Simulation: Next Steps

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International Meeting on Simulation in Healthcare
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Disclosures

• Mary D Patterson, MD, MEd
  • Occasional Consulting for SimHealth Group
  • Employment
    • Children’s National Medical Center
• Ellen S Deutsch, MD, MS, FACS, FAAP
  • Employment
    • Pennsylvania Patient Safety Authority
    • ECRI Institute
    • Children’s Hospital of Pennsylvania
Goals

• Review Resilience Engineering and Safety II Concepts

• Discuss ways to incorporate these concepts into simulation practice and research

• INSPIRE next steps
Are humans the problem, the weak link in our efforts to provide safe healthcare?

Patient accuses Yale doctors of cover-up, removing wrong body part

accessed 03May2017
Or are humans the resources that solve problems, invent, create, and improve?
- People working in health care are among the most educated and dedicated work force in any industry

- The problem is not bad people, the problem is that the system needs to be made safer

To Err is Human. Institute of Medicine 2000
Healthcare delivery is a human modified system

- A human-made system integrated into a natural system as a subsystem

- “The search for a human in the path of a failure is bound to succeed. If not directly at the sharp end as a ‘human error’ or unsafe act, one can usually be found a few steps back.”

- The assumption that humans have failed therefore always vindicates itself.

Blanchard & Fabrycky System Engineering and Analysis 5th Ed 2011;
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Limitation of humans

• Knowledge, understanding
• Physical strength
• Technical skills
• Memory
• Energy, attention, vigilance
Strengths of humans

• Situation Awareness: perception, comprehension, projection
• Understanding and sense-making in complex contexts
• Focus in dynamic, chaotic environments
• Pattern recognition and classification
• Decision making and goal setting
• Perception and cognition!

Based on concepts from: Gary Klein, Laura Militello, F Jacob Seagull, Mica Endsley, Daniel Kahnemann, others
Healthcare delivery is a complex adaptive system

- Networks of agents constantly act, and react to each other
- Changes are fluid and dynamic
- Control is dispersed and decentralized
- In healthcare, providers continually adjust how they work

Complex Adaptive Systems

• Complexity is a feature of the entire system, not of components inside it

• Systems are influenced by, and influence, the environment in which they operate
WORKAROUND EXAMPLE*

- Nurse unable to scan barcode before administering medication: barcode was incomplete
- Pharmacy instructed nurse to
  - Type in patient’s name and medical record number
  - Document medication confirmation manually

Workaround benefited the patient

Process did not address the underlying problem: “First order” workaround**

*Details of event narratives received by Pennsylvania Patient Safety Reporting System (PA-PSRS) have been modified to preserve confidentiality.

**Tucker AHRQ 2009
ANOTHER EXAMPLE*

- Barcode reading was invalid
- Pharmacy determined the medication was non-formulary
- Pharmacy instructed nurse to
  - Override error message; administer medication
  - Report event to the facility’s incident and serious event reporting system

- Patient benefited
- Documentation to support investigation and mitigation

*Details of event narratives received by PA-PSRS have been modified to preserve confidentiality.
ONE MORE EXAMPLE*

- High-risk medication brought to a patient in respiratory isolation*
- Nurse unable to scan barcode before administering medication: barcode was incomplete
- Medication given
- RN returned to where the high-risk medications are held to scan an undamaged one for documentation purposes
- The scanner indicated that this was not the correct medication for this patient

The workaround bypassed a safety mechanism, creating a patient hazard

*Details of event narratives received by PA-PSRS have been modified to preserve confidentiality.
Healthcare delivery is a socio-technical system

Vincent 1998; Carayon et al 2006; Harrison 2007; Sittig & Singh 2010; Deutsch 2016
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Workarounds

- Ubiquitous in healthcare, “workaround culture”
- Actions to
  - Circumvent or temporarily “fix” workflow hindrances or system design deficiencies
  - Cope with exceptional patient care circumstances
  - Achieve a goal or achieve it more readily
- Non-standard procedures that don’t follow explicit or implicit organizational rules
- When used to solve workflow obstacles, should not be misunderstood as errors and mistakes, deviance or shortcuts

What processes are involved in workaround events?

