”AHEAD” – a consolidated framework for behavioural infectious risks in acute care

Part 1

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No competing interests to declare

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- Look at patient care as a continuum producing multiple behaviour-related **infectious risk moments** for patients
- Appreciate the importance of moments with low individual risk for healthcare infections, but important **cumulative risk** due to their frequent occurrence
- Get to know an observation-based **taxonomy** for classifying infectious risk moments
- Learn about how an international panel of experts evaluated the risk of infectious **outcomes** following specific infectious risk moments
- Consolidate these building blocks in a **comprehensive framework** on infectious risks in acute healthcare

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Mountains :)


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ETH Zurich
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[900 beds-all inclusive]
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Infectious Risk Moments (IRM)

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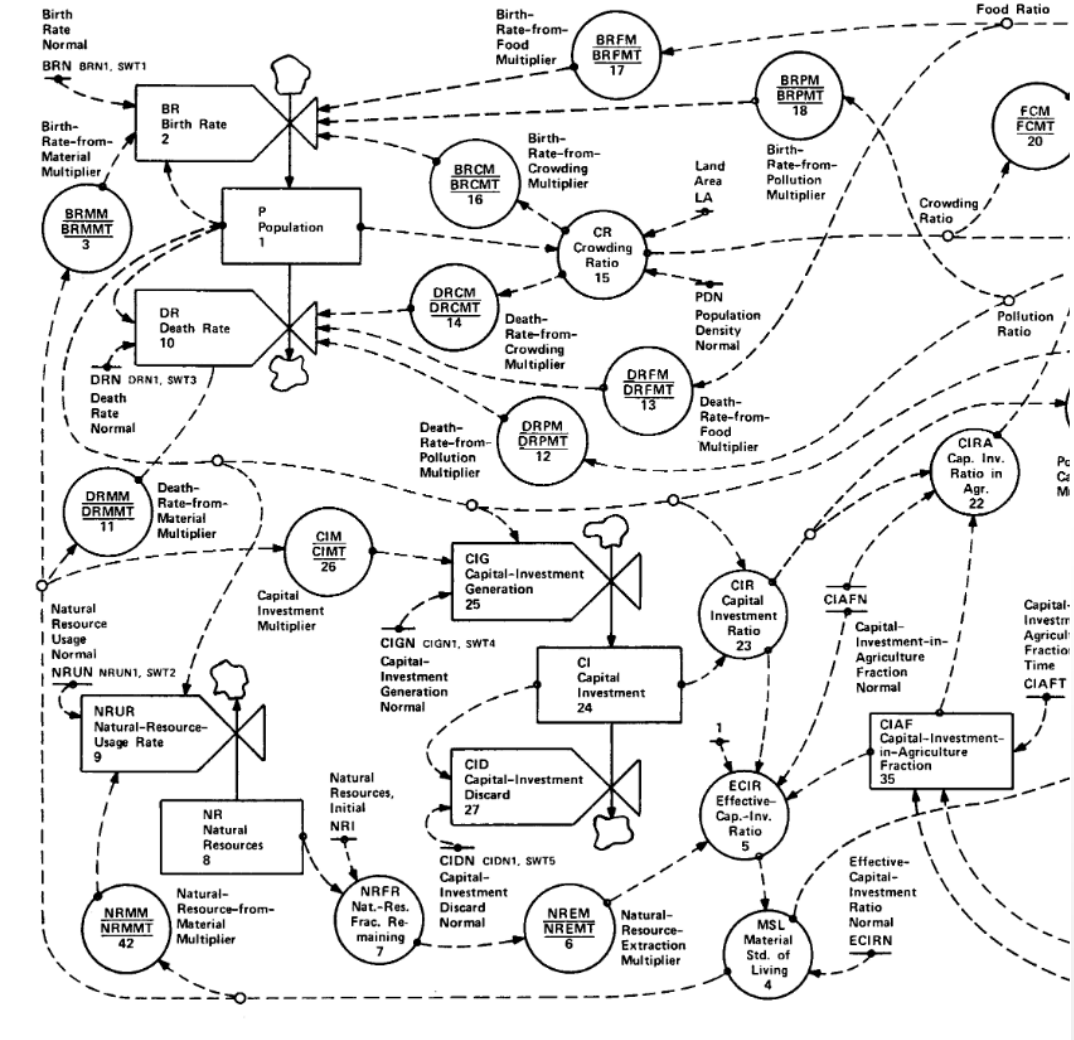
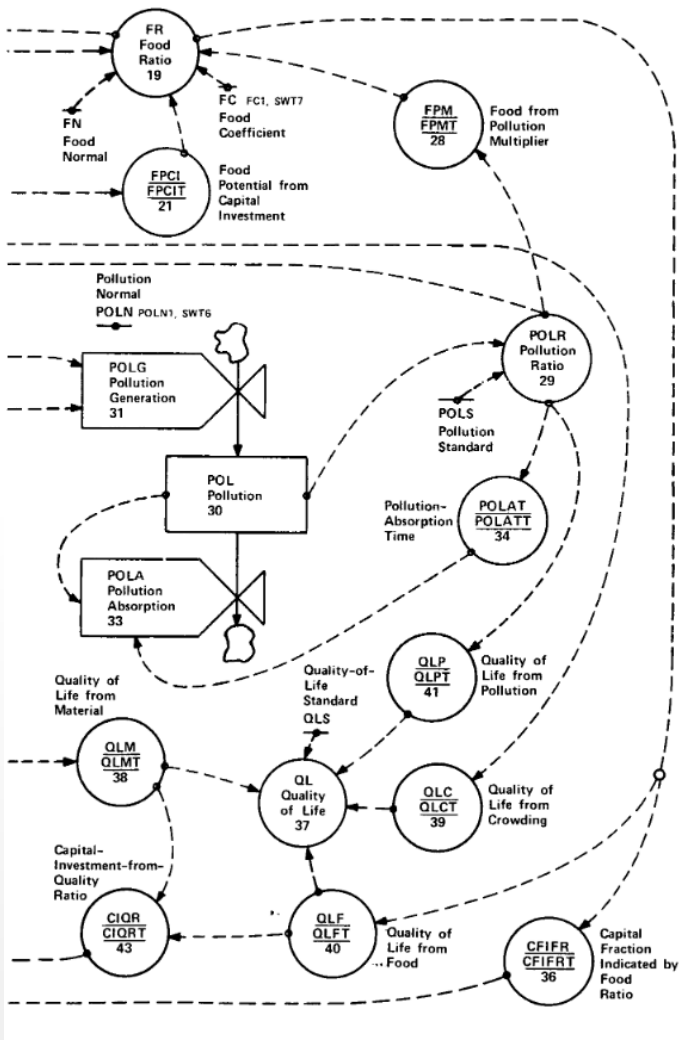
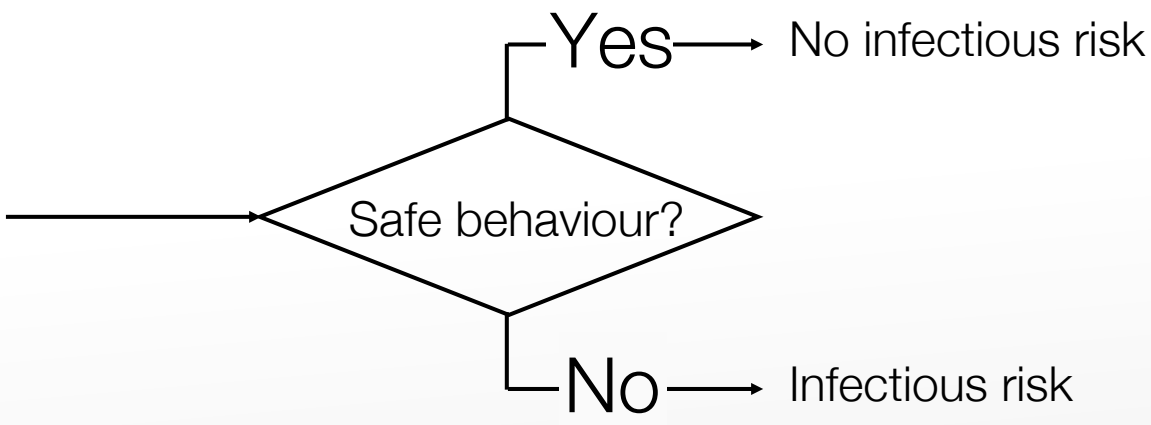
Systems Thinking





