AHRQ National Web Conference on Reducing Provider Burden Through Better Health IT Design

Presented by:
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Moderated by:
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Agency for Healthcare Research and Quality

January 25, 2018

Agenda

- Welcome and Introductions
- Presentations
- Q&A Session With Presenters
- Instructions for Obtaining CME Credits

Note: After today's Webinar, a copy of the slides will be emailed to all participants.

Presenter and Moderator Disclosures

The following presenters and moderator have no financial interests to disclose:

Pascale Carayon, PhD
Presenter

Zia Agha, MD
Presenter

Lukasz Mazur, PhD
Presenter

Bryan Kim, PhD
Moderator

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PESG, AHRQ, TISTA, and RTI staff have no financial interests to disclose.

Commercial support was not received for this activity.

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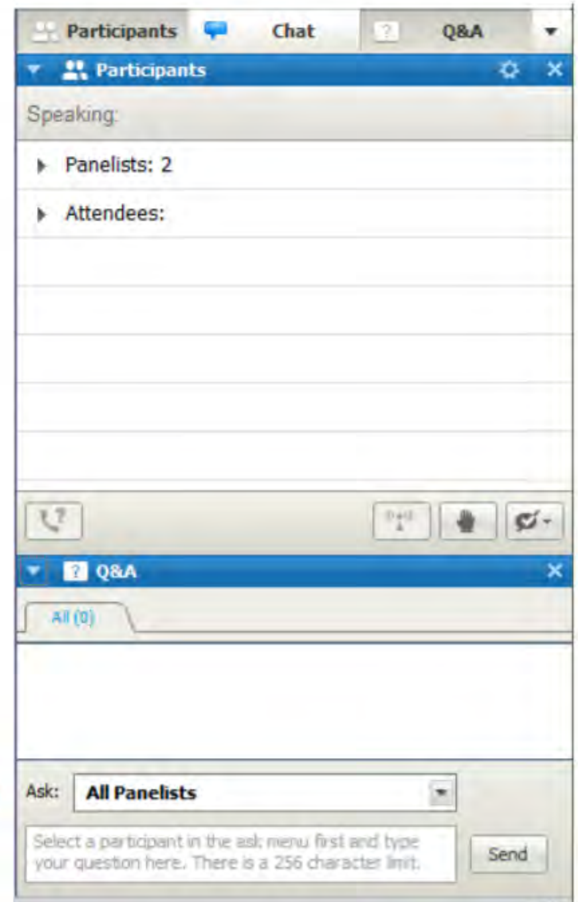
- At any time during the presentation, type your question into the “Q&A” section of your WebEx Q&A panel.
- Please address your questions to “All Panelists” in the drop-down menu.
- Select “Send” to submit your question to the moderator.
- Questions will be read aloud by the moderator.



Learning Objectives

At the conclusion of this activity, participants should be able to:

1. Identify the cognitive and team work involved in venous thromboembolism (VTE) prophylaxis and the sociotechnical system design requirements that support collaborative VTE prophylaxis teamwork.

2. Describe methods for capturing and analyzing EHR use for providing a comprehensive assessment of usability, clinical workflow, physician-patient communication, cognitive load, and user satisfaction in two distinct outpatient settings.

3. Explain an evaluation to assess provider mental workload and performance on abnormal test result follow-up in both a standard and an enhanced EHR environment that includes results tracking functionality.

Sociotechnical Design of Health IT for Teams Application to VTE Prophylaxis

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Wisconsin Institute for Healthcare Systems Engineering
University of Wisconsin-Madison

Acknowledgments

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"Health IT-supported process for preventing and managing VTE"

UW-Madison

- Ann Schoofs Hundt
- Peter Hoonakker
- Megan Salwei
- Roger Brown
- Yushi Yang [Drexel]
- Yudi Wang
- Doug Wiegmann
- Emily Wirkus

UW Health

- Peter Kleinschmidt
- Brian Patterson
- Shashank Ravi [Yale]

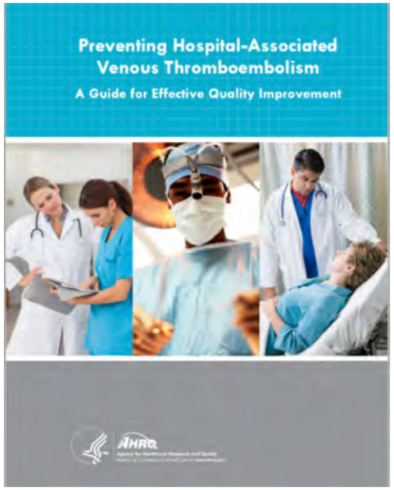
Geisinger

- Vaibhav Agrawal
- Jason Stamm
- Ken Wood [University of Maryland]
- Becky Price

https://cqpi.wisc.edu/vte-and-health-it/

Venous Thromboembolism (VTE)

- VTE:
  - Patient safety problem (Goldhaber & Bounameaux, 2012; Maynard et al., 2013, 2014)
- Solutions for preventing VTE:
  - Guidelines for VTE prophylaxis
  - Risk assessment algorithms
  - EHR (CDS) to support VTE prophylaxis
- But…
  - ➢ Usability, usefulness and workflow integration of health IT
  - ➢ Not just admission:
    - Missed doses of enoxaparin → DVT formation [Louis et al., 2014]
  - ➢ Collaborative work of physician, pharmacist, nurse, etc…

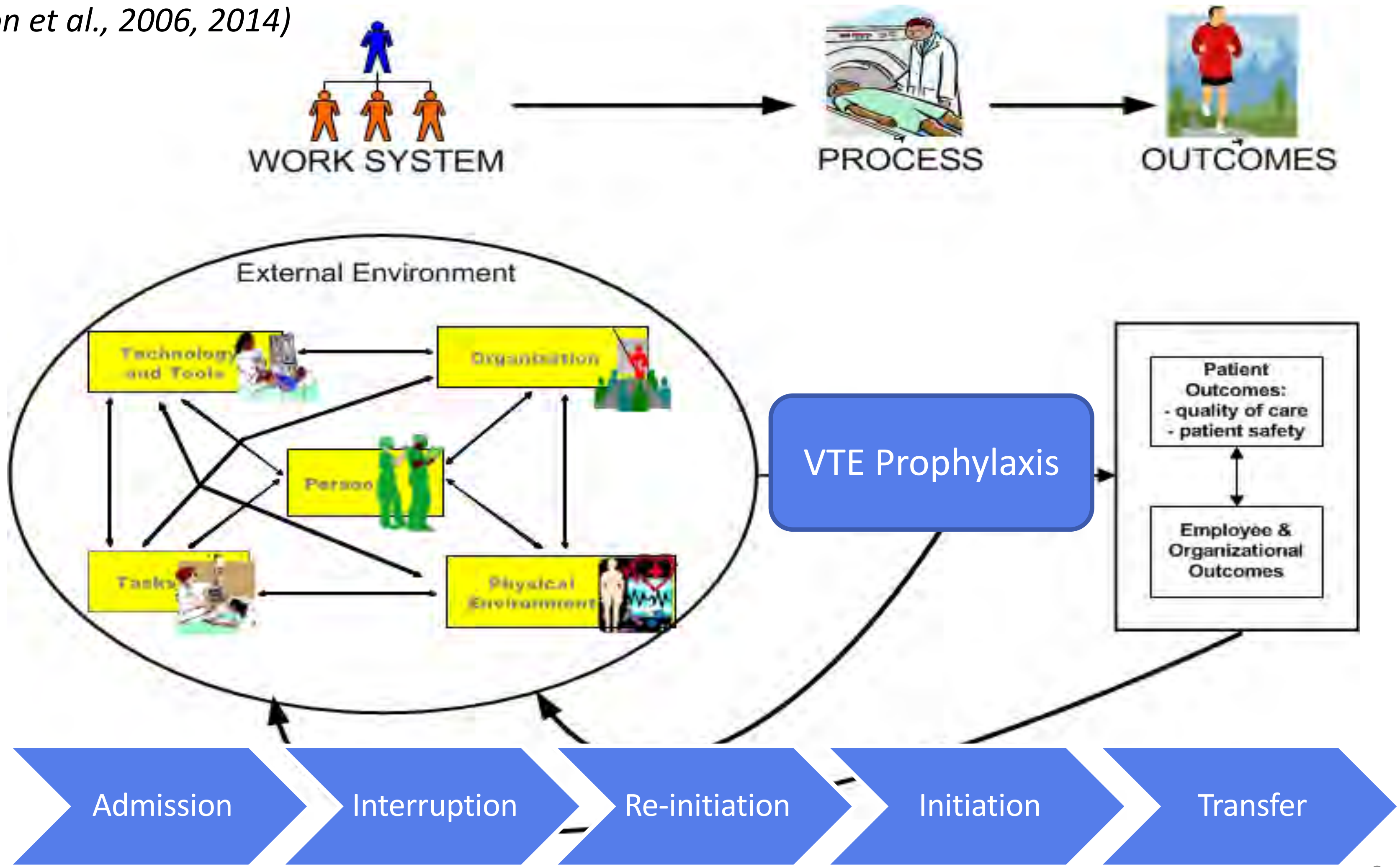


VTE Prophylaxis in the Hospital

SEIPS Model of Work System and Patient Safety

[SEIPS = Systems Engineering Initiative for Patient Safety]

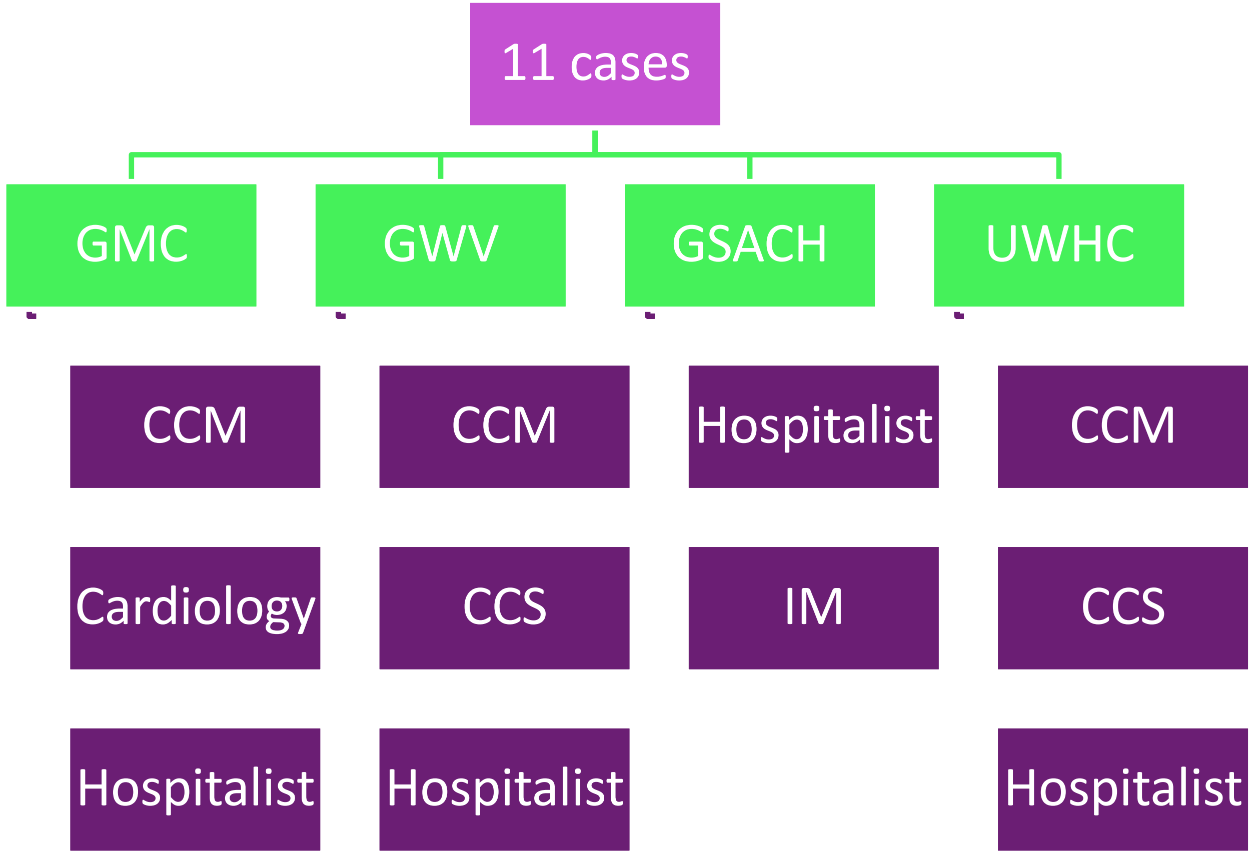
(Carayon et al., 2006, 2014)



Study Design

- Multiple case study design (Eisenhardt, 1989)

4 hospitals

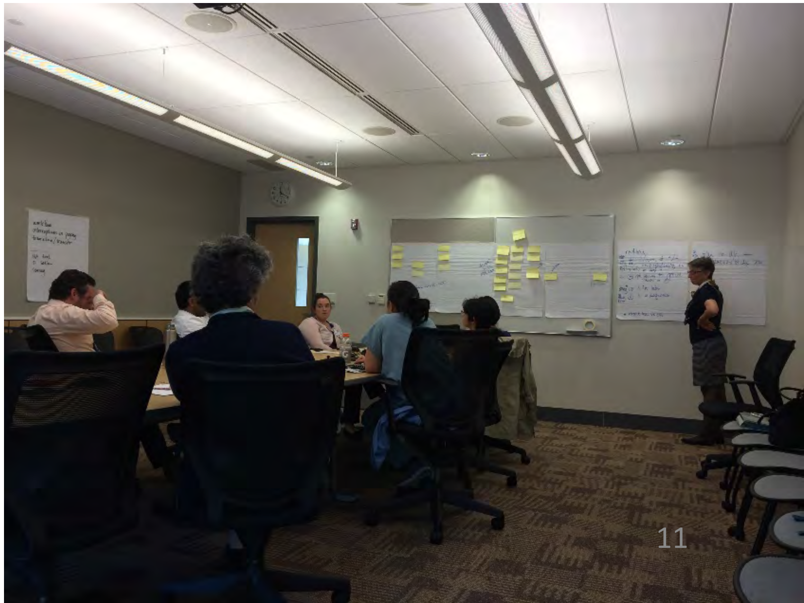


CCM=Critical Care Medicine
CCS=Critical Care Surgery
IM=Internal Medicine

Data Collection Methods

- Survey:
  - To assess clinician attitudes toward and perceptions of VTE prophylaxis and potential solutions
  - *N=1,009 (attendings, residents, PA/NP, pharmacists, nurses); 85% response rate*
- Observation:
  - Focused on morning rounds: VTE-related activities
  - *N=40; 69 hours*
- Interviews and focus groups:
  - Based on SEIPS model: What is the work system? System barriers and facilitators?
  - *N=40; 61 hours*

Multiple feedback loops



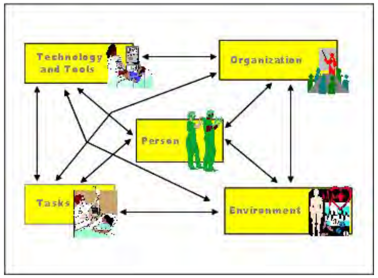
Results → Sociotechnical Design Considerations

