If You Build It, Build It Well: How User-Centered Design and Agile Development Delights Users

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Conflict of Interest

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Addressing a Clinical Need by Building Technology That Delights Its Users

• Introduction to the problem
• Case study: An academic center’s homegrown workflow tool
  – Versions 1 & 2 – Traditional design format
  – Version 3 – Reimagined with user centered design & agile development
• Results
• Lessons learned
Learning Objectives

• Apply a collaborative, multi-disciplinary approach to feature development for better user-focused design

• Evaluate the design and presentation of clinical information with the goal of improving clinical workflow

• Identify unique challenges faced by front-line clinicians in an effort to improve patient care and reduce physician burnout

• Recognize importance and value of being able to iterate when developing new clinical tools
Policies Influencing Adoption of EHRs

2008 US Federal Budget
$2.9 trillion

ARRA Stimulus
$787 billion (27%)

HITECH ACT
$38 billion
~5% of package

$18 billion in incentives to promote adoption & use of EHRs
EHR Adoption Rates

96% of all hospitals have an EHR certified by HHS as of 2017.

https://dashboard.healthit.gov/quickstats/quickstats.php

NOTE: Basic EHR adoption requires the EHR system to have a set of EHR functions defined in Table A1. A certified EHR is EHR technology that meets the technological capability, functionality, and security requirements adopted by the Department of Health and Human Services. Possession means that the hospital has a legal agreement with the EHR vendor, but is not equivalent to adoption. *Significantly different from previous year (p<0.05).

SOURCE: ONC/American Hospital Association (AHA), AHA Annual Survey Information Technology Supplement
How well do you think EHRs have met these goals?

A. Very Well
B. Well
C. Somewhat
D. Not at all

Results
“If you think good design is expensive, you should look at the cost of bad design.”

Dr. Ralf Speth, Chief Executive Officer, Jaguar Land Rover
Little Form Improvement in EHRs
Buyer ≠ User

Source: www.channelweb.co.uk/crn-uk/news/2261284/employee-power-will-spark-distie-schism-says-magirus-boss
Red “X” to continue to payment?

www.uxepicfails.com/

How do I select more items?

www.uxepicfails.com/

Stovetops, From “The Design of Everyday Things”, Donald A. Norman
Unhappy Users
Inefficiency
Errors
67% Surgeons Report Decreased Efficiency

- Decreased efficiency: 36%
- Severe disruption: 8%
- Major disruption: 23%
- No change: 12%
- Significantly improved: 21%

2015 American College of Surgeons Survey
Decreased Time With Patients

EHRs’ Effect on Patient Encounters

- Improves my ability to respond to patient issues: 35%
- Allows me to more effectively manage patient treatment plans: 33%
- Allows me to spend more face-to-face time with patients: 10%
- Allows me to see more patients: 9%
- Decreases my face-to-face time with patients: 70%
- Decreases my ability to see more patients: 57%
- Decreases my ability to effectively manage patient treatment plans: 27%
- Decreases my ability to respond to patient issues: 26%

Respondents could choose more than one answer.

2014 Medscape Survey
The Reality of Clinicians’ Views of the EHR

Stanford Med Study on EHR Satisfaction:

- **Provide an intuitive user experience**: 97% Important, 54% Satisfied
- **Change or adapt in response to user feedback**: 91% Important, 44% Satisfied
- **Facilitate better patient-provider interaction**: 91% Important, 50% Satisfied

Source: https://med.stanford.edu/content/dam/sm/ehr/documents/EHR-Poll-Presentation.pdf
“The next big thing is the one that makes the last big thing usable.”
- Blake Ross, Co-creator of Mozilla Firefox
Problem Definition
Waterfall

Understanding clients’ needs

Designing a solution

Building software

Delivering a product

Agile

Understanding

Designing

Delivering

Building

Designing Building

Delivering Underst

Building

Image source: https://blogs.nottingham.ac.uk/digitalresearch/files/2018/01/Waterfall-vs-Agile.png
Case Study

Communication Errors & Inefficiencies During Transitions-in-Care

2004 JCAHO Report:
Communication failures contribute to 70% of preventable adverse events.
Which of these challenges have you experienced most often?

A. Relying on paper lists
B. Using unsecure documents
C. Errors due to miscommunications
D. Too many siloed applications

Results
Paper Lists - Static, Outdated

<table>
<thead>
<tr>
<th>Name</th>
<th>Diagnosis/Concerns</th>
<th>Medications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jane Smith</td>
<td>57 year old woman, p/w abd pain ➔ acute cholecystitis</td>
<td>Abd pain</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cholecystitis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HTN</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Breast Ca</td>
</tr>
<tr>
<td>John Doe</td>
<td>67 year old with chest pain, concerning for ACS</td>
<td>NSTeMI</td>
</tr>
<tr>
<td>542</td>
<td></td>
<td>HTN</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Diabetes</td>
</tr>
<tr>
<td>Ted Jones</td>
<td>73 year old with delirium, dysuria ➔ UTI</td>
<td>UTI</td>
</tr>
<tr>
<td>487</td>
<td></td>
<td>Delirium</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cefepime</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Insulin</td>
</tr>
</tbody>
</table>
Version 1 Solution – Cloud Based

