Panel Discussion: The AHRQ Patient Safety Learning Labs

(what are we learning?) (in 75 minutes!)

Improving Primary Care Through Industrial and Systems Engineering

June 3, 2019
<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Speaker</th>
<th>PSLL</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:25 (5)</td>
<td>Me (James Benneyan)</td>
<td>(EHRLL, BWH, name)</td>
</tr>
<tr>
<td>12:30 (20)</td>
<td>Emma S</td>
<td></td>
</tr>
<tr>
<td>12:50 (20)</td>
<td>Mike W</td>
<td></td>
</tr>
<tr>
<td>1:10 (20)</td>
<td>Matt C</td>
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<tr>
<td>1:30 (10)</td>
<td>Discussion</td>
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Motivation

Patient Safety Progress

- 20 years since landmark IOM report
- Great safety progress has been made, albeit slowly
- Mostly limited set of common simple methods and quick look at outside industries

But

- Many problems still remain
- What else do we need to learn? (methods, problems, fields, theories, concepts)
- Increasing calls for more engineering partnerships

AHRQ PSLLs

- Foster clinician-engineer research partnerships
- 3 (4) funding rounds, 21 PSLLs total (so far)
- P30 and R18 mechanisms, $60m-80m investment
Significant interest in quality & systems engineering methods (IOM, NAE, AHRQ, NSF, NIH, PCAST)

‘Time for science of health care to embrace science of systems engineering...’ (JAMA, 2012)

‘Greater use of... principles... widely used in manufacturing and aviation... small number health care organizations... not widespread in U.S. health care’

National Calls in Healthcare
IOM, NAE, AHRQ, NSF, NIH, PCAST, HBR, RAE, etc

Widely Used Elsewhere
<table>
<thead>
<tr>
<th>Current PSLL’s</th>
<th></th>
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<tbody>
<tr>
<td>Making Acute Care (Safety) More Patient Centered (Bates/Benneyan)</td>
<td>Enhancing Patient Safety Through Cognition and Communication (Saint)</td>
<td></td>
</tr>
<tr>
<td>Ambulatory Patient Safety Learning Lab for Diverse Populations (Sarkar)</td>
<td>Failure to Rescue Patient Safety Learning Lab (Blike)</td>
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<tr>
<td>Safety of Mother and Neonate in a Mixed Methods PSLL (Halamek)</td>
<td>Patient Imaging Quality and Safety Laboratory (Horwitz)</td>
<td></td>
</tr>
<tr>
<td>Learning Lab to Eliminate Patient Harm and Reduce Waste (Pronovost)</td>
<td>Engineering High Reliability Learning Lab (Singer/Benneyan)</td>
<td></td>
</tr>
<tr>
<td>Yale Center for Healthcare Innovation, Redesign, and Learning (Chaudry)</td>
<td>Improved Patient Care Through Human-Centered Design in the OR (Joseph)</td>
<td></td>
</tr>
<tr>
<td>Brain Health Patient Safety Learning Lab (Callahan)</td>
<td>Design of Environments Aligned for Patient Safety (Moffatt-Bruce)</td>
<td></td>
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<tr>
<td>Caregiver Innovations to Reduce Harm in Neonatal Intensive Care (Thomas)</td>
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</table>
Themes for panel / panelists

• Overview of types of problem(s) each PSLL is focused on
• Types of methods being used
• How doing the work
• How measuring the work / improvement / impact
• What are you learning?
  – Problems
  – Methods
  – Barriers and strategies
NYU Langone Health
Emma Simon
Patient Imaging Quality and Safety (PIQS) Laboratory

Emma Simon, BS
I-PrACTISE Conference, June 3, 2019
Radiology Continuum

Project 1: ED CTPA ordering

Project 2: Vascular interventional radiology

Project 3: Incidental finding follow-up

Center for Healthcare Innovation and Delivery Science
Radiology Systems Redesign

Center for Healthcare Innovation and Delivery Science
## Problem Analysis: Chart Review

<table>
<thead>
<tr>
<th>Guideline Discordance</th>
<th>Yield</th>
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<tbody>
<tr>
<td>25%-37%</td>
<td>8.5%</td>
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</table>

Center for Healthcare Innovation and Delivery Science
Problem Analysis: Chart Review

Guideline Discordance
25%-37%

Hypercoagulability
(pregnancy, exogenous estrogen, cocaine use etc.)

