Architectural and Usability Considerations for a Web 2.0-based EHR Interface:

MedWISE^3

Medical Widget-based Information Sharing, (extension, evolution) Environment

Yalini Senathirajah

E-health Observatory

October 12, 2010

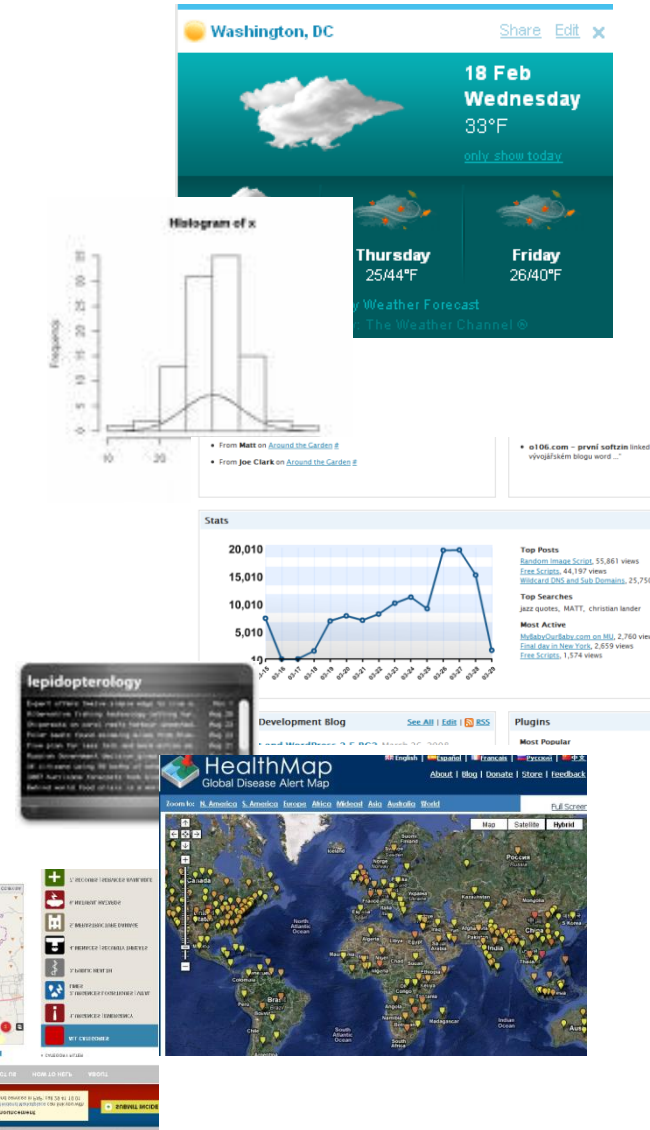Nyborg, Denmark

Introduction

- Motivation and Rationale

- Architecture and Features

- Demonstration + video

- Cognitive Usability Study with real cases and users

- Limitations

- Conclusions

- Next steps

What is a Widget?

- Fragment of programming/display affords particular capabilities,
  - can be defined, configured, shared, duplicated and mixed into new forms by the user
  - e.g. lab data display widget, trends, disease in population, protocol widget, diabetes tracker...

"Mashable"widgets pass events, so that they can be wired together to create something new.

MedWISE is a widget-based system

Public Web

EHRs

Why

- Give those with medical knowledge control of the software:

  "EHRs will never be adopted until doctors and nurses can configure the information and layout as they wish…" CIS WG writer

- **User-created custom views** for different specialities/Dxs/patients/groups

- Collaboration, share user creations, capture tacit knowledge
- Not just information access but real tool for thinking
- Time/efficiency: residents on EHR ~65 hours/week
- **Adapt to rapid change** – distribution of new treatments, public health features into CIS

  "Clinicians need to take back ownership of the medical record as a tool for improving patient care" – Schiff & Bates, 2010