- Adopted by 5 residency programs
- Cloud based tool
  - Easier to access
- Auto-Import some data
  - Patient demographics
- Little form improvement
  - Online table
  - Limited adoption
Problem:
Inaccurate Data
Inefficient workflow
Outdated Paper

Surgery – needed shorter lists
Medication lists, labs not imported, often inaccurate

No HL7/API available at the time
Version 2– Medication Import

EHR module
Data imported (med lists, labs)
⇒ Less inaccuracies

Limited functionality

Outcome:
Most inpatient services using system
Poor usability, very cumbersome
STILL PAPER
<table>
<thead>
<tr>
<th>Pt Info</th>
<th>HPI</th>
<th>Prob List</th>
<th>MEDS</th>
<th>To Do</th>
<th>CrossCover</th>
</tr>
</thead>
</table>
| **Smith, John**<br>Bob<br>F14 1465A<br>MR: 34520984<br>DOB: 11/3/38<br>DOA: 11/2/06<br>Allergies: NKDA<br>Code: FULL<br>Access: RJI 3L (11/4)<br>Cc: >101.4<br>Precautions: MRSA<br>Contact: Wife Mary 215-777-7777 | Age, Gender, CC (on DOA): short of breath<br>CC (after dx): aspiration pna<br>Race, pertinent PMH, presentation to ED, HPI.<br>-relevant ROS<br>-relevant ED issues (vitals, meds given)<br>-relevant things done o/n<br>-important events during hospitalization<br>11/20 - desat last night improved after diuresis | **Asp Pna** – on cefepime, still borderline<br>**ARF on CKD: Cr 0.8 → 2.5**, likely 2/2 dehydration. Getting volume<br>**CAD – EF 10%**, on coumadin for low EF<br>**DM – on insulin<br>**HTN<br>**Diarrhea – possibly CDIff, ex pending<br>-Prostate ca – resced, cured | Cefepime 1gm IV q12<br>Colace 100mg po bid<br>Docosate 5mg po daily<br>Piroxicam 20mg po daily<br>Metoprolol 50mg po bid<br>Metrizamide 50mg po bid<br>Warfarin 5mg po qHS<br>Diet: Cardiac, mech grnd, NS @ 150<br>—Other Med Info—<br>Flagyl 500mg q2T1/2-4 | ---D/C Info---<br>PMD Dr. Jones<br>444-2244<br>needs gi appt<br>---To Do---<br>---fu xxxx test<br>---daily pulm note<br>---fu 7pm Na—— increase IVF if Na < 130<br>-if labs bad, consider fungal coverage< | "LLE 0S"<br>---2nd set ensyns<br>---Check EKG<br>---Check Lab<br>---Start Teli<br>---42"22<br>---110<br>---22<br>---210<br>---30<br>---10<br>---2<br>---4""<br>---enda<br>---1st set ensyns<br>---talk to sw<br>---A2I<br>---2 way<br>---div<->recheck cr
Paper is just **not good enough**...

Average list in hands = 9-12 hours old  
(3pm cross-sectional evaluation at UPenn)

Printed documents out of date within  
3.3 hours (day shift), 6 hours (night shift)

_Rosenbluth et al, BMJ Qual Saf, 2015_

Paper is not HIPAA compliant…
Version 3 – Digital Solution

Replace paper lists as a “clinical workflow tool”

Interdisciplinary approach

Build a tool meant to delight users – the clinicians.

Real-Time Data
Synchronized Tasks Lists
Any Device, Any EHR
User Centered Design

- Start with the problem
- Throw out all assumptions
- Involve key stakeholders
- Start with MVP—get in users hands early
  - Do the process again
- Design for workflow and user delight
  - Usability
  - Efficiency
  - Simple interface
Agile Development

Focus on **Quality** >> timeline

Revise requirements based on user input

Close collaboration developers + clinicians

Image source: http://codigodelsur.com/what-is-agile-software-development
Design Process

1. User stories, Initial designs
2. Revise designs
3. Build UI only
4. Iterate on UI
5. Connect Database
Initial UI Design
Revisions With User Feedback
Device Decision: Smartphone
Toolbar Iteration
Graphs Iteration

### HR

**Normal range:** 60 - 100

![HR Graph](image)

1 Day Graph - 13 result(s) between 3/23/15 4:56 and 3/24/15 6:06

**Past 72 Hours**

<table>
<thead>
<tr>
<th>Date</th>
<th>BPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/24/15 00:06</td>
<td>99</td>
</tr>
<tr>
<td>3/23/15 23:56</td>
<td>98</td>
</tr>
</tbody>
</table>
Careplan Designs