39%

Hemodynamic changes
(travel ≥ 4 hours)

Clinical gestalt-elevating factors
(patient history of non-VTE thrombosis, patent foramen ovale)
Problem Analysis: Provider Interviews

I never really hear from IR about what happened down there… I have no idea: was there an intra-op complication? Is there anything I should be doing specifically post-op? Can I restart their anticoagulation?

My biggest challenge would be communication with the floors… we can’t even get a hold of the person on the floor to figure out what’s going on with the patient. We’ll call the floor, either to get report before or give report after, and the phone will be ringing for 10 minutes on end.
Problem Analysis: Patient Interviews

I thought I knew what I was going to expect, but I didn’t expect that much pain… I could just say that out of 0 to 10 to be realistic it was a 10 but if I could’ve said a higher number it was 100.

The worst was just feeling the pressure and something going in that my mind just couldn’t figure out what was going on in the moment so I was really emotional. But I was trying to focus so I could say, “Okay. This is happening,” but my mind was just all over the place.
Problem Analysis: Process Maps
Problem Analysis: Process Maps

Incidental Findings Management: Ideal Current State

Provider orders imaging exam

Ordering provider receives imaging report

Ordering provider takes note of incidental finding from imaging report and documents finding

Patient completes imaging exam

Patient completes follow-up imaging exam on scheduled date

Patient schedules follow-up exam

Patient receives reminder before exam

Ordering provider communicates incidental finding to patient and to other relevant members of care team

Provider orders follow-up imaging exam

Patient understands plan for follow-up

Relevant provider(s) make decision on follow-up interval based on radiology recommendation

Relevant provider(s) keep track of follow-up timeline
That’s one of the things that we’ve struggled with is all the clicking and searching that we have to do for not only orders but medication and everything… anything that could help streamline the process.

What I do now currently, I keep a separate list of all the nodules I’m following and when I need the follow-up otherwise I’ll never remember it.
Design Charrettes
# Design Charrettes

<table>
<thead>
<tr>
<th>Feasibility</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Standardized pre-procedure checklist</td>
<td>Music headphones in procedure room</td>
<td>Status board view in Epic for all</td>
</tr>
<tr>
<td>Medium</td>
<td>Notifications for RNs re delays</td>
<td>IR review DBN list daily</td>
<td>Ask for patient’s learning style</td>
</tr>
<tr>
<td>Low</td>
<td>Better pre-op holding area</td>
<td>Point person in IR for patient to ask questions</td>
<td>Robot transport</td>
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</table>
# Design Charrettes

<table>
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<tr>
<th>Feasibility</th>
<th>Impact</th>
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Center for Healthcare Innovation and Delivery Science
Intervention Implementation
Interventions: Clinical Decision Support

Center for Healthcare Innovation and Delivery Science
Interventions: CTPA Dashboard

Center for Healthcare Innovation and Delivery Science
Interventions:
Standardized Documentation

Post-procedure Care and Recommendations:

Diet:
- No restrictions

Activity:
- as tolerated (no restrictions)

Pain management:
- received monitored anesthesia care during procedure
- will likely not require additional pain medication upon return to floor

Medications:
- can resume anticoagulation in 12 hours
- can resume all other medications as scheduled

Monitoring:
- no special monitoring (monitored in IR post procedure)

Labs:
- none required

Drain Care:
- flush drain with 5-10 mL saline once daily (to be done during VIR rounds)

Disposition:
- from VIR standpoint, patient can be discharged in 23 hours
  - instructions for nephrostomy tube care placed in patient discharge instructions

Please page VIR at 917-802-7393 with any questions.
Interventions: Music Therapy

• RCT to assess effect of music on patient relaxation levels during IR procedures
• Target sample size: 126
• Current accrual: 77
Interventions: Pulmonary Nodule Macro

Management Recommendations: According to a consensus statement published by the American College of Chest Physicians and the Fleischner Society, the NYU collaborative imaging recommendations for a solid > 8 mm pulmonary nodule are:

Consider follow up CT in 3 months, PET imaging, or tissue sampling.

