Clostridium difficile prevention using a human factors and systems engineering approach

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Objectives of the Session

1. Identify how to apply a systems engineering approach to *C. difficile* prevention
2. Describe the complementary data collection approaches useful in characterizing *C. difficile* prevention efforts.
3. Examine the interprofessional aspects of *C. difficile* prevention

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Complexity of *C. difficile* infection

Challenges to containment

- Uncertain incubation period
- Multiple reservoirs
- Environmental persistence
- High rates of recurrence
- Need for soap and water for hand hygiene
- Multidisciplinary approach to containment
- Need for both infection prevention protocols and antibiotic stewardship interventions

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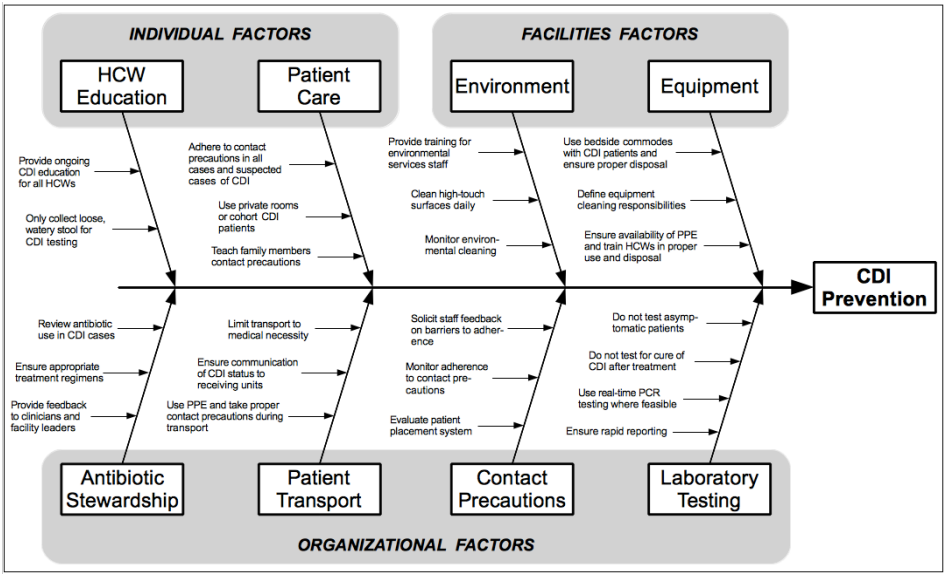
Fishbone diagram showing the complexity of CDI



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Systems Perspective

An individual perspective may be narrow, underestimate the scope of the problem, may not be sufficient to recognize root causes and may make implementation of infection prevention for CDI challenging

A systems perspective takes the whole picture into consideration from all relevant perspectives and stakeholders

Breaks the problem down into its component parts

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Human Factors

- Misperceptions:
  - Fact #1: *Human factors is about designing systems that are resilient to unanticipated events*.
  - Fiction: *Human factors is about eliminating human error*.
  - Fact #2: *Human factors addresses problems by modifying the design of the system to better aid people*.
  - Fiction: *Human factors addresses problems by teaching people to modify their behaviour*.

The science of human factors: separating fact from fiction Alissa L Russ et al https://qualitysafety.bmj.com/content/22/10/802

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- Fact #3: *Human factors work ranges from the individual to the organisational level*.
- Fiction: *Human factors is focused only on individuals*.

- Fact #4: *Human factors is a scientific discipline that requires years of training; most human factors professionals hold relevant graduate degrees*.
- Fiction: *Human factors consists of a limited set of principles that can be learnt during brief training*.

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- Fact #5: *Human factors professionals are bound together by the common goal of improving design for human use, but represent different specialty areas and methodological skills sets*.
- Fiction: *Human factors scientists and engineers all have the same expertise*.

