

Applying Human Factors to the Design of Safe Systems | Clinical Excellence Commission,  
The Mint, Sydney, Australia; August 6, 2015

## Human Factors Engineering & Health IT Design

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## Usability and User Centered Design

- **Usability:** Extent to which a product can be used by specified users to achieve specified goals with **effectiveness, efficiency** and **satisfaction** in a specified context of use
- UCD

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### Bin 2 - Basic

[FIND DRUGS]

Drug:  Find

**Trimethoprim/sulfamethoxazole 160/800 mg (Bactrim) DS po bid x 3 days**  
**Trimethoprim/sulfamethoxazole 160/800 mg (Bactrim) DS 2 po bid x 7 days (C-MRSA dose)**  
**Trimethoprim/sulfamethoxazole 160/800 mg (Bactrim) DS po bid x 14 days**  
**Trimethoprim/sulfamethoxazole 160/800 mg (Bactrim) DS po bid x 7 days**

Description:  
 8 Trimethoprim/sulfamethoxazole 160/800 mg  
 DEA Number Required  
 Sig: 1 pill by mouth 2 times a day for 3 days for infection  
 Class: sul  
 Notes: Avoid Sun  
 May cause a rash  
 No Refill  
 May Substitute

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### Bin 2- basic

Dispense (total):  Quantity (per dose):  Unit:  Schedule:

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### Focus #1: Bin 2 – Advanced

#### Applied Cognitive Systems Engineering

#### NIBIB K08, AHRQ R01, AHRQ R18



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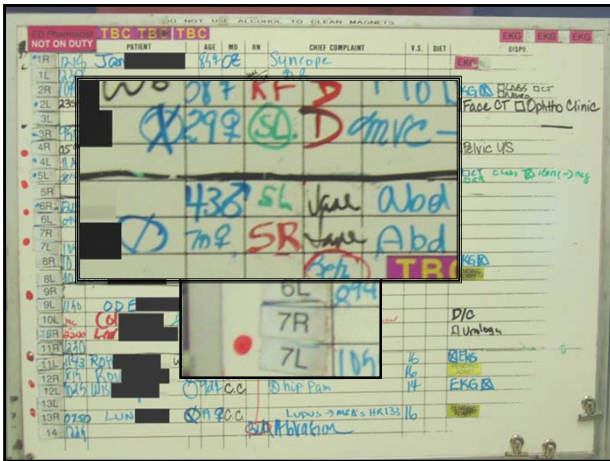
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Time	Page	Complaint	AGE	SEX	ETHNIC	DIAG	STATUS	Priority	Assigned	Estimated
WEST 08:23:01	1	F42 (Disturbance of Breathing-Pneumonia, CC)	68	M	ASIA	T103	MM11	F	P	0:15
WEST 08:23:01	1	F30 (Rectal Bleeding, NAUSEA, ABD PAIN)	68	M	ASIA	T103	MM11	F	P	0:05
WEST 08:23:01	1	F77 (FEVER)	68	M	ASIA	T103	MM11	F	P	11:00
WEST 08:23:01	1	F37 (Abdominal Pain)	68	M	ASIA	T103	MM11	F	P	2:11
WEST 08:23:01	1	M63 (Pneulobes)	68	M	ASIA	T103	MM11	F	P	0:45
WEST 08:23:01	1	M64 (Disturbance of Breathing-Pneumonia, CC)	68	M	ASIA	T103	MM11	F	P	0:47
WEST 08:23:01	1	M62 (Chest Pain)	68	M	ASIA	T103	MM11	F	P	11:07
WEST 08:23:01	1	M62 (Chest Pain)	68	M	ASIA	T103	MM11	F	P	11:25
WEST 08:23:01	1	F30 (ELEVATED BP)	68	M	ASIA	T103	MM11	F	P	11:45
WEST 08:23:01	1	F77 (Altered Mental Status)	68	M	ASIA	T103	MM11	F	P	0:05
WEST 08:23:01	1	M68 (eye pain)	68	M	ASIA	T103	MM11	F	P	0:05
WEST 08:23:01	1	F34 (HEART TRICULAR)	68	M	ASIA	T103	MM11	F	P	0:05
WEST 08:23:01	1	M62 (Abdominal Pain)	68	M	ASIA	T103	MM11	F	P	0:15
WEST 08:23:01	1	F30 (FLU ABD PAIN)	68	M	ASIA	T103	MM11	F	P	0:15
WEST 08:23:01	1	M68 (Mid para costal pain)	68	M	ASIA	T103	MM11	F	P	0:05
WEST 08:23:01	1	F44 (Nausea and Vomiting)	68	M	ASIA	T103	MM11	F	P	0:05
WEST 08:23:01	1	F40 (COPD With Exacerbation)	68	M	ASIA	T103	MM11	F	P	0:05
WEST 08:23:01	1	M62 (Chest Pain)	68	M	ASIA	T103	MM11	F	P	0:05
WEST 08:23:01	1	F30 (Abdominal Pain)	68	M	ASIA	T103	MM11	F	P	0:05

