CIS Seminar: human factor engineering

Dr. AMC Kwan
Department of Intensive Care
Pamela Youde Nethersole Eastern Hospital

Human factor is..

- A discipline concerned with
  - Design of tools, machines, systems
  - Take into account human capabilities, limitations, characteristics
- Fundamental goals
  - minimize workplace injuries/hazards
  - Minimize system-related error
  - Maximize workers and workspace efficiency and productivity

Human Factor Engineering

- ✓ Interaction between human and system
- ✓ Dialogue between end-user and their tools
- ✓ Tools and concepts to help us with patient safety
- ✓ Applications of HFE
  - ✓ medication error and confusion
  - ✓ medical devices
  - ✓ identifying and controlling hazards
  - ✓ Patient safety and good system

Historical background

- "Experimental psychology"
  - Applies to problems of military aviation near the end of WWII
  - Poor usability of cockpits
  - The original design ignored the normal limitations on human perception and cognition under **stress**

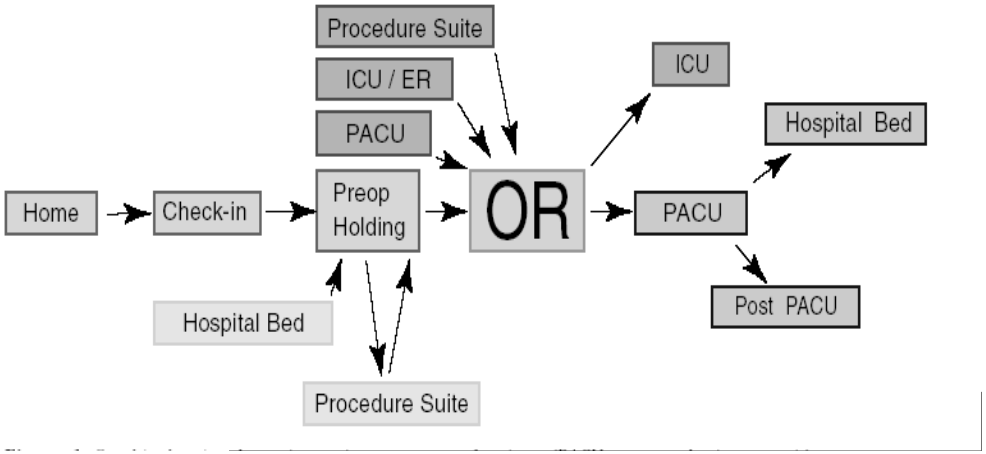
A catalyst for the development of HFE

Broad impact of HFE

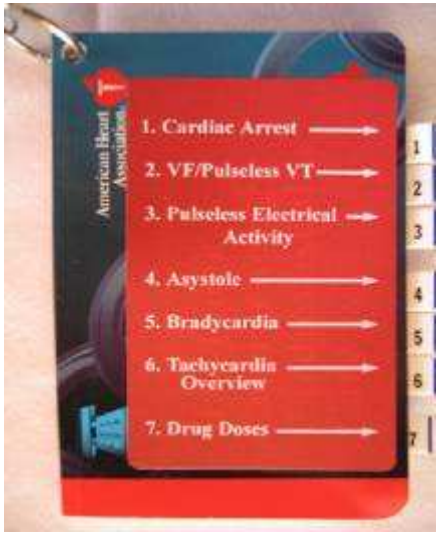
- Aviation (since 1940's)
- Nuclear Power
- Space flight
- Computer software and hardware (Xerox PARC 1970s)
- Consumer products (Palm Pilot)
- Railroad, motor vehicle, farm machinery, etc.

Healthcare "Systems" Range from the Simple to Complex

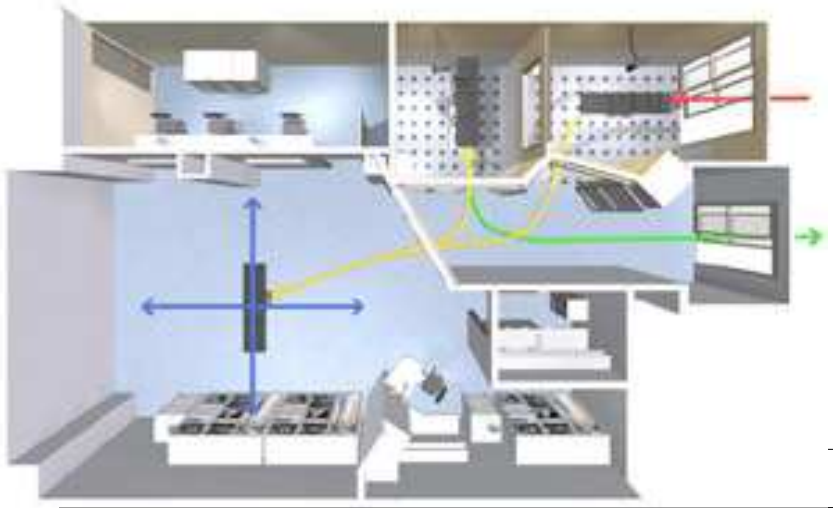
- Syringe, catheter bag and its tubing
- O_2 cylinder, ECG machine, IV pump
- Code cart, anesthesia work station
- Hospital computer system
- ICU, AED, OT



Human Factors Engineering is about the whole system

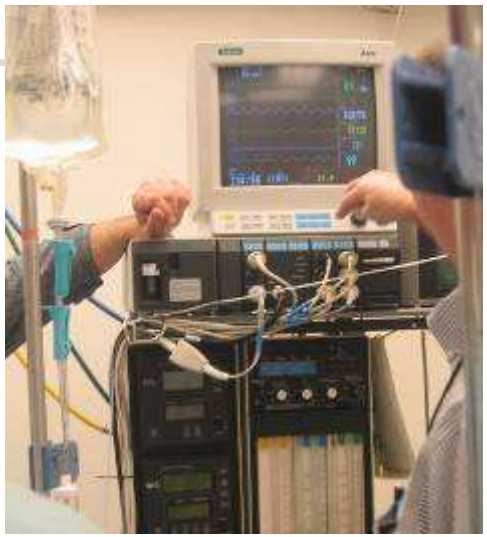


- Labeling and instructions attached to device
- Medication error
- Policy and procedures
- Layout and structure of
  - The room
  - The overall environment



Human Factors Engineering and our World

- Anesthesiology
  - Design of alarms, monitors, and safety systems
- Emergency Medicine
  - Design of decision-making tools and monitoring
- Surgery
  - Design of hand tools and visualization devices (laparoscopy)



