduce burdens of secondary data entry and collation

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requires well thought out clinical documentation workflows

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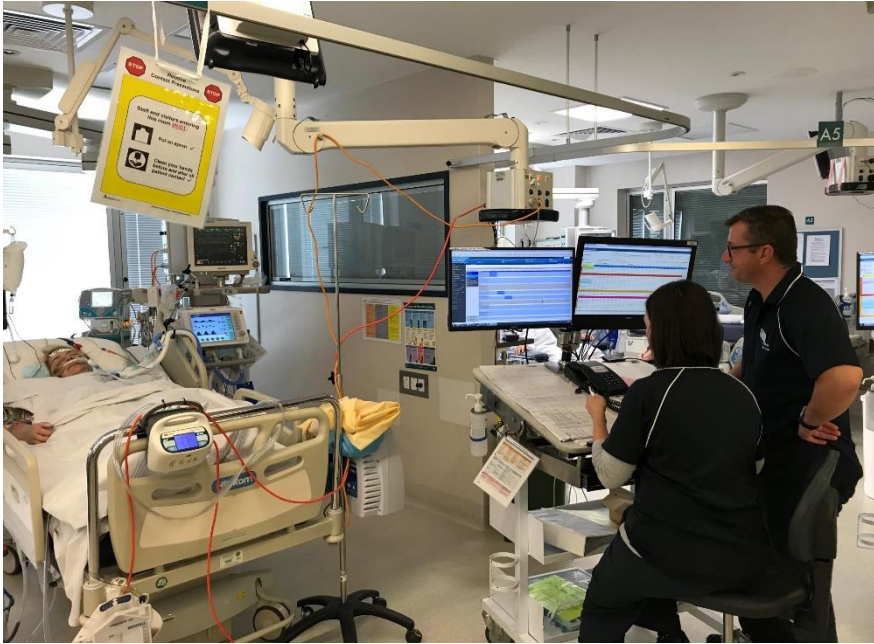
sustained training and

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regular reporting to key stakeholders for data checking.

# Personalised Medicine

- Automated EMR workflows can identify target populations for specific therapeutic interventions.
  - Sepsis sniffers
  - Deteriorating patient alerts
  - Risk assessment algorithms
  - Medications Safety
  - Genomics



ICU – A complex socio-technical environment

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# Janet's Challenge !

- -What are the biggest things that you would want to have known/ done in retrospect prior to your EMR/ CPOE/CDSS ?
- -What would you like to improve most about your EMR/CPOE/CDSS ?
- -What do you like and dislike about your EMR/CPOE/CDSS ?
- -How does your EMR/CPOE/CDSS impact on your relationships with other clinicians and departments ?
- -Have you done anything with the data you're collecting ?
- -How was the roll out of your systems done (Big Bang or incremental ?)
- -How was the training in how to use it ? how many tweaks did you do after the initial implementation ? What is ease of use in the system ?
- -How do you deal with the increased data entering requirements ?
- -Interoperability with other systems ? Not relevant ?
- -How do you deal with data from another system, I.e I don't think all states have the same systems ?
- -Are you concerned about the limited evidence for different proprietary systems for information manipulation algorithms ?
- -What do you do for data backup ; what do you do for backup systems if the EMR/ CPOE goes down ?
- -How do you think the EMR/ CPOE/ CDSS has affected how your ICU runs ?

# Austin Health Strategic Plan: Strategic Priorities



# Digital Health Framework



# Major Medical Systems

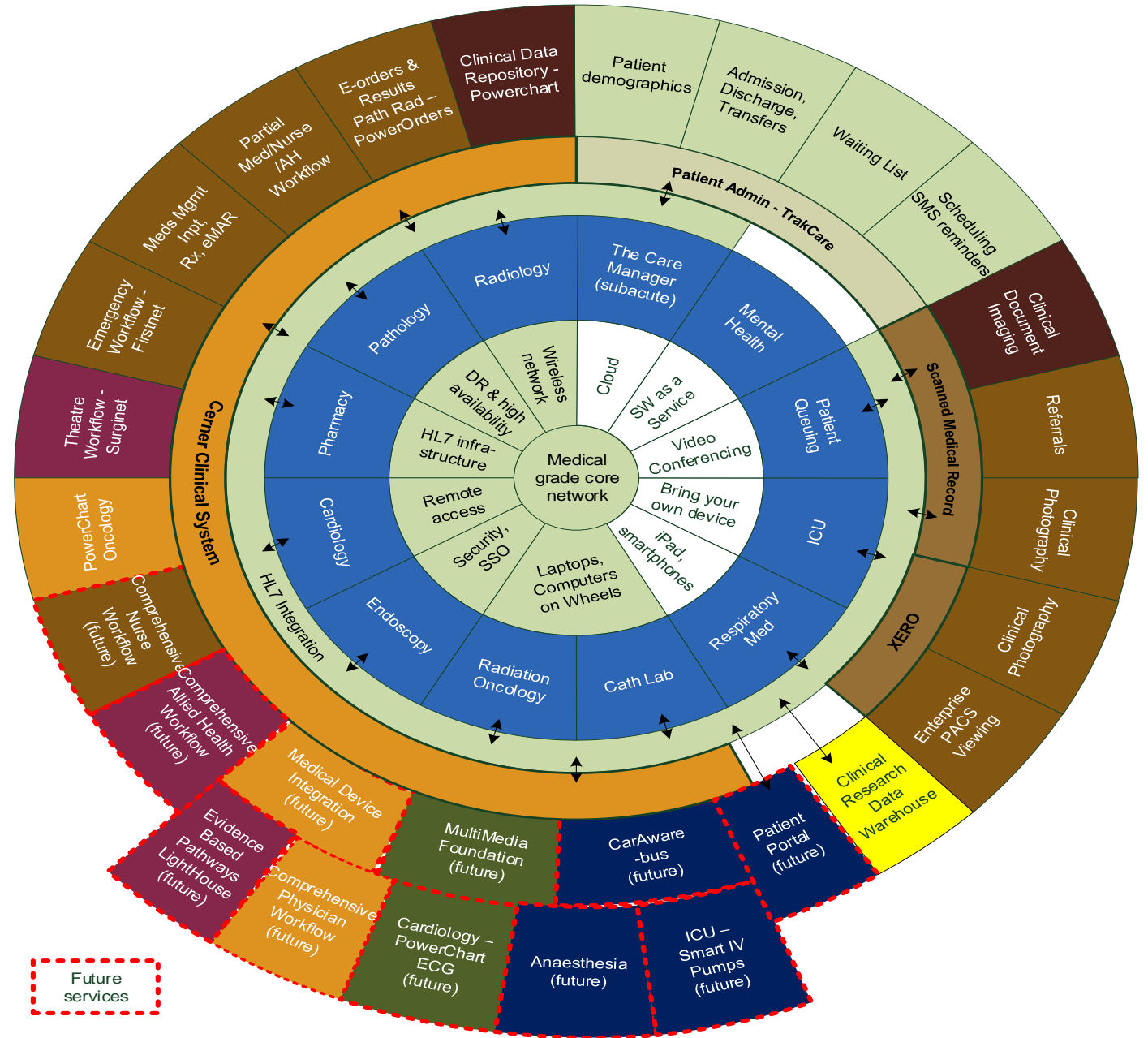
## How Do your ICU workflows fit??

### HIMSS Electronic Medical Record

Complete EMR: external HIE, Data analytics, governance, Disaster recovery	Level 7
Technology enabled medication, blood product, human milk administration	Level 6
Physician documentation structured templates; full CDS; Intrusion protection	Level 5
CPOE; CDS (clinical protocols); Nursing and Allied Health documentation	Level 4
Nursing and Allied Health documentation; eMAR; role based security	Level 3
CDR; Internal interoperability; basic security	Level 2
Ancillaries – Lab Rad, Pharmacy, PACS for DICOM & NON DICOM installed	Level 1
Mandated Ancillaries installed	

### Other Enterprise Systems

- Patient Billing
- HR: Payroll, Rostering, Recruitment, Credentialing
- Finance
- Management Reporting
- Facilities Management & Security
- Clinical Costing & reporting
- Telecommunications
- Riskman (OHS)



# Digital Transformation



Transformation of care delivery



Designed after systematic review of inefficient, unsafe and suboptimal work practice.



Replacing paper forms with electronic ones will not generate the rewards expected.