- Events in the Pennsylvania Patient Safety Reporting System
  - Health information technology
    - Also in the national literature
    - Large volume and granular data
  - Medication doses based on estimated weights
  - Consents from surrogates
  - Substitution of equipment, medications, other resources

- Hoarding possibly less likely to be reported

PA-PSRS: events that cause or could cause unanticipated patient harm; Ser et al PLoS ONE 2014; Koppel et al JAMIA 2008; MCARE Act of 2002
The hazards of workarounds

- Short term
  - Breach an intentional barrier*
- Long term
  - Missed opportunity, allows unsafe systems to persist**

*Halbesleben et al Health Care Manage Rev 2010
**Tucker AHRQ 2009; Stutzer & Rushton AACN Adv Crit Care 2015
Workarounds as adaptive problem-solving behavior is a double-edged sword

- Workarounds can be sources for solutions
  - Prevent failure but obscure design flaws*
  - Align work context and available tools and resources, but limit awareness, investigation and mitigation of problems**
  - Limits diffusion of improvements**

**Tucker AHRQ 2009
©2018 Pennsylvania Patient Safety Authority
Workarounds as learning opportunities

- Contain useful data
- Identify flaws
- Indicate operational shortcomings
- Illuminate goal conflicts

Resilience Engineering

The Deliberate Design And Construction Of Systems That Have The Capacity Of Resilience

Simulation?

Fairbanks et al, 2014

https://thinkcreative30.files.wordpress.com/2013/04/chronology-of-disruptive-events.png
<table>
<thead>
<tr>
<th>Case</th>
<th>Description</th>
<th>Event Scale</th>
<th>Activities</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>“SOFT” EMERGENCY SURGERY (1)”</td>
<td>Very small</td>
<td>• Inquiry into specifics of the emergency case</td>
<td>• Required multiple assessments</td>
</tr>
<tr>
<td></td>
<td>In the midst of a busy day, an “emergency” case is inserted into the sequence of cases without major impact on the schedule.</td>
<td></td>
<td>• Evaluation of current state of work in the OR</td>
<td>• Resolved competing demands for resources</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Negotiation of resource allocation</td>
<td>• Made use of multiple degrees of freedom</td>
</tr>
<tr>
<td>2</td>
<td>AUTOMATED MEDICATION DISPENSING FAILURE (14)</td>
<td>Small</td>
<td>• Recognition of the nature of the obstacle</td>
<td>• Adapted organizationally to overcome technology failure</td>
</tr>
<tr>
<td></td>
<td>A software upgrade causes the automated dispensing unit in a busy ED to freeze without warning.</td>
<td></td>
<td>• Setup of informal back-and-forth pharmacy runner</td>
<td>• Reverted to manual system</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Use of “stashed” drug supplies, “borrowing,” and substitution</td>
<td>• Loss of ordinary accounting exchanged for speed of access to medications</td>
</tr>
<tr>
<td></td>
<td>Examples of Resilience in Health Care</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td><strong>ED IN “FREE FALL” (15)</strong>&lt;br&gt;An influx of patients into the ED overwhelms the staff, leading to deviation from normal organizational protocols.</td>
<td>Medium</td>
<td>Distribution of authority/responsibility&lt;br&gt;Forgoing of usual oversight&lt;br&gt;Work to recover ordinary operations</td>
<td>Continued work in spite of loss of central organization&lt;br&gt;Used capacity reservoir in personnel</td>
</tr>
<tr>
<td>4</td>
<td><strong>SUICIDE BUS-BOMBING (1)</strong>&lt;br&gt;A bombing creates &gt; 50 casualties, who are evacuated to hospitals and treated efficiently.</td>
<td>Large</td>
<td>Direct care by senior clinicians in triage area&lt;br&gt;Dispersal of casualties to care locations&lt;br&gt;Self-mobilization of personnel taking on nonstandard roles&lt;br&gt;Dropping noncritical tasks (for example, paperwork)</td>
<td>Entire facility involved&lt;br&gt;Repeated experience refined performance (learning)&lt;br&gt;Rapid return to “normal” operations</td>
</tr>
</tbody>
</table>
• Systems are influenced by and influence the environment in which they operate

• Complexity is a feature of the system, not of components inside it

• Small events can produce large results
  - Dekker, Drift into Failure, referencing Von Bertalanffy