Key Slide…

Psychomotor

- Hand
- Feet

Senses

- Vision
- Hearing

INTERFACE

Input Devices

- Buttons
- Foot pedal

Output

- Color display
- Sound

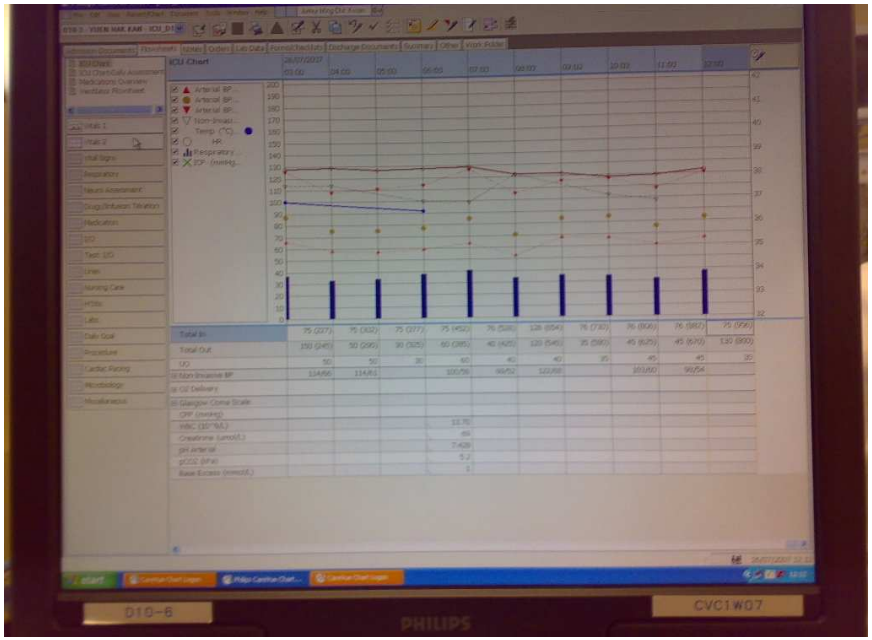
Human Factor engineering Guidelines

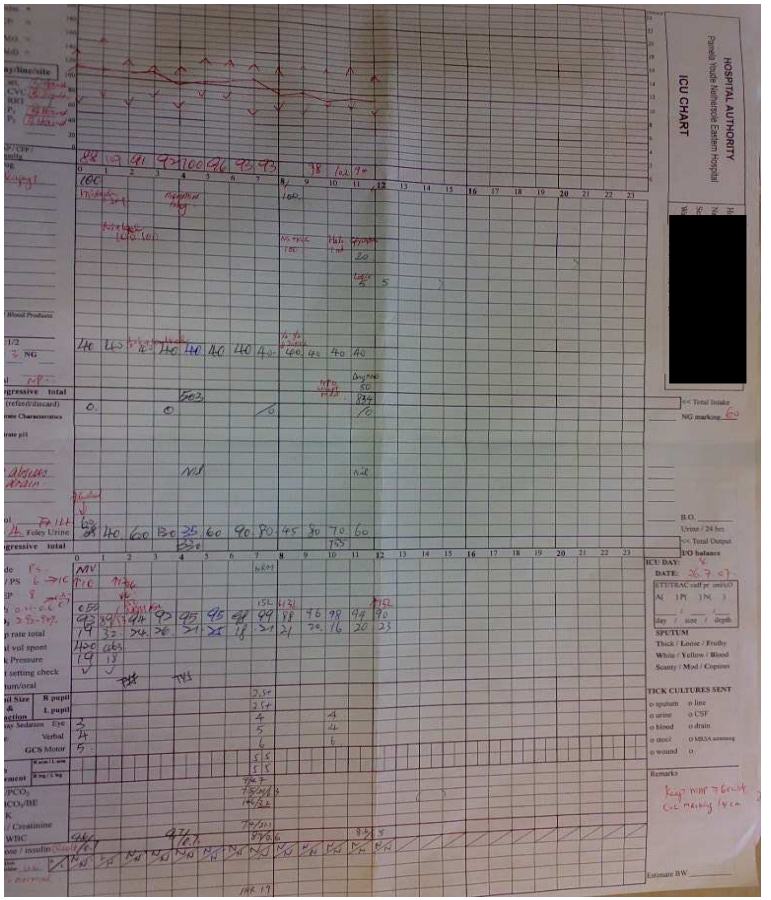
1. Simple and Natural Dialogue
2. Speak the Users' Language
3. Minimizing User Memory Load
4. **Consistency**
5. **Feedback**
6. Clearly Marked "Exits"
7. Prevent Errors
8. Good Error Messages
9. Help and Documentation
10. **Readable and understandable labels and warnings**

Consistency

- Controls that look the same act the same
- Displays or terms that look the same act the same
- Overall
  - Refer to one item with the same name all the time
  - Conversely, refer to different items with distinct names

An example of consistency….





Consistent

"Connect Oxygen mask and tubing to the green spigot……."

Feedback

- Users want to know what is happening in terms they understand
- Device or system should indicate current status of the system
- Examples of feedback from your computer
  - “Beep” when you do certain “bad” things
  - “Thermometer” or “hourglass” display to indicate progress in task

A typical feedback system….

- Straightforward
- A lay person, or even children knows there's something wrong.

Readable and understandable labels and warnings

- Seemingly easy to do…it's not
- Thousands of examples, including our own earlier….*midazolam vs magnesium*

- Caused by
  - Jargon
  - Complexity of most design processes
  - Unneeded creativity

An example of poor labeling and naming….

Application of HFE: avoid medication error and confusion

A small question…

Are labels effective in changing our behavior…?

1) All of the time, if people are motivated
2) For some people, if the labels are readable and understandable
3) Some of the time, if people are paying attention
4) Not enough information to tell

