RELATING HEALTHCARE WORKERS' MENTAL MODELS TO THE TRANSMISSION OF INFECTIOUS AGENTS DURING PATIENT CARE

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EMORY UNIVERSITY SCHOOL OF MEDICINE — Healthcare Human Factors Laboratory
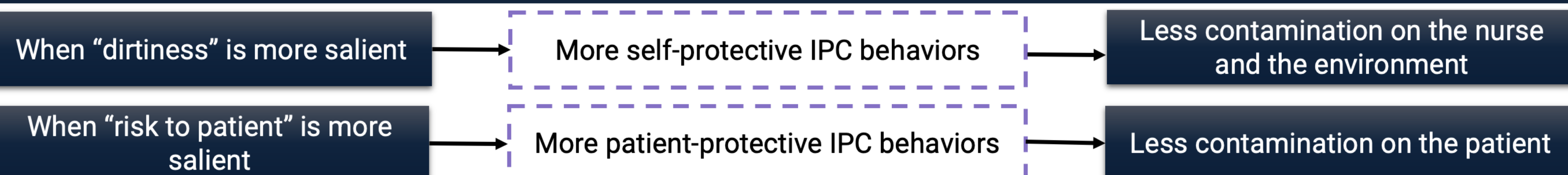
BACKGROUND AND OBJECTIVE

Mumma et al. (2021) assessed nurses' mental models of patient care tasks and identified *the perceived magnitude of infection risk to the patient* in the task and *perceived "dirtiness" and risk of HCW exposure to body fluids* as salient characteristics of tasks.

We want to understand if these perceptions have implications for how nurses deliver patient care.

We presume that how nurses sequence/organize their tasks may reflect the characteristics they perceive tasks to have (mental models). For example, HCWs may intentionally "batch" dirtier tasks together and cleaner tasks together to be more efficient (Chang et al., 2022).

We hypothesized that mental model of nurses will guide how nurses sequence their tasks and consequently spread cross-contamination.

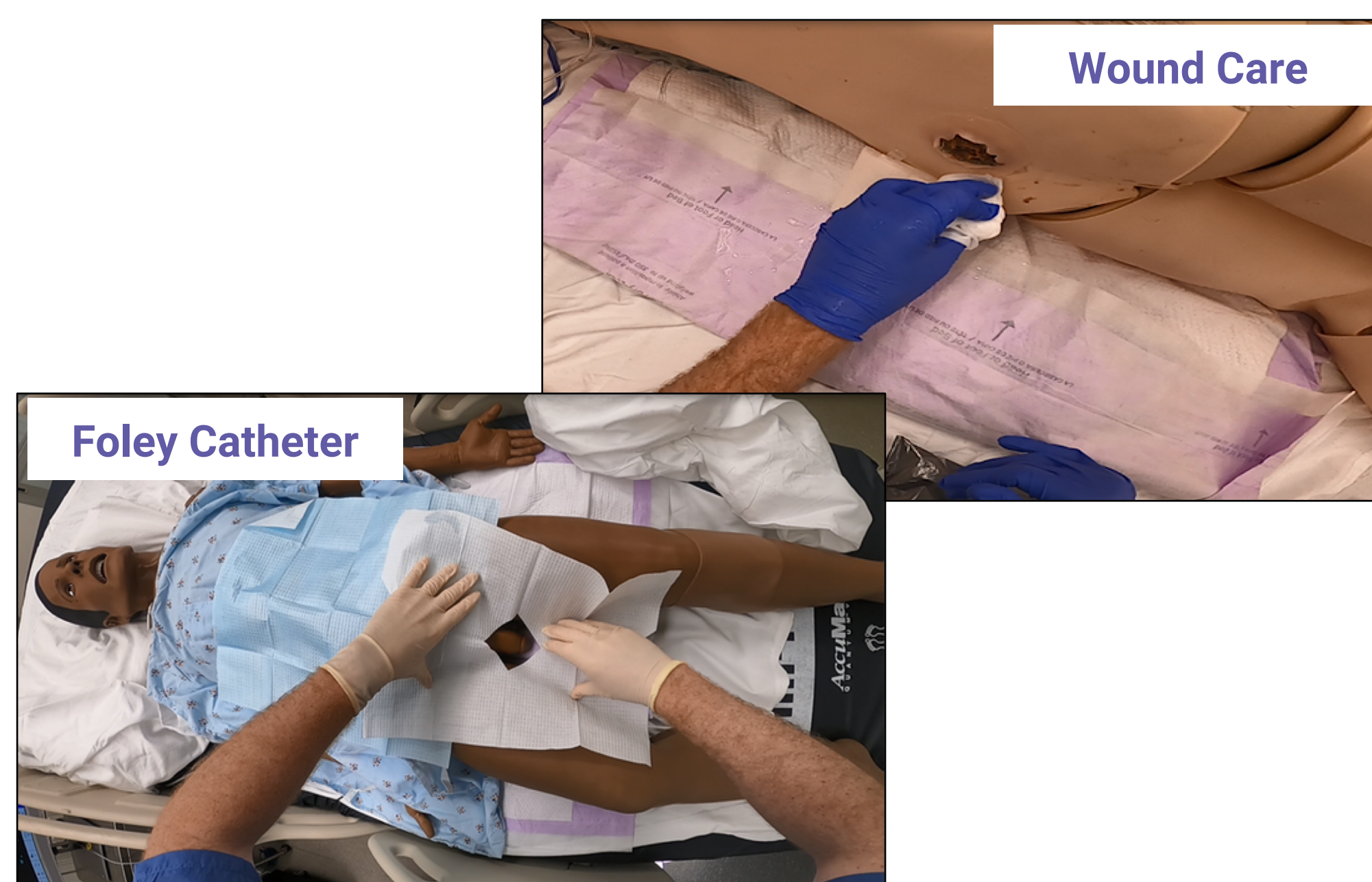| When "dirtiness" is more salient | → | More self-protective IPC behaviors | → | Less contamination on the nurse and the environment |
| When "risk to patient" is more salient | → | More patient-protective IPC behaviors | → | Less contamination on the patient |