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Human Factors/Ergonomics

HFE mechanisms	Objectives of system design
1. A work system that is not designed according to HFE design principles can create opportunities for errors and hazards (see table 2 for examples of design principles)	The objective of HFE-informed system design is to identify and remove system hazards from the design through maintenance phases.
2. Performance obstacles that exist in the work system can hinder clinicians' ability to perform their work and deliver safe care	If some obstacles cannot be removed, for instance, because they are intrinsic to the job, then strategies should be designed to mitigate the impact of performance obstacles by enhancing other system elements (ie, balance theory of job design)**4142**
3. A work system that does not support resilience can produce circumstances where system operators may not be able to detect, adapt to, and/or recover from errors, hazards, disruptions and disturbances	Work systems should be designed to enhance resilience and support adaptability and flexibility in human work,**43** such as allowing problem or variance control at the source**44**
4. Because system components interact to influence care processes and patient safety, HFE system design cannot focus on one element of work in isolation.**32 35**	Whenever there is a change in the work system, one needs to consider how the change will affect the entire work system, and the entire system needs to be optimised or balanced**41 42**

HFE mechanisms between system design and patient safety
•HFE, human factors and ergonomics.

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Human Factors/Ergonomics

Focus of HFE	Examples of HFE design principles
Physical HFE	To minimise perception time, decision time, and manipulation time
	To reduce or mitigate need for excessive physical exertion
	To optimise opportunities for physical movement
Cognitive HFE	To ensure consistency of interface design
	To match between technology and the user's mental model
	To minimise cognitive load
	To allow for error detection and recovery
	To provide feedback to users
Organisational HFE	To provide opportunities to workers to learn and develop new skills
	To allow worker control over work system
	To support worker access to social support
	To involve users in system design

Examples of HFE design principles
•HFE, human factors and ergonomics.

Human factors and ergonomics as a patient safety practice Pascale Carayon, Anping Xie, Sarah Kianfar
https://qualitysafety.bmj.com/content/23/3/196#block-system-main

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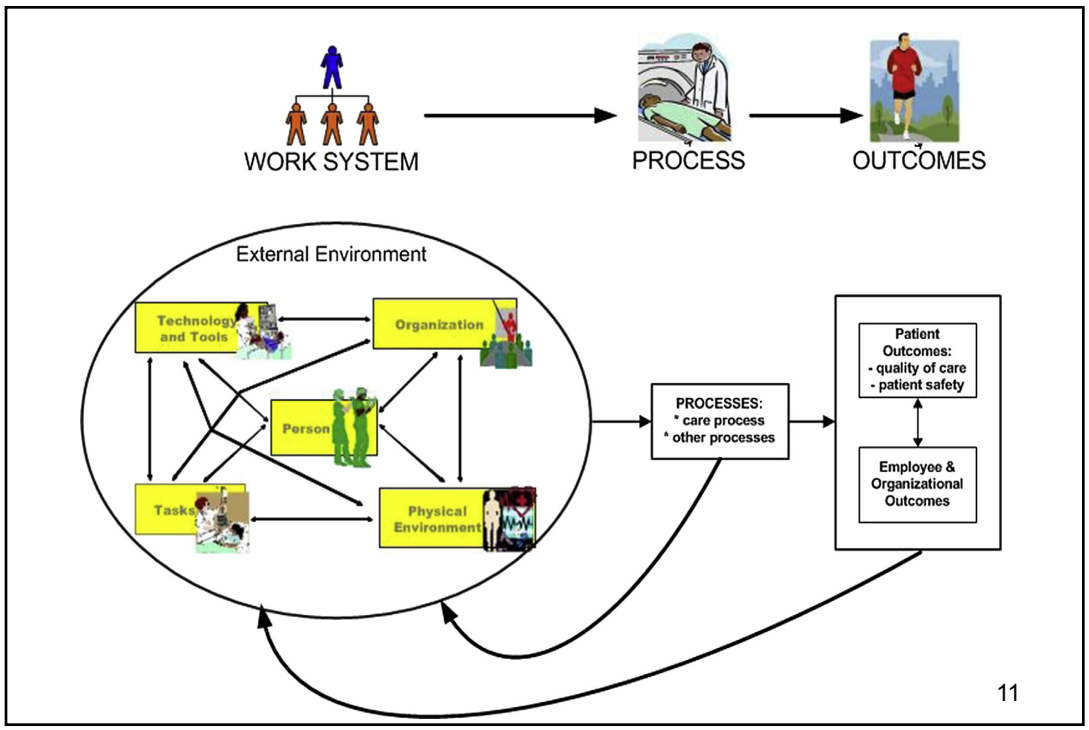

Table 2
Value of SEIPS model to healthcare.