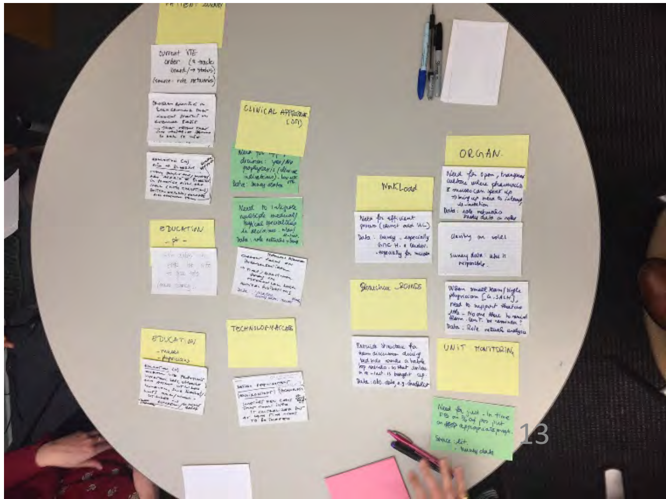
1. Survey
2. Role network analysis
3. Cross-case analysis

→ **Participatory Human-Centered Design**

Participatory Human-Centered Design

- Objective:
  - *To define design considerations for health IT that supports cognitive and team work in VTE prophylaxis [interruption/re-initiation]*
- Divergence/convergence (Brown, 2009-Design Thinking]
- Local and national experts
- Participation of clinical team members
  - **Sociotechnical system**





Sociotechnical Design Considerations for VTE Prophylaxis

focus on interruption & re-initiation

- 13 categories with 22 specific design considerations:
    1. Patient journey
    2. Clinical appropriateness
    3. Physician teamwork
    4. Role clarity
    5. Built-in redundancy/error recovery
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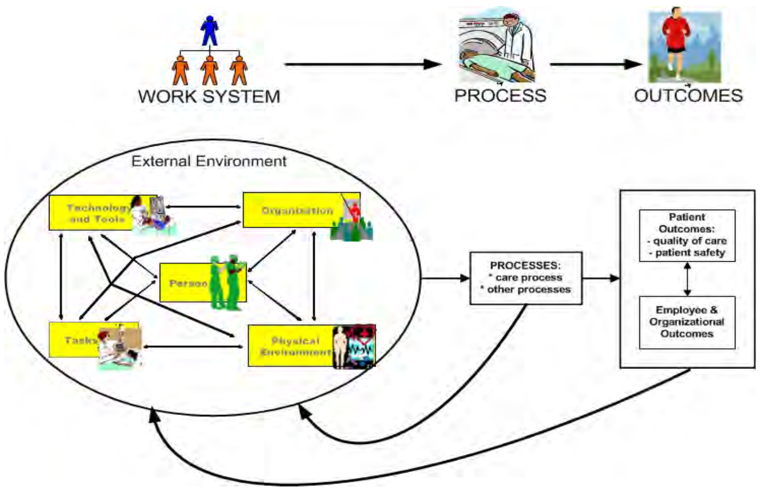

Results → Sociotechnical Design Considerations

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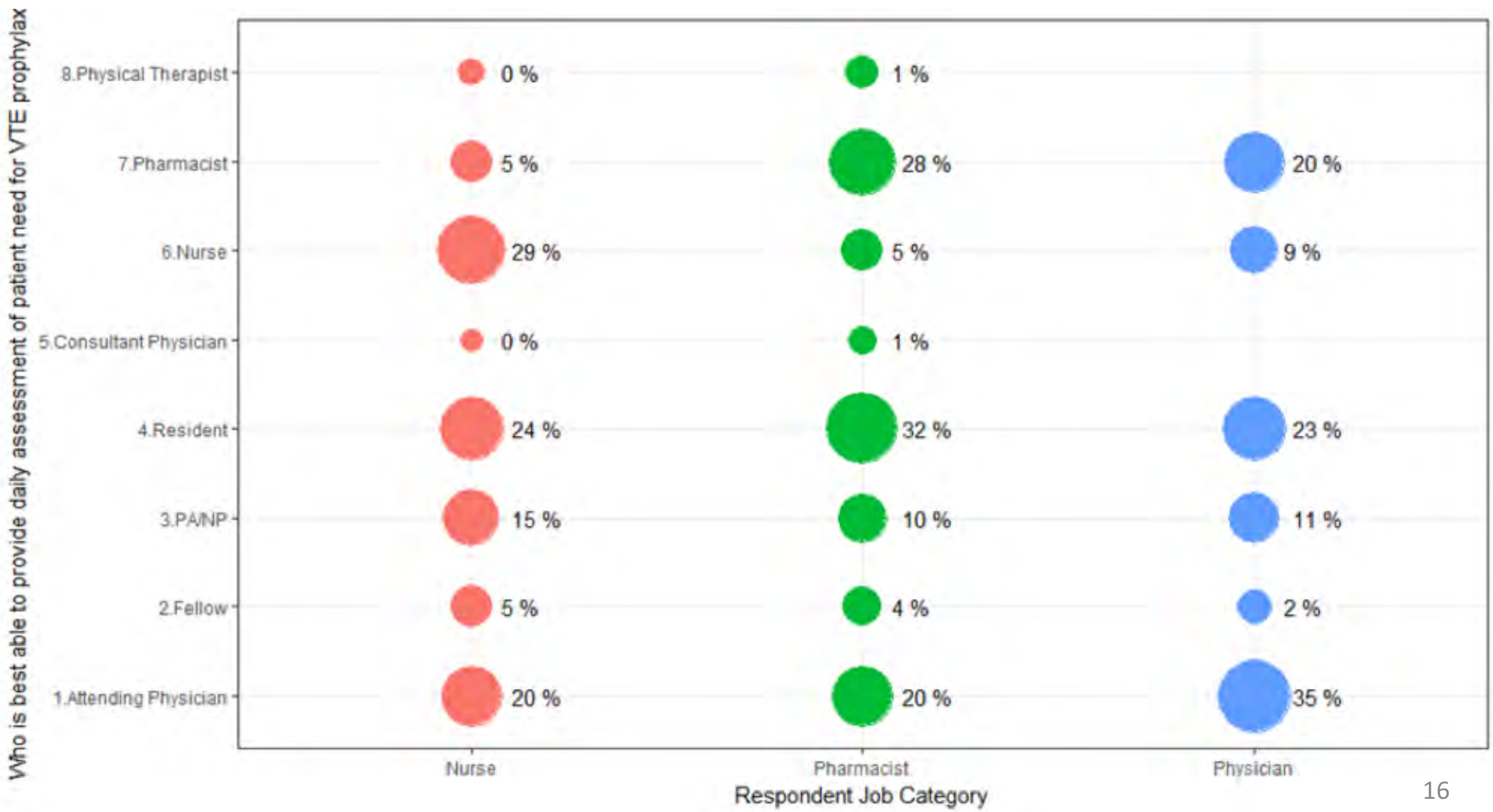
3. Cross-case analysis

Who is best able to provide *daily assessment* of patient need for VTE prophylaxis?

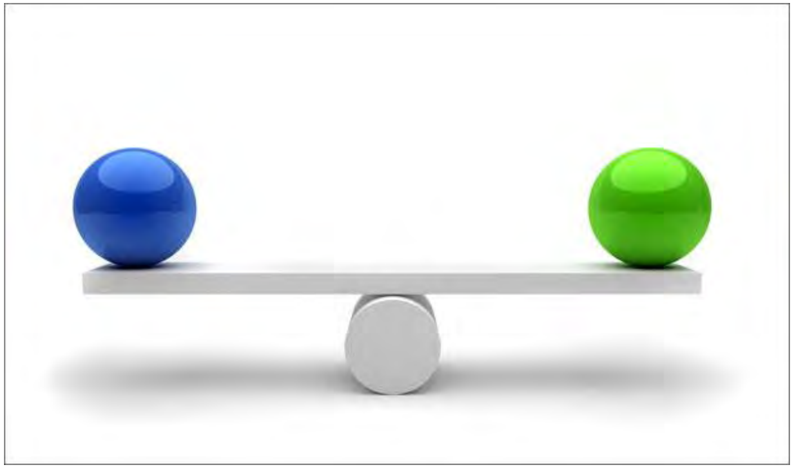


Sociotechnical Design Considerations

- Need to reduce role ambiguity

  … but also need for a “second pair of eyes”
- Team configurations and responsibilities
- Automation to monitor and/or suggest interruption or re-initiation

Role clarity

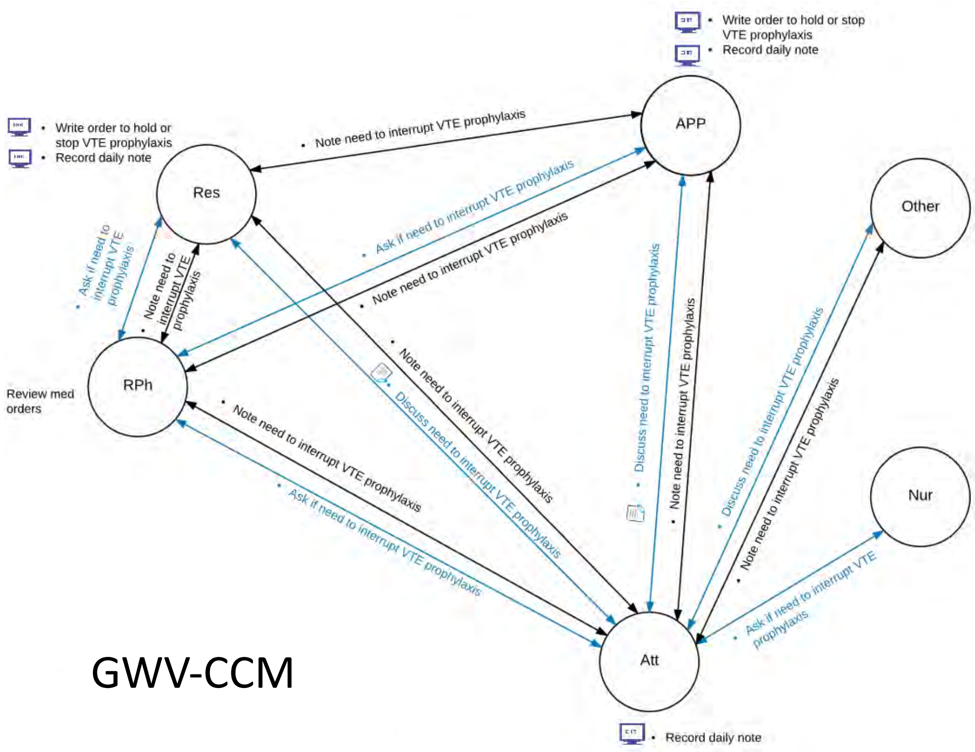


Error recovery (resilience)

Results → Sociotechnical Design Considerations

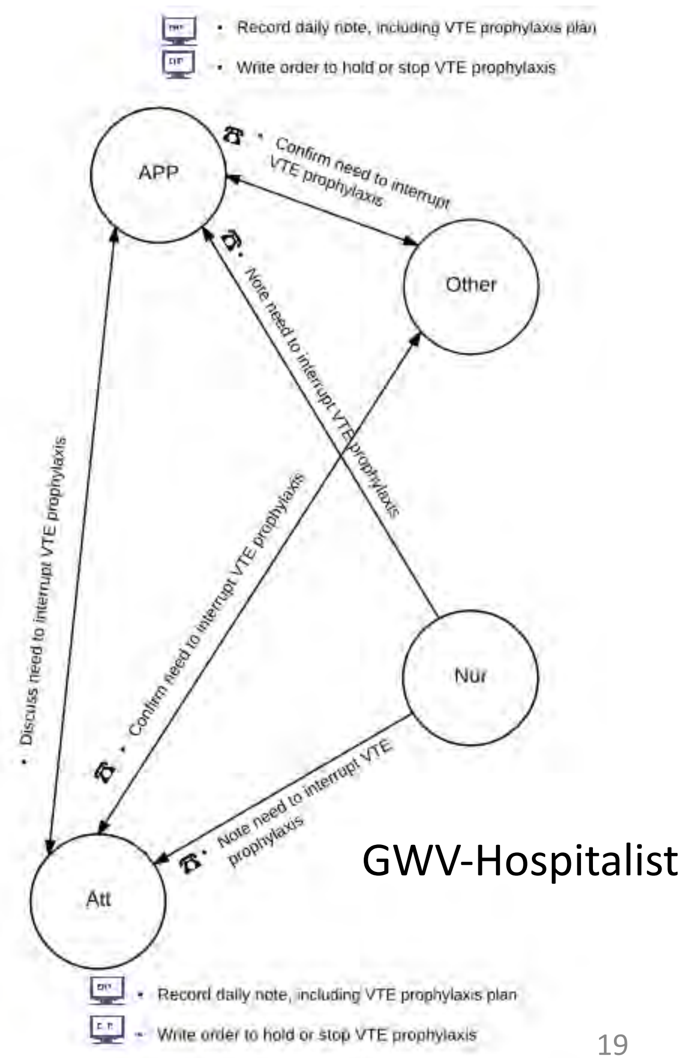
1. Survey
2. Role network analysis (Hundt et al., 2017)
3. Cross-case analysis

Role Network Analysis [Interruption]



GWV-CCM

Activities in blue = performed during multidisciplinary bedside rounds



GWV-Hospitalist

(Hundt et al., 2017)

Sociotechnical Design Considerations

- Need to support teamwork

  … in particular communication between attending physician and proceduralists [technology for team communication]

- Transparent, open organizational culture

  … anyone can suggest interrupting or re-initiating VTE prophylaxis

- Structure for team discussion and team awareness

  … checklists and reminders in EHR

Results → Sociotechnical Design Considerations

1. Survey
2. Role network analysis
3. Cross-case analysis

(Miles, Huberman & Saldana, 2014)

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Cross-Case Analysis

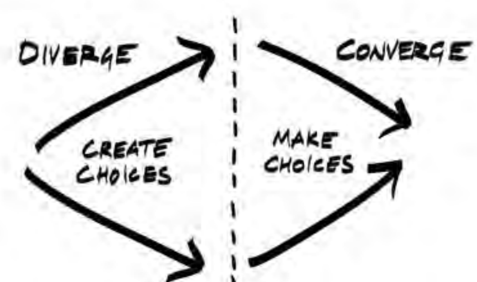
11 case reports: 11-25 pages each

1. Contextual information
2. Data on VTE process and outcomes [survey, observation]
3. Perceptions of and attitudes toward VTE prophylaxis [survey]
4. VTE prophylaxis across the hospital journey [role network analysis]
5. Roles in VTE prophylaxis [survey]
6. VTE-related team interaction during morning rounds [observation]
7. Perceived barriers to VTE prophylaxis [survey]
8. Possible solutions for VTE prophylaxis [survey]

Cross-case analysis table

[focus on interruption & re-initiation]

A	B	C
	GMC	GMC
	Critical Care Medicine	Hospitalist
Contextual information		
size -	24 beds	58 beds (on two units)
beds	5,548 annual admissions (2014)	4,314 annual admissions (including GSACH) (2014)
patients		
roles -	Att - 14	Att -35
Att	Fel -12	Fel - 0
Fel	Res - 12 (IM, Med-Peds)	Res - 3-4 (per team)
Res (incl. Int)	APPs - 12	APPs - 22
APPs (incl. PAs and NPs)	Nur - 131	Nur - 74 (on two units)
Nur (incl. RNs and LPNs)	RPh - 2	RPh - 1 (assigned to help teaching service)
RPh		
staffing	3 teams work on unit at one time. 4 PAs/NP at night mostly, work during day depending on resident #; RPh on unit during weekdays	AGPS (green hospitalist team) and BP7 (yellow hospitalist team) are two of serveral units with internal med patients
Observation-team interaction		
% pts with VTE interactions	64%	54%
roles-initiate, involve	initiated- primarily: pharmacist; a little: attending involved- primarily: pharmacist; a little: attending	initiated- primarily: attending; a little: intern and medical student