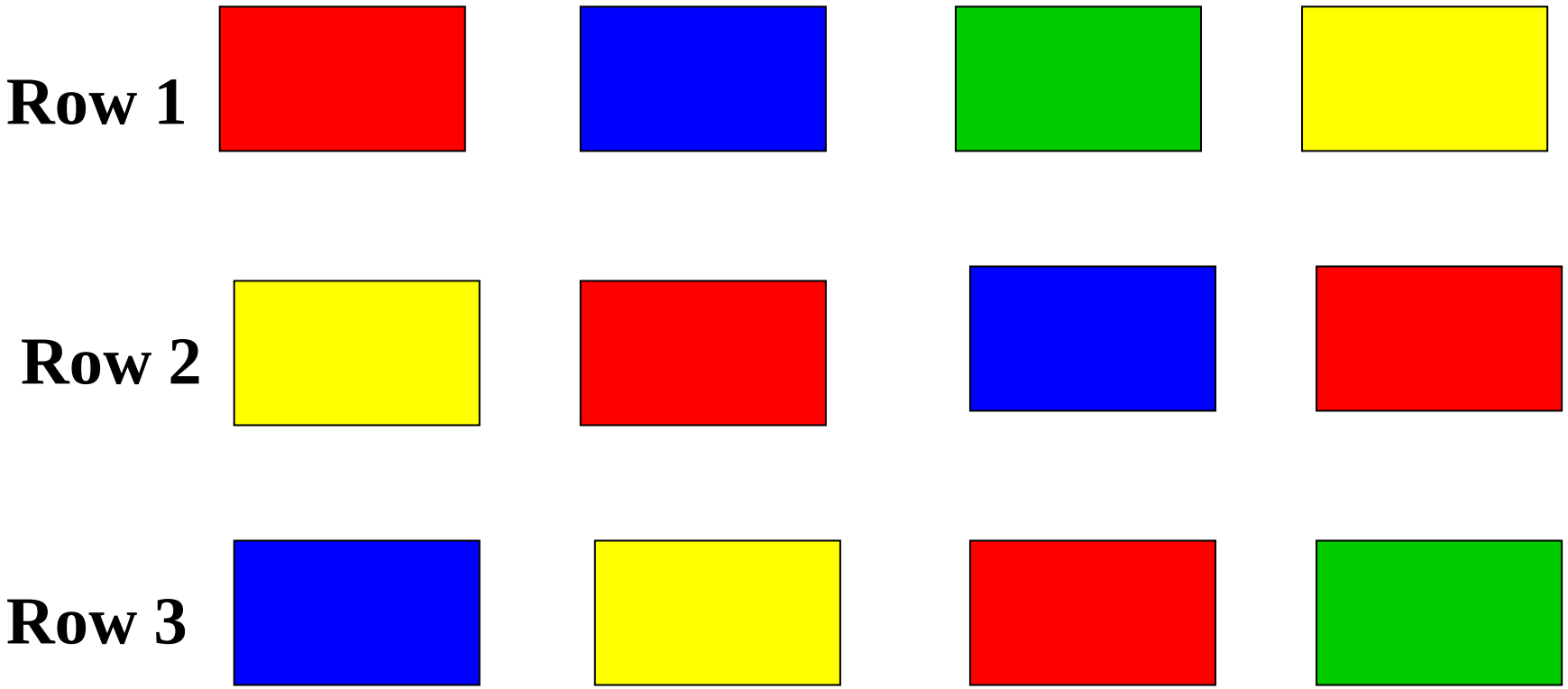
I have a mild cataract….

- *…and I have to do the injections myself..*

Eyedrops…


BAUSCH & LOMB
NDC 24208-585-64
Tropicamide Ophthalmic Solution USP, 1%
STERILE OPHTHALMIC SOLUTION
Rx only
15 mL
BAUSCH & LOMB
Cyclopentolate Hydrochloride Ophthalmic Solution USP, 1%
STERILE OPHTHALMIC SOLUTION
Rx only
15 mL

Demonstration: Stroop Test



State the Color of the Text as Fast as You Can…

Row 1	Red	Blue	Green	Yellow
Row 2	Yellow	Green	Blue	Red
Row 3	Green	Red	Yellow	Blue

State the Color of the Text as Fast as You Can…

Row 1	Red	Blue	Green	Yellow
Row 2	Yellow	Green	Blue	Red
Row 3	Green	Red	Yellow	Blue

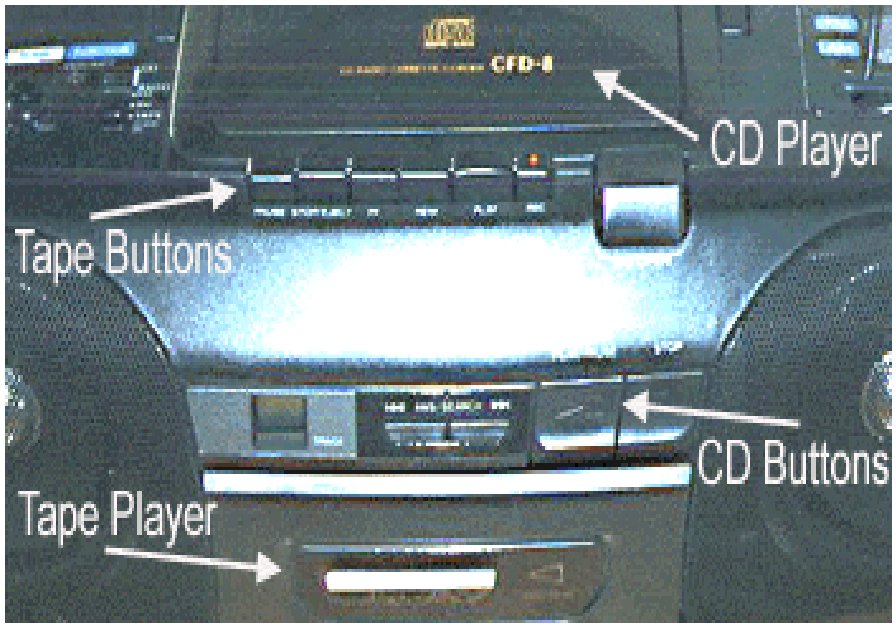
Application of HFE: medical device

A good medical device

- *Ideally….*
- A perfectly designed device should be easy to use and no one should make mistake
- A poorly designed device will be difficult to use and prone to mistakes

Something we should know

- Poor design increase the likelihood of error
- Device-user interface is where error happens



Use error vs User Error

- USER error
- *"If an error is made with a device that is working the way it was designed"*

- USE error
- *"NOT considered to be someone's fault, but the fault of the system e.g. equipment, policies, communication, staffing"*

Unfortunately…

- A combination of influences leads to use-related error with medical devices
  - The device is **too complex**
  - The device is used **under stress**
  - **Users think differently** as **device designers** do
  - *If problem arises…..*
    - blame the user
    - Less focus on poor product design or inadequate instructions

Usability Testing Exercise

- Director
  - Reminds end-users to think aloud
  - Leads team discussion about issues and re-design AFTER usability test is complete
- End User
  - Read the instructions and use the device
  - Use the systems as normally would (without help)
- Observer
  - Document end-users actions and words (also facial expressions, swearing…..)