Work Flow – Process Mapping – current / ideal / achievable



Decision Support



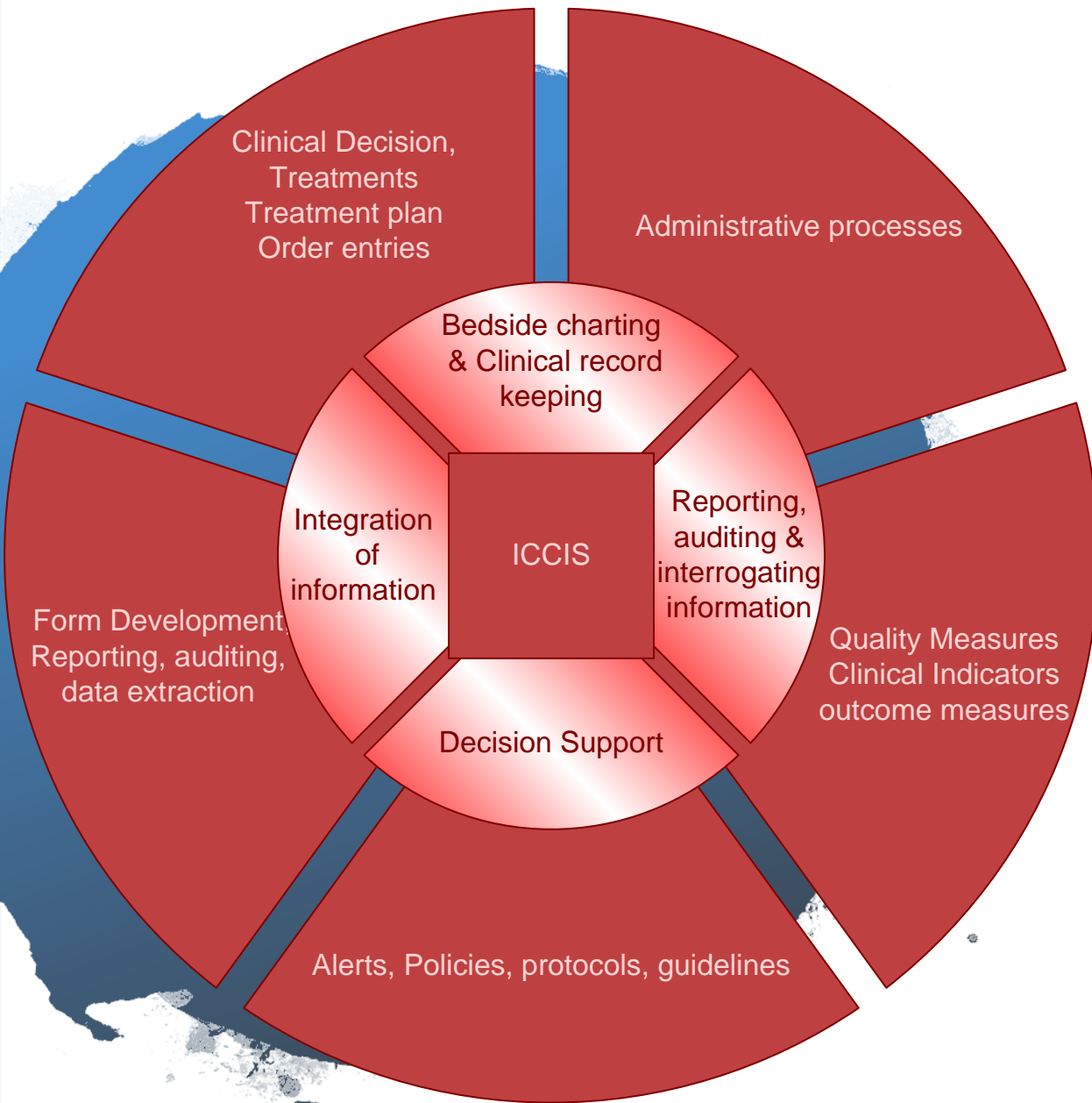
Patient Risk Assessment tools and process



AI / NLP /

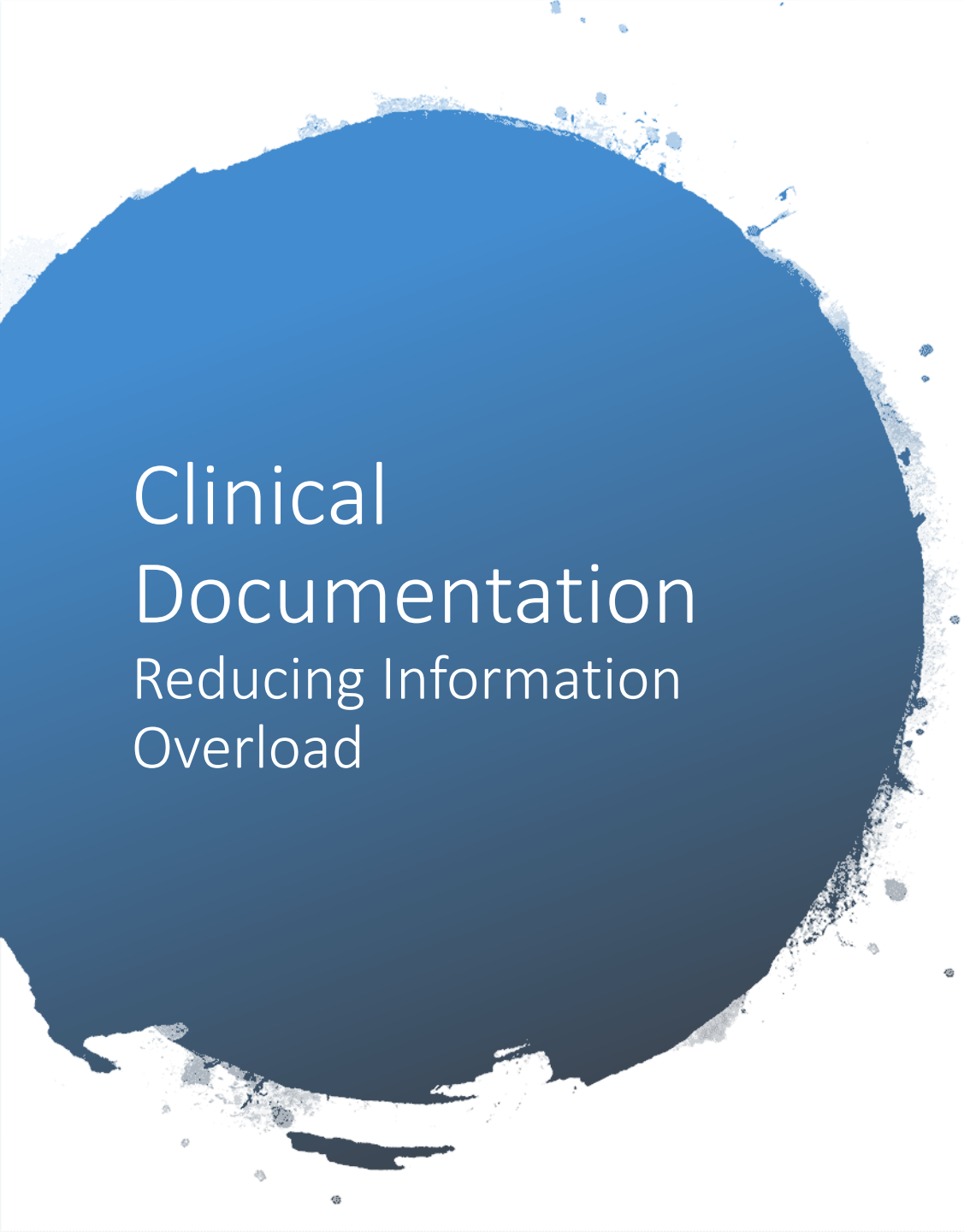


Reporting : Audit , Accreditation, Research



An Intensive Care Clinical Information System (IC CIS) is a networked group of bedside computers devoted to direct patient care which enable

- Data integration - bedside devices, investigational services & patient management systems & organises the information in a meaningful way
- Medical, nursing & allied health notes, patient care plans & orders
- Integrates - hospital drug, fluid and investigation order entry systems
- Decision support systems to improve patient care
- Continuity of Care / Handover
- Data storage, access and reporting
- ICU / HDU Booking ?