Perspectives:
- ✓ Contextual data
- ✓ Survey data
- ✓ Observation data
- ✓ Role networks
- ✓ Comparing CCM
- ✓ Comparing CCS
- ✓ Comparing hospitalist

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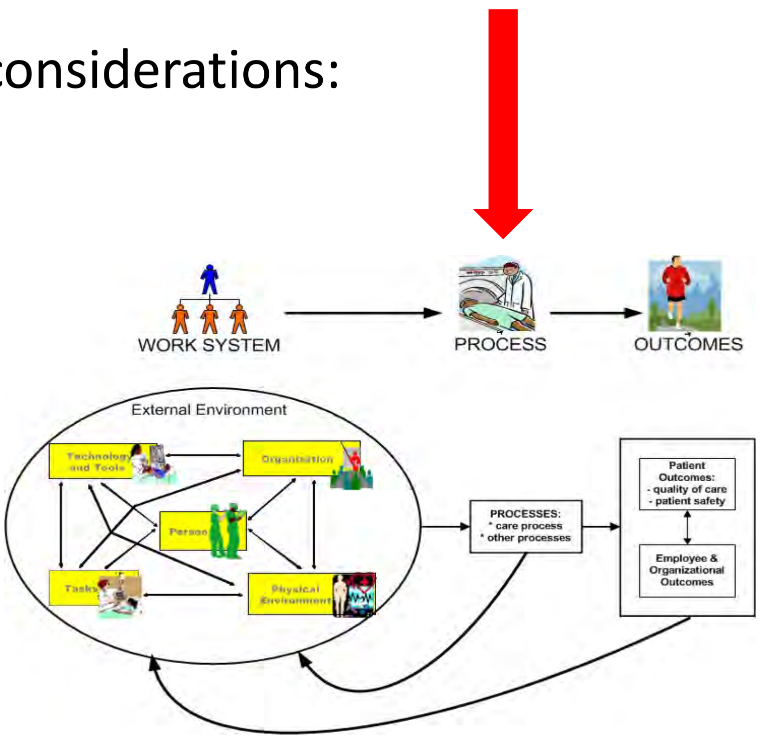

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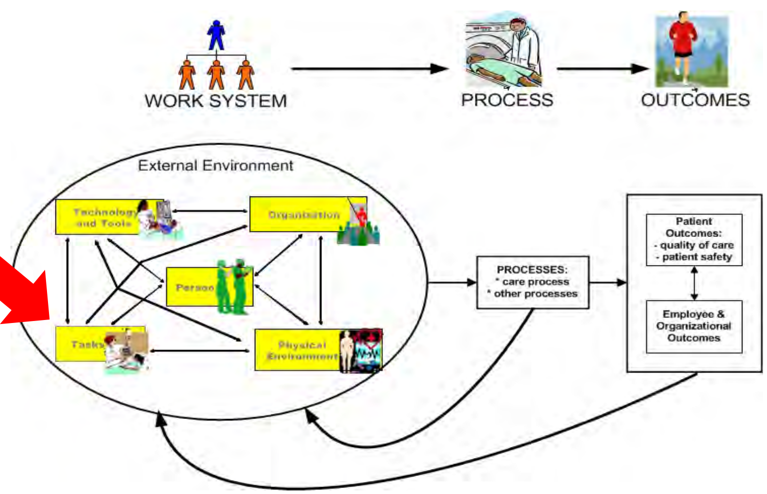

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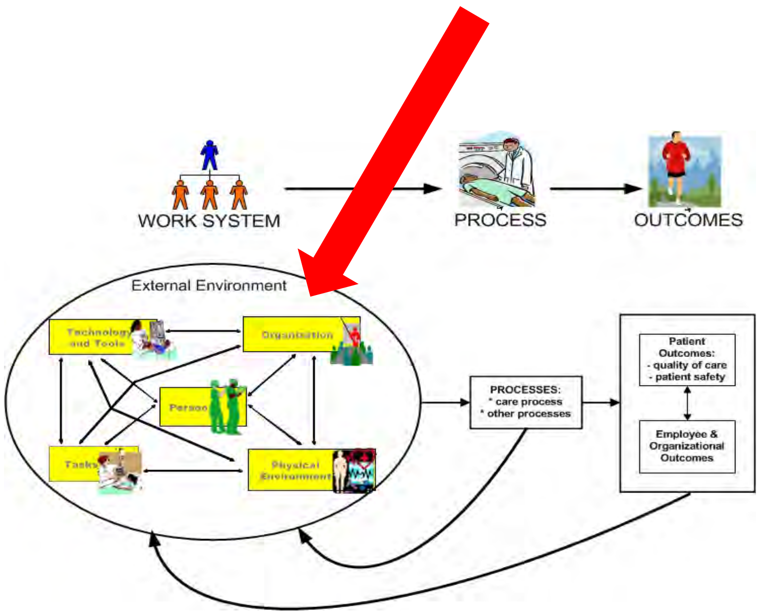

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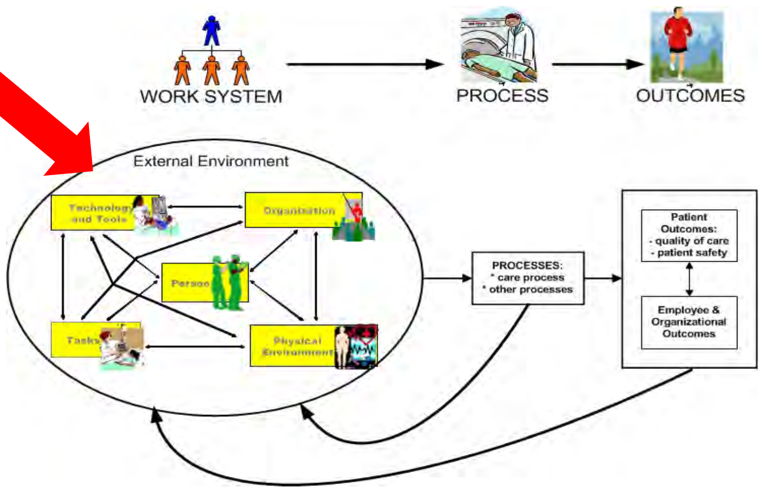

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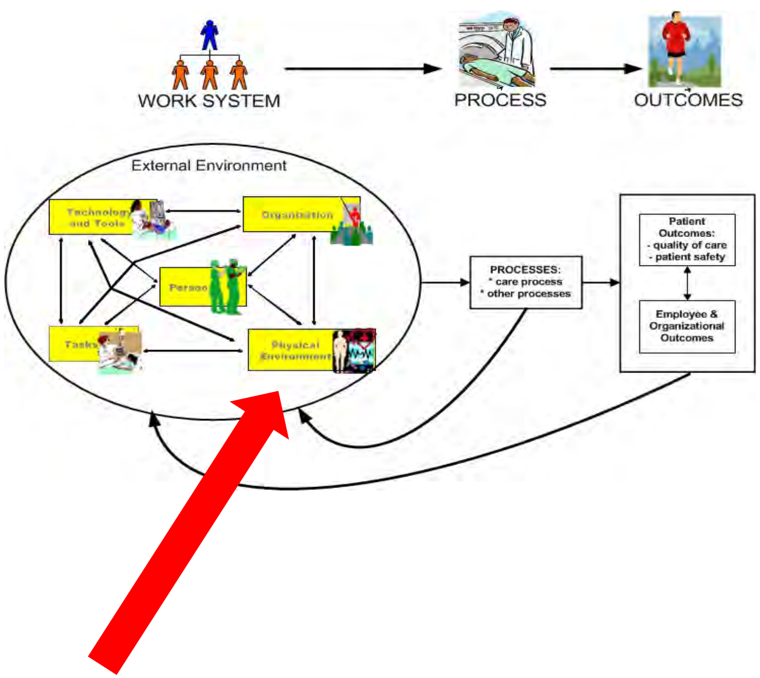

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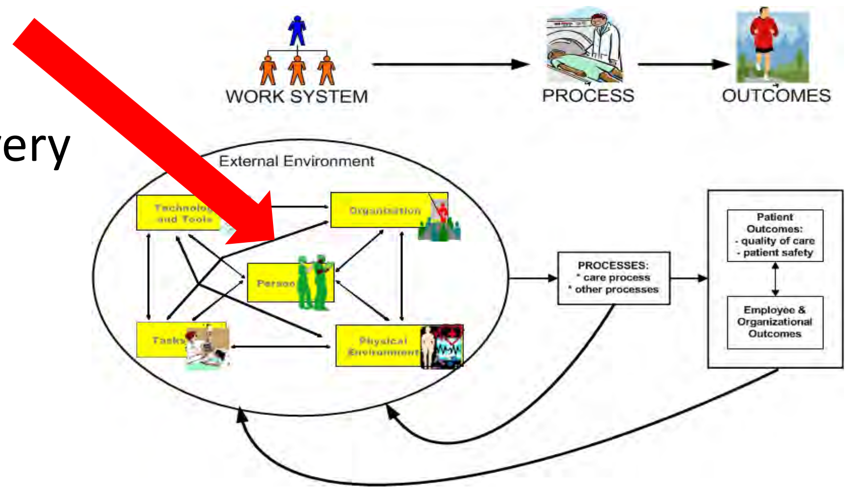

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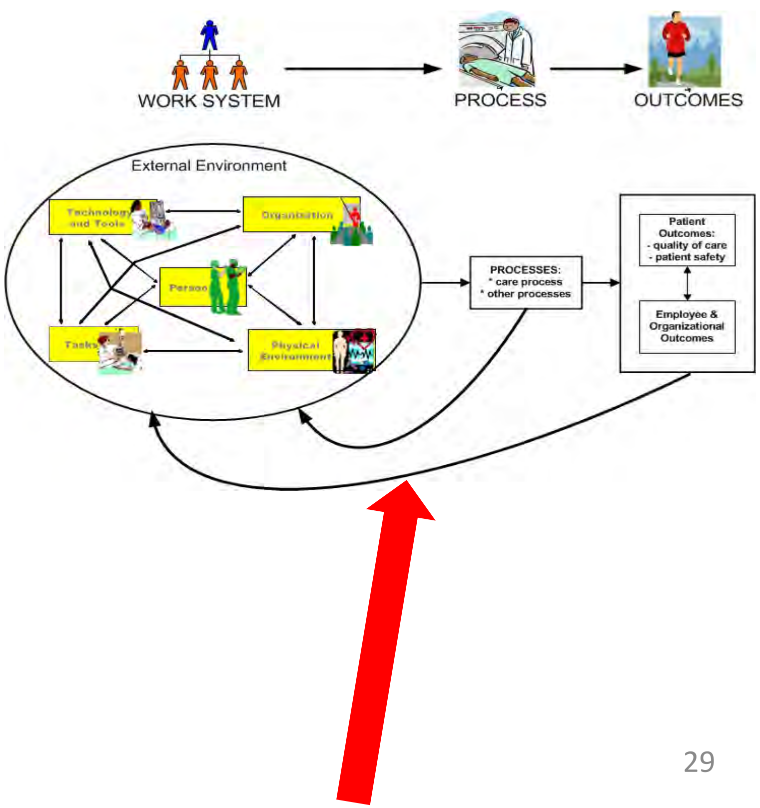

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Context matters!

Sociotechnical Design Considerations for Care Process

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- ✓ Sociotechnical system (SEIPS model)
- ✓ Participatory human-centered design
- ✓ Multidisciplinary
- ✓ Multiple contexts

Contact Information

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Quantifying EHR Usability To Improve Clinical WorKflow - QUICK

Funding support AHRQ R01 2012-2016

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CMO and EVP West Health
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Aim 1: Measure and compare EMR use patterns.

- EMR usability must be expressed in operational terms to guide objective comparisons.

- We propose to measure and compare clinicians' use of EMRs during outpatient visits, based on video recordings, EMR screen capture, and EMR mouse-click and key-click data.

Aim 2: Measure and compare clinical workflow and clinician-patient communication.

- During the limited timeframe of an outpatient visit, clinicians multitask between EMR work and interaction with patients.
- The complexity of the clinical workflow is not directly observable from EMR alone, yet must be taken into account to make meaningful comparisons across visits.
- We propose to measure clinician workflow and clinician-patient verbal communication, based on video recording of visits and coded to a discrete set of behaviors.

Aim 3: Measure satisfaction and cognitive load.

During clinical encounters, clinicians manage multiple needs that impose an administrative and cognitive burden. Therefore, we will measure cognitive burden via the NASA Task Load Index (NASA-TLX), a validated and widely used tool that enables subjective assessments of the workloads associated with those interacting with human-machine systems.

Aim 4: Explore associations between aims 1, 2, and 3.

- To understand real-world EMR usability, we will explore associations between EMR usage, workflow, communication, user satisfaction, and cognitive load.

- Additionally, separate analyses will also be conducted to study the effect of sites (UCSD and VA), clinician types (Primary and Specialty), and EHRs (CPRS and EPIC) on usability and workflow.

Site comparison in terms of care delivery model, staff support, and EHR features.

Factor	UCSD	VASD
Patient study population	Balanced male/female patient demographics	Predominantly male patients
Scheduled visit lengths	20/40 min visits (Follow up/New patient visit)	30/60 min visits (Follow up/New patient visit)
EHR	EpicCare Ambulatory	CPRS (Computerized Patient Record System using VistA back-end)
EHR features, and configuration	• Typically single monitor, but 9 doctors use the dual window • More levels of menus, objects and paths • Associations (Dx to Rx) (no CPRS counterpart) • Non-blocking split screen (used by ~1/2 physicians) • Real time Care coordination - Patient instructions filled in → printed out (often Nurse out of room sees change in real-time visit status "scheduling") • Epic access logs to profile pre/post work • Epic logs to profile patient complexity • Voice recognition used only 2 visits) • Dual windows allows e.g., working in Notes without blocking other functions • Scheduling • Web links available in Haiku and Canto apps • History documentation interface is structured	• Dual monitor present in ~35% of visits • CPRS functions (Notes, Orders etc.) takes up full screen, blocking other functions (even on dual monitor PCs) • Associations for Consults and Imaging but not Dx • Real time Care coordination (patient status) not in CPRS but available elsewhere • Computerized clinical reminder work • Order imaging has more mouse clicks • No separate history documentation UI – only notes

Recruitment by site and specialty groupings

	UCSD	VASD	Total
Primary	8/63 (physicians/patients)	9/64	17/127
Specialty*	7/53	8/43	16/96
Total	15/116	17/107	32/223

- Specialties included gastroenterology, pulmonology, cardiology, rheumatology, nephrology.

