Infection Prevention and Human Factors and Systems Engineering

Carla J. Alvarado, Ph.D.,
Research Scientist Emerita
University of Wisconsin-Madison
Contact Information
3100 Lake Mendota Drive
Madison, WI 53705
Tel: 608-695-8746
E-mail: calvarado@cqpi.engr.wisc.edu
Grudin’s Law:

– When those who benefit are not those who do the work, then the technology is likely to fail or, at least, be subverted
Infection Control? .... Infection Prevention

The Model Infection Prevention System of the Future

• Epidemic of HAIs is symptomatic of a structure that does not adequately reinforce and support infection prevention and control.

• *Errors result from faulty systems, not faulty people, so it is the systems that must be fixed.*”- Lucien Leape, MD

• Goal: To create a more fully integrated approach to infection prevention.
Current Reality of Average Infection Control Program

- More isolation than integration
- No learning systems dedicated to IP
- Lack of authority to implement change
- Poor understanding of economics of HAI
- Disbelief that zero can be achieved
- ICP is more “cop” than “coach”
- Staff see IP measures as a distraction or interruption
“It must be remembered that there is nothing more difficult to plan, more doubtful of success, not more dangerous to manage than the creation of a new system; for the initiator has the enmity of all who would profit by the preservation of the old institution and merely lukewarm defenders in those who would gain by the new one.”

Machiavelli – The Prince 1513
WORK SYSTEM (STRUCTURE)

Patient Outcomes:
- quality of care
- patient safety

Employee & Organizational Outcomes

PROCESS

OUTCOMES

Technology
Tools
Training
Organization
Environment
Person
Task


SEIPS - Systems Engineering Initiative for Patient Safety - www.fpm.wisc.edu/seips
Person

- Capabilities and Limitations
  - Musculo/skeletal
  - Sensory
  - Cognitive
Tasks

• Studied more than any element of the model
• Content considerations - repetitiveness and meaningfulness
• Overload and underload
• Paced work
• Lack of participation and control
• Skill/knowledge required
Technology/Tools/Training

- Enhancing job
  - Controls, displays - Cognitive skills
  - Computers
  - New technologies
  - Health and Safety
  - Device design
  - New materials
Environment

• Physical environment
  – Sensory disruptions: make it difficult to carry out tasks
  – Noise: can increase blood pressure, negative mood
  – Air quality: too hot, too cold, smells, stuffy air, “mass psychogenic illness”, comfort
  – Housekeeping
  – Fatigue, stress
Organization - Local

- Corporate structure
- Corporate culture
- Organizational support
  - Training, new technology, time for acclimation, work schedules
- Job growth
- Pay and benefits - Motivation?
- Management and supervision
- Employee identification
• In the late 1940s a man walked into a laboratory of a major photographic manufacturer in America to demonstrate a new photographic process. But he didn't bring along a camera or film. He brought along a red box with a shiny steel plate, a charging device, a light bulb and a container of black powder. The picture he created was faint but discernible. "But where's the film?" they asked. "Where's the developer? Where's the darkroom? Why, that's not really photography!" And so the company passed up an opportunity to acquire the process for electrostatic photography, or xerography...

PARADIGM PARALYSIS
We have “Paradigm Paralysis”

- Analysis of data on clinical outcomes undoubtedly led to many local improvements, BUT...is being precise enough to influence the system?
- In complex systems unpredictability is ever present, and some things will remain unknowable
Despite our attempts to control the machine (infection) in the modern healthcare organization, and despite the numerous machine-control techniques (org charts, policies, procedures, strategic plans, job descriptions, new technology, etc. are deeply rooted in the machine metaphor), it remains our common experience “Stuff Happens”… anyone remember New Coke?
• True to the machine metaphor, our usual reaction to “stuff” is to retrace the analysis, pinpointing the cause, extract the lessons learned and fix things up for the next round of analysis, when different “stuff” happens the next time around…

• Root Cause Analysis? Perhaps there are many cause-associated roots on the “fault tree”…
Better at times to be vaguely right, rather than precisely wrong…
• An underlying problem connecting hand hygiene to patient infection is lack of temporal significance in outcomes – poor hand decontamination today does not reflect an instant negative outcome for the patient. Infection occurs in days, not moments and by that time personal identification with the outcome is lost.
The question we must ask is: Is Infection Control/Prevention the task?