# Clinical Documentation

Reducing Information  
Overload

## Single Patient View

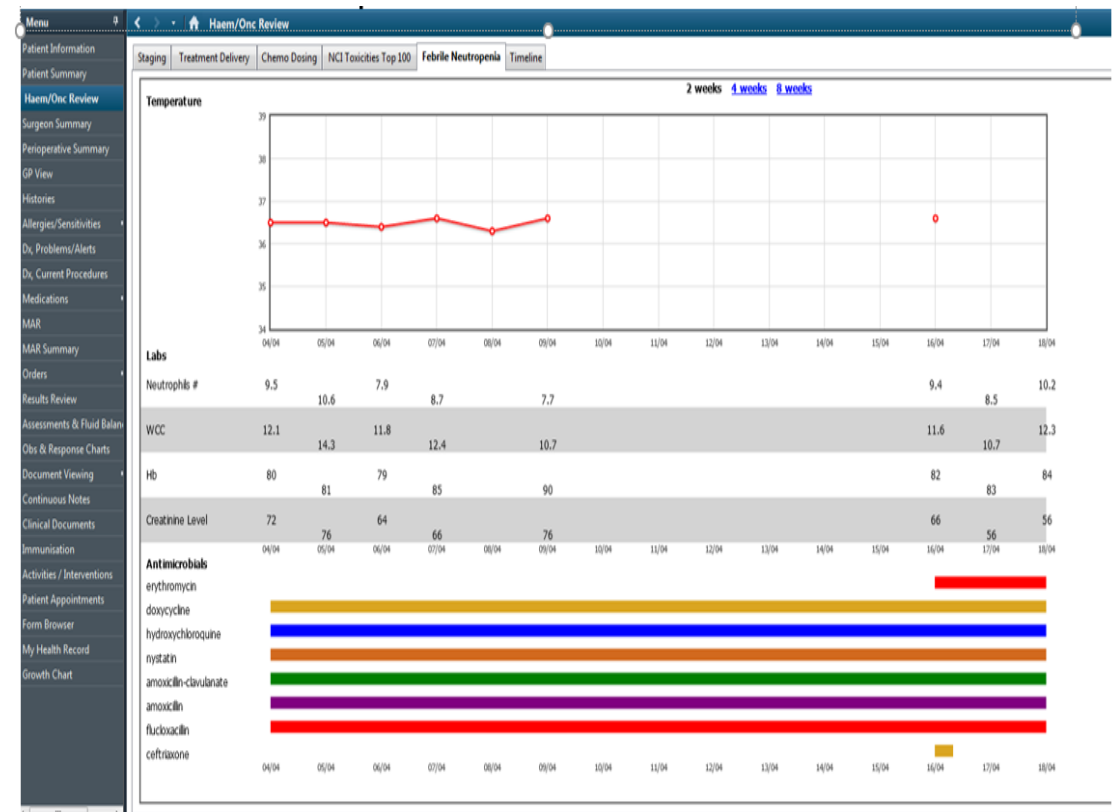
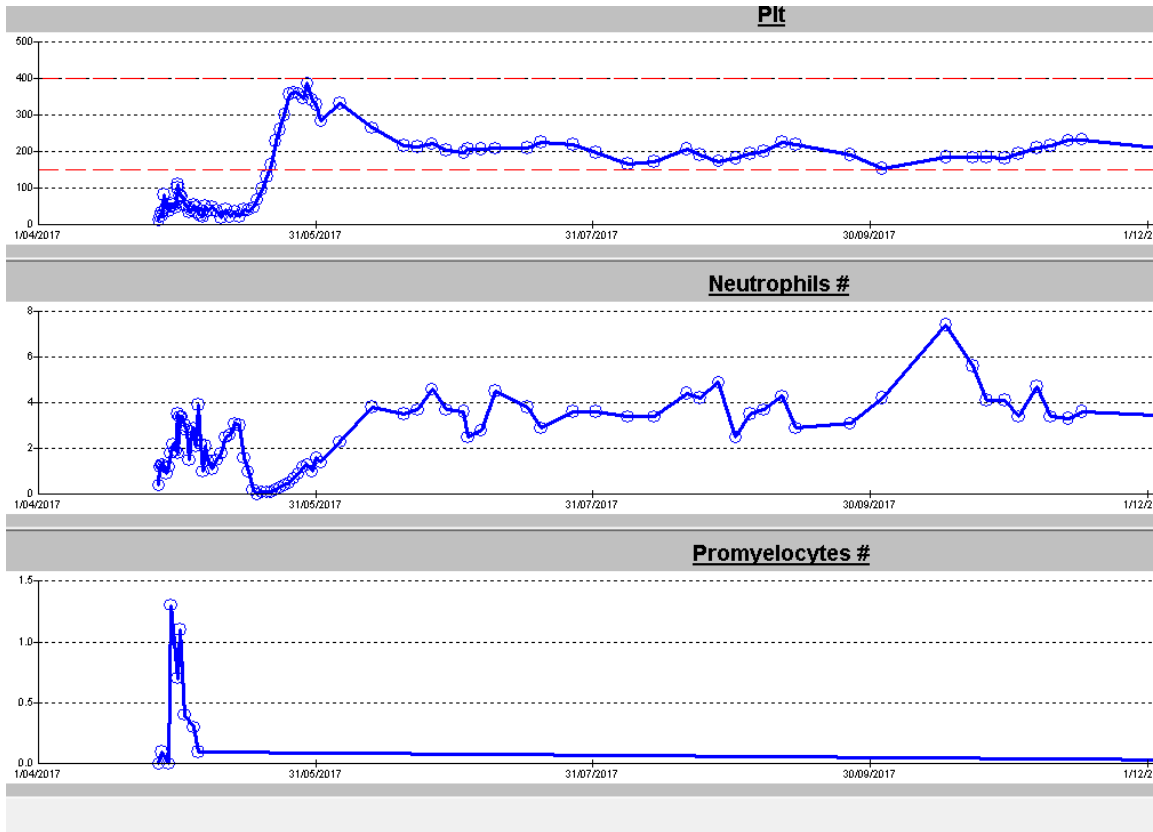
### 300 forms

- Review Form Function and Reinvent the Process of Care subtended
- Define the Process Improvements and Value
- Ensure the Clinician Adoption Achieves the intended benefits

### BUT

- How Do we provide the documentation
  - Structured
  - Narrative Text
  - Avoid Replication
  - Enhance Business and Clinical Process
  - Reduce Information Overload