How the customer explained it

How the Analyst designed it

How the Programmer wrote it
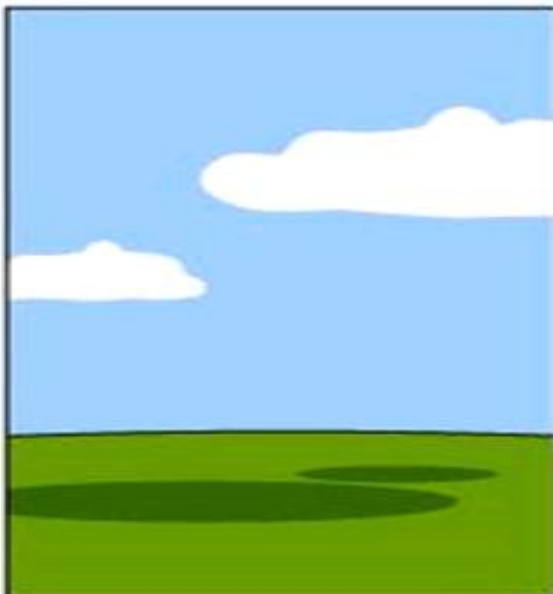
How the project was documented
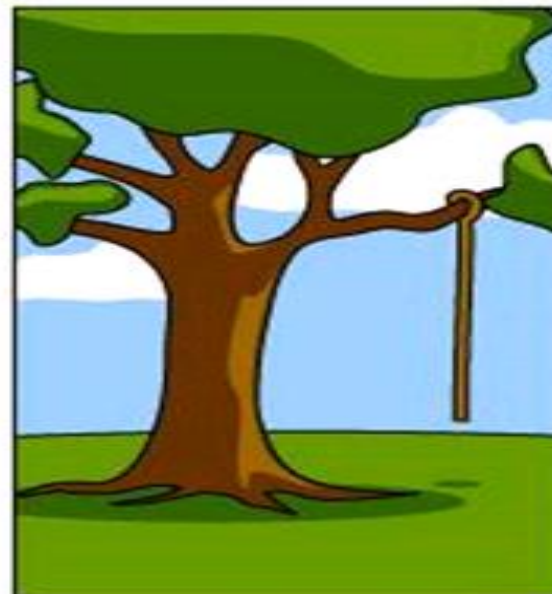
What operations installed
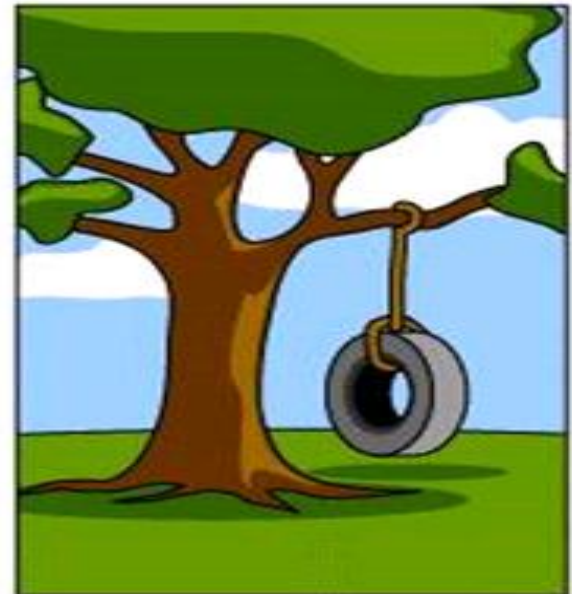
What the customer really needed