SEIPS 2.0. Ergonomics. 2013 November; 56(11) Holden, Carayon et al
Andrew Johnson, Paul Lane, Robyn Clay-Williams, Townsville Hospital and Health Service, QLD, Australia & Macquarie University, Sydney Australia
Buffering Capacity

• Size and type of disruption that system can absorb/adapt to without fundamental breakdown in performance/structure

Tolerance

• The behavior of system near a boundary as stress/pressure increases.
  • Graceful Degradation
  • Catastrophic Failure
Resilience Engineering

• Provides ways to enhance resilience in the face of surprise

• Predicts how change expands or constricts adaptive capacity

• Monitors the boundary conditions of the current model and adjusts/expands that model to better accommodate change
  • How strategies are matched to demands

http://books.openedition.org/pressesmines/docannexe/image/1115/img-1.jpg
• We should extend our safety strategies to include risk control, monitoring, adaptation and mitigation

• Healthcare uses a very limited set of safety interventions. The limited progress in patient safety is potentially related due to underuse of available strategies
Integration with the Systems Approach
The goal is not to: “Eliminate Human Error”

Human Error cannot be eliminated
• Futile goal; misdirects resources/focus
• Causes culture of blame and secrecy
  • “name, blame, shame, and train” mentality

It is about reducing HARM
Humans are a source of error and resilience
Absence of resilience: Brittleness

• Lack buffering capacity: unable to absorb or adapt

• Stiff: inability to restructure in response to changes or pressures

• Lack of margin: closeness to a performance boundary

• Intolerant: collapses (vs gracefully degrading) when pressure exceeds adaptive capacity

Resilience engineering; Essential Characteristics of Resilience  David D Woods
Faster, better, cheaper

Safe, patient centered, equitable, efficient, effective, timely
Optimality – Brittleness tradeoff

- Equivalent of “no free lunch”

- Increasing adaptation to some aspects of variations of a system inherently make that system less adapted to others
How are our teams and systems functioning?

Is there margin for maneuver?
Patient Requires emergency ECMO
Tale of Two Safeties:

Activities of Resilience:
• Monitor
• Respond
• Learn
• Anticipate

https://upload.wikimedia.org/wikipedia/commons/1/14/Ecmo_schema-1.jpg
Graceful Extensibility vs Waste

http://www.growingyup.com/graceful-vs-full-of-grace/

http://www.theinnovationdiaries.com/918/how-to-minimize-waste/
Law of Fluency

• Well adapted cognitive work occurs with a facility that belies the difficulty of the demands resolved and the dilemmas balanced

• The adaptive behaviors of individuals may be unrecognized by the organization’s leaders, who may become progressively miscalibrated.

• All compensatory behaviors have a finite limit
Law of Fluency

• When system limits are approached, the system becomes brittle, develops characteristic patterns of decompensation:
  • Falling behind the tempo of operations (challenges grow faster than they can be met)
  • Working at cross purposes (changes introduced at one level surface as unintended consequences at another;)
  • Getting stuck in outmoded and dysfunctional behaviors

• These are indicators of impending failure, either gradually or suddenly.

Woods DD, Hollnagel E. Joint Cognitive Systems: Patterns in Cognitive Systems Engineering. 2006,
Cuvelier L, Falzon P. Coping with uncertainty: resilient decisions in anaesthesia. 2011
Miscalibration
Another way of looking at performance

<table>
<thead>
<tr>
<th>Network Option Variety</th>
<th>System Instability</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td><strong>High</strong></td>
<td>Just-in-time</td>
<td>Just-in-case performance</td>
</tr>
<tr>
<td></td>
<td>performance</td>
<td>performance</td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td></td>
<td>Just-this-way performance</td>
</tr>
</tbody>
</table>

*Journal of Contingencies and Crisis Management*
One way to look at this

**NASA Task Load Index**

Hart and Staveland's NASA Task Load Index (TLX) method assesses work load on five 7-point scales. Increments of high, medium and low estimates for each point result in 21 gradations on the scales.