# Pictures distil vast amounts of data

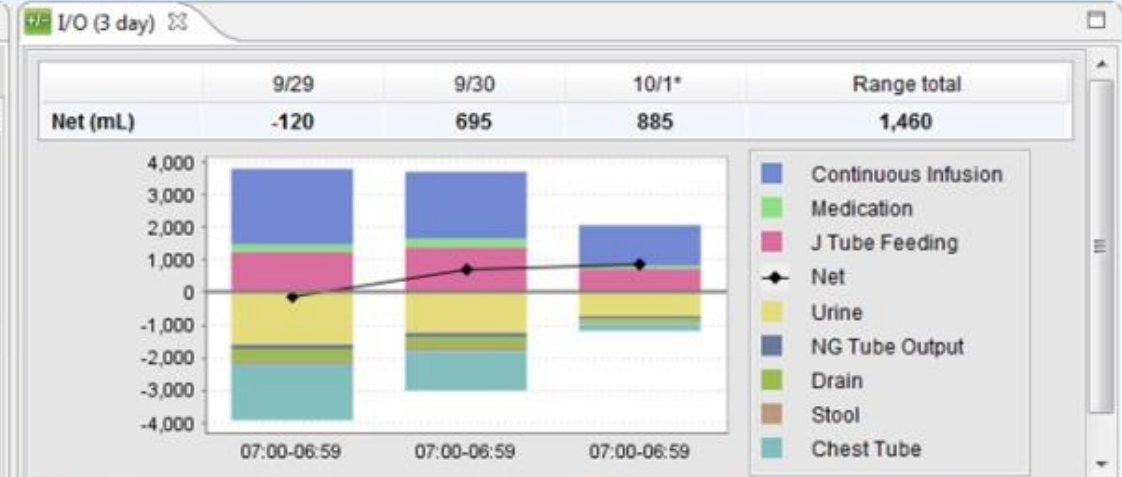
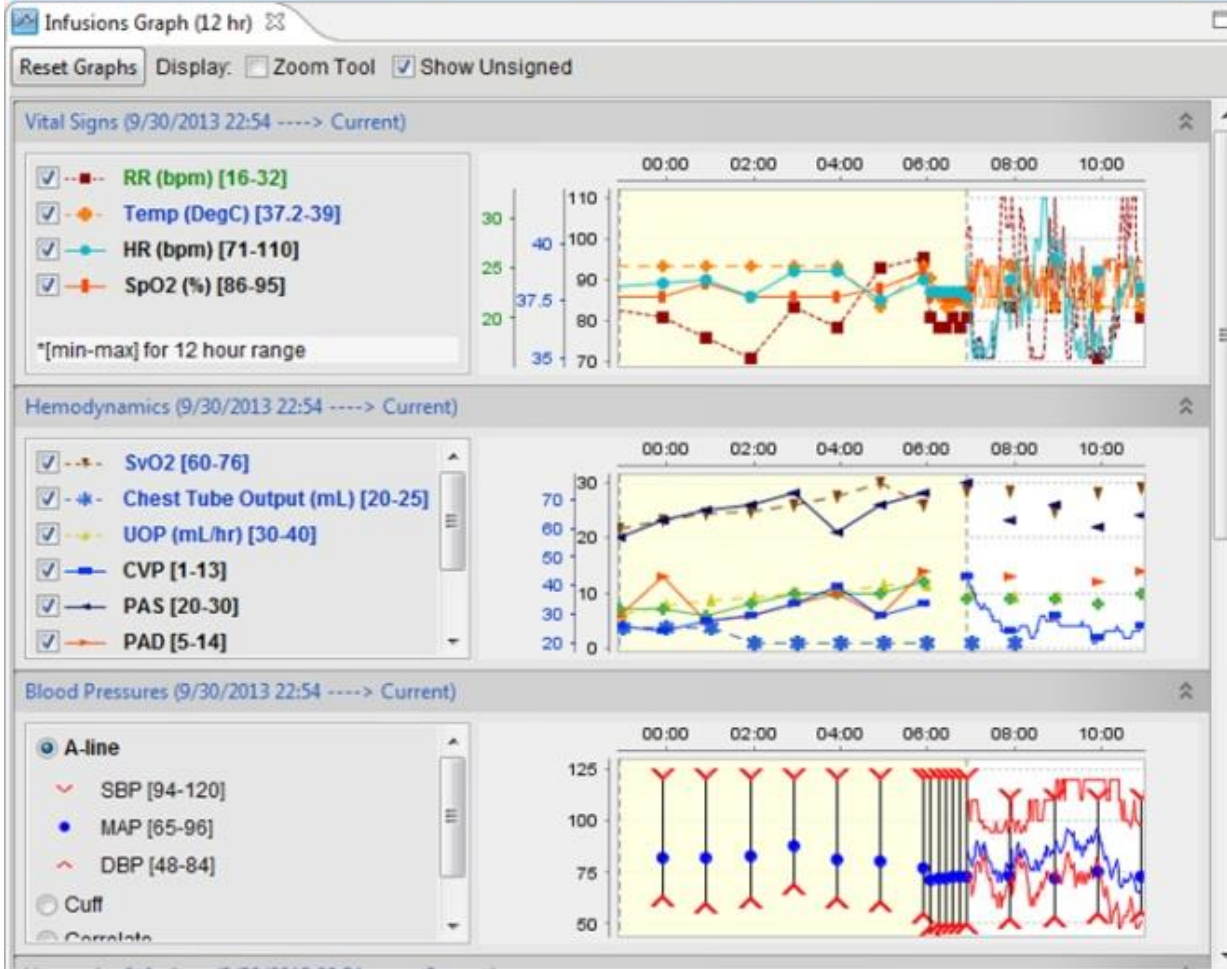


**Woods, Stella 64 years F** DOB: 3/23/1949 MRN: BWMC 010-866 FIN: 023426 Admit: 9/28/2013 Unit LOS: 3 days Location: CCU/10

Dose Weight: 60kg (9/30/2013 08:00)

Actual Weight: 62kg (9/30/2013 08:00)

Allergies: Shellfish, Peanuts



Labs

Blood Gases (Last 2 in 24 hours)

Lab	10/1 09:35	9/30 21:05
pH	7.4	7.38
PO2	79 ↓	79 ↓
PCO2	39	37
HCO3	23	22
BE	1	1

Chemistry

Lab	Latest	Previous
Na	138	149 ↑
K	2.8 ↓	3.1

Respiratory

RR	15 bpm
FIO2	35%
<b>Ventilator</b>	
Mode	SIMV
TV Set	700
TV Inhaled	690 mL
TV Exhaled	675 ml
Rate	14 bpm
PIP	30 cmH2O

# Scope

Define your problem as a Hospital, Department, Care Unit, Individual

What are the Consumer issues?

What are the practical outcomes you need to achieve

Can you prioritise them – method?

Who can help you fix the problems?

- IT department, vendor, consultants

What is your Clinical System Context?

- EMR /non-EMR Hospital - critical difference in approach !

Budget ?

# ICU CIS requirements

## Bedside Technology requirements

Clinician user interface: Due to the multiple complex clinical workflows occurring each day, there are several key requirements for efficient access to the ICIS.

Large format planning screen in each pod to display multi-patient clinical needs acuity and flow –

Large format portrait oriented screen displaying patients summary information and vital signs charting to emulate the "at a glance: oversight of the current large format paper observation charts. [ consider flat mounted touch screen to replace chart board??]

Conventional Landscape screen for clinical notes, orders results and image viewing.

COWs for medical notes during ward rounds

Device integration interface devices

Terminals for central nurses stations

TOTO technology at each computer

## Consumer Requirements

Patient and family information portal or communications structure to enable updates on patient condition and communications between family and ICU staff.

Follow-up Survey documentation for telephone consult of patients at 3 months post ICU discharge, together with work flow to enable list creation and signoff.

## GP Support

Automated notification to GP of admission to ICU, death in ICU to facilitate support of family.

## Virtual ICU Support

for deteriorating patients at Repatriation Campus and on general wards on Austin campus. Mobile trolleys with teleconferencing, portable vital signs monitors with remote data entry to patient record camera orientable to patients.

# Investment Options for CS - Software

## Best of breed

- Self sufficient systems for specific purposes
- Integration platform critical
- Different look and feel in each system & variation between health services
- Smaller companies

## Integrated system

- One system with several modules
- Integration and transfer of data built in
- Where integrating with other external systems, integration expertise and capacity is critical
- Same look and feel easier for users to transfer between health services
- Behemoth companies

# Best of Breed vs Enterprise

- Standalone ICU clinical systems may offer value if there is no hospital wide EMR, however the technical and workflow integration issues in an EMR environment are substantial.

# Investment Options for CS - Hardware

## Stand alone

- Initial Investment required ( full EMR) would be prohibitive to most health services
- Server / site duplication, networks, routers, switches, wireless and user devices
- Maintenance and refresh costs high
- System as a Service

## Hosted by a bureau

- HSS - shared Cerner database (Austin/Peninsula )
- Local Hosting - separate database (Alfred model)
- HSS – but separate databases (as per PCMS model)
- Vendor Cloud

# System and Vendor selection



System and vendor selection requires

- wide review of other implementations
  - Literature, site visits, “anecdote”
  - Vendor contracts assistance
- knowledgeable team,
  - scope, available local team skills, clinical workflow requirements, integration issues.
  - Informatics knowledge
  - How do you find expertise and internally grow the skillset
- Executive sponsorship and IT department support is crucial.
- The more planning before tender, less \$ over runs / limitations
- Include implementation methodology in assessment

# Project Management & Budgeting



Governance



Design



Implementation



Education and Training : never ending



Post Implementation Review



System Modification



Continuing support and evolution of the system



Benefits Realisation.



# Technical [Physical] Infrastructure

- Wireless access for mobile devices,
- Uninterruptable power supplies for local workstations but also for wireless antenna and routers are hidden costs.
- Workstation and screen size and location
- number of concurrent users requiring access for efficient workflow should be mapped out.
- Downtime procedures planning and training are crucial.
- Data Security –

# System Outage – a Major Problem

## Alert

HTS Major Technical Failure

What are Your contingency plans  
Planned and UnPlanned System Outage

### Cerner down (clinical systems)

Wed 3 April

The Cerner system is currently down affecting clinical systems across Austin Health.

We're currently on standby for a code brown to ensure we're ready to respond if the incident escalates.

The Hospital Incident Management Team is carefully managing the issue and centrally co-ordinating efforts across the organisation to ensure that that we continue to provide safe, timely and quality care to our patients.

Further updates will be provided as required.