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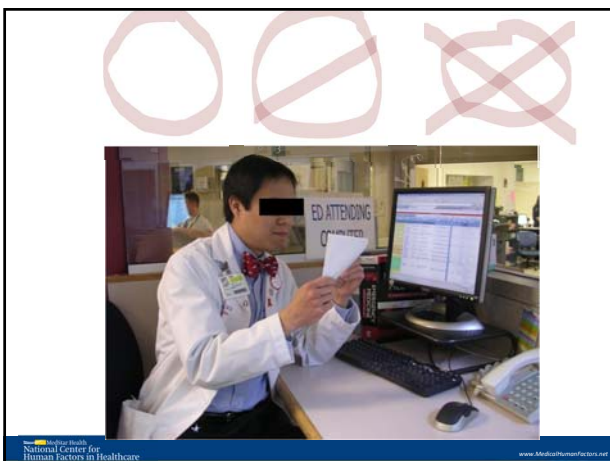
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Callsign	Squawk	Dep Apt	Arr Apt	Alt Apt	Route	Annotations
EAL218	3481	KALB	ALB GOM2			22L VIS
Aircraft Type	B752/P	118	XBUS	KPYD		
CRD	420	I	210	fuel	/V/Have charts	
IFR/VFR	Temp Alt	Cruise Alt	Scratchpad	Remarks		
GOFR06	2427	ADW		+BUFFER JS18 INB+		v N ✓
T/C138/I	P1311	IL		ADW BUFFER JS18 DJB J34 BAE		1335 ✓
841	Z	240		EAUS MSP	FLYK	


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## Complex Adaptive Systems

**WORK AS IMAGINED**  
*How managers believe work is being done (rules)*

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**GAP**

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**WORK AS PERFORMED**  
*Every-day work: How work IS being done*

*Adapted from: Ivan Pupulidy*

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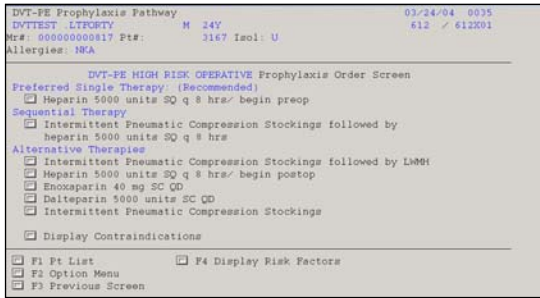
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### CPOE Pathway: Screen #3




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### Result of CPOE Pathway

- Readily accepted by physicians
- Increase in appropriate prophylaxis rates  
50% → 66% → 93%

Fairbanks RJ, Caplan S, Panzer RJ. Integrating Usability Into Development Of A Clinical Decision Support System. *Proceedings of HCI-International 2005*, Mira Digital Publishing (ISBN 0-8058-5807-5). July 2005; Las Vegas, Nevada.