Visit process data

Primary Instruments

Secondary Instruments

Room Video

- Nonverbal + clinical workflow
- Vocalization + verbal activity

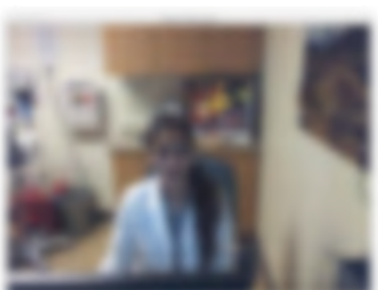
Usability Software

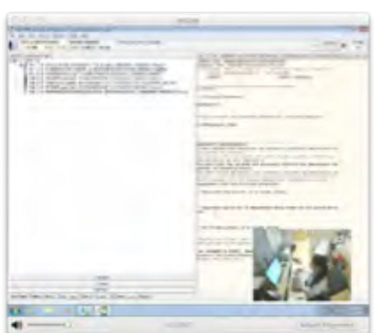
- Mouse + keyboard activity
- EHR screen recording

Sensor data restricted to window of the visit

Body tracking

Eyetracking





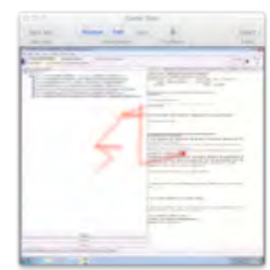
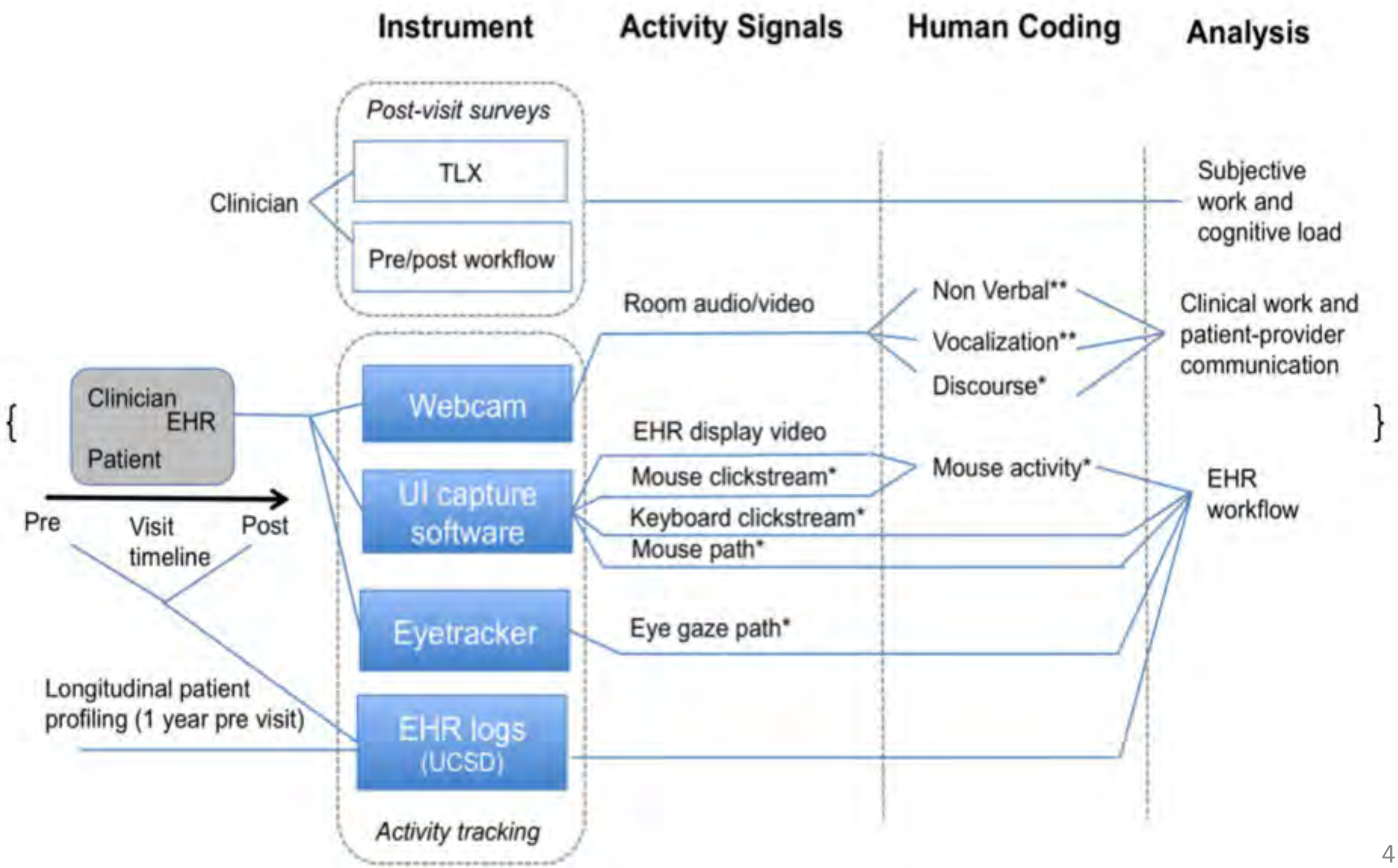


Figure 1: Visit activity



Summary of data coding quality in terms of intercoder agreement across dual-coded visits.

Summary of data coding quality in terms of intercoder agreement across dual-coded visits.

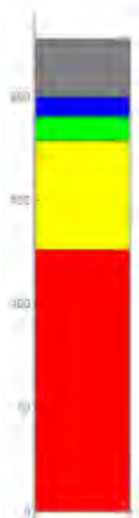
Measure	Sample size (visits)	Intercoder agreement	
		Method	Agreement: (Median, IQR)
EHR CPRS (Aim 1)	n = 15 (15 VASD)	Sequential Tab-level comparison	0.98 (0.97–1.0)
EHR Epic (Aim 1)	n = 11 (11 UCSD)	Sequential CPRS-equivalent Tab-level comparison	0.92 (0.69–0.94)
NonVerbal (Aim 2)	n = 21	Time-resolved comparison	0.94 (0.86–0.95)
Vocalization (Aim 2)	n = 7	Time-resolved comparison	0.64 (0.56–0.7)
		Averaged sum of speaker time comparison	0.96 (0.88, 0.99)

Comparison of EHR function activity between the two sites based on mouse clicks and timing based on physicians' gaze-to-EHR.

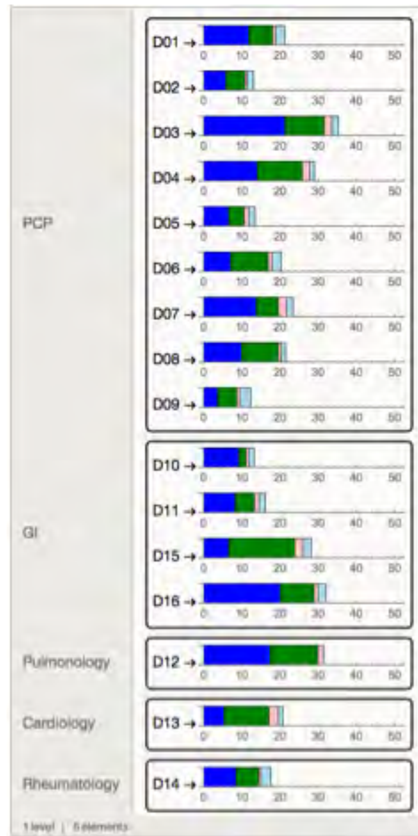
CPRS (VASD) n = 89 (16668 mouse clicks)			Common and frequent tabs in CPRS and epic	Epic (UCSD) n = 106 (8280 mouse clicks)		
(*) CPRS "Other" Tabs:	Timing (min)	Count		Timing (min)	Count	(*) Epic "Other" Tabs:
Consults, Cover, Discharge, Patient Selection, Problems, Review/Sign, Surgery, Unidentified	578 (58%)	8300 (50%)	Notes	311 (41%)	1842 (21%)	Association, Cover, Patient Selection, Problems, Review/Sign, Surgery, Ambiguous or Unidentified
	198 (20%)	4547 (27%)	Orders	117 (16%)	1960 (23%)	
	55 (5%)	1084 (7%)	Labs	41 (5%)	639 (7%)	
	43 (4%)	666 (4%)	Meds	20 (3%)	274 (3%)	
	24 (2%)	403 (2%)	Reports	64 (9%)	693 (8%)	
	107 (1%)	1668 (10%)	Other*	195 (26%)	3272 (38%)	

EHR Activity + NonVerbal Gaze / Visit

→ Notes
→ Orders
→ Labs
→ Meds
→ Unidentified



unid actually group of 9 CPRS tabs



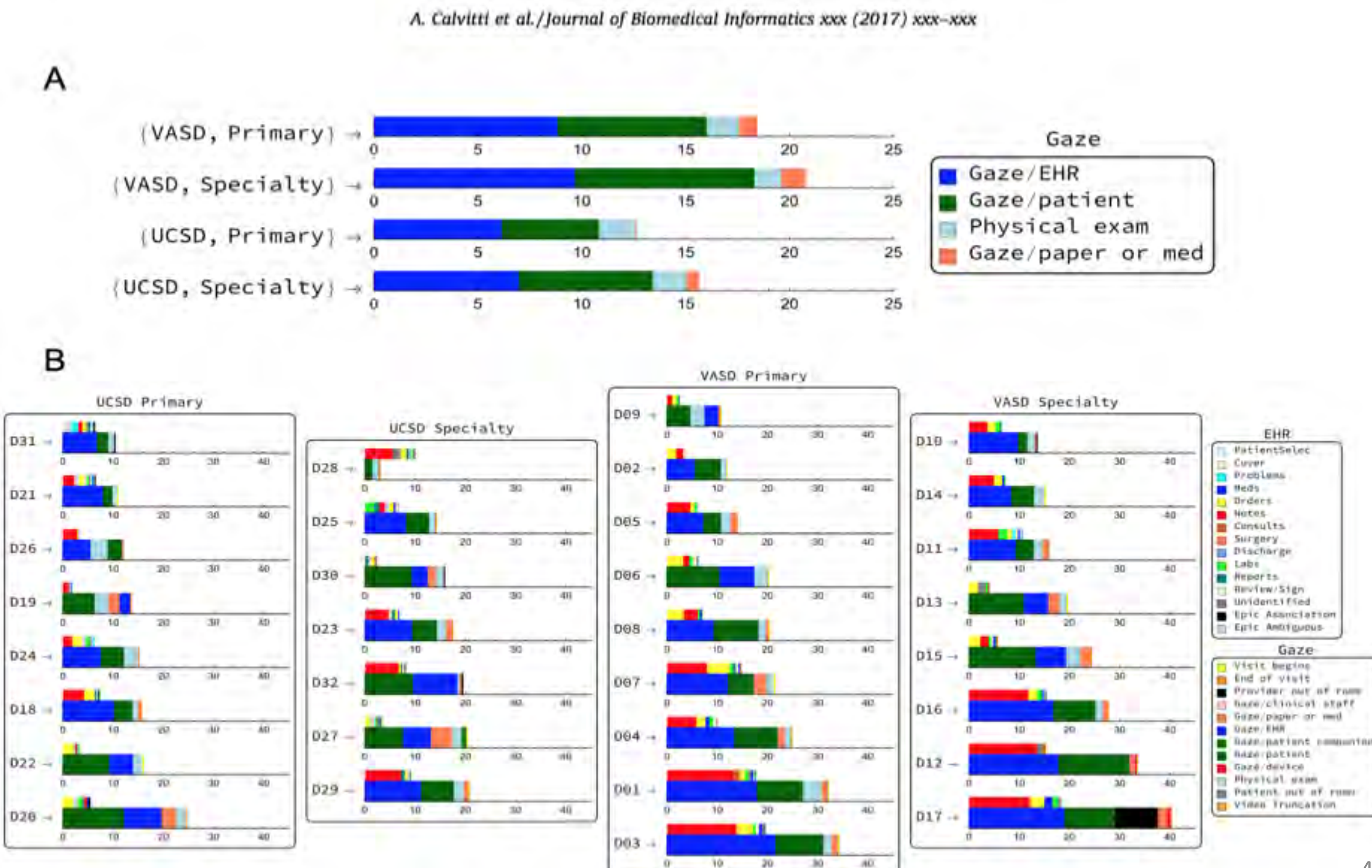
→ Gaze to EHR
→ Gaze to patient
→ Gaze to clinical staff
→ Physical exam

not all behaviors are considered here, will add up to less than 100% of visit duration

Comparison of CPOE frequency, time-at-task per order and EHR UI burden as measured by numbers of clicks/order

	UCSD			VASD		
Order type	Orders (n = 106 visits)	Timing median (IQR) seconds	Mouse clicks median (IQR)	Orders (n = 89 visits)	Timing median (IQR) seconds	Mouse clicks median (IQR)
Consult	27 (25%)	49 (29, 75)	11 (8, 15)	44 (49%)	52 (36, 82)	16 (11, 24)
Imaging	22 (21%)	47 (28, 86)	8 (6, 11)	20 (22%)	43 (28, 70)	12 (6, 17)
Lab	32 (30%)	12 (6, 28)	4 (3, 6)	44 (49%)	12 (7, 19)	5 (3, 7)
Med	54 (51%)	38 (24, 78)	10 (6, 13)	54 (61%)	26 (18, 47)	9 (7, 12)
Other	5 (5%)	3 (25, 93)	6 (5, 8)	6 (7%)	6 (8, 32)	4 (4, 14)
Reminder*	5 (5%)	9 (6, 11)	5 (4, 6)	33 (37%)	19 (14, 32)	5 (4, 7)
Return to Clinic	58 (55%)	12 (7, 30)	3 (2, 4)	37 (42%)	25 (16, 47)	9 (8, 14)

Figure 4



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A
(VASD, Primary)
(VASD, Specialty)
(UCSD, Primary)
(UCSD, Specialty)
0 5 10 15 20 25
Gaze
Gaze/EHR
Gaze/patient
Physical exam
Gaze/paper or med
B
UCSD Primary
D31
D21
D26
D19
D24
D18
D22
D20
UCSD Specialty
D28
D25
D30
D23
D32
D27
D29
VASD Primary
D09
D02
D05
D06
D08
D07
D04
D01
D03
VASD Specialty
D10
D14
D11
D13
D15
D16
D12
D17
0 10 20 30 40
EHR
PatientSelec
Cover
Problems
Meds
Orders
Notes
Consults
Surgery
Discharge
Labs
Reports
Review/Sign
Unidentified
Epic Association
Epic Ambiguous
Gaze
Visit begins
End of visit
Provider out of room
Gaze/clinical staff
Gaze/paper or med
Gaze/EHR
Gaze/patient companion
Gaze/patient
Gaze/device
Physical exam
Patient out of room
Video truncation