Back to square one…

If technology doesn't work for people, then it just doesn't work

Human factor in CIS – practical aspect

Frontline physican's perspective

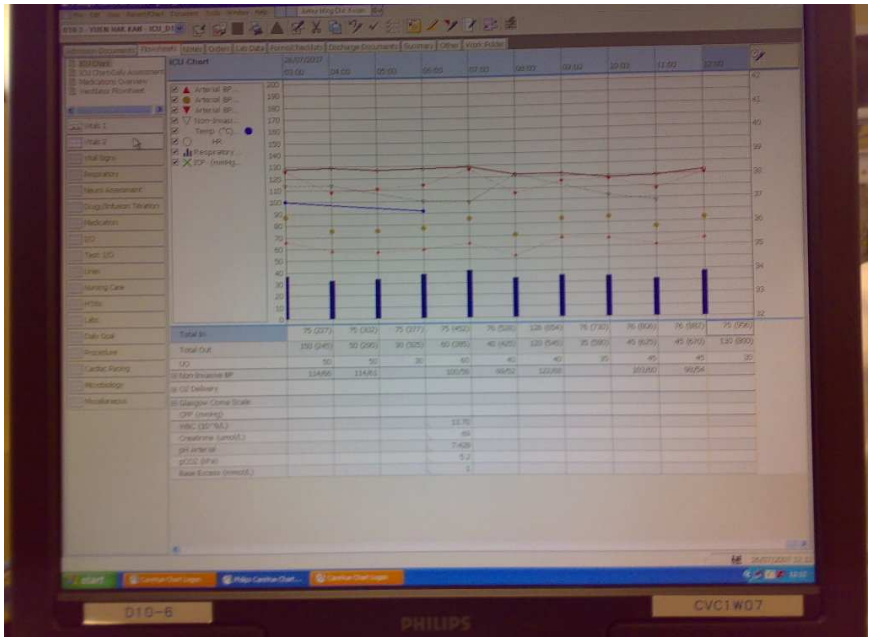
Our experience: frontline physicians

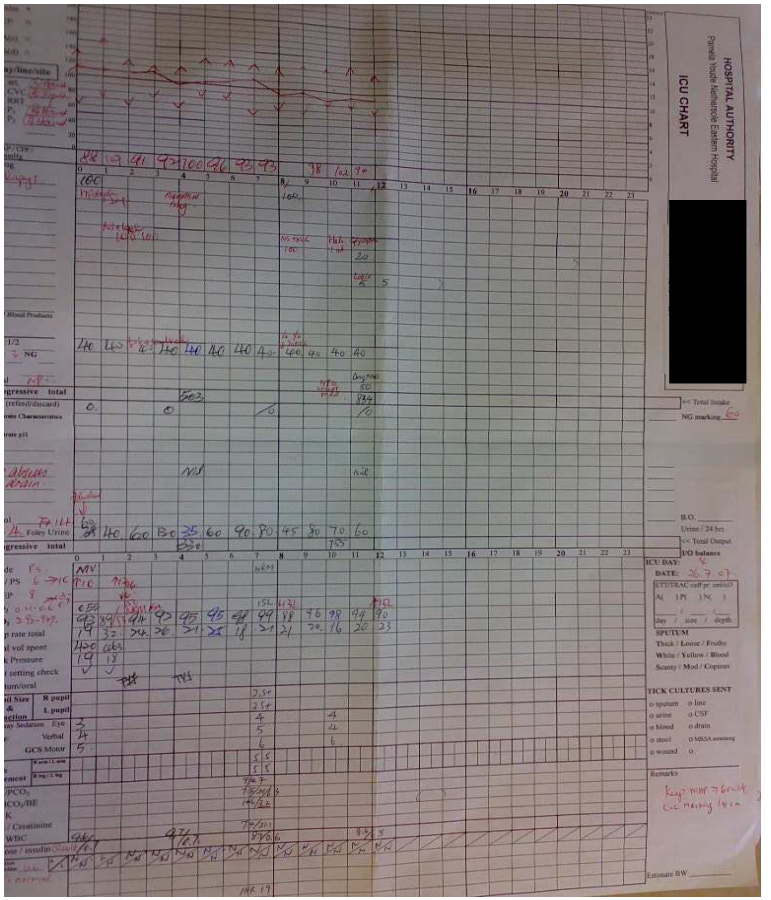
- Improve efficiency and consistency of work process
- Adopt the change
- *"What do we expect?"*
  - *Speed*
  - *Different perspective*
  - *Timely information*
  - *Can CIS fit in my workflow*
- *Video clips*

To improve the efficiency of the work process...

Not only in our unit….

An example of consistency….



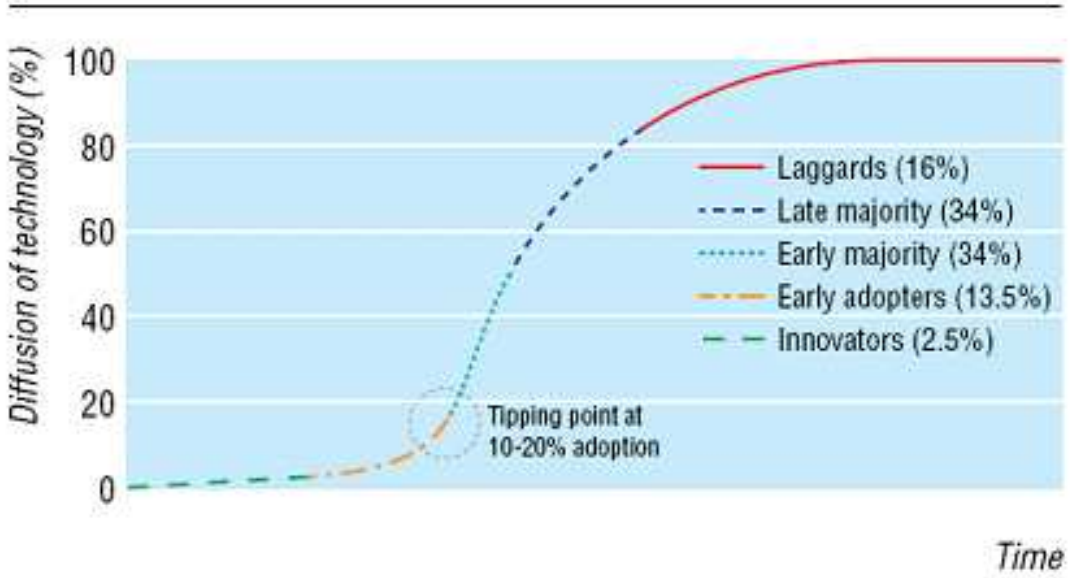


Adopt the change - People

- Medical culture is difficult to CHANGE
- CHANGE is difficult to anyone, especially the
  - Seniors
  - Computer Phobia
  - Rotating MOs

Adopt the change- People

Adoption of innovations



S-curve showing the five stages in adoption of innovations[2]

Rogers EM. *Diffusion of innovations*. 4th ed. New York: Free Press, 1995.
Wilson C, **BMJ** VOLUME 332:112, JANUARY 2006

What do we expect ?