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### Human Factors “Bin 2” Considerations

- Ideal systems- built to support the cognitive work of the end users
  - *This is complex- we should do together*
- For safety- remember skills based (automation) error
  - Education & Training NOT effective
- Make it easy to do the safest & best thing

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### EHR Vendor UCD Processes

<p><b>No True UCD</b></p> <ul style="list-style-type: none"> <li>• Focused on customer requests</li> <li>• Responding to user feedback is UCD</li> <li>• No formalized method for incorporating and testing user needs throughout design and development</li> </ul>	<p><b>Challenges:</b></p> <ul style="list-style-type: none"> <li>• Context and exposure</li> <li>• General process</li> <li>• Support</li> </ul>
<p><b>Basic UCD</b></p> <ul style="list-style-type: none"> <li>• Understand UCD and its importance</li> <li>• Striving to implement UCD processes</li> <li>• UCD is not fully integrated yet</li> </ul>	<p><b>Challenges:</b></p> <ul style="list-style-type: none"> <li>• Resources</li> <li>• Participant access</li> <li>• Use case development</li> </ul>
<p><b>Well Developed UCD</b></p> <ul style="list-style-type: none"> <li>• Rigorous UCD processes in place</li> <li>• Efficient testing methods</li> <li>• Extensive infrastructure</li> </ul>	<p><b>Challenges:</b></p> <ul style="list-style-type: none"> <li>• Detailed work flow analysis</li> <li>• Safety data</li> </ul>

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### Focus #3: Analysis of SED Reports: *Do Vendors & ACBs Adhere to Policy?*

- Tremendous variability in evaluation of 50 CHPL
  - As few as 3 participants (some with 20)
    - Violates usability standards & creates double standard
  - Diverse range of participant expertise
    - Some with no clinical expertise (eliminates bin 2)
  - Diverse experience levels
  - Variability in amount of training on the system
- Not at all ACBs are posting the SED results

*Ratwani RM, Benda N, Hettinger AZ, Fairbanks RJ. Electronic Health Record Vendor Adherence to Usability Certification Requirements and Testing Standards. JAMA (Letter, in press)*

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### Focus #4: How do end users & buyers know who is good at UCD?

- No good way for people to make comparisons
- ACB analysis extremely complex for experts
- Working on scorecard so non-usability folks can better understand & evaluate usability
  - How many participants should you run?
  - What is a rigorous use case?
  - Who should the participants be?
  - NIST effectiveness, efficiency, satisfaction: what is a good metric??

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### Focus #5: Implementation

- Implementation processes:
  - Variability in implementation processes across vendors/providers
  - Few guidelines (AHRQs SAFER guides are a start)

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### Acetaminophen (Tylenol)



325 mg, Soln-Oral, PO, One Time, STAT, ED ONLY  
120 mg, Supp, PR, One Time, STAT, ED ONLY  
650 mg, Supp, PR, One Time, STAT, ED ONLY  
325 mg, Tab, PO, One Time, STAT, ED ONLY  
500 mg, Tab, PO, One Time, STAT, ED ONLY  
650 mg, Tab, PO, One Time, STAT, ED ONLY  
1,000 mg, Tab, PO, One Time, STAT, ED ONLY  
1,000 mg, Inj, IVPB, One Time, Indication: Other One time dose  
325 mg, Soln-Oral, PO, q6h PRN, pain/fever/headache, Indication: Other pain/fever/headache  
650 mg, Soln-Oral, PO, q6h PRN, pain/fever/headache, Indication: Other pain/fever/headache  
325 mg, Supp, PR, q6h PRN, pain/fever/headache, Indication: Other pain/fever/headache  
650 mg, Supp, PR, q6h PRN, pain/fever/headache, Indication: Other pain/fever/headache  
325 mg, Tab, PO, q4h PRN, pain/fever/headache, Indication: Other pain/fever/headache  
650 mg, Tab, PO, q4h PRN, pain/fever/headache, Indication: Other pain/fever/headache  
650 mg, Tab, PO, q4h PRN, pain/fever/headache, Indication: Other pain/fever/headache  
650 mg, Tab, PO, q6h PRN, pain/fever/headache, Indication: Other pain/fever/headache  
650 mg, Tab, PO, q6h PRN, pain/fever/headache, Indication: Other pain/fever/headache  
650 mg, Tab, PO, One Time, STAT, ED ONLY

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### User Centered at every level

- Example: How are orders searched for in the system?
  - Urine Sodium
  - Urine NA
  - NA Urine
  - NA Level Urine




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### Alarm Fatigue- Not well controlled