Jay Forrester. Counterintuitive Behavior of Social Systems; 1995. www.clexchange.org

Infectious Risk Moments



Human factors

Human factors is the scientific discipline concerned with the understanding of **interactions** among **humans** and **other elements of a system**, and the profession that applies theory, principles, data and methods to design to **optimise human well-being** and overall **system performance**.

30-70% of healthcare-associated infections are preventable.

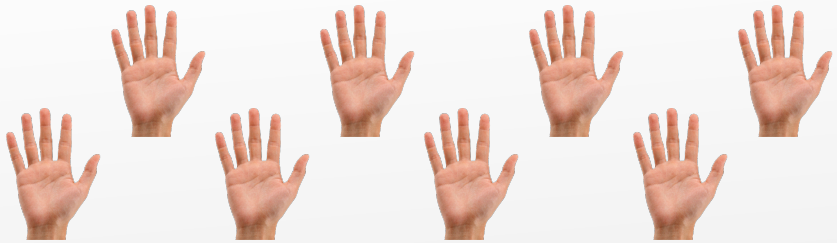
Still…

Schreiber PW, et al. ICHE 2018


Your 5 Moments
for Hand Hygiene
1
4
AFTER
TOUCHING
A PATIENT
5

risk = f [frequency x impact]

HIGH likelihood of infection x LOW frequency = high RISK



LOW likelihood of infection x HIGH frequency = high RISK

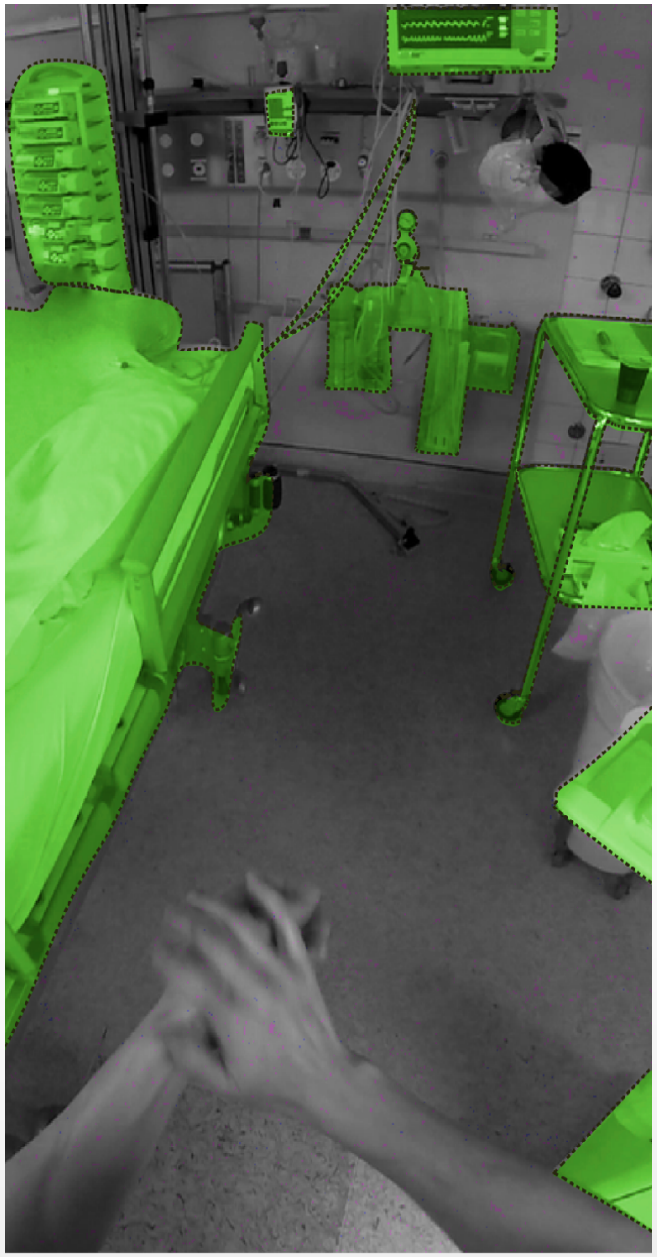
Head camera study > hand-to-surface exposures (HSE)