METHODOLOGY

Participants:
N=45 Registered Nurses from ICU (15), ED (12), or Med/Surg (18), 2 excluded due to missing data

Simulation Steps:
- Prior to each simulation, four variants of a harmless bacteriophage (Phage Lambda) are inoculated onto two known sources of nosocomial bacteria in each patient room.
- Nurses perform eight patient care tasks across two staged patient rooms and a supply room in a high-fidelity simulation.
- Simulations include common barriers: Time pressure, scripted interruptions, and clutter
- Sample surfaces for cross-contamination after simulation.
- Perform retrospective "think aloud" with participants.

Measures
- **Perceived Similarity:** Ordinal proximity of tasks
- **Contamination:** Count of surfaces with any bacteriophage present
- **Behavioral Analysis:** Audiovisual recordings were collected

Table 1. Eight Patient Care Tasks for Simulation

	High "Dirtiness"/ Risk of Body Fluid Exposure	Low "Dirtiness" / Risk of Body Fluid Exposure
High (Perceived) Risk to Patient	1. Changing a stage-4 pressure ulcer dressing. 2. Inserting a Foley catheter.	1. Inserting a PIV in an upper extremity. 2. Administering an IV medication and flush.
Low (Perceived) Risk to Patient	1. Toileting in bed with a bedpan. 2. Collecting a stool specimen from an under-pad.	1. Inserting an NG tube. 2. Auscultating breath, heart, and abdominal sounds.

Wound Care

Foley Catheter

Contamination Sampling Locations

Room 1: "Harry"
Room 2: "Sam"
WoW
Nurse

High Touch Surfaces (12)
Bedside table
Bedrails top
Bedrails buttons
Touchscreen
Supply cart
WoW