HCI Considerations: Keyhole Effect
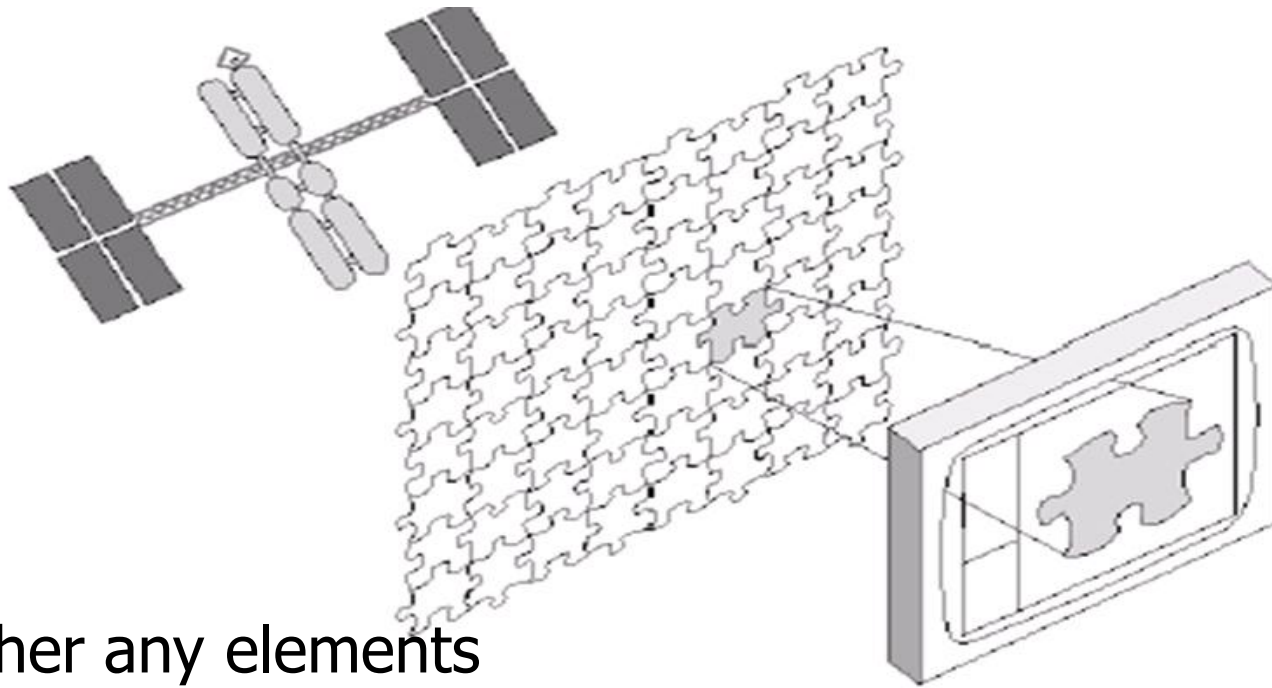
Bring together any elements
-> decrease keyhole effect

Woods D. Toward a theoretical base for representation design in the computer medium: Ecological perception and aiding human cognition. In: J. Flach PH, J. Caird, K.J. Vicente, editor. Global perspectives on the ecology of human-machine systems. Hillsdale, NJ: Lawrence Erlbaum. ; 1995. p. 157–88.

HCI Considerations: Spatial Arrangement

- Juxtaposition ->insight, creativity[1,2]

- Simultaneous, not sequential->decreased cognitive load

- Perception, not computation
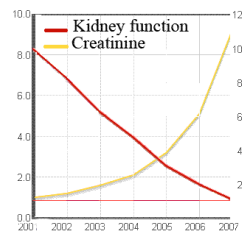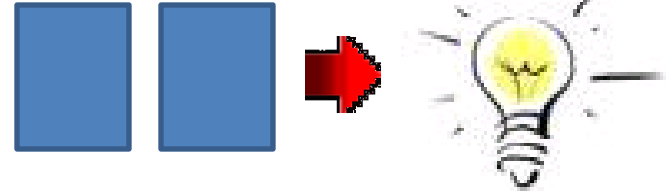
YEAR Creatinine %Renal
(mg/dl) function
2001 1 100%
2002 1.2 83%
2003 1.6 63%
2004 2.1 48%
2005 3.2 31%
2006 5.1 20%

1. Few, S. *Information Dashboard Design*, 2006 p.50
2. Kerne, A.,et al. "Promoting Emergence in Information Discovery by Representing Collections with Composition," *ACM Creativity & Cognition 2007*

NewYork Presbyterian

Columbia Presbyterian Medical Center

- ~1500 beds (West campus), 2000 Drs.
- 2 main CIS (WebCIS, Eclipsys) + dozens of smaller systems
- Integrated architecture/interfaces
- Central Medical Entities Dictionary (MED)
- CDR (operational, EAV) and CDW (research, relational) Dbs

NYP Computing Environment Sep 2006

NYP

Weill Cornell

ITS
NYP Email
NYP Calendar
WMC Network
WMC Email,
etc.

Internet

Core & ITS
NYP/WMC
Network

Service Corp

Cornell PO
(Adm) IDX
(Clin) Epic

Pub Relations
www.nyp.org
Development DB

Research

Departmental

Information Service
(Adm),Eagle ● ●, BIS,
(Clin) Eclipsys SCC & XA ●
WebCIS, Cisyphus.
(Clin) Amicas,GE PACS
(Clin) Imnet, Surgical Mgr
(Adm ●) Lawson, P'soft, *etc.*
(Clin ancil) Cerner, Misys
MPI ●,Egate ●, Data Warehouse
Network ●, Desktop, Security

Departments (admin)
(Clin) My Medical File
(Clin) Mobile Telemetry (CUMC)
Pyxis (WMC/CUMC) - OR

Departments (clin)
Climacs (WMC) - Med
(Clin) Copath
Helix (CUMC) - Surgery
Many others.