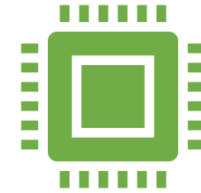
# DATA Security



**Technical Failure – back up systems – frequency / geography**



**Internal - inappropriate use**



**External cyber-attack –**

NHS Ransomware

Cabrini Cardiac group – Ransomware

All Scripts US - Ransomware

# Informatics Infrastructure



Clinical terminologies, medicines and test (pathology and radiology) catalogues



decision support frameworks

Order sets, medications information, appropriate test frequency, alerts, best practice



human computer interface design



critical technical elements of successful implementations that are often given inadequate attention due to lack of trained informatics practitioners.

# Safety Monitors



Compromise is inevitable : \$ / technical / process / training



Implementation Team enthusiastic



Vendors and Executive keen to deploy and move on



Sometimes safety issues are not realised or impact minimised



Individuals raising issues may be marginalised [whistleblowers and troublemakers]



Incorporate a Governance structure that empowers and protects (everyone)

# Data Model

PMI

ADT

LIS

RIS

PACS

Cerner

ALARTA

CardioBase

Respiratory  
Medicine

etc

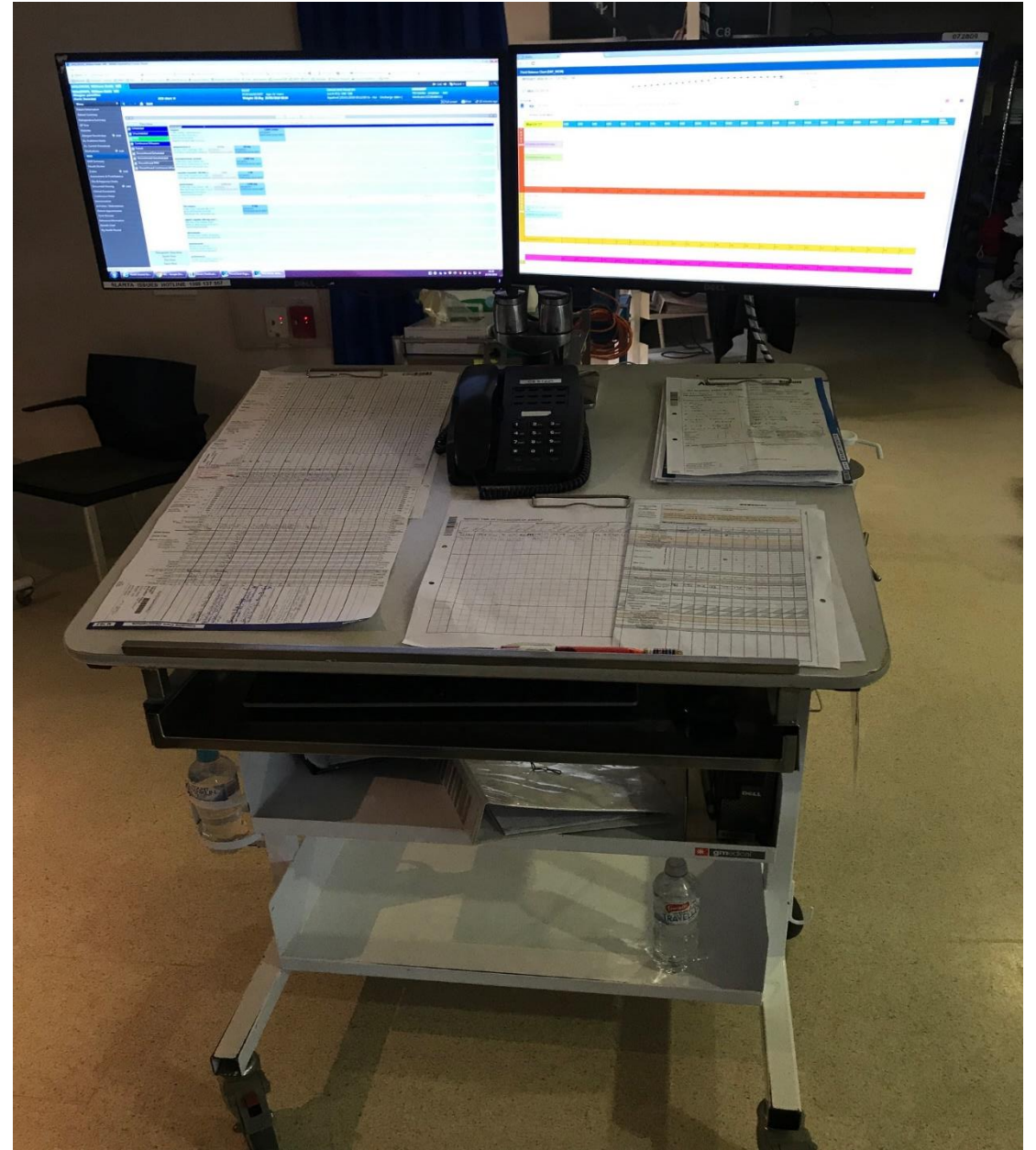
- All Linked through HL7

# Foundation Informatics Requirements / Standards

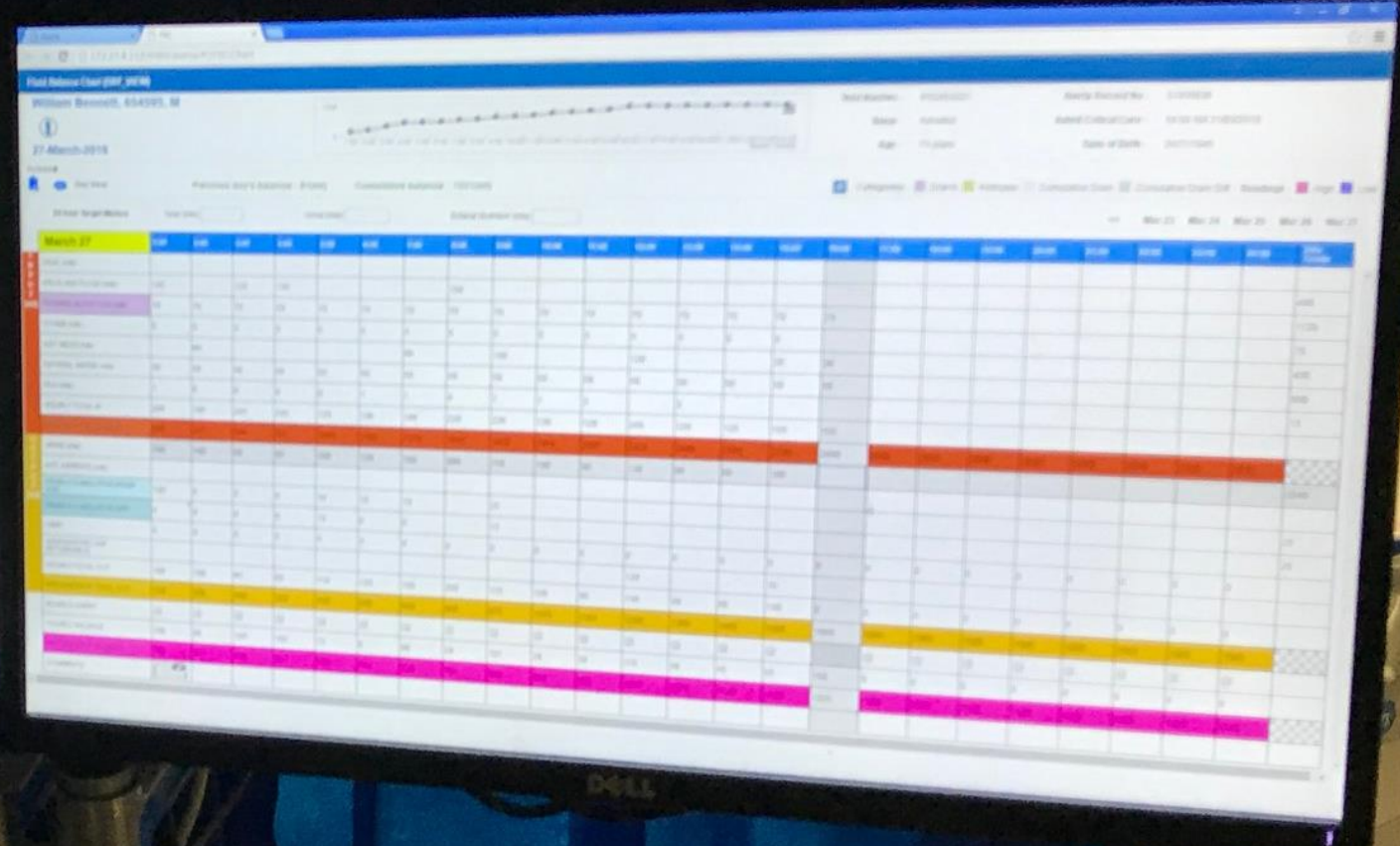
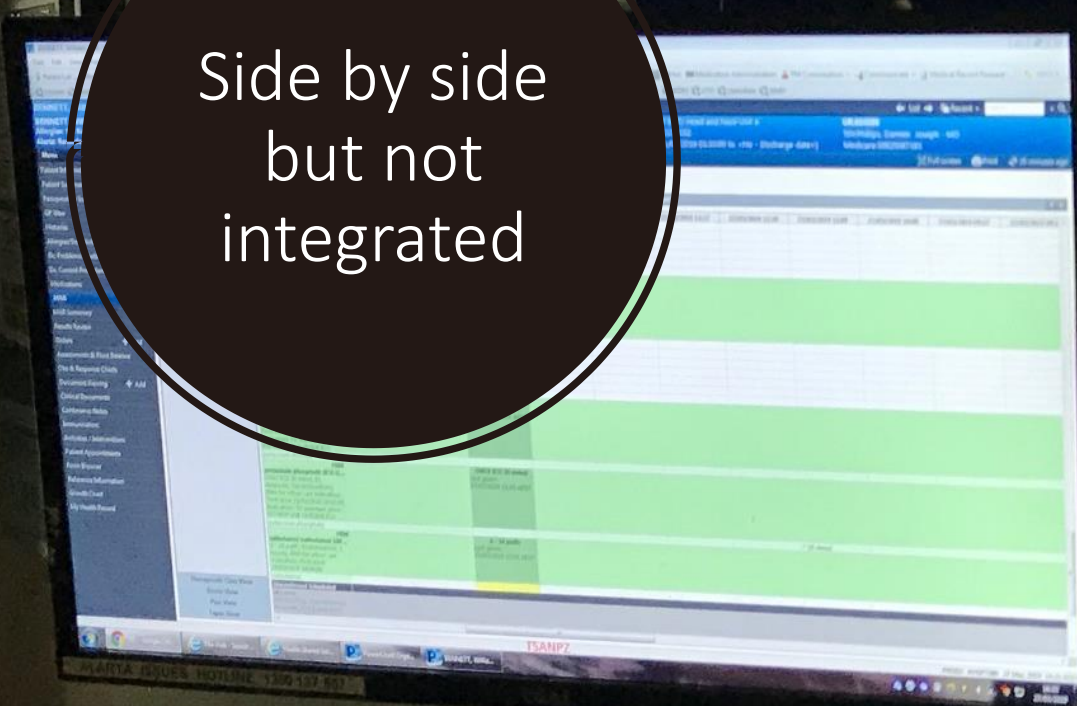
- Medicines : AMT, local formularies, Decision Support Content (including allergies), PBS
- Pathology : LOINC
- Radiology : DiCOM
- Terminologies and classifications: SnoMed CT, ICD10-AM, CMBS, custom, Terminology Managers - IMO
- Staff credentialing and roles
- Integration Engines
- HL7
- SMART on FHIR
- OpenEHR