- What would be an acceptable time to flip CIS screens?

- An engineer's suggestion
- 5 sec
- 3 sec
- 1 sec

Actual practice

- ....look at this video clip

However…THIS is frustrating..

For frontline users…

- Speed is everything
  - Not the fancy screen
  - Not the warnings or alert
  - Not the versatile features
  - But the system response time….

Different perspective

- Administrator-
- Computer's pearls!?
  - Quality?
  - Cost?
  - Less error

- Frontline-
- Doctor's pearls!?
- -get it done
  - Quickly!
  - Accurately!
  - Nicely!

Different perspective

- Improve quality
- Control cost

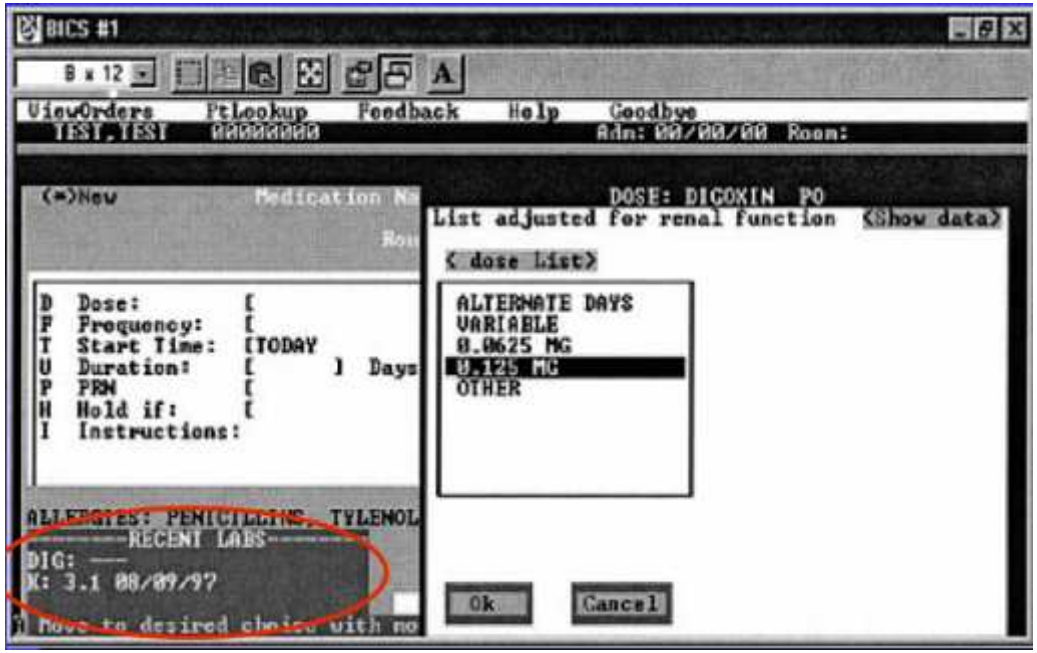
- The system *lookup* for more information
  - cost the system more time
- The system *present* more information
  - Cost the user more time

- "yes….I agree….."

- " but I don't have time to wait…!!"
- "Why I've to wait if I can write…!?"
- "I suppose it's a STAT action…"

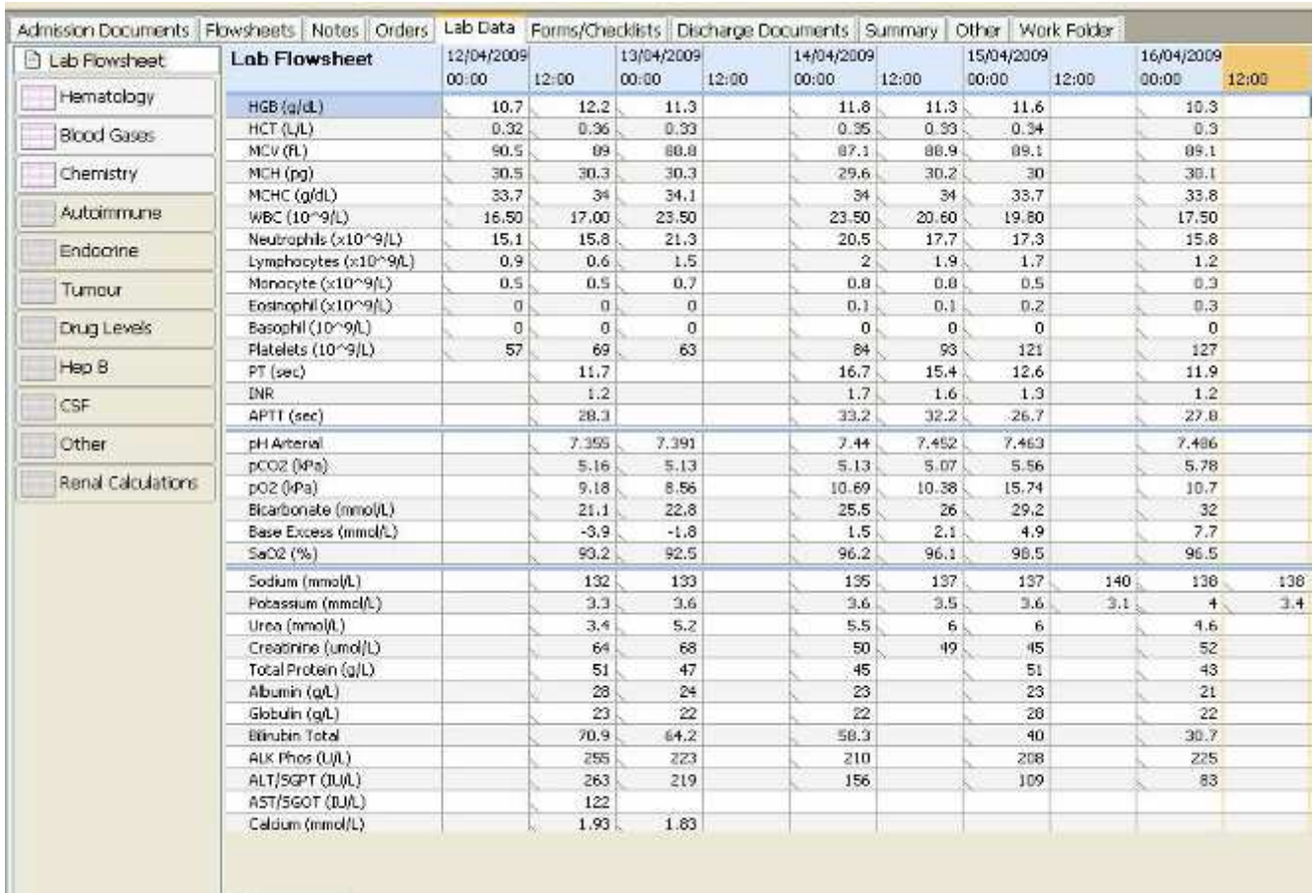
"Give me timely information"

- What is timely?
  - "...Patient with sudden onset of fast AF with apical rate ~ 135bpm...."