Patient Surfaces (2)
Wound
Groin

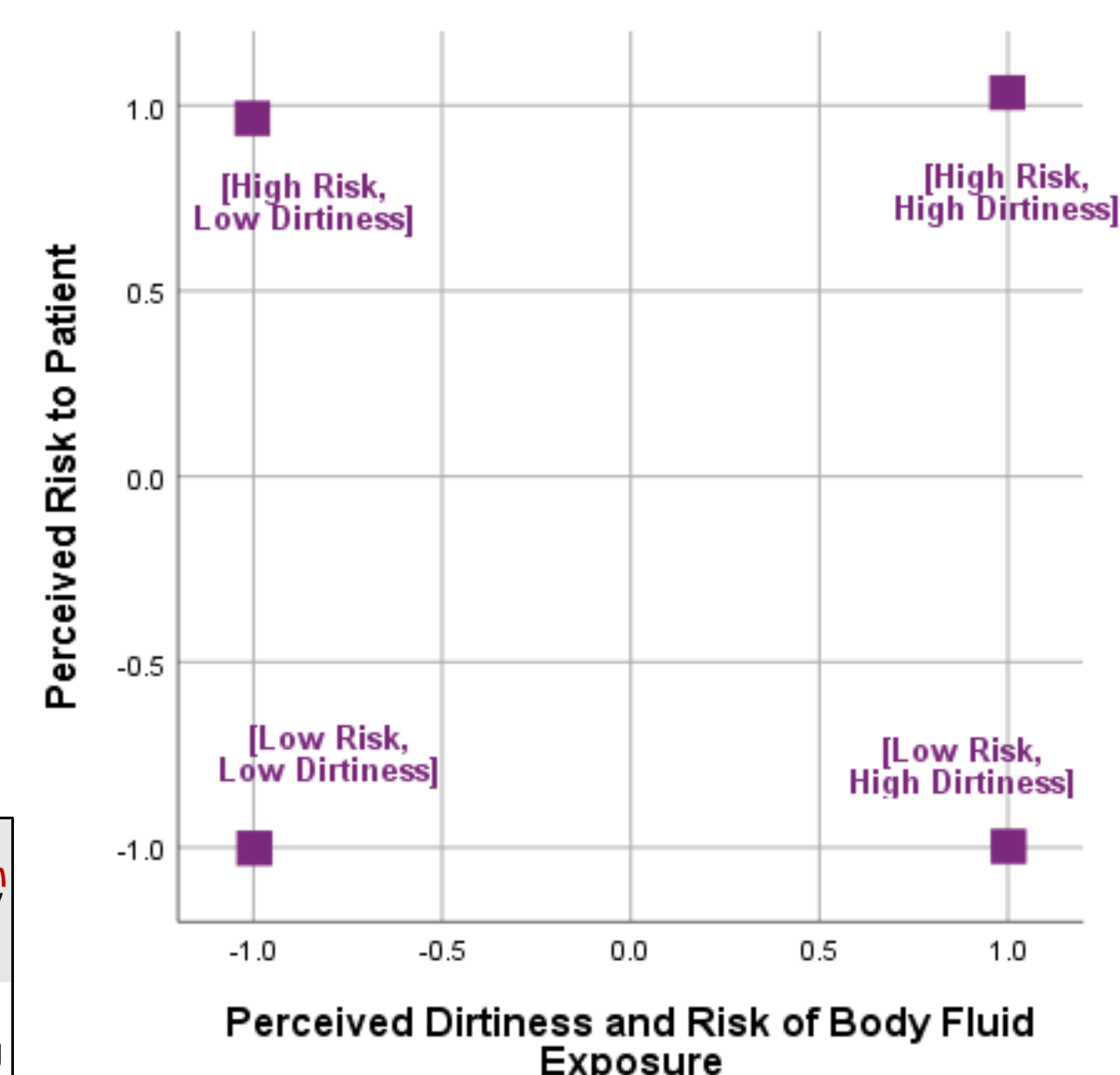| Nurse Surfaces (2) |
|---|
| Hands |
| Scrubs |

ANALYSIS

Multidimensional Scaling (MDS) of Ordinal Task Proximity:
- MDS was used to uncover the characteristics of tasks (dimensions) and the weight/salience of each dimension, for each nurse.
- One sampled t-test for MDS bias scores shows that nurses weigh "dirtiness of task" dimension more heavily ($M=1.82, MD=0.82, SD=1.9, d=0.43$) than being neutral (bias=1), $t(42)=2.81$ $p =0.007$.

$$Bias = \frac{MDS\ Weight\ on\ "Dirtiness"\ Dimension}{MDS\ Weight\ on\ "Risk\ to\ Patient"\ Dimension}$$

Table 2: Examples of task sequences of participants with different biases showing different task batching behaviors

Bias > 1 (Dirtiness more important); ICU1	Low Dirtiness .... High Dirtiness Room 1: Auscultating, Medication Administration, Stool, Foley Room 2: PIV, NG Tube, Toileting, Wound Care
Bias = 1 (Neutral), ED18	Room 1: Medication Administration, Stool, Foley, Auscultating Room 2: Toileting, PIV, NG Tube, Wound Care
Bias < 1 (Risk to patient more important), ICU9	Low Risk .... High Risk Room 1: Stool, Auscultating, Medication Administration, Foley Room 2: Toileting, NG Tube, Wound Care, PIV

Perceived Risk to Patient / Perceived Dirtiness and Risk of Body Fluid Exposure

[High Risk, Low Dirtiness] [High Risk, High Dirtiness] [Low Risk, Low Dirtiness] [Low Risk, High Dirtiness]

MDS applied to ordinal proximity of simulation tasks

Regression between Bias and Contamination:

Three separate Poisson Regression models were run to predict three different contamination frequencies (DV) based on MDS bias (IV).
- **Nurse Surfaces:** β= -0.04 (95% CI, -0.247 to 0.166), χ^2 =0.147 , p=0.702
- **High Touch Surfaces:** β= -0.043 (95% CI, -0.158 to 0.073), χ^2 =0.519, p=0.471
- **Patient Critical Sites:** β= 0.094 (95% CI, -0.124 to 0.311), χ^2 =0.71, p=0.4