• or is it an interruption to what is perceived as the “real” task?
• A task has inputs → throughputs → outputs
  
  FEEDBACK

• If it is a task, how can it be imbedded into other tasks and not remain a “stand alone task” with no clear and timely feedback?
• Remember a “stand alone task” can be worked around…HAND HYGIENE IS A STAND ALONE TASK - AN INTERRUPTION!
Most nights, unexpected contingencies unwound the tight choreography of the shift, diagrammed in hourly increments in the sprawling spreadsheets of patients' charts. I lurched from one task to the next, fulfilling all requirements, but little more.

For a while, the electronic thermometers we used were in short supply, and the shift started with a mad dash to nab one. We made a joke of it, but behind the laughs, I heard the clock ticking. Infection control slows down all movement: Hands must be washed before and after every contact with a patient, and fresh gown and gloves donned every time one enters a patient room, to be discarded when exiting. A thermometer or any other piece of equipment moved from one room to another must be cleaned, too.
Understand the “System”

- Large scale issues in sociotechnical systems
- In IC we were trained to break down into parts…but in complex systems - *Relationships* between parts are far greater than the parts alone…
Examples

• Language
  – The meaning of any element depends on its relationship to other elements
  – Say the following word aloud: read
Example

• Termite hill
  – Can’t be reduced to the termites
  – Statistically emergent from termite
    • By the way there is no CEO termite or CNO-VP patient services termite etc., just termites that all know their places and tasks in the system
  – We establish order and control through actions of a few top people in the organization – this may be the biggest factor holding back innovation and progress in our organizations
In a Complex System *Relationships* between parts are far greater than the parts alone...
Science of controlling infections by...

- Identify the cause and take steps to remove it (e.g. disinfection) or contain it (e.g. isolation)
- Today’s HAI have fuzzier boundaries – result of interplay of genetics, technology, tasks, environment, the “organizations” themselves – the SYSTEM
- Our traditional ways of “getting our heads around the problem” are no longer appropriate in Infection Prevention
Complex Adaptive System

- Collection of individual agents (MDs, RNs, patients) with freedom to act in ways that are not always totally predictable...

- NOT A MECHANICAL SYSTEM or MANUFACTURING
  - There the boundaries are fixed and well defined – you know what is part of the Toyota and what is not and it does not have opinions!
Inherent Self Organization Through Simple Locally Applied Rules

• Order, innovation, and progress can emerge naturally from the interactions within a complex system; they do not need to be imposed centrally or from outside.

• In everyday life many complex behaviors emerge from relatively simple rules in such things as driving in traffic, interacting in meetings or a well trained OR team.
Complex Systems – agents actions are based on internalized rules

- Instincts, constructs and mental models
- Internal rules may not be shared, explicit or even logical
- i.e. the doctor, the nurse, the housekeeper – all have different internalized rules
- Is there a “shared mental model” for hand hygiene or is it individual, internalized rules?
Perhaps this is your ‘mental model’ for this lecture?

“But our system works fine! It’s not complex or out of control…in fact we’ve got IHI bundles in place!”

I’m very happy for you
But, look carefully for workarounds, “shadow” aids, etc.
- Indicators of attempts to bridge gaps in performance

Non-threatening observations of real work give voice to the unvoiced
Infection Prevention is a Complex Adaptive System and a Socio-technical System

• Every organization has social (people, values, norms, culture, climate) and technical (tools, equipment, procedures, technologies, facilities) parts, and exists in an external milieu (economics, regulation, law)

• Reciprocal determinism (Bandura)
  – Changes to one aspect cause changes in the other (after varying time delays), which cause changes in the first, etc
  – Any “simple” change will reverberate thru the system in planned and unplanned ways

• All components need to fit together – joint optimization

• That means the technical issues, such as Infection Prevention and especially hand hygiene – are social issues!
Emergency Room
Can’t go to OR because…

Operating Room
Can’t go to RR because…

Recovery Room
Can’t go to ICU because…

Relatives are not here…NO RIDE

Ward
Can’t go home because…

ICU
Can’t go to Ward because…
Systems are embedded within other systems and co-evolve