How does your EMR fit into your total documentation, work flow and data model?

- Paper
- Scanned Medical Record
- EMR Enterprise
- ICU CIS

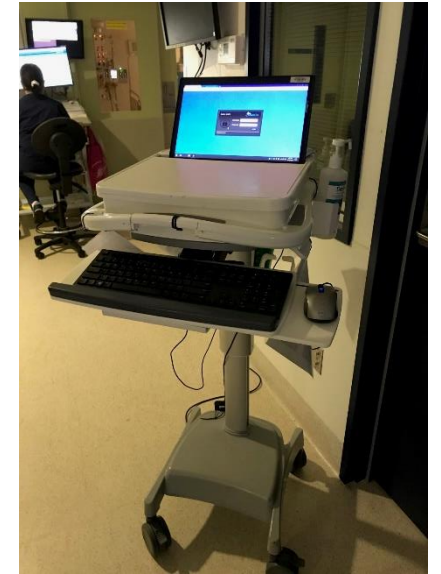


Side by side  
but not  
integrated



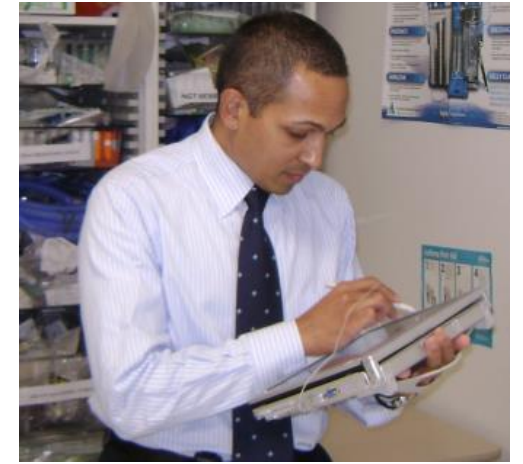
# Access Modalities

- Mobility is a key success factor

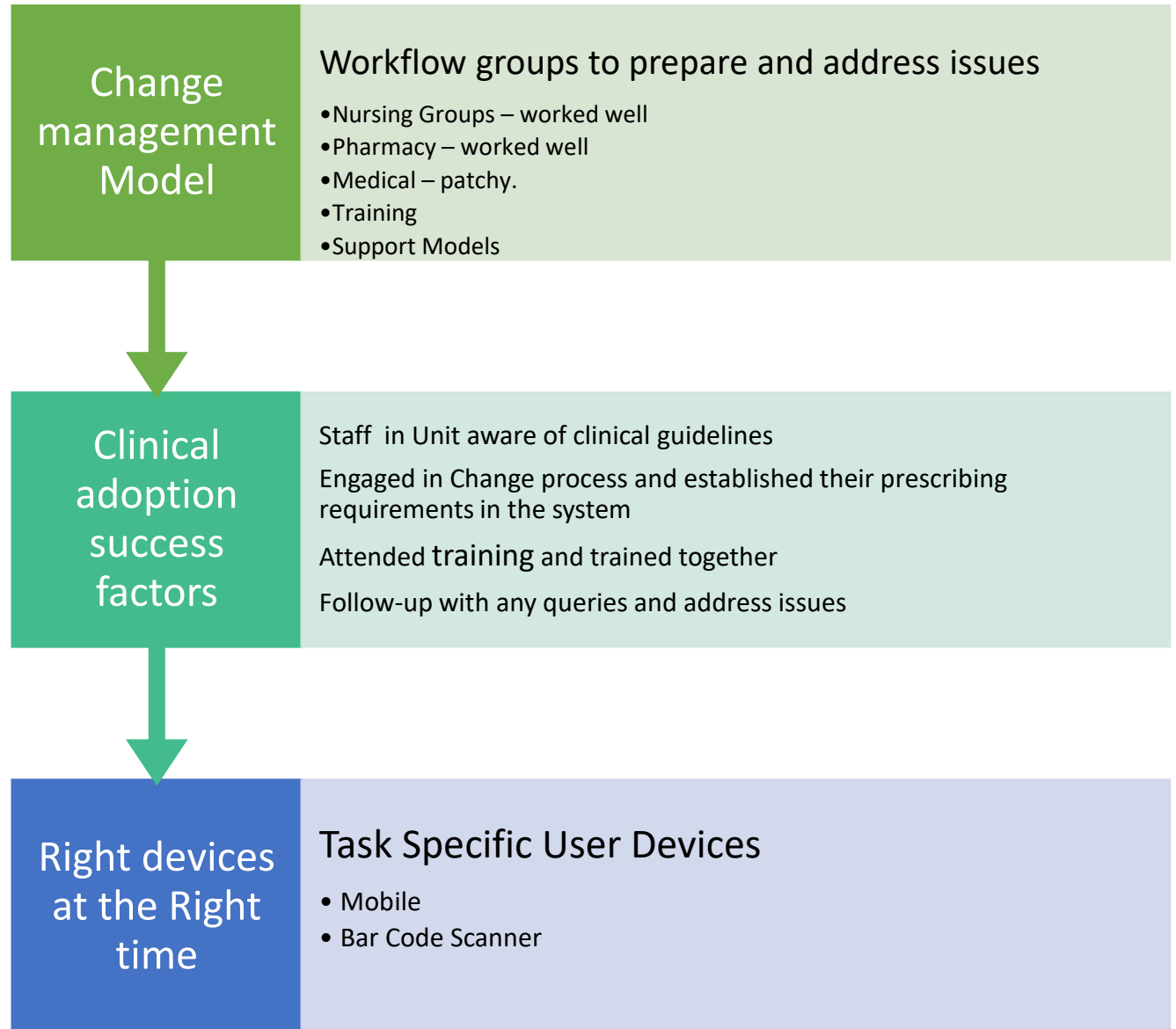


# New Work Patterns – New Risks

- Hand over tools
- Changed communication pattern between team members
- Patient identification
- Multiple screens
- Copy and Paste
- Missed information