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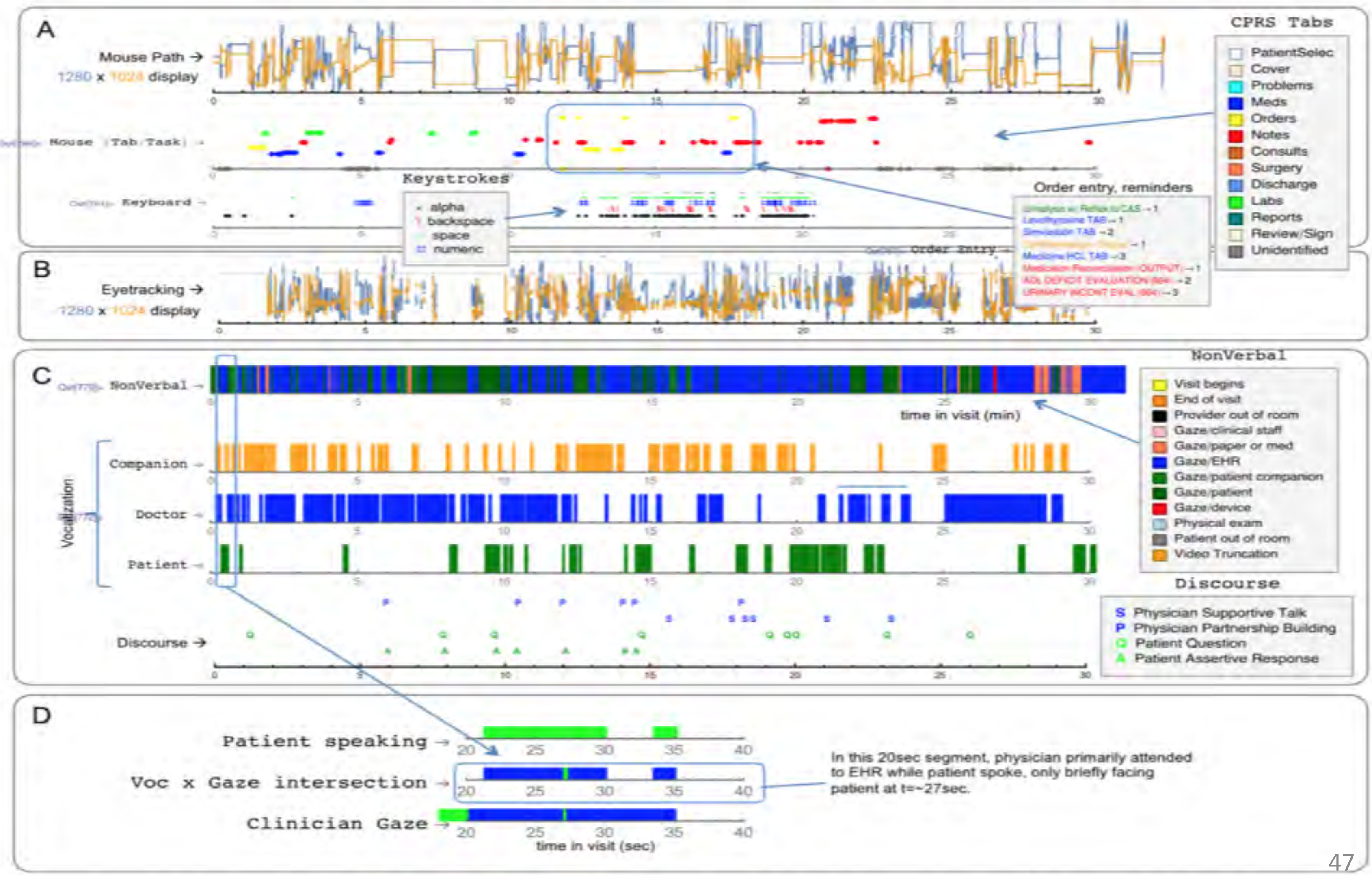

Distribution of navigation across EHR functions. Tab-level transitions based on mouse clicks tagged to the top-level screen or "Tab" coding.

	Study pop.	By site		By specialty		By status	
	n = 195 (100%)	UCSD 106 (54%)	VASD 89 (46%)	Primary 113 (58%)	Specialist 82 (42%)	New 41 (21%)	Established154 (79%)
Tab-level transitions (count)	16 (9,27) (median, IQR)	22 (13,34)	12 (8,22)	21 (11,32)	14 (8,22)	15 (10,26)	17 (9,29)

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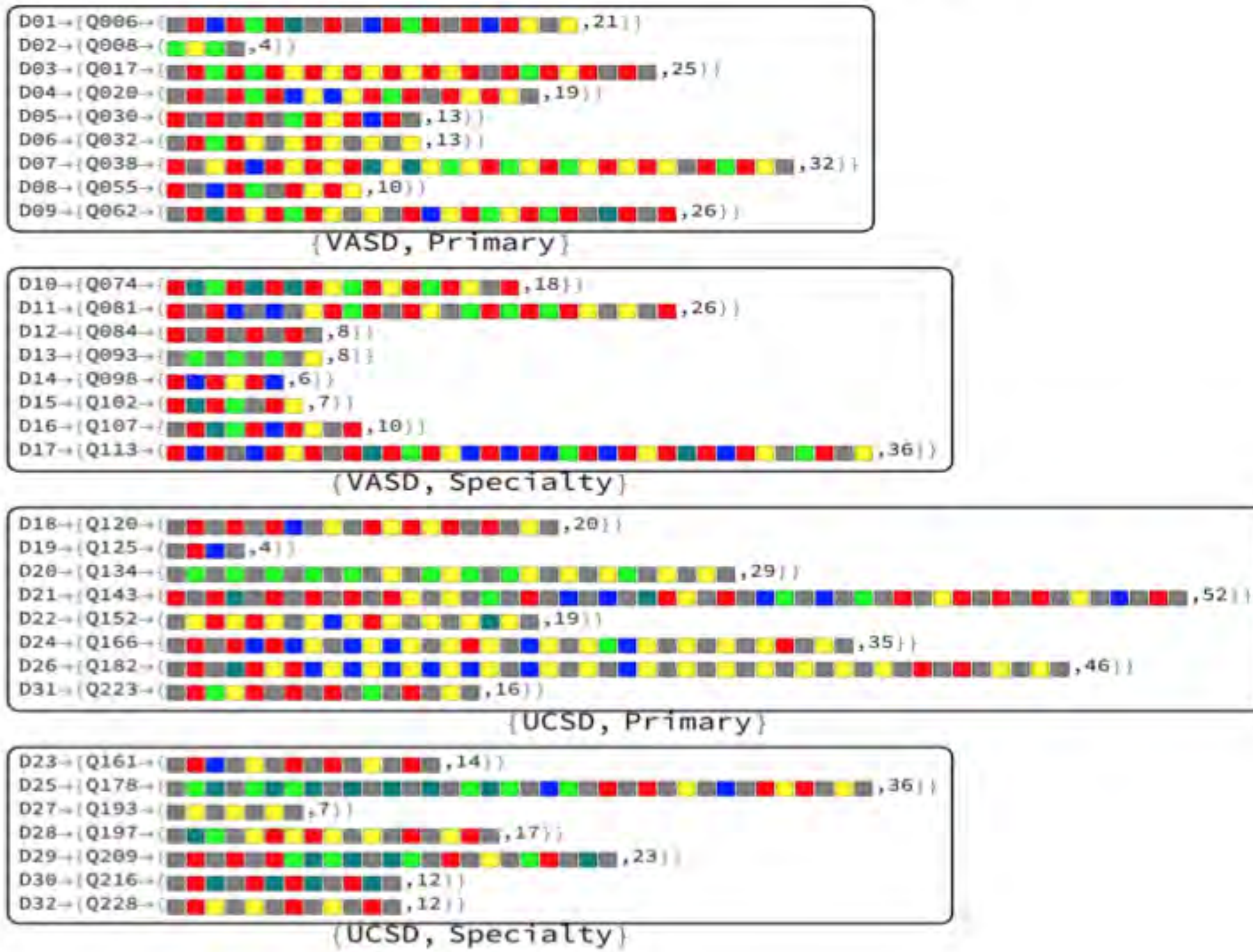
EHR Navigation patterns for one randomly selected visit for each study physician, based on mouse click activity human-coded to top-level Tab or EHR screen.

Each colored square represents a transition between major EHR functions or "Tabs" (e.g., Notes ? Orders).

The number of Tab transitions is shown to the right of each navigation sequence.



Cognitive load ratings and rank orders - NASA TLX

Activity measure	Subjective workload (TLX subscale)	Sample size (physicians)	Physician-aggregated correlation Spearman rho: median, (IQR)	Rank (based on median)
Visit Length (minutes)	Effort (5-item)	n = 32 (100%)	0.49 (0.12, 0.67)	1
EHR Tab (screen) transitions (count)	NegPerformance (2-item)	n = 29 (91%)	0.42 (−0.36, 0.63)	2
EHR Tab (screen) transitions (count)	Effort	n = 29 (91%)	0.38 (0.14, 0.61)	3
Epic Log Size (count)	Effort	n = 16 (50%) UCSD	0.35 (0.24, 0.52)	4
EHR Mouse Clicks (count)	Effort	n = 32 (100%)	0.32 (0.03, 0.6)	5
Gaze Dominance (ratio)	Effort	n = 32 (100%)	0.28 (−0.07, 0.58)	6
Charlson Comorbidity Index (raw)*	Effort	n = 24 (75%)	0.27 (−0.29, 0.54)	7
Charlson Comorbidity Index (raw)*	NegPerformance	n = 25 (78%)	0.26 (−0.23, 0.47)	8
EHR Mouse Path Length (pixels)	Effort	n = 32 (100%)	0.23 (−0.06, 0.56)	9
Verbal Patient Concerns (count)	NegPerformance	n = 25 (78%)	0.21 (−0.22, 0.32)	10
EHR Keystrokes (count)	Effort	n = 31 (97%)	0.20 (−0.07, 0.49)	11

Gender in NASA TLX

Question	Male	Female	P-value
Mental demand	9.5	4.5	<0.001
Physical demand	10.5	4	<0.001
Time pressure	9	7	0.022
Successful in EHR	18	15.5	0.045
Both mental and physical	11	9	0.024
Stress level	5	5.5	0.78
Satisfied with interaction	15	15.4	0.61

Bonferroni adjustment $p<0.007$ indicates statistical significance.

Correlation of CPOE activity and effort rating on TLX

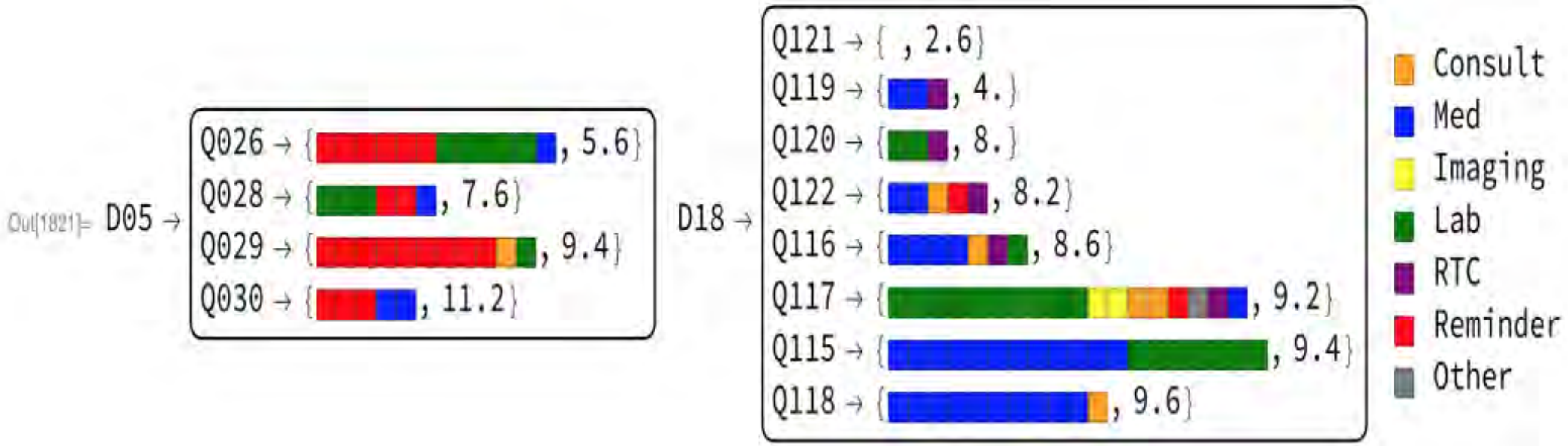


Figure 5

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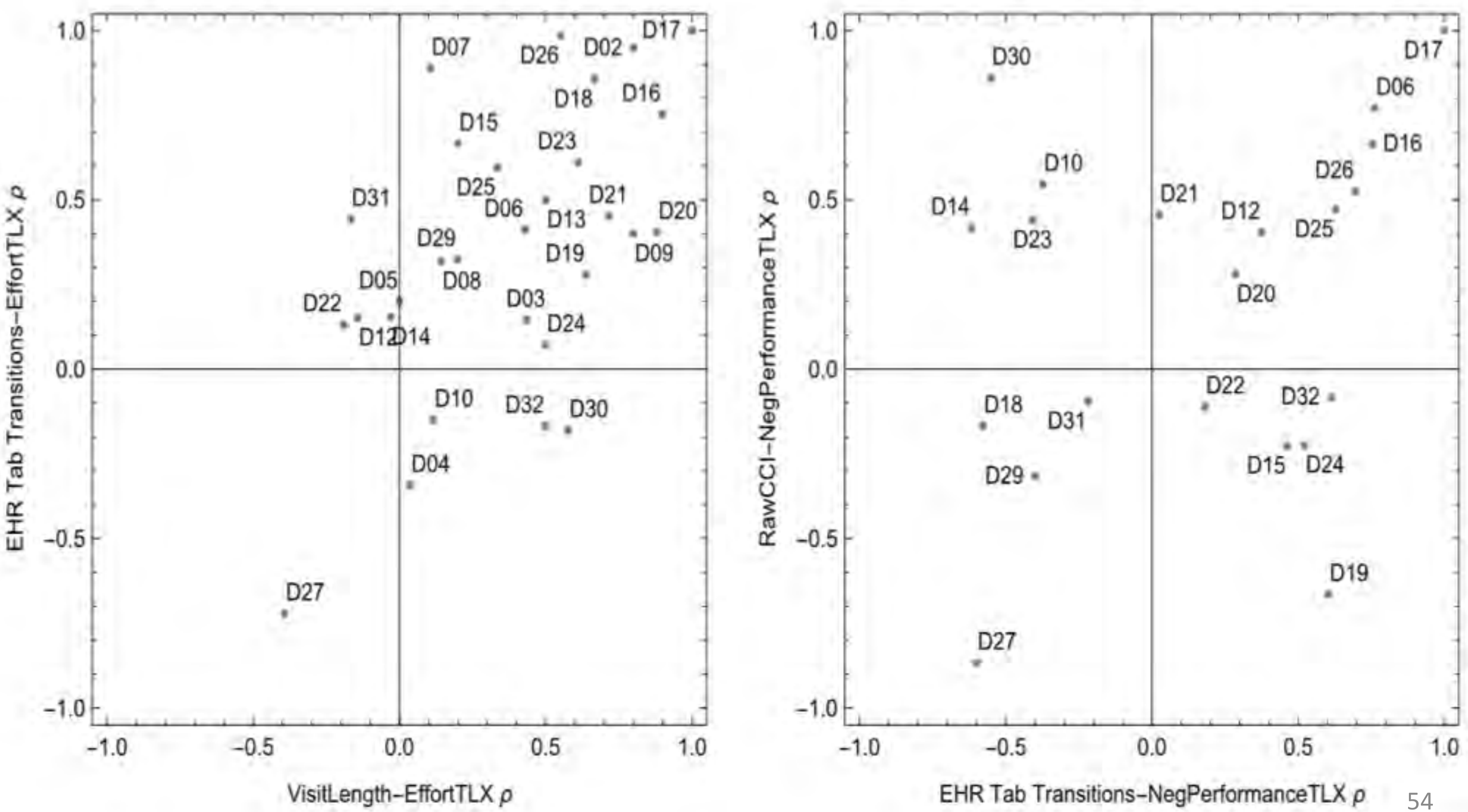

Summary

We demonstrated a novel approach to collecting and analyzing multiple sources of data during clinical activities and integrated these streams into meaningful measures, enabling comparison across two clinical settings with different EHRs and a spectrum of primary and specialty (outpatient) care.

This effort revealed a high degree of variation in observed activity and clinical practice despite accounting for similar types of visits and patient complexity.