LabTest   **Psych Inst**
Rogosin   **Clearing Houses**
TSI, Eagle   **Regulatory**

Service Corp

Columbia PO
(Adm) IDX

CUBHIS
CUMC Calendar
Desktop, etc.

Core
CUMC
Network

Clin Trial
Velos

Security

Research

Departmental

Internet & CU MS

CUIT
CU Email

Columbia

Sponsored Hospitals | **HSS** | **NYQ** **NYM** | **CHOB** | **Etc.**

Local Clinical and Admin Systems

*Presbyterian
New York
MSCHONY
Westchester
Allen Pavilion*

St Luke's   **Harlem**

Dept Billing

**Heath Plan,
etc.**

● Also used by some sponsored hospitals
● Contractual/Outsourced relationship
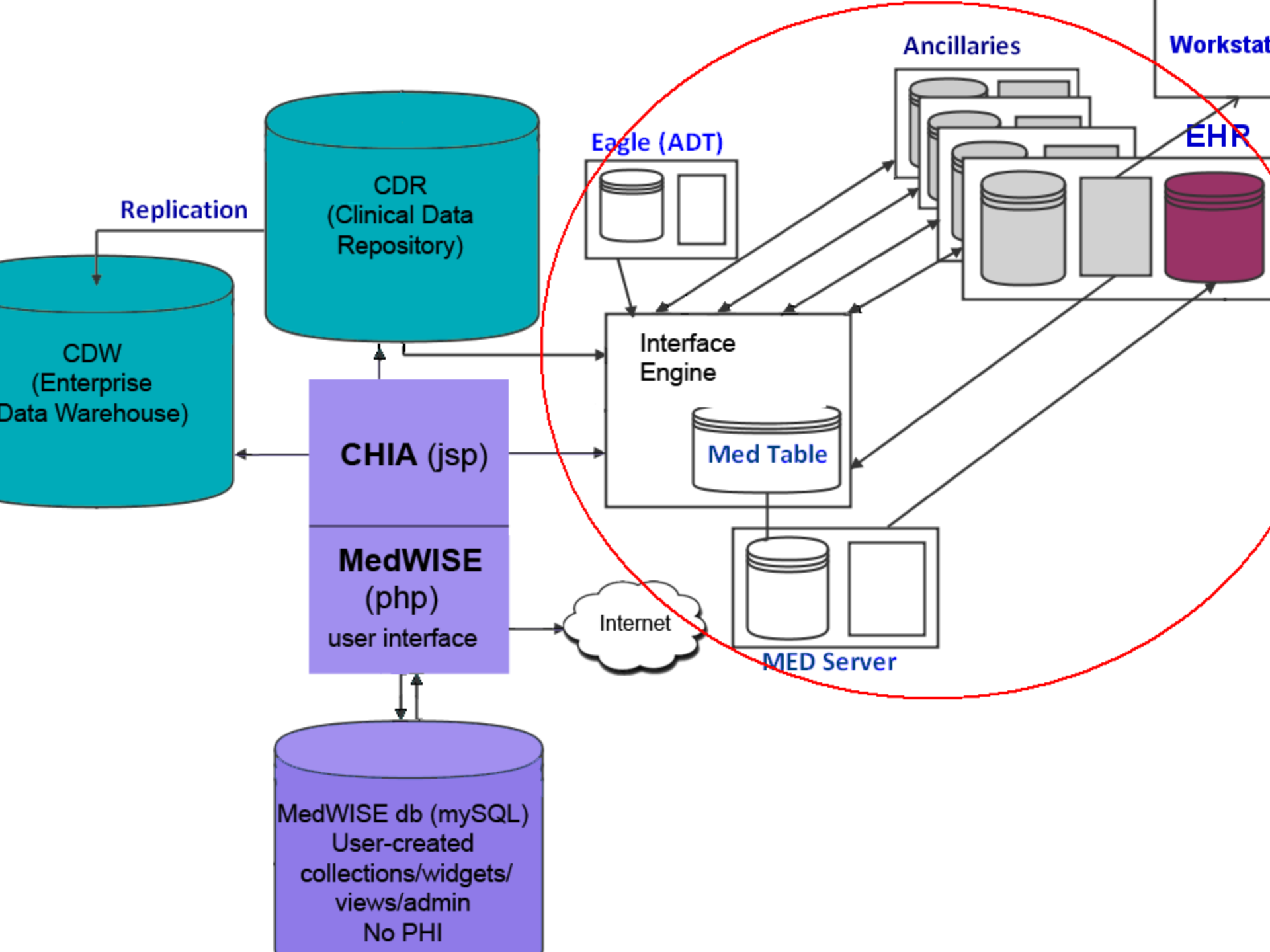
MedWISE³