HSE definition: contact resulting in bi-directional exchange of microorganisms between hand and the touched surface

Method: Indirect observations of HSE using head-camera in trauma ICU

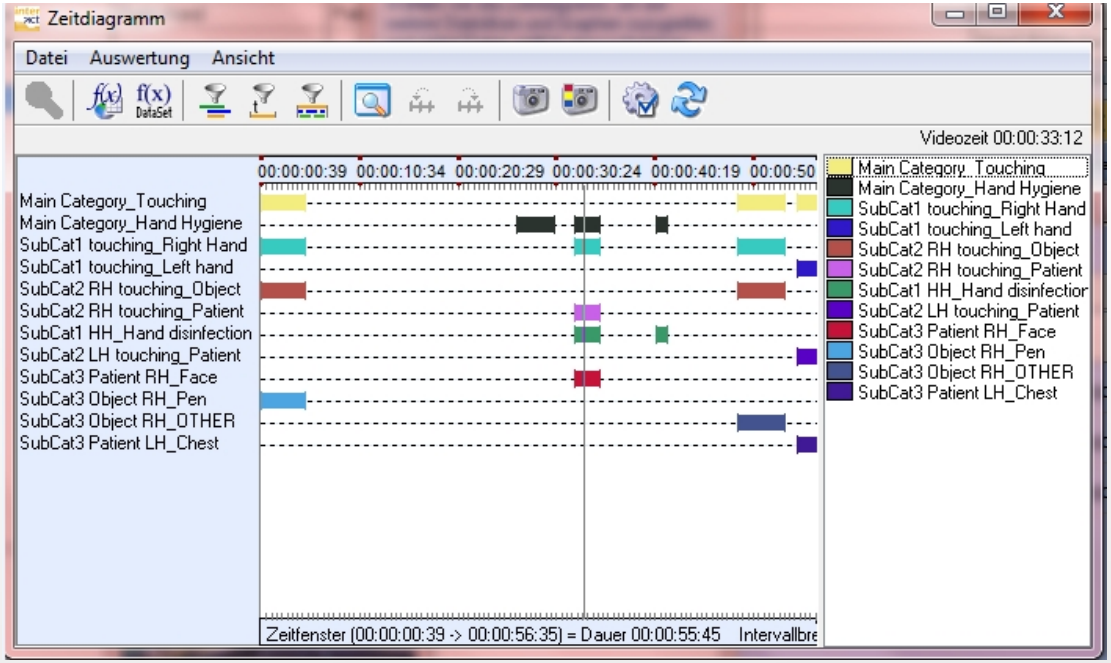
Results:

- Filmed and coded 300 minutes of care (8 nurses, 2 physicians) in ICU
- 4,222 hand-to-surface exposures (1 HSE every 4.2 seconds)
- 291 transitions from outside to inside the “patient zone”
- 117 (61%) of colonisation events and 7 (2.3%) infection events
  occurred after HCWs touching their own body.
- **Hand hygiene:** 14/191 (**5%**) before colonisation events; 3/217 (**1%**) infection events (!!!)