	# Removed	# Canceled	# Overridden	# Total alerts	% Overridden
Drug-Dose	606	0	12,689	14,429	88%
Drug-Allergy	455	0	1,742	4,497	39%
Drug-Disease	40	0	2,093	2,435	86%
Duplicate Drug	1,388	0	32,939	37,259	88%
Duplicate Ther. Class	1,017	0	22,100	25,439	87%
Drug-Drug	89	0	14,063	15,250	92%
Pediatric	0	0	25	29	86%

*Matt Scanlon MD, Professor of Pediatrics, Medical College of Wisconsin, USA*

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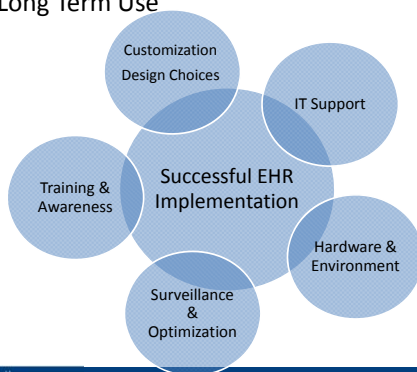
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### Factors Contributing to Successful Implementation and Long Term Use




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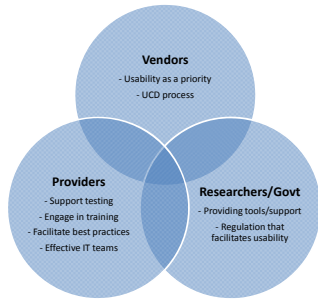
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### Shared Responsibility for EHR Usability



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### Impact of EHR Implementation on Practice

- Observational study of EM physicians:
  - Pre EHR: few weeks prior to introduction of EHR
  - GoLive: Week of the new system in place
  - Post EHR: 3 months after go-live date
- Tracked physician tasks on a minute by minute basis
  - Computer, patient, paper etc
- 2 hour samples from 14 different EM physicians in each phase

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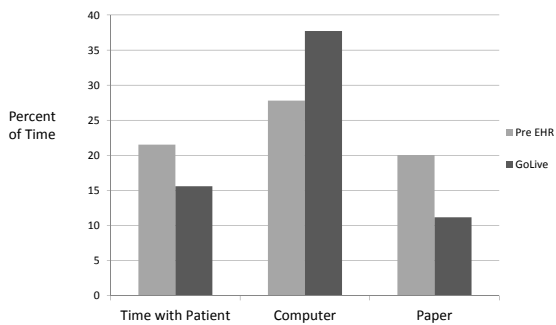
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### Pre EHR Compared to GoLive



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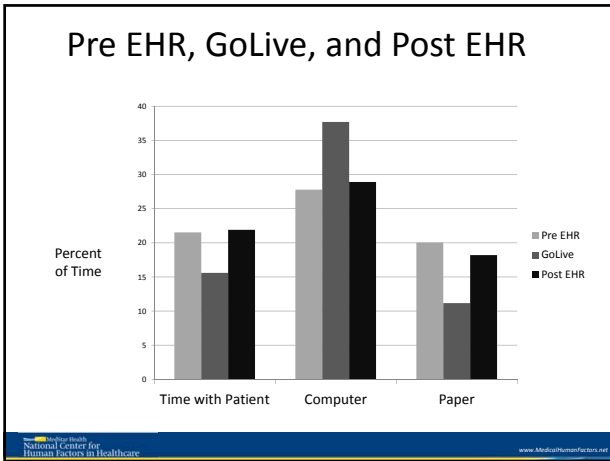
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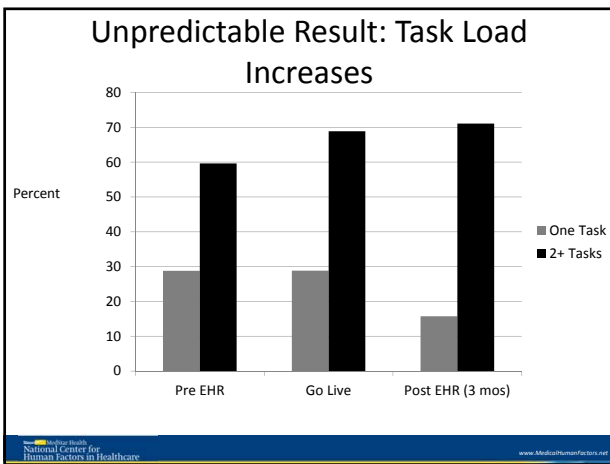
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### Customization