Home ▾ | MyMedPage | [new]CHIApage | Dump page | New items | OutPatient Info | + New page

open10012 open10105 Lab Composer Get Web page

Sidebar navigation

- 📦 **Timeline**
- 📦 **Summary**
- 📦 **Newinfo**
- 📦 **Notes**
  - Eclipsys (WC-East)
  - Eclipsys (CU-West)
  - WebCIS (CU-West)   2008-10
- 📦 **Labs**
  - WC-East
  - CU-West   2008-10
- 📦 **Radiology**   2008-08
- 📦 **Pathology**   2005-02

Laboratory (2008-10-13 14:00 to 2008-07-02 17:06)

- 📇 DIFFERENTIAL
- 📇 ABC WITH ANC
- 📇 HGB AND HCT
- 📇 COAG PROFILE
- 📇 BASIC METABOLIC PANEL
- 📇 ABC
- 📇 FOLATE, SERUM
- 📇 CHOLESTEROL
- 📇 BASIC METABOLIC PANEL
- 📇 ABC
- 📇 LIPID PROFILE
- 📇 LEAD
- 📇 HEMOGLOBIN A1c
- 📇 HEMOGLOBIN A1c
- 📇 CA15-3
- 📇 THYROID ANTIBODY PNL
- 📇 BASIC METABOLIC PANEL
- 📇 RHEUMATOID FACTOR

Lab — MAGNESIUM(ALLEN) 2008-03-29 12:22

Test	Result	Range	Unit
MAGNESIUM	2.3	1.5-2.3	mg/dl

Collection time: 2008-03-29 12:22 Received time: 2008-03-29 13:23

Last updated: 2008-03-29 14:01

Status: Final, Accno: S23611MGZ 083T

DSUM

CPMC Report: Discharge Summary Note   2008-03-31 16:30

CHIEF COMPLAINT — SOB

HISTORY OF PRESENT ILLNESS — This is a 78 yo F with a h/o COPD, still smoking 1ppd, who presents with SOB and wheezing, onset the am PTA. She noted a slow increase in DOE over the last 3 days, but on the am PTA felt more SOB at rest and noted increasing cough productive of whitish sputum and tightness in her chest. She denies any Chest pain but reports some left lower back discomfort with cough or movement. She reports that this am, she noted

Lab — BASIC METABOLIC PNL(ALLEN) 2008-03-29 12:22

Test	Result	Range	Unit
SODIUM	139	136-146	mM/l
POTASSIUM	4.4	3.6-5.0	mM/l
CHLORIDE	101	102-109	mM/l
CO2	24	25-33	mM/l
BUN	17	7-20	mg/dl
GLUCOSE	86	70-110	mg/dl
CREATININE	1.0	0.5-0.9	mg/dl
CALCIUM	9.1	8.4-9.8	mg/dl

Collection time: 2008-03-29 12:22 Received time: 2008-03-29 13:23

Last updated: 2008-03-29 14:01

Status: Final, Accno: S23611BMETZ 083T

ABC(ALLEN) 2008-03-31 08:36

ABC(ALLEN) 3-31

Test	Result	Range	Unit
WBC	11.1	3.54-9.06	10*9/l
RBC	4.09	4.00-5.20	10*12/l
HEMOGLOBIN	12.9	12.0-15.8	g/dl
HCT	38.5	35.4-44.4	%
MCV	94.1	79.0-93.3	fl
MCH	31.5	26.7-31.9	pg
MCHC	33.5	32.3-35.9	g/dl