- The doctors and/or the nurses have evolved their own system – apart from the other ICPs, managers, and even other MDs and nurses
- The hospital is embedded in the larger healthcare system and this plays a part in their behavior
- Our efforts to improve the formal system must also consider the “Shadow System”
Simple Rule: Infection prevention and hand hygiene embedded into the all parts of the model/processes

- Our learned instinct with such issues, based on reductionist thinking, is to troubleshoot and fix things—in essence to break down the ambiguity, resolve any paradox, achieve more certainty and agreement, and move into the simple system zone. But complexity science suggests that it is often better to try multiple approaches and let direction arise by gradually shifting time and attention towards those things that seem to be working best.
Help! I am stuck in the “IP Zone of Complexity”…What do I do?

- Good enough planning-minimum specification, simple rules – your tidy solution may not be their’s
- Multiple action – Bundles
- Experiment and tune system – PDSA
- Listen to the *shadow system* tells you – it’s there for a reason, follow it and work with it
- Use intuition, muddle through - Outbreaks
- Chunking – Work on several IP issues at once
- Metaphors – Communication can be difficult when issues are complex. Using metaphors can often create a shared understanding
- Ask hard questions
Complex Adaptive Systems are guided by *Simple Rules*

**No patient should be harmed by HAI**

- Targeting Zero HAI is an organizational goal
- Hand Hygiene is an organizational goal
- Chief executives must deliver clear expectations, set goals/metrics, provide necessary resources
- IP and hand hygiene incorporated into each task
Simple Rules

*We learn from our errors in a safe environment*

– All are empowered to stop risky processes
  • No matter when, where or with whom
  • Without fear of retaliation
– Transparency
– Rapid problem solving
– Integrity and trust engrained in culture
Simple Rules

*Everyone is responsible for infection prevention and Hand Hygiene*

- There is reciprocal responsibility for infection prevention - everyone owns it
- Patients are partners in their care
- Rewards follow compliance, responsibility
- Participation at every level
Therefore, a multi-factorial approach is essential

- Education: how, when, why with specific emphasis on elective hygiene
- Environmental designs
- Motivation: peer pressure and modeling, overt and continuing administrative support
- Cues to action: posters, easy access
- Patient/staff empowerment (“Ask me if I have cleaned my hands”)

Things to Watch Out For in IC System Re-design

• “More training”
  – If frequent users are making mistakes, that’s a design problem, not a training problem

• Banning work-arounds – rules and policies
  – Every work-around is a solution to some problem – find the problem and fix it

• Don’t believe reports that everything is fine
  – Clinicians will work around problems, and interpret that as “no problems”
  – Non-threatening observations of low-status users

• Emulating the old artifact, i.e. paper copies of e-info
  – Understand the important functionality of the old artifact and try to provide it

• “The next version will fix that”
  – You can’t debug poor system design
OK, show me the evidence…

  
  - Single intervention (2% CHG disposable cloths) targeting source control lowered new acquisition of VRE, reduced VRE in environment and on healthcare workers hands (chunking)

- non-optimal hand hygiene lack of “user friendliness” of hand hygiene resources due to violation of ergonomic principles in the design of hospital environment and lack of timely replenishment of consumable resources
- ergonomics-based tool, SWAG (for the four main hand hygiene resources—sinks, waste receptacles, alcohol-based hand rub dispensers, and gloves) was developed and implemented to assess the intensive care units and individual rooms in hospital for ergonomic characteristics that facilitate usage
- deficiencies identified that hinder usage: poor visibility, difficulty of access, placement at undesirable height, lack of redundancy, and wide spatial separation of resources that are used sequentially. consumable hand hygiene resources were often not available because of lack of timely replenishment
Remember Semmelweis?

• What was his “Root Cause” of puerperal fever?

• The Root Cause was one of advancement in medical technology – the ORGANIZATION part of the model, explaining that in years prior, incidence of puerperal fever had been equally low in both wings of the hospital. But, with emergence of forensic pathology and the opening of the new Institute of Anatomy, instructional autopsies performed on this indigent patient population came into academic fashion and were required of all physicians with patients that died in the hospital.
Thank you for listening me!
Questions?