We identified similar patterns of EHR use and navigation at the 2 sites despite differences in functions, user interface, and consequent coded representation.

Both sites displayed remarkably high burden (frequency and time at task) to attended to EHRs along with high subjective workload as measured by NASA Task Load survey.

Summary

Commonly noted high-level clinical tasks, such as medication reconciliation or preventive care were highly distributed across the visits and very difficult to measure, suggesting the need for further levels of integration.

Preliminary workload analyses suggested a complex relationship between levels of measurable physicians’ activity during visits and perceptions of effort and task performance.

As no single visit activity factor was highly correlated with subjective task load, a fuller understanding of the workflow and cognitive flow will require integration of qualitative data, e.g., physician interviews.

QUICK Team

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Reducing Provider Burden through Better Health IT Design – Part 3

Providers' Interaction with EHRs

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Acknowledgment

- **Federal Project Officer:** Steve Bernstein, AHRQ, CEPI, Division of Health IT

- **Grant Number:** R21HS024062
- **Co-PI:** Carlton Moore MD, Lawrence Marks, MD
- **Investigator:** Prithima Mosaly, PhD
- **UNC Epic consultant:** Amy Coghill, MSN, RN, OCN

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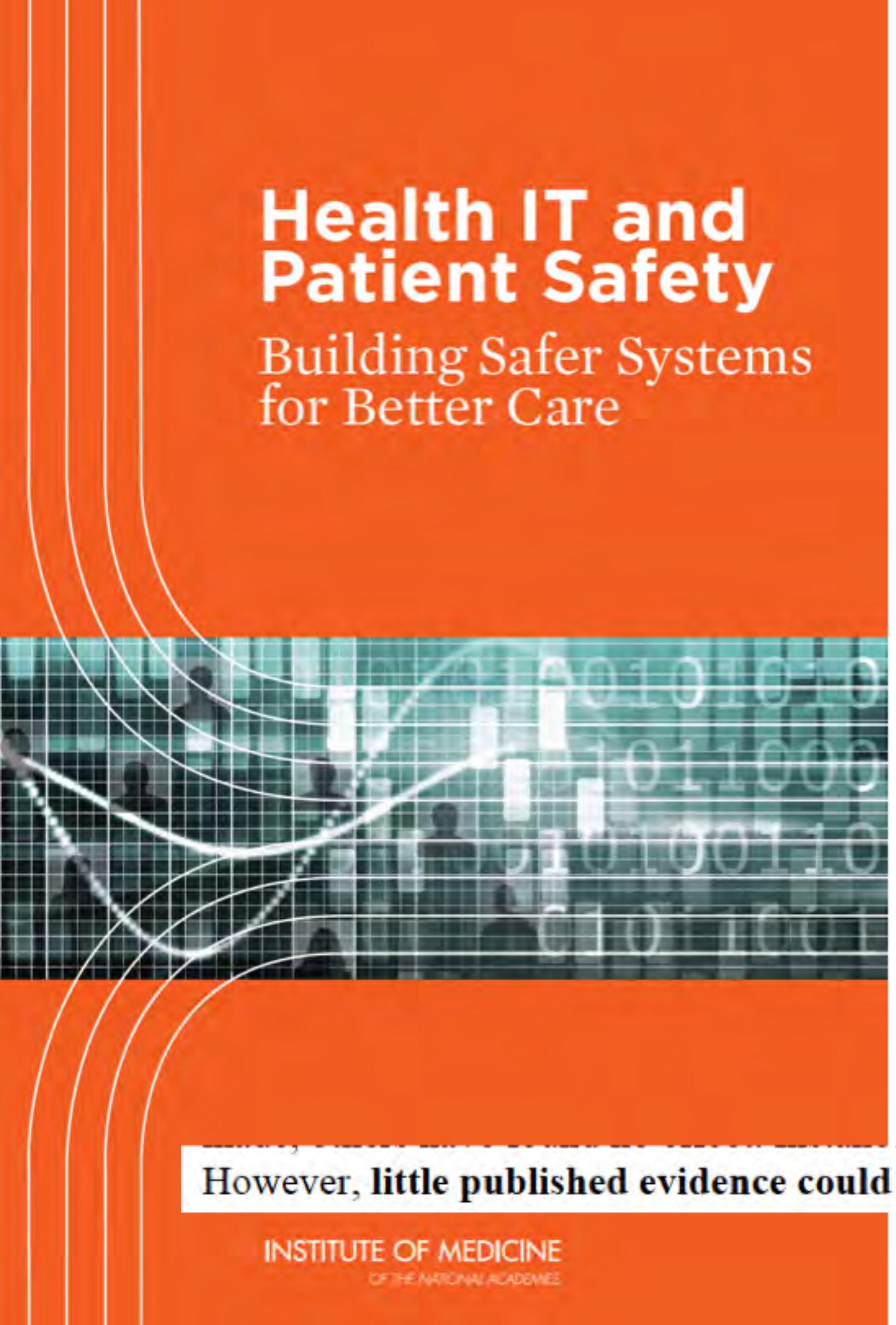


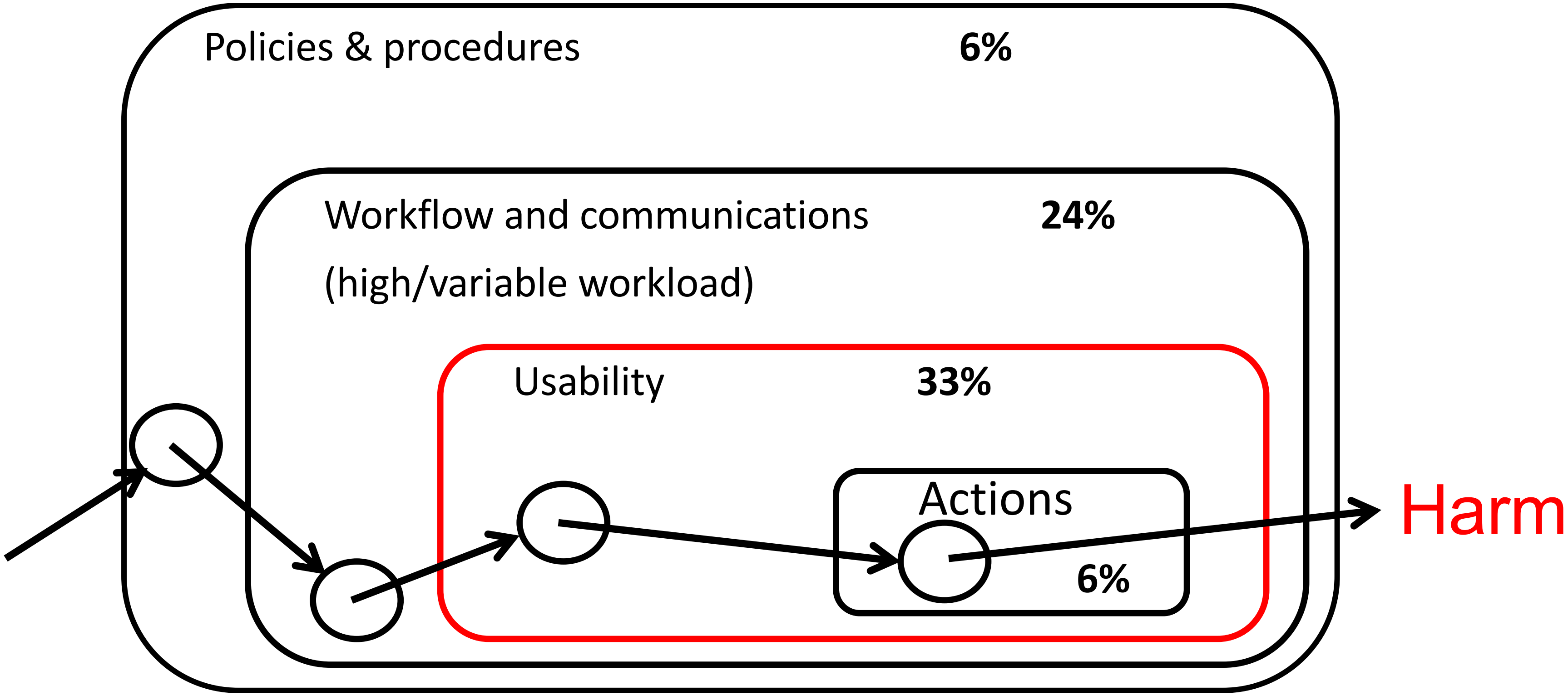
- Health IT <u>can</u> improve patient safety and quality of care and should be widely embraced (Bates 2003; Ash 2009).

- For example, Hill (2013) found that providers seeing (on average per hour) 2.4 patients require about 4,000 mouse-clicks in EHRs during a 10-hour shift.

- Reports focused on EHR-related medical malpractice identified over 80% of the reported events involve patient harm (Garber 2015).

However, **little published evidence could be found quantifying the magnitude of the risk.**

The Joint Commission Report on EHR-related errors (n=120)



A complimentary publication of The Joint Commission
Issue 54, March 31, 2015

Specific Aims

To **quantify** the effect of:

- EMR environment (baseline/enhanced)
- Volume (low/high) of abnormal test results

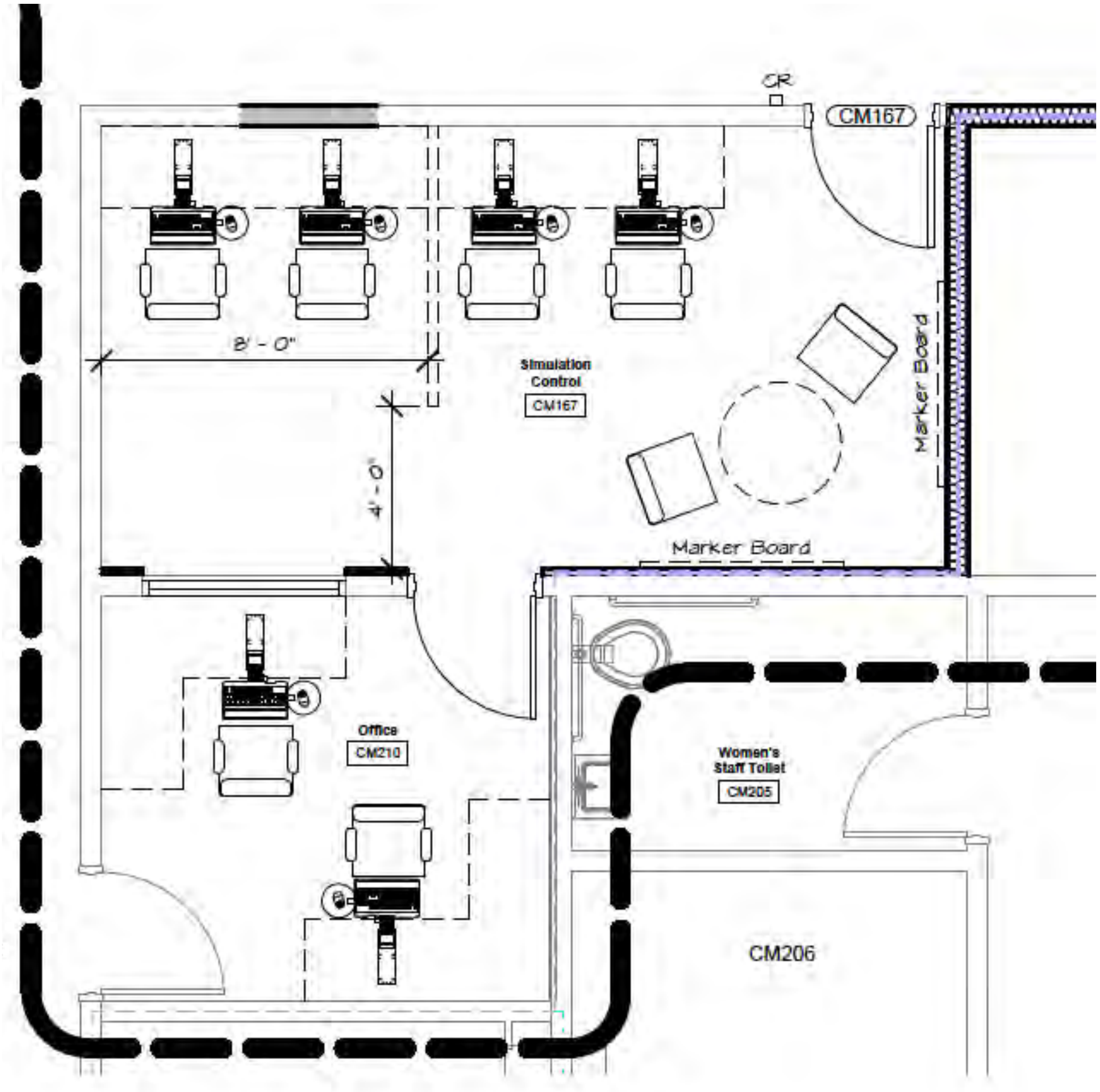
on providers' experienced task demands, workload, and performance.

Our focus was on follow-up of abnormal test results, and the baseline and enhanced EMR environment used for the study was Epic®.

Background and Significance

- Clinicians fail to acknowledge <u>**over one-third**</u> of the EHR alerts for critically abnormal imaging studies (Singh 2007).
- Even when providers acknowledge abnormal results, **<u>7-10%</u> of patients still do not receive timely follow-up** (Singh 2009; Hysong 2010, 2011).
- The likelihood for lack of timely follow-up <u>**doubles**</u> with dual-alert communication in which providers receive abnormal results for other providers’ patients (Zapka 2010).