- Adhere to design principles

Principle	Description
Consistency	Internal and external consistency in the methods by which you interact with the system
Cognitive Load	Cognitive/memory load requirements should be reduced.
Feedback	Explicit and specific feedback should be provided to the user.
Visibility	The user should know the state of the system (e.g. goal state)
Information Presentation	Information should be effectively presented to facilitate cognitive performance (reduce clutter, meaningful use of color)
Efficient Interaction	The system should be easy to interact with

HIMSS, 2009; AMIA, 2012; Zhang & Walji

Source: National Center for Human Factors in Healthcare

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## Customization

- Ask the vendor and other providers for guidance
- Push vendors to share their experience from other implementations
- System updates don't always play well with customization

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## Focus #6: Safety Monitoring and Analysis

- Machine learning (NLP) to analyze HIT related safety events (>70,000)  
"A prescription was written under the wrong ED patient's name... patient unable to read the medication label to me over the phone... continual problem in the ED because the [EHR] whiteboard screen resets itself to the patient at the top of the list even when a doctor is trying to print discharge papers or a prescription on a different patient."
- Analyze these events in the context of UCD practices to provide insights on how to improve UCD
- Early data showing many downtime events  
– Focus #7

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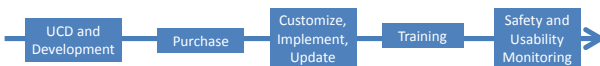
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## Our Proposed Roadmap of Safety Opportunities from a Usability Perspective