Lab — HEPATIC FUNC PANEL(ALLEN) 2008-03-28 01:15

Test	Result	Range	Unit
PROTEIN, TOT	7.3	6.7-8.6	g/dl
ALBUMIN	4.4	4.0-5.0	g/dl
T-BILIRUBIN	0.7	0.3-1.3	mg/dl
D-BILIRUBIN	0.1	0.0-0.4	mg/dl
AST	14	12-38	U/L
ALT	8	7-41	U/L
ALK PHOS	106	33-96	U/L

Collection time: 2008-03-28 01:15 Received time: 2008-03-28 01:43

Last updated: 2008-03-28 02:47

Orders — Amlodipine Oral   2007-08-13 09:48

Order Name	Amlodipine Oral
Summaryline	10 MG PO Daily Routine
Requested Time	2007-08-13 09:48
Entered Time	2007-08-13 09:48
Stop Time	2007-08-14 18:24
Performed Time	
Type	Medication
Title	Pharmacy - Medication PO
Dosage	
Uom	
Frequency	Daily

⚠ Custom Alerts

Hb A1C > 6
See diabetes panel

Incoming results

Radiology available

Orders

▪ (5) HubMed - COPD

- Positive Expiratory Pr with Chronic Obst Disease - A Systematic
- Alcoholic Beverage Inta Cancer: The California M
- Pulmonary Vascular Invo
- Tracheobronchoplasty tracheobronchomalacia: outcome analysis.
- A quick and easy meth hypercapnic ventilato patients with COPD.

COAG PROFILE   200

Test	Result
PT	11.5
INR	2.00
APTT	25.6
FIBRINOGEN	
THROMBIN TIME	

Demonstration

Research Questions

Can typical clinicians learn and use the system?

What use patterns and created resources emerge?

Difference, if any, in repeat viewing of elements in WebCIS v. MedWISE?

User engagement

- What new uses or improvements are suggested by users?

- Users' perceptions of ease of use, usefulness, effect on mental process

Methods

13 clinicians

+

5 Real Patient Cases

Thinkaloud → Coded transcript

Layouts → Spatial patterns
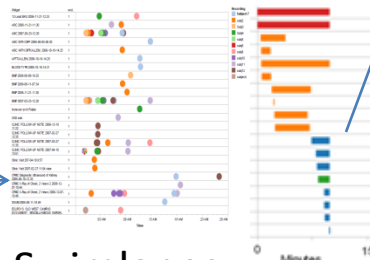
Timestamps → Swimlanes and Timelines

Qualitative Interpretive Analysis, Statistics

Patterns of Use

Diagnostic process

Diagnostic Momentum errors?

Repeat Navigation

User engagement

Learning, uses, improvements, perceptions

Findings

- 4 general strategies: 'bag of stuff', structured, dynamic stage, mixed

- Back and forth navigation & Keyhole effect reduced

- Users make use of the system to improve task-technology fit: note splitting is an example

- Most users: beneficial effect on mental process

- Theoretical reduced work (2X-14X reduction)

Video

4 users:

- Start of case, structured approach
- Renal specialist gets shared labs, makes plot
- 'Bag of stuff'
- User summarizing via 'bag of stuff'

Notes

yo M

ISSUES:
peripheral vascular disease
AAA repair,
CKD ? 2/2 RAS (angiogram Neg)

OTHER CLINICAL NOTE 2008-03-18-15.00

Hba1c 6.4
PSA 0.3
Microalb 104
CT: Status post type A dissection of the aorta is complex
intimal flap as described in. Both to one false lumen are
opacified. Aneurysmal dilatations of the distal ascending
aorta, aortic arch and descending thoracic aorta are
unchanged since prior examination.