Human Factors Laboratory



- VisionTrack ISCAN
- Tobii X-60
- SMI glasses
- BrainVision
- ABM EEG
- NeXus

- Epic Playground
- Mosaiq
- PLUNC
- Elekta Emulator

- Computers
- Printers
- Phones

Study Participants

Total of **38 residents** from the school of medicine at one large academic institution participated in this study, all with sufficient experience with EHR (Epic) as related to our simulated scenarios

Specialty	# of Participants	Post Graduate Year (PGY) PGY: count	Gender F: female; M: Male
Internal Medicine	14	1:4 2:2 3:5 4:3	F:9 M:5
Family Medicine	4	1:1 2:1 3:1 4:1	F:2 M:2
Pediatrics	9	1:3 2:2 3:4 4:0	F:7 M:2
Surgery (general, neuro, ortho, head & neck)	5	1:1 2:2 3:0 4:1 5:1	F:3 M:2
Other (cardiology, psychiatry, critical care, ob/gyn)	6	1:1 2:1 3:1 4:2 5:1	F:3 M:3
Total	**38**	**1:10** **2:08** **3:11** **4:06** **5:03**	**F:24** **M:14**

Study Design

Session 1:
Current Epic Environment

Session 2:
Current (n=20) vs. Enhanced (n=18) Epic Environment

Providers (n=38)

Randomize

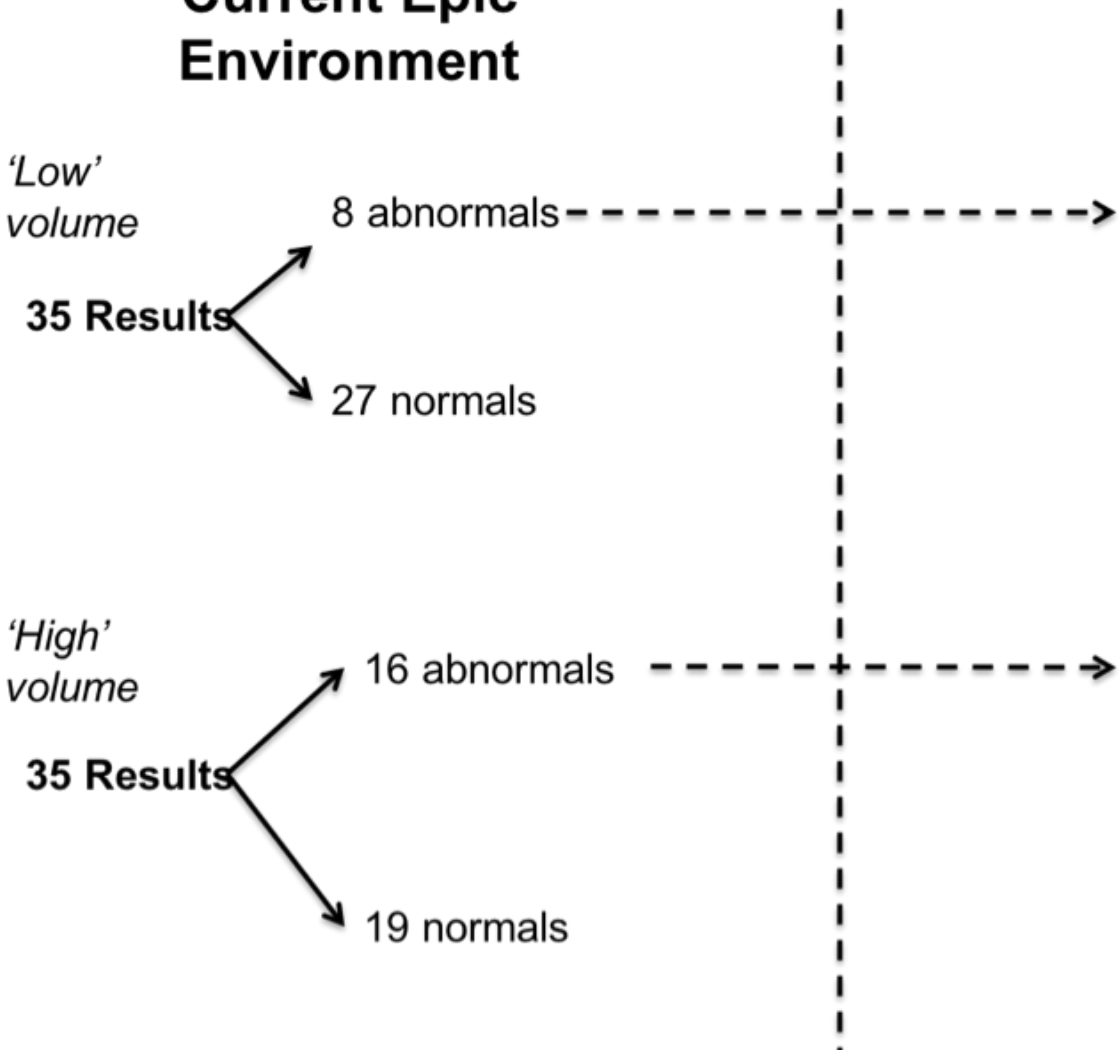
Recognition of Abnormal Results

Recognition of Abnormal Results

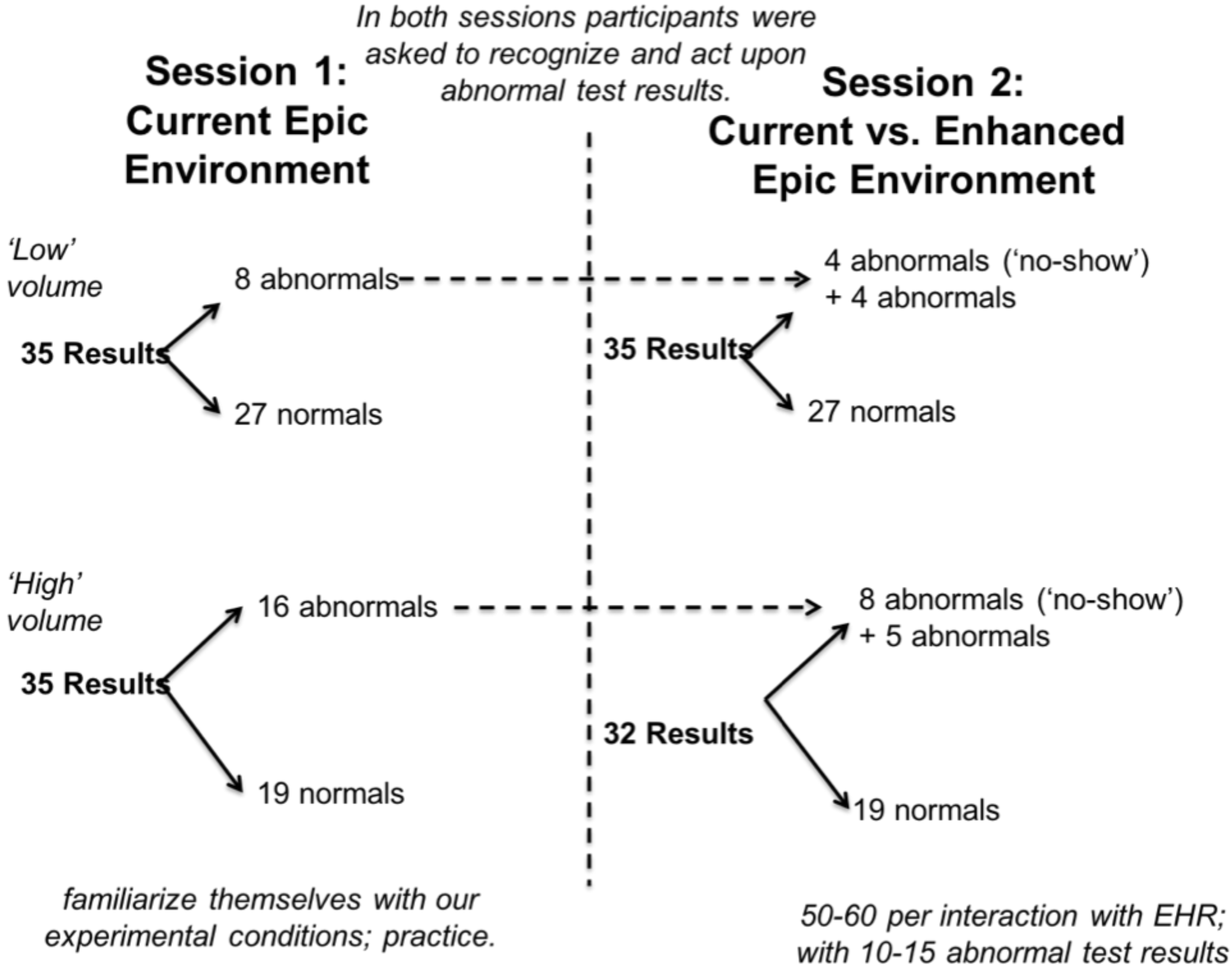
Track & Follow-up on Planned Diagnostic Evaluation

Low vs. High volume of abnormal test results

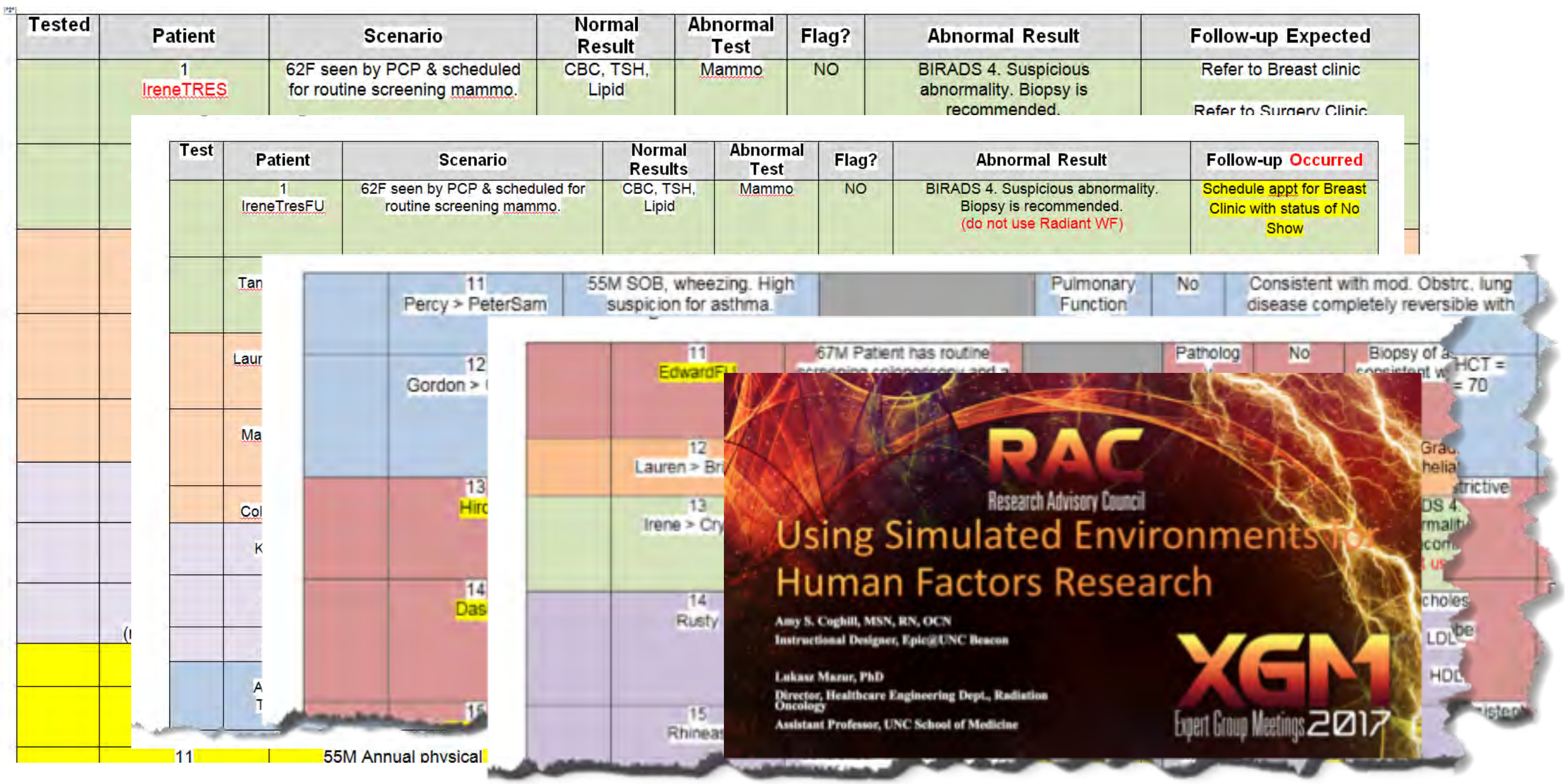
Session 1: Current Epic Environment



familiarize themselves with our experimental conditions and practice the simulated scenarios.

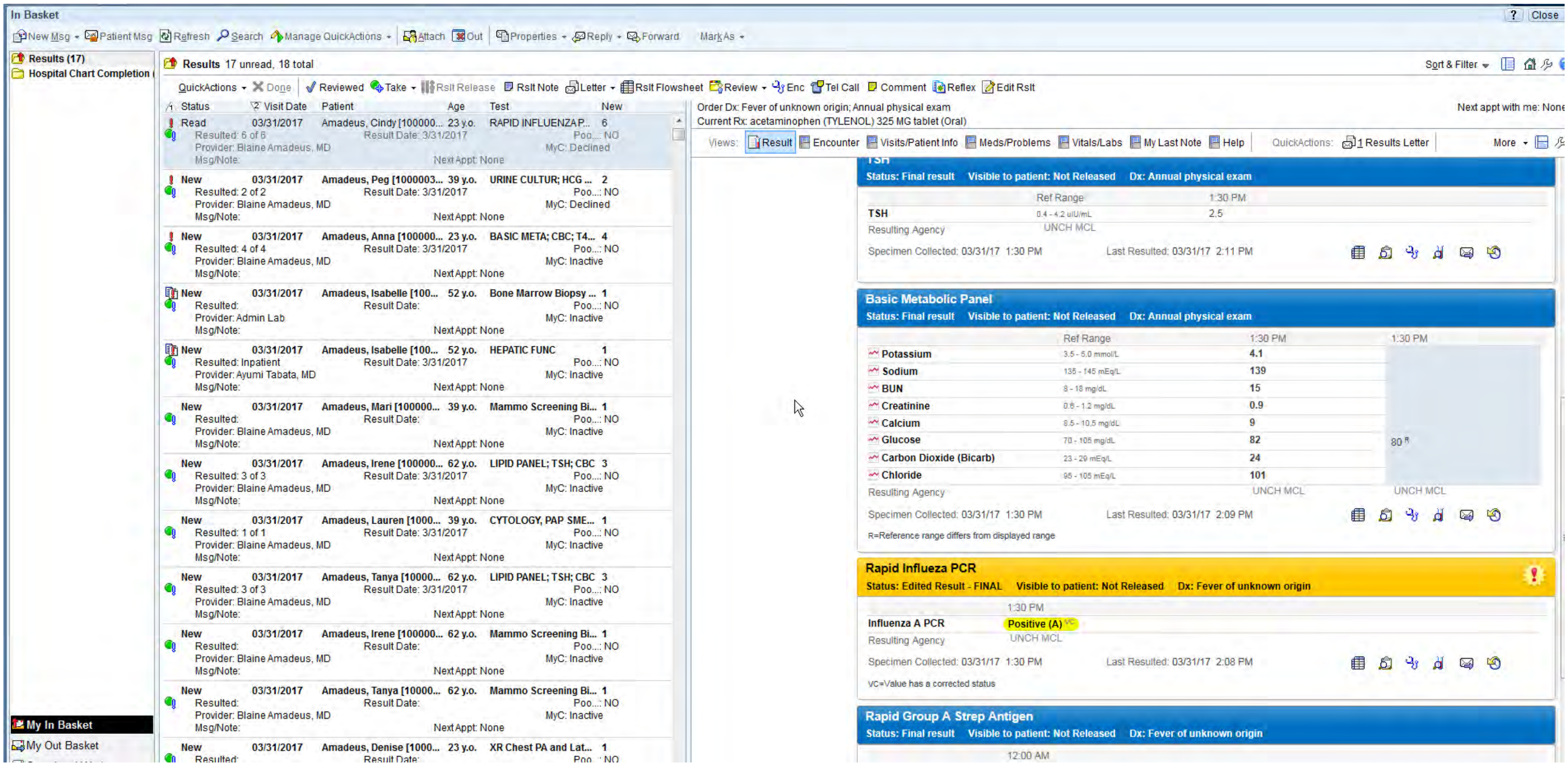

In both sessions participants were asked to recognize and act upon abnormal test results.
Session 1: Current Epic Environment
Session 2: Current vs. Enhanced Epic Environment
'Low' volume
35 Results
8 abnormals
27 normals
35 Results
4 abnormals ('no-show') + 4 abnormals
27 normals
'High' volume
35 Results
16 abnormals
19 normals
32 Results
8 abnormals ('no-show') + 5 abnormals
19 normals
familiarize themselves with our experimental conditions; practice.
50-60 per interaction with EHR; with 10-15 abnormal test results