<table>
<thead>
<tr>
<th>Name</th>
<th>Task</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mental Demand</td>
<td>How mentally demanding was the task?</td>
<td></td>
</tr>
<tr>
<td>Physical Demand</td>
<td>How physically demanding was the task?</td>
<td></td>
</tr>
<tr>
<td>Temporal Demand</td>
<td>How hurried or rushed was the pace of the task?</td>
<td></td>
</tr>
<tr>
<td>Performance</td>
<td>How successful were you in accomplishing what you were asked to do?</td>
<td></td>
</tr>
<tr>
<td>Effort</td>
<td>How hard did you have to work to accomplish your level of performance?</td>
<td></td>
</tr>
<tr>
<td>Frustration</td>
<td>How insecure, discouraged, irritated, stressed, and annoyed were you?</td>
<td></td>
</tr>
</tbody>
</table>

*Very Low* - *Very High*
NASA Task Load Index

Hart and Staveland’s NASA Task Load Index (TLX) method assesses work load on five 7-point scales. Increments of high, medium and low estimates for each point result in 21 gradations on the scales.

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<th>Name</th>
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<th>Date</th>
</tr>
</thead>
</table>

Mental Demand

0-20 very low
20-40 low
40-60 medium
60-80 high
80-100 very high

How mentally demanding was the task?

Very Low

Very High

0

50

100
Creating Capacity for Adaptation

- Recognition of Risk
- Situation Awareness
- Common Language
- Shared Mental Model
- Interprofessional
Organizational Level of Resilience

• Depends on Relational Rehearsal
  • Shared expectation and collective trust

• System structuring
  • Organizational improvement and cognitive infrastructure

• Practice Elaboration
  • Embodied Wisdom and reflective inquiry


https://assets.rockefellerfoundation.org/app/uploads/20130805163211/100-Resilient-Cities-Ball-Graphic.png
Much of what we do, could be reframed and evaluated in RE terms

- Look at simulation in terms of understanding how the system functions with respect to unexpected stress and disruptions.

- Think about and use alternative methods to evaluate where the system is relative to margins and safe performance.
• “Main Solution to problem of surprise is in recovering from surprise by employing the range of abilities that fall under the heading of flexibility”

• We should “train” for surprises and how to respond and adapt to surprise
Regular Threat: Difficult Airway

• Individual & team learning opportunity: response to unplanned events
• Organizational learning: Safety II-solutions emerge
• Promotes learning from a crisis before an actual crisis occurs

### Table. Time Response Data

<table>
<thead>
<tr>
<th>Simulation No.</th>
<th>ENT Page Request Time</th>
<th>ENT Arrival Time</th>
<th>ENT Page to Arrival</th>
<th>Anesthesia Page Time</th>
<th>Anesthesia Arrival Time</th>
<th>Anesthesia Page to Arrival</th>
<th>Time of Equipment Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.87</td>
<td>10.75</td>
<td>5.88</td>
<td>6.80</td>
<td>9.95</td>
<td>3.15</td>
<td>10.75</td>
</tr>
<tr>
<td>2</td>
<td>2.50</td>
<td>10.00</td>
<td>7.50</td>
<td>Never</td>
<td>Never</td>
<td>Never</td>
<td>10.00</td>
</tr>
<tr>
<td>3</td>
<td>1.32</td>
<td>9.02</td>
<td>7.70</td>
<td>1.32</td>
<td>Never</td>
<td>Never</td>
<td>Never</td>
</tr>
<tr>
<td>4</td>
<td>1.78</td>
<td>12.00</td>
<td>10.22</td>
<td>2.33</td>
<td>5.83</td>
<td>3.50</td>
<td>Never</td>
</tr>
<tr>
<td>5</td>
<td>2.37</td>
<td>8.97</td>
<td>6.60</td>
<td>3.00</td>
<td>7.33</td>
<td>4.33</td>
<td>Never</td>
</tr>
<tr>
<td>6</td>
<td>1.55</td>
<td>10.62</td>
<td>9.07</td>
<td>3.00</td>
<td>5.92</td>
<td>2.92</td>
<td>Never</td>
</tr>
<tr>
<td>Mean</td>
<td>2.40</td>
<td>10.23</td>
<td>7.83</td>
<td>3.29</td>
<td>7.26</td>
<td>3.48</td>
<td>10.38</td>
</tr>
</tbody>
</table>