# Lessons learned – Clinical Adoption of Medications Management



# Prescribing

- Scripts are electronic
- System provides decision support for allergies/drug interactions
- PBS information available in prescribing screens
- Support streamline PBS authority
- Locked down printing of scripts (tamper-proof printing)
- Inpatient – Complex regimens and care plans

420130712  
 302921392L  
 Unit/Consult: Neurosurgery AH  
 Ward/Clinic: A-06W  
 Class: Public: Eligible  
 Concessional or Dependent, RPBS  
 Beneficiary of Safety Net  
 Concessional Cardholder  
 PBS  
 RPBS  
 Chemotherapy Pharmacist Access Program

*Stelli - flu nurse in 6/52*

Prescribing Details	Qty	Rpts	Approval number if required / S100 / Reg.24	Pharmacist Use-Only
Oxycodone (Oxynorm 10 mg capsule: hard, 20 capsules) Oral every 4 hours PRN for pain	20 cap(s)	0		Y
<b>CANCELLED</b>				
Paracetamol 10mg Strength: 10mg Qty (figure): 20 Qty (words): TWENTY Repeats (words & figures): 0 zero				
Chlorzoxazone (Tegretol CR 400 mg tablet: modified release, 200 tablets) Oral TWICE a day Special Instructions: Do not chew. Take with or after food.	200	0		N
Dexamethasone (dexamethasone 4 mg tablet, 30 tablets) Oral TWICE a day Special Instructions: Take with or after food.	30 tab(s)	0		Y
Lactulose + sennosides (Coloxyl with Senna tablet: film-coated, 30 tablets) Oral at night PRN for constipation	30	0		Private Prescribed Item
Ibuprofen (ibuprofen 400 mg tablet, 30 tablets) Oral THREE times a day Special Instructions: Take after food.	30 tab(s)	0		Y
Keppra (Keppra 250 mg tablet: film-coated, 60 tablets) Oral TWICE a day Authority Script Number 19432326	60	0	2664	Y
Pantoprazole (pantoprazole 40 mg tablet, 30 tablets) Oral daily Special Instructions: Swallow whole.	30	0		Y
<b>ONLY</b>				
ALPROSTADIL 500mcg 50mLs 5% Dextrose	0.1-0.6 mcg/kg/hr	IV		ghe.
2mg tacrolimus in 100 ml saline	0.7mg mg/hr	IV		gg
1500mg propofol in 100ml (bottle)	0-200 mg/hr	IV		gg
6mg noradrenaline in 100ml 5% dex	0-20 mcg/hr	IV		gg
30mg pantoprazole in 100ml saline	5mg mg/hr	IV		gg
100mg FENTANYL in 100ml NaCl	0-100 mcg/hr	IV		ghe.
pantoprazole in 100ml saline	5mg mg/hr	IV		

# What has changed – Inpatient medications

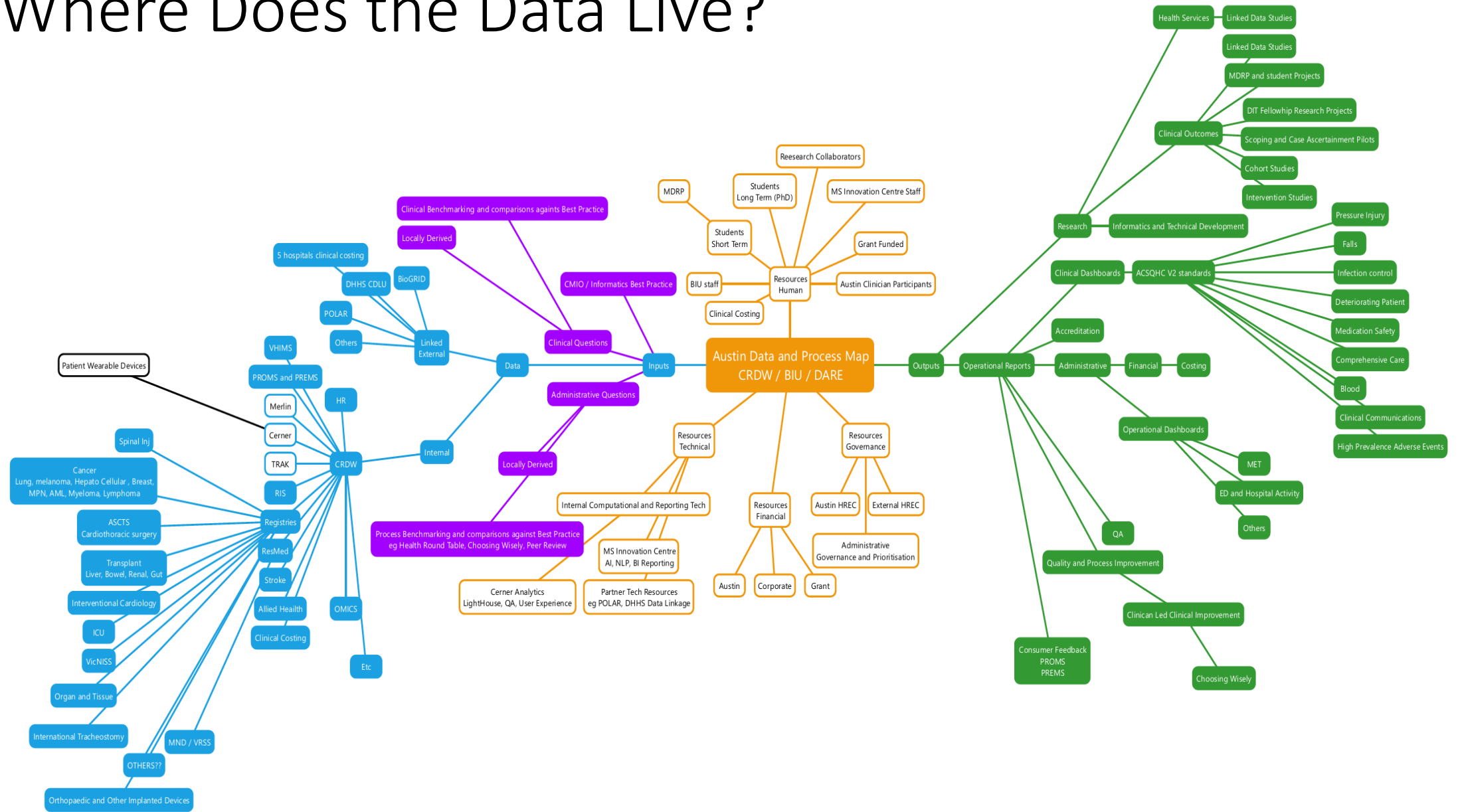
- Nursing staff checking what is due more often
- Can find what is due and what is overdue – more accountable
- Legibility of medication orders improved
- Reduced decimal point errors
- No more time looking for lost medication charts
- Medications given closer to their due time
- Reasons for 'not given' consistent
- Can order from anywhere
- Pharmacists can see orders from anywhere
- Reduced the number of different medication charts

# Analytics

- No digital solution should be installed without a data analytics platform driving quality assurance, audit and research.
  - Dashboards – real time clinical tools
  - Audit
  - Process and Flow management
  - Clinical Costing
  - User experience
  - ANZICS extracts
  - Cohort / Descriptive studies
  - Scoping for RCT
  - Natural Language Processing
  - Machine Learning and AI