Planning Sheets

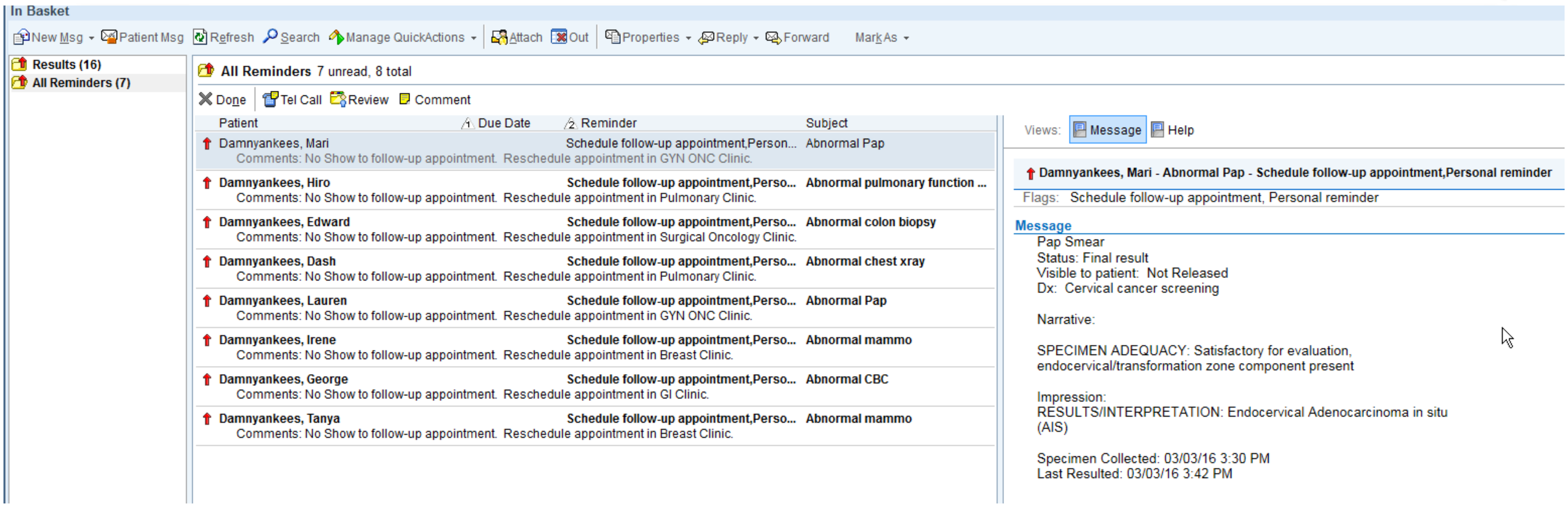


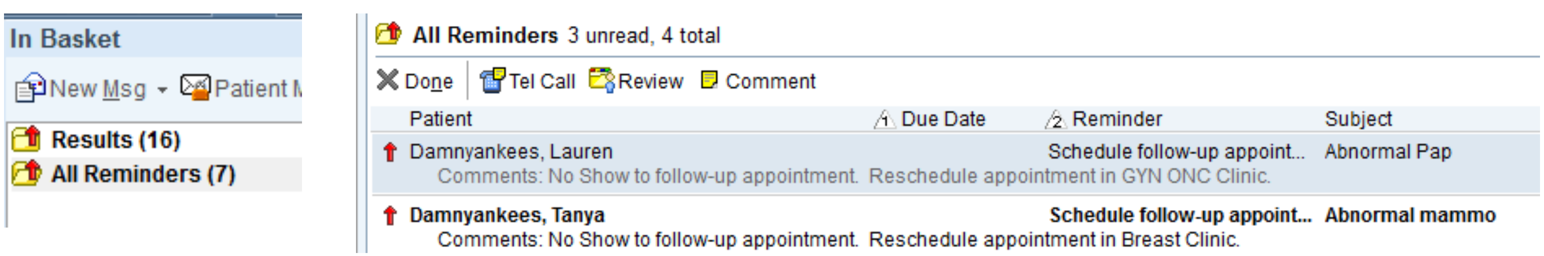
75 master patients; 12 reserved provider logins; 175 hours to plan, build, test **(about 5 weeks)**

Current Epic Design



Enhanced Epic Design





Singh H, Spitzmueller C, Petersen NJ, et al. Primary care practitioners' views on test result management in EHR-enabled health systems: a national survey. J Am Med Inform Assoc 2013;20:727-735.

Data Collection

Experienced task demands:

- navigation clicks (e.g., moving from one window to another window on the screen, etc.),
- decision clicks (e.g., accepting/cancelling a test or medication, etc.),
- search clicks (e.g., initiating the search option for medications/orders/etc.),
- total clicks (sum of navigation, decision, and search clicks).

Data Collection

Quantification of perceived workload

- NASA-Task Load Index (NASA-TLX), a widely applied and valid tool, was used to measure perceived workload.

(PAIR-WISE COMPARISON) Rate the most important component of the load for the task

Effort Or Performance	Temporal Demand Or Frustration
Temporal Demand Or Effort	Physical Demand Or Frustration
Performance Or Frustration	Physical Demand Or Temporal Demand
Physical Demand Or Performance	Temporal Demand Or Mental Demand
Frustration Or Effort	Performance Or Mental Demand
Performance Or Temporal Demand	Mental Demand Or Effort
Mental Demand Or Physical Demand	Effort Or Physical Demand
Frustration Or Mental Demand	

Effort: How hard did you have to work to accomplish your level of performance?

Performance: How successful were you in accomplishing what you were asked to do?

Temporal Demand: How hurried or rushed was the pace of the task?

Frustration: how insecure, discouraged, irritated, stressed and annoyed where you?

Physical Demand: How physically demanding was the task?

Mental Demand: How mentally demanding was the task?

NASA-TLX

Please place an "X" along each scale at the point that best indicates your experience with your task.

Mental Demand: How much mental and perceptual activity was required (e.g., thinking, deciding, calculating, remembering, looking, searching, etc)? Was the mission easy or demanding, simple or complex, exacting or forgiving?

Low High

Physical Demand: How much physical activity was required (e.g., pushing, pulling, turning, controlling, activating, etc.)? Was the mission easy or demanding, slow or brisk, slack or strenuous, restful or laborious?

Low High

Temporal Demand: How much time pressure did you feel due to the rate or pace at which the mission occurred? Was the pace slow and leisurely or rapid and frantic?

Low High

Performance: How successful do you think you were in accomplishing the goals of the mission? How satisfied were you with your performance in accomplishing these goals?

Low High

Effort: How hard did you have to work (mentally and physically) to accomplish your level of performance?

Low High

Frustration: How discouraged, stressed, irritated, and annoyed versus gratified, relaxed, content, and complacent did you feel during your mission?

Low High

Do not write below this line. Experimenter use only.

Subject#: __________ Task: __________________ Date: T2010-☐☐-☐☐

Data Collection

Quantification of physiological workload

- eye tracking
- electroencephalography [EEG]

Data Collection

Quantification of physiological workload

- eye tracking
  - Tobii X2-60, 60Hz remote eye tracker and Eyeworks data recording software.
  - baseline measures, task-evoked pupillary response (TEPR) and blink rate (Mosaly 2017).
- electroencephalography [EEG]
  - X-10 wireless EEG headset system from Advanced Brain Monitoring (ABM)
  - bi-polar sensor sites: Fz, F3, F4, Cz, C3, C4, POz, P3, P4.

Data Collection

- **Quantification of performance**
  - unacknowledged abnormal test results (identified by failure to order a referral, medication or additional testing)
  - unacknowledged patients with ‘no-show’ status for their scheduled appointments (identified by failure to follow up with ‘no-show’ patients)
  - total amount of time that participants took to complete each session.

Data Analysis

- Multivariable analysis of variance
  - Pooled data (all results combined)
  - Abnormal vs. ‘no-show’

- Participants as a random factor.
- All our data analyses were conducted using JMP 13 software with significance level set at 0.05 (normality: all $p>0.05$; equal variance: all $p>0.05$; suitable for parametric analysis).

Results – Task Demands
- Pooled data

Current-EMR (Low-volume)	Current-EMR (High-volume)	Task Demands (average per scenario)	Enhanced -EMR (Low-volume)	Enhanced-EMR (High-volume)
390(91)	496(110)	Total Clicks (count) †	396(83)	479(118)
223(73)	276(76)	Navigation Clicks (count)	239(75)	286(78)
120(22)	155(29)	Decision Clicks (count)	106(25)	124(47)
46(17)	63(14)	Search Clicks (count)	51(18)	69(24)

- High-volume of abnormal test results generated significantly more <u>total clicks</u> when compared to the low-volume of abnormal test results condition ($p<.01$).

Results – Task Demands
- Abnormal vs. No-show

Current-EMR (Abnormal)	Current-EMR (No-Show)	Task Demands (average per result)	Enhanced -EMR (Abnormal)	Enhanced-EMR (No-Show)
33(11)	28 (12)	Total Clicks (count) †	31(12)	21(9)
17(7)	15(7)	Navigation Clicks (count) †	16(6)	11(5)
5(2)	4(2)	Decision Clicks (count)	5(3)	3(2)
11(4)	9(5)	Search Clicks (count) †	9(2)	6(4)

- Enhanced-EMR, specifically for patients with ‘no-show’ status, indicated lower task demands as quantified by <u>total</u>, <u>navigation</u>, and <u>search</u> clicks ($p<.01$).

Results – Subjective Workload
- Pooled data

Current-EMR (Low-volume)	Current-EMR (High-volume)	NASA-TLX	Enhanced -EMR (Low-volume)	Enhanced-EMR (High-volume)
48(15)	58(13)	NASA-TLX (0=low to 100=high)	49(18)	49(13)

- Analysis of NASA-TLX scores indicated no significant differences ($p>.05$).
- NASA-TLX > 55 are associated with degradation in performance (Hart, 2006; Mazur, 2013, 2016).

Results – Physiological Workload - Pooled data

Current-EMR (Low-volume)	Current-EMR (High-volume)	Physiological Workload	Enhanced -EMR (Low-volume)	Enhanced-EMR (High-volume)
15(9)	17(7)	Blink Rate (blinks/minute)	24(10)	22(6)

- On average, human eye blinks 20-25/minute.
- Blink rate was significantly lower in the current-EMR (p=.01), suggesting higher mental workload (Mosaly 2017).

Results – Physiological Workload
- Abnormal vs. No-show

Current-EMR (Abnormal)	Current-EMR (No-show)	Physiological Workload	Enhanced-EMR (Abnormal)	Enhanced-EMR (No-show)
18(9)	18(9)	Blink Rate (blinks/minute) †	19(9)	24(11)
0.8(0.4)	0.7(0.4)	Power of Fz (6-7 Hz) - Pz (8-10 Hz) (μV^2)†	0.9(0.6)	0.9(0.7)

- Blink rate was significantly lower in the current-EMR, specifically for ‘no-show’ ($p<.01$) patients, suggesting higher mental workload.
- Power of Fz (6-7Hz) – Pz (8-10 Hz) was significantly less in enhanced-EMR, specifically for ‘no-show’ patients ($p=.02$), suggesting ‘less optimal’ information processing efficiency (Klimesh, 1999).

Results – Performance

Current-EMR (Low-volume)	Current-EMR (High-volume)	Performance	Enhanced -EMR (Low-volume)	Enhanced-EMR (High-volume)
		Clinical Performance†		
2	6	-missed abnormal results	0	1
15	17	-missed to follow-up on 'no-shows'	2	4
26:12(7:48)	37:18(10:24)	Time-to-complete (min) †	28:54(6:12)	34:12(12:06)
2:20(0:58)	2:42(1:00)	Abnormal results only: Time to Scenario Completion (min:sec) †	2:25(0:49)	2:30(1:12)
1:48(0:36)	2:06(1:13)	'No-show' results only: Time to Scenario Completion (min:sec) †	1:36(0:48)	1:25(0:46)

- Significant improvement in performance in the enhanced-EMR ($p<.01$).
- Significant longer time to complete scenarios in the high-volume of abnormal test results condition ($p<.01$).
- Significant less time to process patients with abnormal test results in the enhanced-EMR ($p<.01$), specifically with no-show status ($p<.01$).

Reducing Provider's Burden - Abnormal & No-Show

(n = results)	Performance (total # of errors)	Task Demand (total clicks)	Average Time to Complete a Result (min:sec)
Enhanced EMR (n=189)	0	23	1:51
Current EMR (n=210)	0	32	2:27

+9 clicks

+36 sec

Given 50 results per interaction: 450 clicks and 30 min!

Conclusions

- Need to 'optimally' design features of the EMR to focus providers attention on:
  - i) abnormal test results
  - ii) patients' status, both with enough detail to facilitate (or not facilitate) appropriate follow-up communications.
- Develop and publicize policies and guidelines regarding work practices and demands to ensure appropriate levels of workload and performance.
- Innovative education/training requirements (e.g., simulation based training vs. traditional training) and performance feedback systems could be organized and implemented (Mazur 2017).

http://www.ihi.org/resources/Pages/Publications/Closing-the-Loop-A-Guide-to-Safer-Ambulatory-Referrals.aspx

Limitations

- One experiment with relatively small number of participants from one teaching hospital, performed on set of scenarios.
- Time between simulated sessions varied from 1 to 3 weeks, which could have unexpectedly bias the study due to some carryover effects between sessions.
- Day and time of the day to conduct assessments varied, which could have also affected the results.
- Simulated environment, where the subjects knew that their work was going to be assessed, may have affected participants' performance.
- Reporting workload via NASA-TLX is subjective and can be challenging for some participants.
- Quantification methods of physiological workload, while validated and broadly used, may not fully considered potential confounding factors streaming from cognitive information processing or general cognitive states.

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Questions

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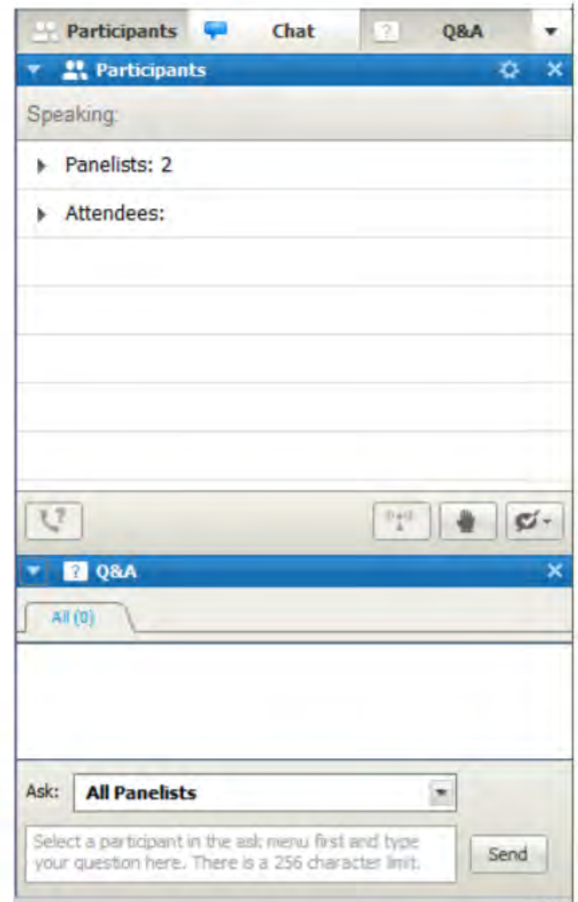
- Please address your questions to "All Panelists" in the drop-down menu.
- Select "Send" to submit your question to the moderator.
- Questions will be read aloud by the moderator.



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