Characteristics of SEIPS model	Value to healthcare
Integration of SPO model in SEIPS model	Healthcare professionals' familiarity with SPO model translating to adopting SEIPS model
Work system model	Broad focus, not just individual focus; support to develop wide set of solutions for redesigning system
Patient outcomes and employee/organizational outcomes	Benefits for both patients and healthcare workers
Generic model	Applicability to any healthcare domain and healthcare quality or patient safety problem
Person at the center of work system can be healthcare professional, patient, or team	Flexibility in applying model to various work systems and various people
Feedback loops from processes and outcomes, to work system	Emphasis on the need for healthcare organizations to monitor, consider, and take advantage of ongoing feedback
Process influenced by work system	Expanded view of process that integrates all work system elements Importance of care processes as well as connected processes (e.g., housekeeping)
System interactions	Emphasis on systemic impact of organizational and sociotechnical changes

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Key interventions for CDI prevention - a CDI bundle

1) rapid, appropriate diagnostic testing for *C. difficile*

2) empiric isolation for patients with diarrhea and suspected CDI

3) contact isolation for patients with confirmed CDI

4) environmental decontamination of CDI patient rooms

5) full compliance with hand hygiene by all entering and leaving CDI patient rooms.

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SEIPS model for CDI

Five Components

- Tools
- Technologies
- Environment
- People
- Organization
- Tasks

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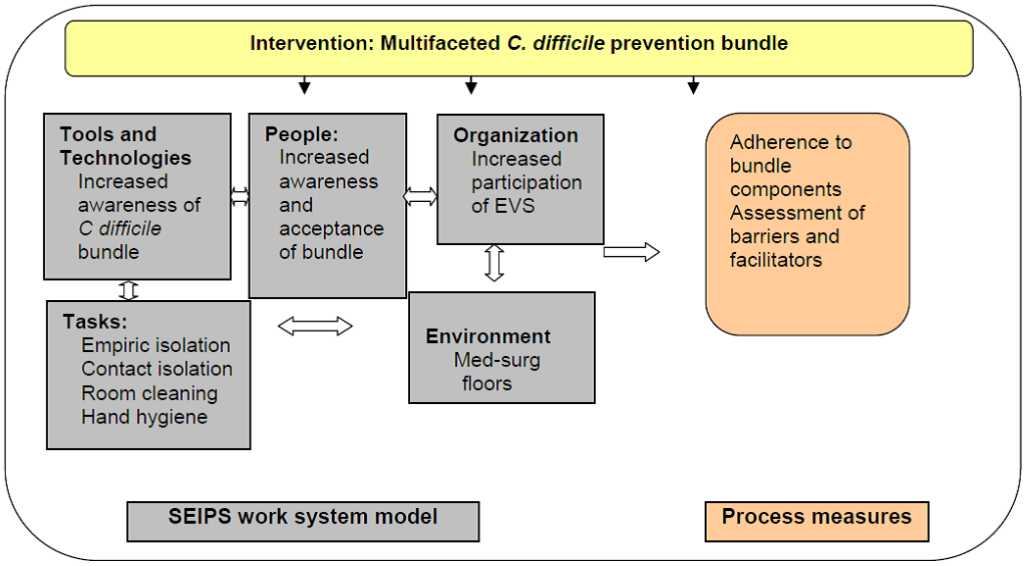
SEIPS for evaluation of *C difficile* bundle



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SEIPS application to CDI

- Create a process map to understand current practice and procedures
- Review of policies and procedures, signage, diagnostic testing procedure
- Supplement this data with focus groups/interviews of relevant groups
- Supplement with direct observations of PPE donning and doffing, room layout, PPE supplies.