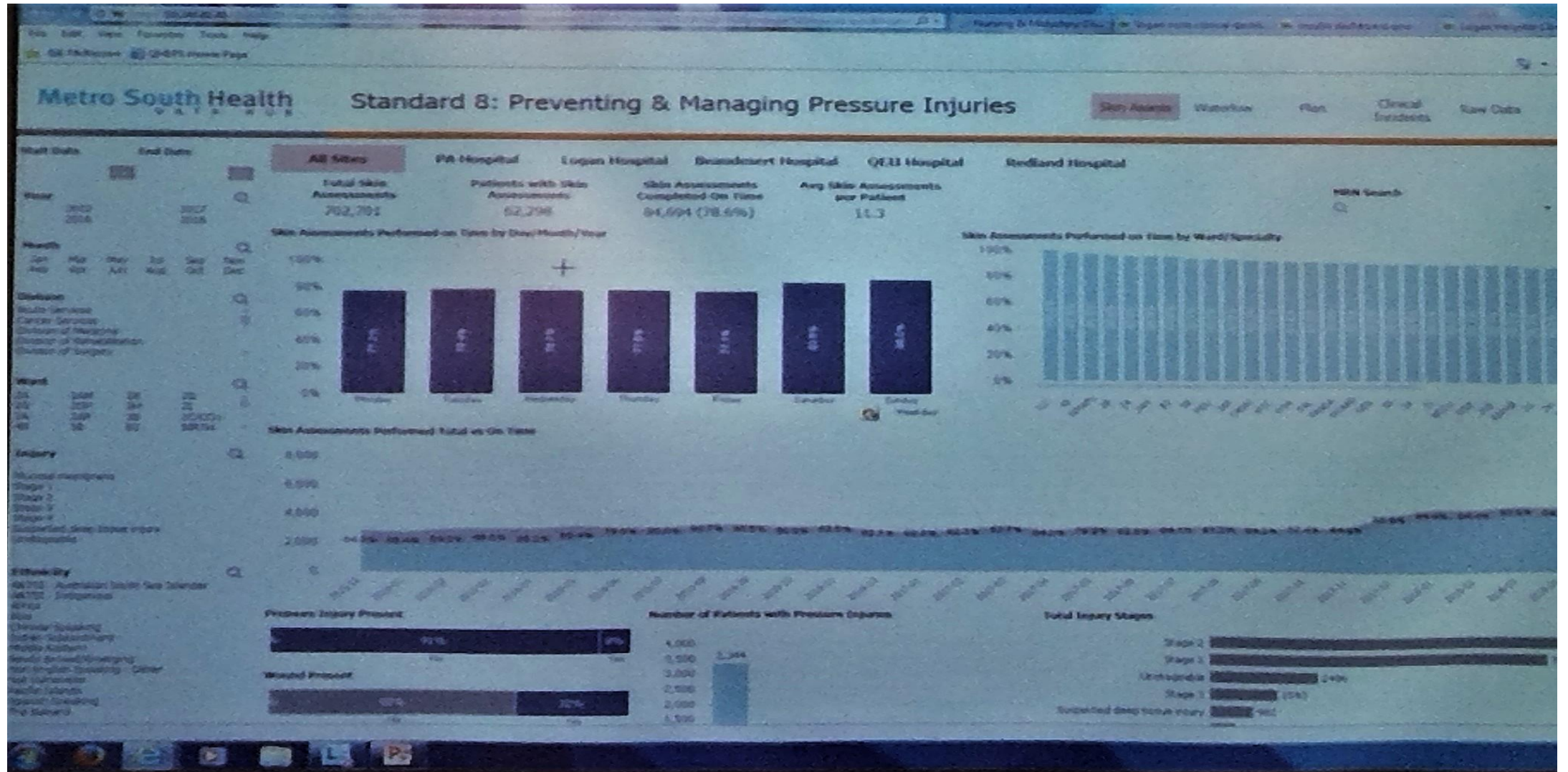
# Where Does the Data Live?



# Cerner APACHE 4 reporting



# Clinical Dashboards



# Clinical Decision Support Systems

Special article

## Clinical decision support systems and infection prevention: To know is not enough

### Table 1

“‘Ten commandments’ for Successful Design, Implementation and Use of Clinical Decision Support Systems” adapted from David W. Bates and colleagues in the *Journal of the American Medical Informatics Association* with overlaying themes of technical and human factors<sup>11</sup>

1. It must be fast. Speed, or the time it takes for the CDS system to gather and process the data and return meaningful information or actionable recommendations to the end user.
2. Keep the CDS system simple. Guidelines can be complicated and not readily adaptable to automated systems. Overly complicated systems are more susceptible to technologic fails, and too much information may overburden the end user.
3. Require the user to enter data only when it is essential. Asking end users to enter data already documented (eg, in the EMR) is double documentation and poorly received by users. If it is necessary, get end user acceptance early in the design process by explaining the necessity and the inability to gather the data elsewhere.
4. Routinely maintain and evaluate the CDS system. When guidelines change, the CDS tool built on those recommendations needs to change as well. Retire CDS tools when no longer needed.
5. Identify latent needs and inform the end user. Latent needs are supplemental recommendations in the CDS tool. As an example, if the primary output of CDS is to recommend vancomycin for treating a specific positive culture, a latent need to order therapeutic drug monitoring can be provided at the same time.
6. Build the CDS system to fit the existing workflow and seek input from end users early in the design process to understand their natural workflows better.
7. Understand that usability is essential and nuances matter to end users. Professionals that design or customize CDS tools and clinician end users may both use the same computer program but in very different ways. End users must be involved in the design and development phase from concept to completion.
8. Do not stop, change course and
9. Physicians will not stop. Stopping refers to not allowing the end user to complete their desired course of action and sometimes may be referred to as a hard stop. Offering clinically appropriate alternatives (drug A instead of drug B) and override options (eg, requiring the user page infectious diseases for preapproval for a medication order to be filled) allows the end user to complete their task.
10. Measure and share success. When a CDS tool is implemented it inherently changes how end users do their job. Measuring how end users are responding to the CDS tool and sharing data on the (ideally improved) clinical outcomes reinforces the value in their efforts and builds trust for future development.

# Realising the Benefits

- We need to be able to Measure, Report and Change
  - Data Quality : Design, Usability, Training, Process, Control and Audit
  - Data Type : Codified, Narrative
  - Data Integration:
  - Data Governance:
  - Data Use: Operational, Audit, Research, Personalised Medicine
  - Data Analytics: Natural language Processing, Deep Learning,
  - Data Reporting: Tools and Training to make data use easy for clinicians
  - Algorithmic Risk Assessment and Targeted Interventions
  - Data Linkage
  - Population Health

# Linked Data Research in ICU

- Predicting Risk

- Can acute delirium be predicted?

- What validated markers of Delirium Risk exist? - Previous episode, Age, dementia, alcohol, medications

- Where does such data live ?

- GP, coded hospital discharge data, previous ICU admission data

- How to link? Prediction algorithm?

- Intervention?

- Outcomes Assessment

- What is the long term behavioural / dependency risk for patients receiving narcotics in ICU?

- Behavioural, medications use in post hospital period.

- GP, National Prescribing data,

# Digital Benefits – Princess Alexandra 2017 – HIMSS level 6

## Digital Hospital Benefits 2017

A benefit is a measurable improvement resulting from a change that is perceived to be an advantage by a stakeholder.

The benefits associated with the digital hospital system at PAH have been achieved because the hospital's clinical and non-clinical staff have embraced innovation in healthcare.



### Early Identification of deteriorating patients

Rapid Response Team calls

AUG 2015 vs AUG 2017



### Drug administration and monitoring

Incidents linked to drug administration and monitoring

1 APR-6 AUG 2016 vs 1 APR-6 AUG 2017



### Drug Dispensing and Supply

Incidents linked to drug dispensing and supply

1 APR-6 AUG 2016 vs 1 APR-6 AUG 2017



### Radiology results

Formal endorsement of ED Radiology results

DEC 2014-MAY 2015 vs DEC 2016-MAY 2017



### Readmissions

Emergency readmissions within 28 days of discharge

JAN-JUN 2014 vs JAN-JUN 2017



### Inpatient length of stay

Average for all admissions

JUL-DEC 2014 vs JUL-DEC 2017



### Drug costs per WAU

Drug costs per weighted activity unit

JUL-DEC 2016 vs JUL-DEC 2017



### Reported Hospital Acquired Stage 3 and 4 pressure injuries

No. of patients with stage 3 and 4 pressure injuries per 1000 bed days

JUL-DEC 2014 vs JUL-DEC 2017



### Infections

Healthcare associated SAB per 10,000 bed days

JUL-DEC 2014 vs JUL-DEC 2017



### Clinical form costs

Including printing costs

MAR-MAY 2014 vs MAR-MAY 2017



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