"Give me timely information"

- Occasionally it cannot be achieved



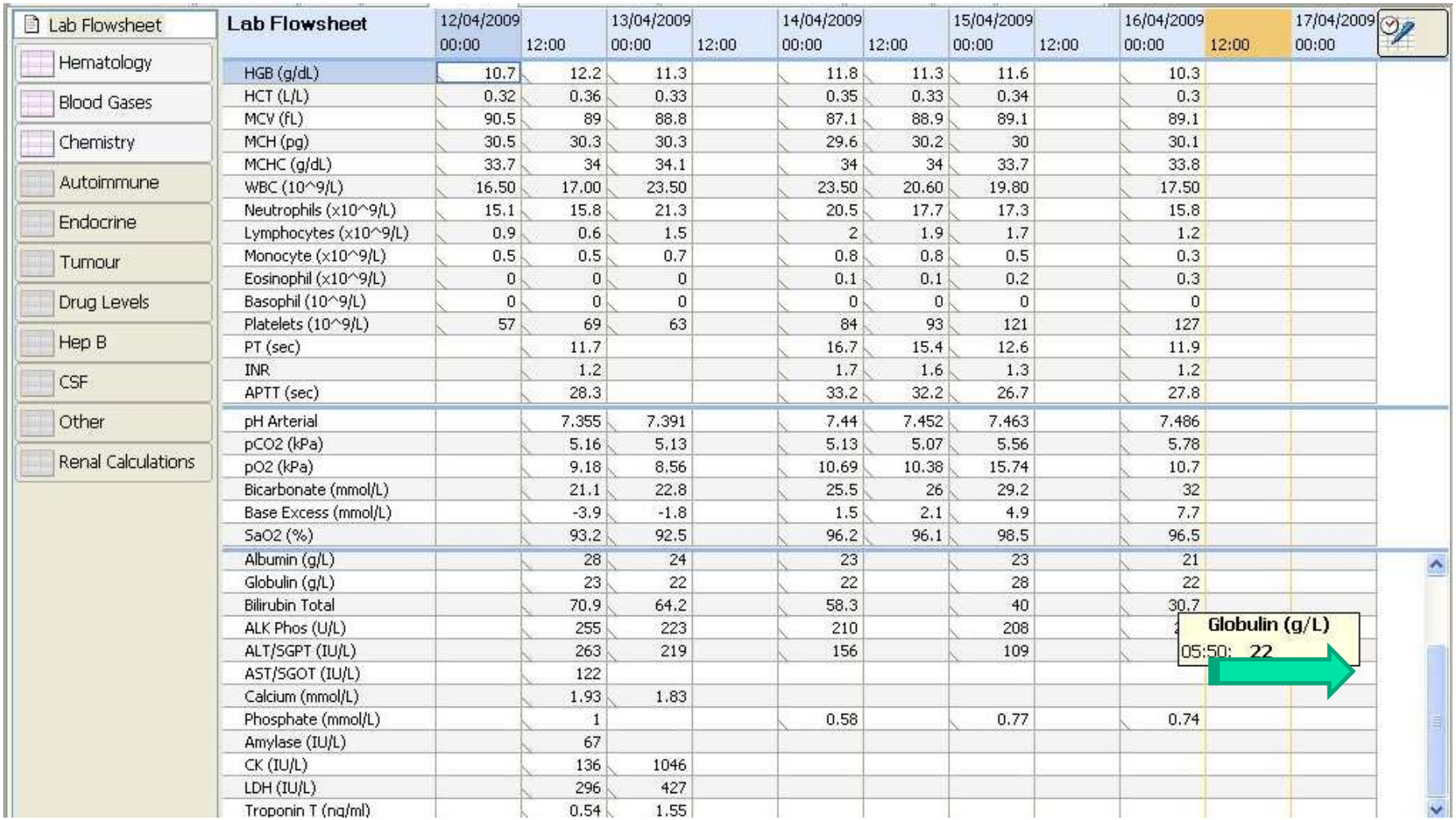
Admission Documents | Flowsheets | Notes | Orders | Lab Data | Forms/Checklists | Discharge Documents | Summary | Other | Work Folder

Lab Flowsheet

- Hematology
- Blood Gases
- Chemistry
- Autoimmune
- Endocrine
- Tumour
- Drug Levels
- Hep B
- CSF
- Other
- Renal Calculations

Lab Flowsheet	12/04/2009 00:00	12:00	13/04/2009 00:00	12:00	14/04/2009 00:00	12:00	15/04/2009 00:00	12:00	16/04/2009 00:00	12:00
HGB (g/dL)	10.7	12.2	11.3		11.8	11.3	11.6		10.3	
HCT (L/L)	0.32	0.36	0.33		0.35	0.33	0.34		0.3	
MCV (fL)	90.5	89	88.8		87.1	88.9	89.1		89.1	
MCH (pg)	30.5	30.3	30.3		29.6	30.2	30		30.1	
MCHC (g/dL)	33.7	34	34.1		34	34	33.7		33.8	
WBC (10^9/L)	16.50	17.00	23.50		23.50	20.60	19.80		17.50	
Neutrophils (x10^9/L)	15.1	15.8	21.3		20.5	17.7	17.3		15.8	
Lymphocytes (x10^9/L)	0.9	0.6	1.5		2	1.9	1.7		1.2	
Monocyte (x10^9/L)	0.5	0.5	0.7		0.8	0.8	0.5		0.3	
Eosinophil (x10^9/L)	0	0	0		0.1	0.1	0.2		0.3	
Basophil (10^9/L)	0	0	0		0	0	0		0	
Platelets (10^9/L)	57	69	63		84	93	121		127	
PT (sec)		11.7			16.7	15.4	12.6		11.9	
INR		1.2			1.7	1.6	1.3		1.2	
APTT (sec)		28.3			33.2	32.2	26.7		27.8	
pH Arterial		7.355	7.391		7.44	7.452	7.463		7.486	
pCO2 (kPa)		5.16	5.13		5.13	5.07	5.56		5.78	
pO2 (kPa)		9.18	8.56		10.69	10.38	15.74		10.7	
Bicarbonate (mmol/L)		21.1	22.8		25.5	26	29.2		32	
Base Excess (mmol/L)		-3.9	-1.8		1.5	2.1	4.9		7.7	
SaO2 (%)		93.2	92.5		96.2	96.1	98.5		96.5	
Sodium (mmol/L)		132	133		135	137	137	140	138	138
Potassium (mmol/L)		3.3	3.6		3.6	3.5	3.6	3.1	4	3.4
Urea (mmol/L)		3.4	5.2		5.5	6	6		4.6	
Creatinine (umol/L)		64	68		50	49	45		52	
Total Protein (g/L)		51	47		45		51		43	
Albumin (g/L)		28	24		23		23		21	
Globulin (g/L)		23	22		22		28		22	
Bilirubin Total		70.9	64.2		58.3		40		30.7	
ALK Phos (U/L)		255	223		210		208		225	
ALT/SGPT (IU/L)		263	219		156		109		83	
AST/SGOT (IU/L)		122								
Calcium (mmol/L)		1.93	1.83							