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Data collection

- Three homogenous focus groups convened – one each comprised of physicians, nurses and environmental services workers (EVS) – over a 4-week period.
- The physician focus group included 7 medicine residents and one attending physician
- The nursing focus group included 10 nurses from medical units with varying experience
- The EVS group included six participants with 2-30 years of experience from varying types of units (ICU, medical, surgical).

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- Facilitated by a human factors engineer with significant experience in healthcare group facilitation.
- Participants received no financial remuneration for attending.
- Discussion was audio recorded for transcription by a professional service and subsequently coded by two researchers

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Transcripts of the three focus groups were uploaded to Dedoose® web-based qualitative data analysis software.

Each excerpt was coded to three dimensions –

1) which of the five CDI bundle interventions the excerpt corresponded to
2) which of the five elements of the work system it related to
3) and 3) whether it was a work system barrier or facilitator.

An excerpt could be coded to multiple bundle interventions, multiple work system elements and be both a barrier and facilitator.

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Person.

Nurses presented an issue associated with relying on <u>others to inform them that a patient they care for has CDI.</u> This becomes a problem when the expectation is not met. For example, CDI patient rooms must have a sign on the door informing the person entering the room to take additional precautions.

If the person responsible for posting the sign forgets or does not post the notice, hand hygiene and other CDI interventions may not appropriately occur.
[Nurse focus group: "Or if somebody forgets to put the sign up and it's your patient … you have no idea they were in isolation. That's (not) always great."

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Tools/technology.

All three groups noted sink interference posed by the excessive amount of equipment (and also people) in the patient room.

Pose sink access issues. [EVS focus group: "(There are) huge chairs and the patient sits in front of the sink. And then we can't get to the sink to wash our hands. … Supplies in front of the sink … (cause) interference."]

EVS staff commented on their positive and consistent use of pagers as a means of informing them that they will be cleaning a CDI patient room.

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Organization.

The challenge of educating patients' families regarding their need to comply with the CDI interventions was solely discussed by nurses who noted that changes in hand hygiene practice varied based on family member perceptions.

Physicians admitted the lack of clarity of the hand hygiene policy related to when, where, and how long hand washing should occur.

Other organization issues that were identified frequently related to role-specific policies solely relevant to a particular group. For example, EVS workers discussed significant issues related to training and staff turnover that had an impact on compliance with and understanding of the importance of hand hygiene.

Institutional pressure to turnover room fast

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Environment

Eight of the 52 total comments were related to sinks and were made by all three groups.

Consistent issues related to the number and location of the sinks.

[Nurse focus group: "We have to use the sinks in the hallway to wash our hands because you can't get out of a C. diff room without recontaminating your hands after you've washed."]

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Tasks

Wet hands make gloving difficult

PPE when not anticipating touching patient or environment

Inconsistency in where used gowns are disposed

Inconsistency in where clean gowns are stored

Supply

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SEIPS Application to PPE

Person
- Type of healthcare worker
- Patient/visitor
- Knowledge/awareness
- Perception of risk given anticipated activity

Tools/technology
- PPE cumbersome
- Use of phone/iPAD in isolation rooms difficult

Tasks
- Bundling of cares
- Increases time
- Cleaning issues

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SEIPS Application to PPE

Environment
- Disposal
- Supplies
- Signage on door
- Stethoscope issues

Organization
- Policies
- Practice variation
- Leadership involvement

Facilitators
- Leadership engagement
- Consistency of messages
- Ease of availability and disposal

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SEIPS and interventions

- Create a list of barriers and select ones that are modifiable and have high impact
- Examples
  - Creation of new sinks
  - Consistency of messaging- pros and cons
  - Leadership support for EVS

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Acknowledgments

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