Nurse Surfaces (n = 2): 34%
High-Touch Surfaces (n=12): 18%
Patient Critical Sites (n = 2): 20%
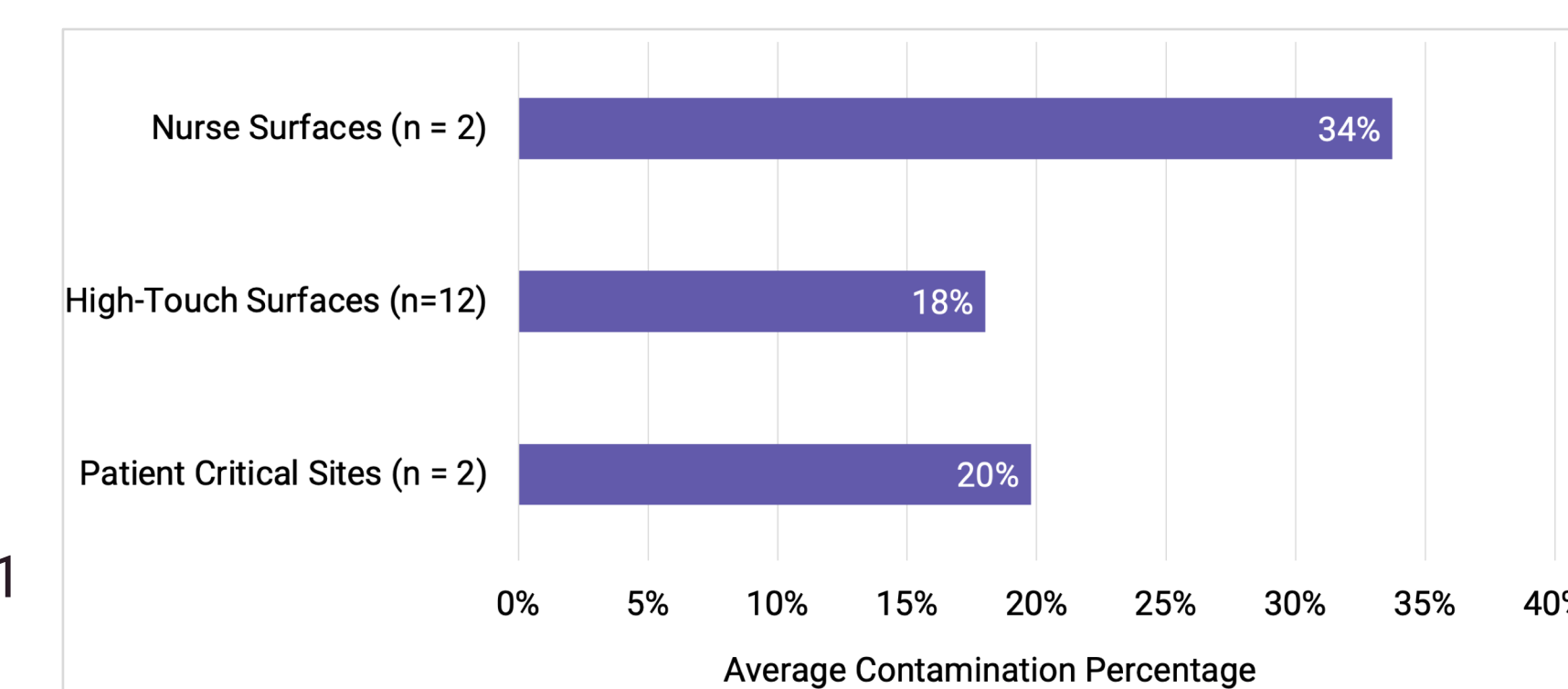
Average contamination data for all participants

RESULTS

- How nurses sequence a set of tasks reflects the perceived infection risk to the patient in the task and dirtiness/risk of HCW exposure to body fluids.
- Nurses give more weight to the dirtiness/risk of body fluid exposure of tasks than risk to the patient.
- How nurses weight these characteristics was not related to how much they contaminated themselves, high touch surfaces, or critical sites on their patients.

CONCLUSION

- Mental models of nurses play a role in how nurses sequence their tasks, but their relationship with contamination spread was not supported.
- Other mediating factors like, the quality of infection prevention practices, play a role in the spread of contamination.

Important References
- Chang, N. C., Jones, M., Reisinger, H. S., Schweizer, M. L., Chrischilles, E., Chorazy, M., ... & Herwaldt, L. (2022). Hand hygiene and the sequence of patient care. *Infection Control & Hospital Epidemiology*, 43(2), 218-223.

- Mumma, J. M., Howard-Anderson, J. R., Morgan, J. S., Schink, K., Wheatley, M. J., Kraft, C. S., ... & Jacob, J. T. (2021). Healthcare worker mental models of patient care tasks in the context of infection prevention and control. *Infection Control & Hospital Epidemiology*, 1-6.

Watch Simulation Video!