the same patient, at the same time.....



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Lab Flowsheet

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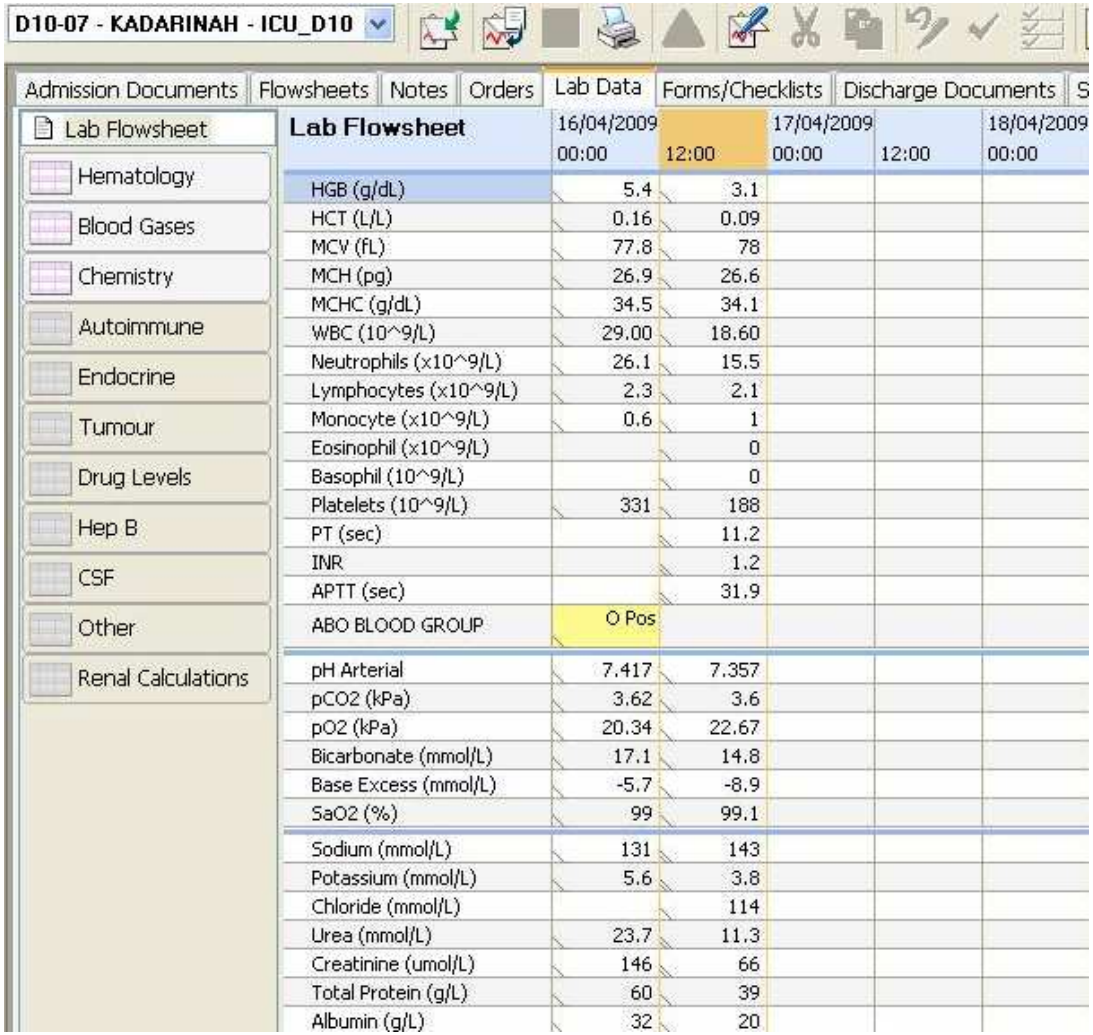
Eosinophil (x10^9/L)	0	0	0		0.1	0.1	0.2		0.3		
Basophil (10^9/L)	0	0	0		0	0	0		0		
Platelets (10^9/L)	57	69	63		84	93	121		127		
PT (sec)		11.7			16.7	15.4	12.6		11.9		
INR		1.2			1.7	1.6	1.3		1.2		
APTT (sec)		28.3			33.2	32.2	26.7		27.8		
pH Arterial		7.355	7.391		7.44	7.452	7.463		7.486		
pCO2 (kPa)		5.16	5.13		5.13	5.07	5.56		5.78		
pO2 (kPa)		9.18	8.56		10.69	10.38	15.74		10.7		
Bicarbonate (mmol/L)		21.1	22.8		25.5	26	29.2		32		
Base Excess (mmol/L)		-3.9	-1.8		1.5	2.1	4.9		7.7		
SaO2 (%)		93.2	92.5		96.2	96.1	98.5		96.5		
Albumin (g/L)		28	24		23		23		21		
Globulin (g/L)		23	22		22		28		22		
Bilirubin Total		70.9	64.2		58.3		40		30.7		
ALK Phos (U/L)		255	223		210		208				
ALT/SGPT (IU/L)		263	219		156		109				
AST/SGOT (IU/L)		122									
Calcium (mmol/L)		1.93	1.83								
Phosphate (mmol/L)		1			0.58		0.77		0.74		
Amylase (IU/L)		67									
CK (IU/L)		136	1046								
LDH (IU/L)		296	427								
Troponin T (ng/ml)		0.54	1.55								

Globulin (g/L)
05:50: 22

Any problem with this patient?