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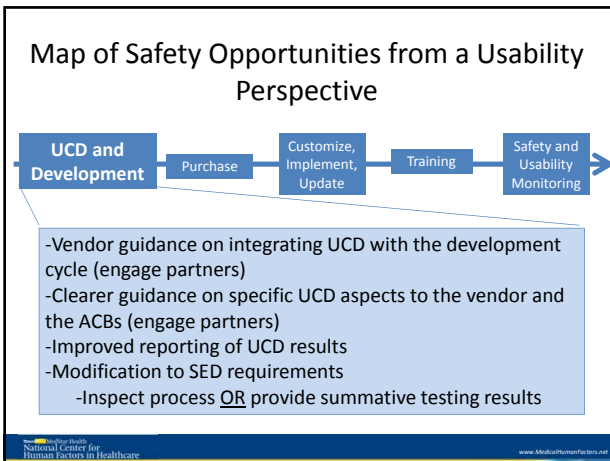
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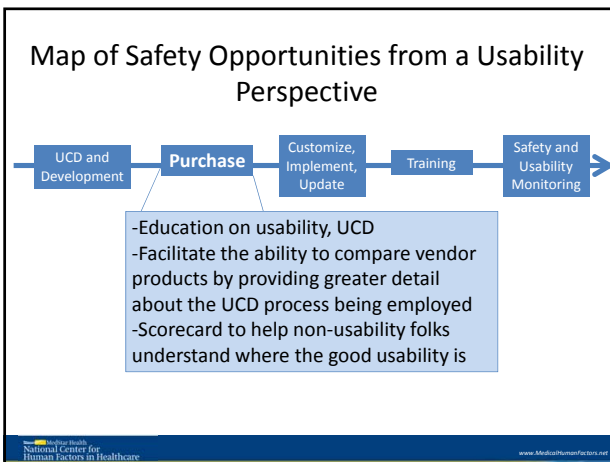
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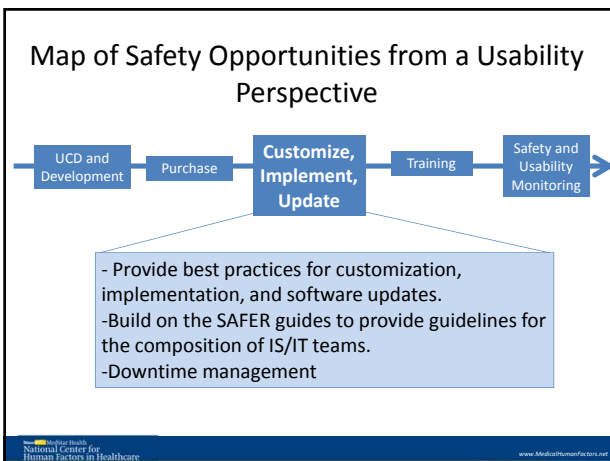
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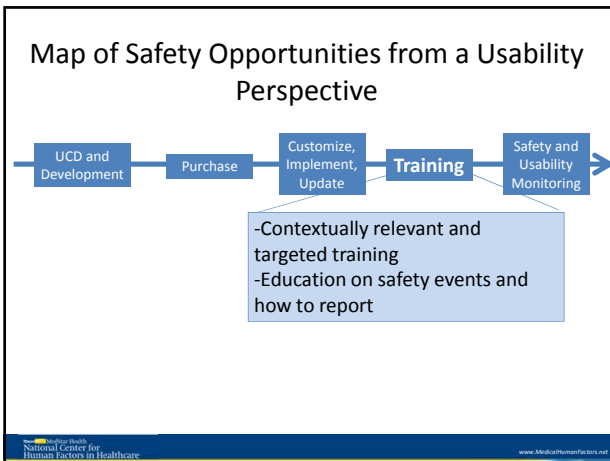
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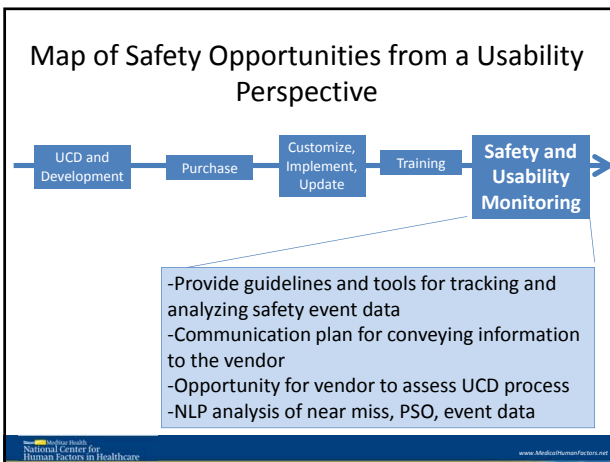
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- ### Our approach to Health IT
- Immersed in the clinical environment with robust access
  - Embrace a multi-disciplinary approach
  - TRUE systems approach: Embedded with health system, know vendors, understand policy, know usability, we are developers, users, implementers, testers
  - Simulation and Technology
    - Eye trackers, Google Glass, Sensor Tech, RFID
- U.S. Department of Health and Human Services  
National Center for Human Factors in Healthcare  
www.MedicalHumanFactors.net

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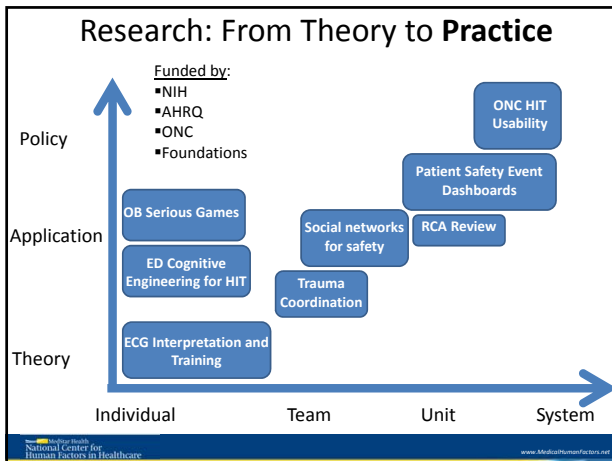
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### Acknowledgments

**Raj Ratwani, PhD**  
Scientific Director

**Zach Hettinger, MD MS**  
Medical Director




**MedStar Health**  
**National Center for**  
**Human Factors in Healthcare**

*Our Health IT work has been supported by Emergency Medicine Patient Safety Foundatoin, Latham Foundation, and US Health and Human Services agencies: AHRQ and ONC*

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