Evaluation
Evaluation: CTPA Utilization

Guideline adherence:
- Pre-intervention: 66.6%
- Post-intervention: 77.9%

Yield:
- Pre-intervention: 12.3%
- Post-intervention: 10.9%

D-dimer rate:
- Pre-intervention: 3.1%
- Post-intervention: 3.7%

CTPA rate:
- Pre-intervention: 1.7%
- Post-intervention: 1.8%

Center for Healthcare Innovation and Delivery Science
Evaluation: CTPA Utilization

157 Avoided CTPAs in the first 9 months

64 CTPA orders cancelled after CDS interaction

31 CTPA orders switched to d-dimer on CDS recommendation; CTPA never ordered after negative dimer

62 CTPA orders never placed after CDS interaction
Evaluation: Standardized Documentation

Overall Utilization

Pre-procedure Note 98%

Post-procedure Note 94%

Elements Included

- Pre-procedure note:
  - Evaluation: 3.5

- Post-procedure note:
  - Evaluation: 4.7
  - 15.3

Legend:
- Pre-intervention
- Post-intervention
Evaluation:
Standardized Documentation

Medicine Survey Responses

- Lack of confidence: 52.9%
- Ineffective collaboration: 11.8%
- Lack of clear recommendations: 35.3%
- 0.0%

Phone Calls

- Incoming: 19625
- Outgoing: 27257

Legend:
- Pre-intervention
- Post-intervention
Next Steps

• Continued intervention implementation and iteration
• Continued evaluation
• Dissemination
• Collaborations
Our Team

**Project PIs**
Eric Aaltonen, MD, MPH  
Saul Blecker, MD, MHS  
Leora Horwitz, MD, MHS  
Soterios Gyftopoulos, MD, MSc  
Stella Kang, MD, MS  
Danil Makarov, MD, MHS

**Co-Investigators**
Eduardo Iturrate, MD, MSW  
Erin McCaffrey, RN, MHM, MPH  
Isomi Miake-Lye, PhD  
Natalie Privett, PhD  
Jordan Swartz, MD, MA  
Silas Smith, MD

**Project Coordinator**
Emma Simon, BS

**Research Data Associates**
Kira Garry, MPH  
Darrian Reyes, BS  
Cathy Santos, MPH
How might we provide more info to patients across the radiological experience?
Transformation Through Collaboration

Lessons Learned

HSyE-Chan SPH-Mount Auburn Hosp.

Matthew Carmody, MD and Linda Powers, MD
Change Collaborators

Chan School of Public Health

Healthcare Systems Engineering Institute

Mount Auburn In-Patient Service and Out-Patient (Ambulatory)
Service: Care Group

Barrier: Our **strength**, multiple perspectives/skills of the collaborators, is our **weakness**, we have different language/models
WHAT WAS THE PROBLEM

• 30 day re-admission rate hovered around 16.5% (19.4% state/17.9% region)1
• COPD and CHF re-admission reduction interventions @ Mount Auburn Hospital showed 30 day re-admission rate reduction that were not sustained. IP + OP
• Our initial intervention aimed to ‘catch’ the patient as they were discharged. OP
• 12% of patients reported that MAH staff did not talk to them about post-discharge care plans or they were not given written information about what symptoms or health problems to look for after discharge. IP
• 54% of patients attested they ‘strongly understood’ their follow-up care plan.2 IP

Lesson: Who agrees this is the problem? Why?
**Lesson**: Know where change occurs that solves the problem.
WHAT WAS THE PROBLEM

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The Aims Statement Evolution

• Our aim is to improve health outcomes for patients post-hospitalization and in danger of re-hospitalization as measured by ED/Inpatient/SNF utilization and patient satisfaction. (12/2016) OP

• Improve health outcomes for patients post-hospitalization as measured by ED/Inpatient/SNF utilization, patient satisfaction, and quality of life by defining risk for readmission for the hospitalized patient and developing a shared care plan among the inpatient team, PCP, homecare, and the empowered patient. (10/2018) IP + OP

Lesson: Rewrite aims to reflect current understanding of the ‘gap’.
IN THE BEGINNING