**ACTIVE**

- **Comm Acquired Pna** (Updated: 1/24/15 7:31am)
  - (Hx) - trf from O2H, intubated for Pox 75%, extubated 1/22
  - (Hx) - CT Chest: LUL consolidation
  - (AP) - cefepime & vanc x10d (till 1/31)
  - (AP) - now 96% on 3L - not on O2 at baseline
  - □ check ab Pox, cont to wean
  - □ reorder abx after expire on 1/28

- **Attending Section** (Updated: 1/24/15 7:31am)
  - Doing well on abx, weaning O2.
  - Need to make sure can ambulate off O2 without desatting prior to discharge.
  - Likely will need f/u CT/CXR in 6 months for resolution (this would need to be copied and pasted into a task for discharge by primary team, we might want to directly)
  - Pulm C/S - recovering well, agree with cef/vanc. recommend pulm f/u on discharge (would be awesome if we could highlight text anywhere and copy to a task or another problem)

- **IDDM** (Updated: 1/24/15 7:31am)
  - (Hx) - poor compliance, last HgA1c 13
  - (Hx) - mult episodes of HHNK in past
  - (AP) - not yet controlled, titrating basal and prandial insulin
  - (AP) - getting DM education from DM nurse.
    - □ follow sugars, titrate insulin
    - □ DM education
    - □ set up outpt DM follow up

- **Attending Section** (not yet controlled, cont to titrate insulin. Poor insight)

**RESOLVED**

- **AKI** (Updated: 1/22/15 7:31 pm)
  - (Hx) - likely 2/2 hypovolemia, recovered with IVF, peak Cr 2.2, now back to baseline 0.9
  - □ i/v - keep even

**CHRONIC**

- **HTN**
  - (AP) - controlled, holding some home meds
    - □ resume HCTZ, lisinopril

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**Dx: Care Plan**

**Acute Problems**

1. Problem #1 (Updated: 2/14/15 14:30)
   - Historical info for this problem (can be hidden to only show ACTIVE bullet points)
   - **ACTIVE dx, plan etc for this problem (these points populate the note)**
   - **Anticipatory guidance item**

   □ To do item
   - To do item (can see crossover and completed items here as well)

**New Item**

- **Attending** (Present for each problem)
  - Attending writes their thoughts/notes here.
  - Can then populate the attending note.

**Consult**

- Consultants put their thoughts here. New block for each consultant. Would also put their to do here.

2. **Discharge Plan** (Updated: 2/14/15 14:30)
   - All providers can contribute to plan & tasks for discharge.

   □ Discharge related tasks would show here, as well as on consolidated task list

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**Resolved Problems**

**Chronic Problems**
Current Interface
Results

Four Hospitals
>130 Services

~5000 Users
150k Sessions

>500,000
Patient views

> 4M actions in platform

*Monthly Usage Info
Truly Interdisciplinary

- MDs & APPs (Attendings + Trainees + APPs): 34%
- Nurses: 45%
- Trainee: 21%
- Attending: 8%
- SW/PT: 8%
- APP: 5%
Mobile login (touch ID, browser open) = ~2-10 s
Desktop login = 39 s – 2 min
### Handoffs...And More

<table>
<thead>
<tr>
<th>Activity</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>During transitions in care</td>
<td>62%</td>
</tr>
<tr>
<td>While writing notes</td>
<td>55%</td>
</tr>
<tr>
<td>During rounds</td>
<td>55%</td>
</tr>
<tr>
<td>While pre-rounding</td>
<td>51%</td>
</tr>
<tr>
<td>While off campus</td>
<td>37%</td>
</tr>
<tr>
<td>While on call</td>
<td>36%</td>
</tr>
<tr>
<td>While talking to patients</td>
<td>31%</td>
</tr>
<tr>
<td>Other</td>
<td>14%</td>
</tr>
</tbody>
</table>

Survey responses: 633
User Impressions of V2 vs V3

- I am able to efficiently manage my patient care responsibilities: p=0.065
- The current written handoff system is safe for patients: p=0.022
- I am satisfied with the current handoff system: p=0.012
- I would recommend the current handoff system to colleagues: p=0.011
Feedback Is Key!

- EASY to give, receive and respond to
- In-app button – readily visible → instant email
- Used frequently, responded often within one hour

Intra-App Feedback Per Week
80% of responders report Carelign saves them time

75% believe Carelign prevents errors

69% of users took 3 days or less to feel comfortable using app
Challenges

• Administrative and stakeholder buy-in
• Demands on clinician time, getting the involvement necessary from stakeholders can often be rate limiting
• Resistance to learning a new system
• Fighting technology apathy
Recommendations

- User centered design
- Start with the problem…not the proposed solution
- Agile development instead of waterfall approach
- Interdisciplinary team – Developers, Clinicians, Users, Informaticians, Human Factors
- “Champion” to connect with users
- Solicit focus groups and user feedback OFTEN
- Iterative improvement – users should feel like they are being heard!
Thank you!

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Please complete the online evaluation!