### Novel System

<table>
<thead>
<tr>
<th>Simulation No.</th>
<th>CAT Page Request Time</th>
<th>ENT Arrival Time</th>
<th>CAT Page to ENT Arrival</th>
<th>N/A</th>
<th>Anesthesia Arrival Time</th>
<th>CAT Page to Anesthesia Arrival</th>
<th>Time of Equipment Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>2.07</td>
<td>5.27</td>
<td>3.20</td>
<td>NA</td>
<td>6.73</td>
<td>4.33</td>
<td>5.83</td>
</tr>
<tr>
<td>8</td>
<td>1.93</td>
<td>8.15</td>
<td>6.22</td>
<td>NA</td>
<td>5.30</td>
<td>2.70</td>
<td>6.05</td>
</tr>
<tr>
<td>9</td>
<td>2.27</td>
<td>8.33</td>
<td>6.07</td>
<td>NA</td>
<td>7.15</td>
<td>4.78</td>
<td>6.10</td>
</tr>
<tr>
<td>10</td>
<td>1.77</td>
<td>6.20</td>
<td>4.43</td>
<td>NA</td>
<td>Never</td>
<td>Never</td>
<td>4.68</td>
</tr>
<tr>
<td>11</td>
<td>1.25</td>
<td>6.60</td>
<td>5.35</td>
<td>NA</td>
<td>5.33</td>
<td>3.33</td>
<td>5.60</td>
</tr>
<tr>
<td>12</td>
<td>3.27</td>
<td>8.07</td>
<td>4.80</td>
<td>NA</td>
<td>10.13</td>
<td>4.73</td>
<td>7.70</td>
</tr>
<tr>
<td>Mean</td>
<td>2.09</td>
<td>7.10</td>
<td>5.01</td>
<td>NA</td>
<td>6.93</td>
<td>3.98</td>
<td>5.99</td>
</tr>
</tbody>
</table>

#### Existing vs Novel Systems Comparison

<table>
<thead>
<tr>
<th></th>
<th>Existing Mean Difference</th>
<th>Novel Mean Difference</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute mean difference</td>
<td>0.31</td>
<td>3.13</td>
<td>NS</td>
</tr>
<tr>
<td>p value</td>
<td>.005</td>
<td>.001</td>
<td>NS</td>
</tr>
</tbody>
</table>

**Abbreviations:** CAT, critical airway team; ENT, otolaryngologist; NA, not applicable; NS, not significant.

*Time response data including absolute time from simulation start and intervals are reported in minutes. Primary outcome was time from page to ENT arrival.
Not how systems fail, but how they work

• Maximize cognitive bandwidth to deal with the unexpected

• How do we design clinical activities to be more observable - rationale to be visible and communicated (Shared mental model)
Functional Resonance Analysis Method (FRAM)

Figure 1 and Table 1 combined from Clay-Williams R, Hounsgaard J, Hollnagel E. Where the rubber meets the road: using FRAM to align work-as-imagined with work-as-done when implementing clinical guidelines. Implementation Science : IS. 2015;10:125. doi:10.1186/s13012-015-0317-y. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4553017/ © 2015 Clay-Williams et al. Open Access This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/)
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4553017/ © 2015 Clay-Williams et al. Open Access This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/)
Functional Resonance Analysis Method (FRAM)

Figure 2 excerpt from Clay-Williams R, Hounsgaard J, Hollnagel E. Where the rubber meets the road: using FRAM to align work-as-imagined with work-as-done when implementing clinical guidelines. Implementation Science : IS. 2015;10:125. doi:10.1186/s13012-015-0317-y. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4553017/ © 2015 Clay-Williams et al. Open Access This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/)
The flexecution model of replanning.

Hoffman et al 2017
How do we maximize the adaptive capacity of individuals, teams, systems?

• Mix of experience, expertise
• Can it be optimized
• Can certain communication techniques or team behaviors be trained to develop, expand adaptive capacity
Time-based measures of components in effective adaptivity and resilience.
What’s next?

- Use simulation to help us understand and improve systems
  - Intentional probes
  - Serendipitous findings
What’s next?

• Safety-I
  • RCAs, FMEAS
• Safety-II
  • Debriefing
  • Root Success Analyses
  • Success Mode Effects Analyses
What’s next?

• Report and document!

• Pennsylvania’s MCARE Act of 2002
  • Hospitals, ASFs, others report Serious Events and Incidents in which patients experienced, or could have experienced, unanticipated harm
  • Criteria do not require that harm was caused by error
  • Incidents can include Unsafe Conditions identified during simulation

• Capture harm avoidance
What’s next?