Swim Lane (Cross Functional Process Flow Diagram)

Takeaway:
Hospital, primary care center, and home care infrequently interacted, communicated, or influenced one another.
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Swim Lane (Cross Functional Process Flow Diagram)

Takeaway:
Hospital, primary care center, and home care infrequently interacted, communicated, or influenced one another.
Project overview

- Swim Lane Diagram
- Contrast Analysis
- FMEA
- Brainstorming Design
- Future Swim Lane
- Driver diagram
- High risk hospital work group
- High-reliability concept map
- Design

Showed no collaboration
**Lesson:** Wide range of stakeholders participants developed a deeper understanding of existing failure types, effects, and probabilities of occurrence.

**Highest Priority Failures:**

- Inpatient and outpatient care do not work together as a team (810)
- No standard risk identification method nor a mechanism to share risk (648)
- Lack of understanding about what med rec is and when it should happen (648)
## Analysis Phase and Methods Used

<table>
<thead>
<tr>
<th>Method</th>
<th>Insight</th>
<th>How Acted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swim lane</td>
<td>Showed no collaboration between primary care, hospital care, and homecare.</td>
<td>Invited many additional stakeholders to participate in a comprehensive FMEA.</td>
</tr>
<tr>
<td>FMEA</td>
<td>1. Inpatient and outpatient care do not work together as a team, 2. No standard agreement on risk identification and sharing, and 3. Lack of understanding around medication reconciliation.</td>
<td>1. Invited Director of Case Management to be member of main multidisciplinary work team. 2. Scheduled meetings with transitional care people from other hospitals to investigate how they evaluate and share risk. 3. Defined a specific process for med rec., and focused on this as first aspect of future process to PDSA</td>
</tr>
<tr>
<td>Contrast analysis</td>
<td>Failures rested on missed knowledge and lack of communication, while successes had frequent, albeit brief, direct communication.</td>
<td>Designed specific points in the future state workflow where communication needs to occur, and what content should be discussed.</td>
</tr>
<tr>
<td>FRAM</td>
<td>Process is very complex and nonlinear, and many functions are interconnected. Missing aspects of each function showed parts of the process that need more thought.</td>
<td>Began deep diving into parts of the future process that were not yet well-defined.</td>
</tr>
</tbody>
</table>
Core Elements to Reduce Readmissions

Our Plan

• Shared risk of readmission
• Team generated care plan
• Patient empowerment and caregiver engagement to empower
• Culture and protocols for team communication

Lesson: Are these the minimum required interventions needed to reach the goal? What are the chances of failure from doing too little change?

Literature

• No single intervention implemented alone reduces 30-day readmission (Hansen LO et al, Annals Internal Medicine 2011 155(8);520-8)
• Successful interventions are comprehensive, extend beyond hospital stay, and have the flexibility to respond to individual patient needs (Kansagara D et al, J Hosp Med 2016 11(3);221-230)
• Managing sx$s$ after discharge, enlisting help of social and community supports, and educating patients to promote self-management most associated with success (Burke RE et al, BMC Health Services Research 2014 14:423)
• Interventions oriented to patient empowerment were more effective compared to all other interventions (Breat et al. Effectiveness of Discharge Interventions from Hospital to Home on Hospital Readmissions: a systematic review JBI Database of Systemic Reviews and Implementation Reports. 2016:14(2):106-173.)
Aim: To improve patient satisfaction and quality of life post hospitalization and to reduce hospital readmission

Outcome Measures:
1. Readmission rates for high-risk patients
2. Patient and caregiver quality of life survey

Primary Drivers
- Shared Risk Assessment
- Shared Care Plan
- Culture and Protocols for High-Reliability Communication
- Patient Engagement

Secondary Drivers
- Risk tool that picks out about 15% highest risk patients (automatic or assigned)
- Tool visible and obvious to all providers
- Accurate medication reconciliation at admission, discharge, and home
- Patient, caregivers, and involved providers participate in generating plan
- In person or virtual multidisciplinary meeting as part of shared care plan
- Facilitation of meaningful communication between inpatient team, homecare, and PCP
- Daily involvement of patient in care (e.g., via AHRQ patient IDEAL tool for generating questions)
- Meeting with patient and primary caregiver(s) day prior to discharge
- Assessment of skills and motivation prior to discharge
System Change/Culture Collision