A/P: /o M with complex vascular hx s/p large
retroperitoneal bleed w/ hypotension from attempted
stenting of thoracic aortic aneurysm.
--> f/u vascular medicine, cont current reg,
DM. technically meets criteria and HbA1c better but
marcroalb
--> follow Hba1c; diet interventions, microalb, eye exam,
cont lisinopril 10
BPH -- failing meds
--> consider TURP

RTC - 6 mths since going to DR

chol 155 LDL 74

Status: F   Written by:

ImpLabs

Plot lab results:

Zoom: 1d 5d 1m 3m 6m 1y 5y max

— CHOLESTEROL (mg/dl)   — CREATININE (n

A OLIGO DI OLIGO
ABSOLUTE NRBC C
ACETALDEHYDE

Notes

Medications:
ecasa 81 qd
toprol xl 50 qd
lipitor 20 qd
proscar 5 qd
flomax .8 qd
neurontin 900 bid (but taking only 900 qhs,
ow requests 1200 bid)
viagra 50 prn, cialis/levitra
flonase 1 bid in spring
lisinopril 10

CKD Labs

Test	Result	Range	Unit
NA	145.0	136-146	mM/l
K	3.4	3.6-5.0	mM/l
PHOSPHORUS	6.2	2.5-4.3	mg/dl

Diabetes

Test	Result	Range	Unit
HEMOGLOBI	5.5	4-6	%
GLUC	130.0	50-110	mg/dL

Notes

HCM:

Diabetic Maintainace:
Eye
Foot
Urine Microalbumin

Note Splitting
Custom panels
Custom multiplot
labs
Regions

Findings – User Engagement

Can typical clinicians learn and use the system?

20 minute training: new features found easy to use (except Timeline)

What new uses or use cases do users envision?

- E.g. clinic duty: efficient for 100-patient caseloads, preparation
- Handoff – common ground
- Templates to track rapid culture speciation
- Communicating tasks, workflow, orders, group communication
- Prepared tabs for quick information in case of ED admission

What improvements are suggested by users?

- Markable timelines
- Double click anywhere in widget to close it
- 'push in' widgets; they get smaller as more added
- Sortable, markable lists, …

- Ease of Use: 3.79 (5-point Likert scale)
- Usefulness: 4.00

Conclusions

- Keyhole effect reduced
- Users innovate to carry out task, given tools
- Most users say it helps their mental processes
- Great enthusiasm from some users:
  - "If you could be in that space, in Eclipsys, it'd be awesome"
  - "It'll save 10 min/patient encounter"
  - -" it allowed me to really quickly summarize relevant stuff; what I liked about it is sitting here thinking 'how do I summarize this person succinctly?' - which is the art of medicine - ... [it] made me question what's really important, so I think that was a positive thing."

Limitations

- Small number of subjects, 3 specialties, 3 roles
- One institution (data from two)
- Laboratory study, possible Hawthorne effect

Future Work

- Precisely controlled laboratory and deployment studies, especially with respect to: errors, time, efficiency

- How simple is simple enough? (mashups, editors)

- New Avenues: HCI, clinician cognition, HIS design, CSCW, data mining of user-created resources, implementation science

Questions for discussion

- How to balance flexibility with need to prevent errors?

- Can nonprogrammer clinicians do complex functions (e.g. control flow, database queries)?

- Other issues: management of large bodies of user-created resources, spread of medical expertise (worldwide), possible role in safety, EBM

- How can such a paradigm spread, if desired?

Acknowledgments

- Dr. Suzanne Bakken (Advisor)
- Dr. David Kaufman (committee member)
- Dr. Soumitra Sengupta (committee member)
- Dr. Pete Stetson (faculty)
- Dr. David Vawdrey (faculty)
- Dr. Adam Wilcox (faculty)
- Dr. George Hripcsak (faculty)
- Dr. Herbert Chase (medical advisor)
- Ms. Yiping Hu (programmer)
- Ms. Cynthia Chen (programmer)

yalini@dbmi.columbia.edu

Comments, Suggestions, Questions?

Yalini Senathirajah
yalini@dbmi.columbia.edu

Columbia University
Department of Biomedical Informatics

PUBLICATIONS
Yalini Senathirajah
yalini@dbmi.columbia.edu

Architectural and usability considerations in the development of a web 2.0-based EHR. Senathirajah Y, Bakken S. Stud Health Technol Inform. 2009;143:315-21.

Logfile analysis of CIS use to inform creation of a user-configurable widget-based web 2.0 CIS interface: a feasibility study. Senathirajah Y, Bakken S. Paper, AMIA Annu Symp Proc. 2009.

MedWISE: clinical mashups development. Senathirajah Y, Bakken S. Poster, AMIA Annu Symp Proc. 2009.

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Senathirajah Y, Bakken S. Poster, AMIA Spring Congress 2009. (Practice-based research track).