• Align with organizational goals
• Expand existing safety processes and resources
• Develop new tools
• Apply concepts of Resilience
  • Monitor, Respond, Learn, Anticipate
  • Appreciate complexity, variation
• Study ways to enhance adaptive capacity
• Use Simulation’s ability to
  • Provide affective, technical and cognitive lessons
  • Elucidate system capacity
  • Develop and test system improvements
Summary I: Humans are AWESOME!

WE:

• Are essential assets and sources of creativity and solutions
• Learn and improve ourselves, our teams and the complex systems we work within
• Invent, create, develop healthcare advances and solutions
• Offer empathy and compassion
• Provide ever-improving healthcare
Summary II

- Healthcare delivery is a complex adaptive system
- Simulation, including debriefing, offers affective as well as technical and cognitive lessons
- Safety is an emergent property
- Resilience emerges from the capacity to monitor, respond, anticipate and learn
- Britteness is related to a lack of resilience
- Safety-II (what goes right) provides a constructive and effective perspective

WHERE DO WE GO NEXT?
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Safety-I
- What goes wrong
- Defined by failure
- Achieved by constraints
- Critical inquiry

Safety-II
- What goes right
- Defined by success
  - Achieved by adaptability
  - Appreciative inquiry

Hollnagel, Wears, Braithwaite; From Safety I to Safety II White Paper. 2015
## Safety-I vs Safety-II comparison

<table>
<thead>
<tr>
<th>Safety-I</th>
<th>Safety-II</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Defined by its opposite: <strong>failure</strong></td>
<td>• Defined by its goal: <strong>success</strong></td>
</tr>
<tr>
<td>• People (ought to) behave as expected &amp; trained</td>
<td>• People (ought to) adjust behavior &amp; interpret procedures</td>
</tr>
<tr>
<td>• Accidents: come from variability in above</td>
<td>• Accidents: come from incomplete adaptation</td>
</tr>
<tr>
<td>• Safety comes from limiting and constraining operators via</td>
<td>• Safety comes from supporting operators via</td>
</tr>
<tr>
<td>• Standardization, procedures, rules, interlocks, barriers</td>
<td>• Making boundaries, hazards, goal conflicts visible</td>
</tr>
<tr>
<td></td>
<td>• Enhancing repertoire of responses</td>
</tr>
<tr>
<td>• Critical inquiry</td>
<td>• Appreciative inquiry</td>
</tr>
</tbody>
</table>

Hollnagel, Wears, Braithwaite; From Safety I to Safety II White Paper. 2015
Learn from both failure and success

• Performance of soldiers doing successive navigation exercises improved significantly when they were debriefed on their failures and successes after each training day, compared with others who reviewed their failed events only.

• Learning from success
  • To clarify ability [and systems?] vs luck
  • When cost of errors is high

Ellis, Davidi; J Applied Psychology; 2005
Three contrasting approaches to safety

<table>
<thead>
<tr>
<th></th>
<th>Embrace risk</th>
<th>Manage risk</th>
<th>Avoid risk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Context</strong></td>
<td>Risk is inherent in the events</td>
<td>Risk is not sought but is inherent in the events</td>
<td>Risk is excluded as far as possible</td>
</tr>
<tr>
<td><strong>Power to:</strong></td>
<td>Experts</td>
<td>The group</td>
<td>Regulators and supervisors</td>
</tr>
<tr>
<td><strong>Training</strong></td>
<td>Peer to peer</td>
<td>In teams</td>
<td>Individuals and teams</td>
</tr>
<tr>
<td><strong>Priority</strong></td>
<td>Adaptation and recovery</td>
<td>Procedures and adaptation to strategies</td>
<td>Prevention strategies</td>
</tr>
<tr>
<td><strong>Examples</strong></td>
<td>Mass casualties</td>
<td>Scheduled surgery</td>
<td>Radiotherapy</td>
</tr>
<tr>
<td></td>
<td>Infrastructure failures</td>
<td>Chronic care</td>
<td>Blood transfusion</td>
</tr>
</tbody>
</table>

Adapted from Vincent, Amalberti. Safer Healthcare Strategies for the real world. 2016