- Our out-patient system collaborator (QA department in Care Group) was dissolved and out-sourced.
- The point of change shifted from outpatient to inpatient as a result of FMEA analysis.
- HSyE change concepts were different from Mount Auburn Hospital (MAH) change concepts.
- Some HSyE and Chan SPH personnel changed.
- Our new MAH collaborators (High Risk Work Group lead by chief of QA) empowered the project and controlled the project. We become a member of another team. HSyE and Chan SPH were not at the table.

**Barrier**: Proposed changes encounters the hidden complexity/culture of the system they are designed to fit.
**Barrier**: Personnel turn over.
Deliberate design: improvement, optimization to account for human factors and process failure
Do: PDSAs @ every step, force function, prevent failure, learn from failures, detect failures and mitigate.
Design change to flow with current work flow. Add work time only while reducing work time.
How do we scale up from our pilot introduction?
**Care Team Timeline and Task List**

[Created by the High Risk Work Group, Yvonne Cheung, MD, chair. Aim: for HIGH RISK Patient: reduce 30-day re-admissions, enhance care team collaboration/efficacy, create a shared care plan with the patient, and empower the patient.]

<table>
<thead>
<tr>
<th>TIMELINE</th>
<th>ACTION</th>
<th>RN</th>
<th>HO</th>
<th>Pharm</th>
<th>PT/OT/SW</th>
<th>CM</th>
<th>Att</th>
<th>HC</th>
<th>Patient</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DAY 2 of hospitalization</strong></td>
<td>#Advises team of high risk status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>#Give patient AHRQ’s Be Prepared to Go Home Booklet</td>
<td>X</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td><strong>DAY 3 through Day before DC</strong></td>
<td>#Engage patient daily to discuss AHRQ’s Be Prepared to Go Home Booklet</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X disc.</td>
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<tr>
<td></td>
<td>#Checks daily Care Team ‘Important Information Message Board’ in EPIC</td>
<td></td>
<td>X</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>under FVI or Notes from Clinical Staff</td>
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<tr>
<td><strong>DAY before DC</strong></td>
<td>#After discussing with Attending and Patient, proposes next day DC to RN and Pharm by 2:30PM</td>
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<td></td>
<td></td>
<td>X</td>
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<tr>
<td></td>
<td>#Discusses Go-No Go with Patient, CM, other and advises HO</td>
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<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
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<tr>
<td></td>
<td>#Schedules same-day meeting with Patient/Caregiver</td>
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<tr>
<td></td>
<td>#Alerts Maryanne Seymour (CareGroup liaison) of DC before 5PM</td>
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<td></td>
<td></td>
<td></td>
<td>X</td>
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<tr>
<td><strong>DAY of DC</strong></td>
<td>#Confirms high risk DC to HC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><strong>DAY after DC</strong></td>
<td>#Visits patient</td>
<td></td>
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*Lesson: Always ask whether this is the simplest intervention for frontline caretakers to use?*
Lessons Learned

• Lesson: Who agrees this is the problem? Why?
• Lesson: Who will agree to own the solution to the problem?
• Lesson: Always ask whether this is the simplest intervention for frontline caretakers to use?
• Lesson: Are these the minimum required interventions needed to reach the goal? What are the chances of failure from doing too little change?
• Wide range of stakeholders participants developed a deeper understanding of existing failure types, effects, and probabilities of occurrence
• Rewrite aims to reflect current understanding
• During the course of the project, look at the horizon – next step, anticipated user. Always think how to scale and drive adaptation.
Barriers Overcome

• Our strength, the multiple perspectives/skills of the collaborators, is our weakness, we have different language/models.

Do: HSyE and Chan SPH taught MAH in Learning Sessions and know each others story

• Keep forward momentum as collaborators change and systems change creating drag.

Do: All collaborators met weekly (telephone conference) with a set pre-conference agenda which built accountability and support no matter what the problem applying collective wisdom to needed adjustments.

• Proposed changes encounters the hidden complexity/culture of the system where the design ‘fit’ can’t be reasonably predicted.