Lab Flowsheet	16/04/2009 00:00	12:00	17/04/2009 00:00	12:00	18/04/2009 00:00
HGB (g/dL)	5.4	3.1			
HCT (L/L)	0.16	0.09			
MCV (fL)	77.8	78			
MCH (pg)	26.9	26.6			
MCHC (g/dL)	34.5	34.1			
WBC (10^9/L)	29.00	18.60			
Neutrophils (x10^9/L)	26.1	15.5			
Lymphocytes (x10^9/L)	2.3	2.1			
Monocyte (x10^9/L)	0.6	1			
Eosinophil (x10^9/L)		0			
Basophil (10^9/L)		0			
Platelets (10^9/L)	331	188			
PT (sec)		11.2			
INR		1.2			
APTT (sec)		31.9			
ABO BLOOD GROUP	O Pos				
pH Arterial	7.417	7.357			
pCO2 (kPa)	3.62	3.6			
pO2 (kPa)	20.34	22.67			
Bicarbonate (mmol/L)	17.1	14.8			
Base Excess (mmol/L)	-5.7	-8.9			
SaO2 (%)	99	99.1			
Sodium (mmol/L)	131	143			
Potassium (mmol/L)	5.6	3.8			
Chloride (mmol/L)		114			
Urea (mmol/L)	23.7	11.3			
Creatinine (umol/L)	146	66			
Total Protein (g/L)	60	39			
Albumin (g/L)	32	20			

Can CIS fit in my workflow

- "而家你就我先定我就你先...!!!"

- Get the existing process computerised DOES NOT equate get the existing process improved

Can CIS fit in my workflow

- Improvement -"to mould the system"
  - User is the KING
  - Always follow the users workflow
  - Communicate with the system administrator and the technical staff- physicians' mindset & workflow
  - An ongoing process of moulding -> streamlining -> speed

Can CIS really save time?

THE IMPACT OF A CLINICAL INFORMATION SYSTEM IN AN INTENSIVE CARE UNIT

Abele Donati, MD, Vincenzo Gabbanelli, MD, Simona Pantanetti, MD, Paola Carletti, MD, Tiziana Principi, MD, Benedetto Marini, MD, Simonetta Nataloni, MD, Gisella Sambo, MD and Paolo Pelaia, MD

Journal of Clinical Monitoring and Computing (2008) 22;31-36

Donati A, Gabbanelli V, Pantanetti S, Carletti P, Principi T, Marini B, Nataloni S, Sambo G, Pelaia P. The impact of a clinical information system in an intensive care unit.
J Clin Monit Comput 2008; 22:31–36

ABSTRACT. Purpose. Although clinical information systems (CISs) have been available and implemented in many Intensive care Units (ICUs) for more than a decade, there is little objective evidence of their impact on the quality of care and staff perceptions. This study was performed to compare time spent charting with pen and paper patient data versus time spent with the new electronic CIS and to evaluate staff perceptions of a CIS in an ICU. **Materials and Methods.** Time spent every day was calculated for each patient, for 7 days, for recording on the paper vital signs and physician therapeutic orders and time spent for computing fluid balance and scores. This time was then compared with time required to make the same activities by means of CIS, 10 months after its introduction in ICU. Four years after the installation of CIS, a questionnaire was given to all staff attending to the ICU to evaluate their opinions of the CIS. **Results.** The CIS took less staff time to record common ICU data than paper records (3 ± 2 minutes/day versus 37 ± 7 minutes/day respectively, $P < 0.001$). Perceptions of the CIS were that computers promoted an improving charting quality. **Conclusions.** The implementation of a CIS was associated with a reduced time spent for daily activity and a positive medical and nursing staff perception.

KEY WORDS. Clinical information system, clinical monitoring, intensive care unit.

methodology -1

- Compare time spent on charting with pen and paper vs CIS
- Measure satisfaction of HCW using CIS
- 12-bed medical & surgical ICU
-

- Pen and paper -12 patients – 7 days
- 1 yr CIS run-in
- CIS – 12 patients-7 days

methodology & result

- Nursing activities
  - Gather & chart vital signs
- Medical activities
  - APACHE II, SAPS II [once] SOFA [daily] , fluid balance prescribe therapy, transcribe lab results
- Questionnaire
  - All ICU non-rotating medical and nursing staff
  - Evaluate the satisfaction to CIS

Table 1. Time spent for each activity for each patient with paper-based record or electronic record

Activity	Paper-based record time (min ± SD)	Electronic record time (min ± SD)
Apache II and Saps II	15 ± 4	0
Sofa score	3 ± 1	0
Fluid balance	10 ± 2	0
Therapies	4 ± 2	1 ± 1
Parameters	12 ± 2	2 ± 1
Exam transcription	8 ± 3	0
Total time spent/Day[a]	37 ± 7	3 ± 1*

[a]In this calculation time spent for Apache II and SAPS II was not included, because this is not daily activity.
*$P < 0.001$ (student t-test).

Result -questionnaire

	Yes	No
Medical staff		
Do you think the clinical information system helps you to save time through the electronic patient record, compared to the paper record?	47	2
Is the electronic patient record more readable and clear than the paper-based record?	49	0
Do you think that the clinical information system would help you to reduce the transcription errors?	43	6
Do you think the clinical information system helps to save time?	39	10
Would you like to revert back to the paper based record system?	0	49
Nursing staff		
Do you think the clinical information system helps you to save time through the electronic patient record, compared to the paper record?	30	0
Is the electronic patient record more readable and clear than the paper-based record?	30	0
Do you think that the clinical information system would help you to reduce transcription errors?	26	4
Do you think the clinical information system helps to save time?	25	5
Would you like to revert back to the paper based record system?	0	30

Does it make a difference !?

	Yes	No
Medical staff		
Do you think the clinical information system helps you to save time through the electronic patient record, compared to the paper record?	47	2
Is the electronic patient record more readable and clear than the paper-based record?	49	0
Do you think that the clinical information system would help you to reduce the transcription errors?	43	6
Do you think the clinical information system helps to save time?	39	10
Would you like to revert back to the paper based record system?	0	49
Consultants		
Do you think the clinical information system helps you to save time through the electronic patient record, compared to the paper record?	20	5
Is the electronic patient record more readable and clear than the paper-based record?	25	0
Do you think that the clinical information system would help you to reduce the transcription errors?	25	0
Do you think the clinical information system helps to save time by reading an electronic patient record and it is more efficient, compared to the paper record?	19	6
Would you like to revert back to the paper based record system?	1	24

Back to square one…

If technology doesn't work for people, then it just doesn't work

Thank you