Do: Expect system ‘misfit’ and apply ‘data/case analysis’ on small numbers (2 single patient runs) gathering the experience of the change from multiple stakeholders. (Allows human factors integration.) Ask the stakeholders what the change would look like for “success”. Let go, let’s go and morph!
THANK YOU!
Thank you!

Healthcare Systems Engineering Institute
Northeastern University, Boston MA
j.benneyan@northeastern.edu
Appendix

Engineering High Reliability Learning Lab
EHRLL (Engineering High Reliability Learning Lab)

- Embedded IEs in teams
- **Problem focus** on failures in communication and coordination between primary & other care
- **Methods focus** on ISE methods broadly and learning re: utility/barriers
- Organizational focus on team dynamics, learning styles, and organizational strategies

<table>
<thead>
<tr>
<th>Design phase</th>
<th>Focus</th>
<th>Methods used in each project</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Atrius</td>
</tr>
<tr>
<td>Problem analysis</td>
<td>Understanding current process</td>
<td>●</td>
</tr>
<tr>
<td></td>
<td>Understanding broader context</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td>Understanding failures</td>
<td>○</td>
</tr>
<tr>
<td>Design</td>
<td>Analytic</td>
<td>○</td>
</tr>
<tr>
<td>Develop</td>
<td>Analytics</td>
<td>○</td>
</tr>
<tr>
<td>Implement</td>
<td>Design and spread</td>
<td>○</td>
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Methods focus on ISE methods broadly and learning re: utility/barriers.
Methods examples

Logic and Context

Failure (and Success) Analysis

1. How did a process fail?
2. How did a process succeed?
1. What are the failure modes
2. What are the causes?

Analytics and Design

O/E Lengths of Stays (Multi-model)
### What are we learning? (EHRLL)

<table>
<thead>
<tr>
<th>Problems</th>
<th>Methods</th>
<th>Collaboration</th>
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</thead>
<tbody>
<tr>
<td>• Upstream problems as primary failure drivers</td>
<td>• Process analysis methods very useful</td>
<td>• Easier said than done</td>
</tr>
<tr>
<td>• Often no singular nor defining event</td>
<td>• ≥ 50% new methods useful in ≥ 1 processes</td>
<td>• Culture, workflow, organizational, value differences</td>
</tr>
<tr>
<td>• Little intra-process awareness</td>
<td>• Lots of learning about these/new methods</td>
<td>• Partnering paperwork delays, competencies</td>
</tr>
<tr>
<td>• Micro-system silos</td>
<td>• Design chasm (methods and awareness)</td>
<td>• Positive tension between improvement needs &amp; research aims</td>
</tr>
<tr>
<td>• Lack of feedback and improvement and loops (a la IOM learning systems)</td>
<td>• Data resistance</td>
<td>• Resistance to new ideas, data analysis, engineer pace and process</td>
</tr>
<tr>
<td>• Cultural resistance to change</td>
<td>• Model-based &amp; analytics methods (IE workhorses) less effectively used</td>
<td></td>
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Acute Care Patient-Centered PSLL

**Patient Safety Dashboard**

- BWH Patient Safety Learning Lab (PSLL)
  - Focused on patient safety, the development and enhancement of tools, health system interventions, and their translation into practice

- Fall TIPS is now electronic!
  - A new Epic printed poster and screensaver

- MySafeCare: Anonymous patient reporting of safety concerns & compliments
  - Real-time visual of Epic documentation

- The Patient SatisfActive Model
  - A communication tool for patient-centered care

- Systems Engineering, Usability, and Integration Core

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**MySafeCare**

- For educating patients and families

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**ARHQ Lifecycle**

- **Analysis → Design → Develop → Implement → Evaluate**

**Methods Application**

- **Year 1**
  - Individual tool focus
  - Usability & interface design
  - Human factors

- **Year 2**
  - System of systems focus
  - Analysis of pilot data
  - SoS simulation model

- **Year 3**
  - Macro ergonomic, SEIPS view
  - Workflow, contextual, failure, cognitive burden analysis

- **Year 4**
  - Prospective view
  - Automated reporting, control charts, risky states detection