What we learned:

- Microorganisms potentially transmitted via hands from outside to inside the patient's direct environment once every 1.01 minutes
- Frequent transition from HCW to patient
- Hand hygiene is much lower in transmission-relevant moments than we thought



Structured taxonomy of infectious risk moments
INFORM

Unstructured exploratory observations

trauma ICU

floor ward

emergency ward

resuscitation room

129.17 hours of exploratory observations → 292 unique IRMs

IRM **coded** based on the surfaces involved in the **transmission pathway** to establish a **structured taxonomy**

INFORM taxonomy

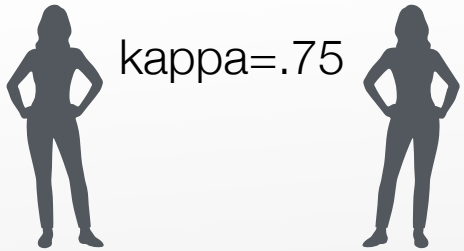
Source	
(Source)	(Source detail)
Environment	Bedside Table, Curtains, Floor, Lamp, Outside Patient Room, Paper Patient Records, Partition Walls, Patient Bed, Trolley, Other
Gloves	HCW Gloves
Hands	HCW Hands
Healthcare Worker	Body, Clothing, Face, Hair, Other
Invasive Device	IV Tubes, Mechanical Ventilator, Suction Catheter, Other
Medical Device	Bedside Monitor, Blood-Pressure Cuff, Blood-Pressure Monitor, ECG, Infusion Pump, Non-Invasive Ventilator, Stethoscope, Thermometer, Ultrasound, Ventilator Monitor, X-Ray, Other
Mobile Object	Flashlight, Mobile Phone, Pen, Secretions, Tape Dispenser, Toilet Brush, Washcloth, Other
Other Patient	Critical Site, Environment, Intact Skin
Patient Critical Site	Airways, Bloodstream, Mucous Membrane Face, Mucous Membrane Genitals, Mucous Membrane Rectum, Open Wound, Uncapped CVC Hub, Uncapped IV Line, Urethra, Other
Patient Intact Skin	Contaminated Skin, Head, Lower Limbs, Trunk, Upper Limbs
Unknown Status	No Disinfection Observed

Vector	
(Vector)	(Vector detail)
Gloves	Don Gloves Without HH, Non-Sterile Gloves, Remove Gloves Without HH, Sterile Gloves
Hands	HCW Hands, Patient Hands
Healthcare Worker	Badge, HCW Private Clothing, HCW White Clothing, Watch
Invasive Device	Arterial Catheter Tip, CVC Tip, Invasive Ventilator, IV Tubes, Needle/Cannula, PVC Tip, Suction Catheter, Thoracic Tube, Uncapped Hub, Urinary Catheter Tip, Ventilation Filter, Other
Medical Device	Blood-Pressure Cuff, ECG, Infusion Pump, Non-Invasive Ventilator, Stethoscope, Thermometer, Ultrasound, X-Ray, Other
Mobile Object	Bedding, Dressing or Bandage, Flashlight, Medical Tape, Mobile Phone, Pen, Secretions, Tape Dispenser, Tourniquet, Transfer, Board, Transfer Cannula, Washcloth, Wristwatch, Other

Endpoint	
(Endpoint)	(Endpoint detail)
Critical Site	Airways, Arterial 3-Way Valve, Arterial Insertion Site, Arterial Lumen Port, Bloodstream, CVC Insertion Site, CVC Line 3-Way Valve, CVC Line-Infusion Connection, CVC Lumen Port, Feeding Tube, Mucous Membrane Face, Mucous Membrane Genitals, Mucous Membrane Rectum, Mucous Membrane Urethra, Open Wound, PVC Insertion Site, PVC Line 3-Way Valve, PVC Line-Infusion Connection, PVC Lumen Port, Urinary Catheter, Other
Non-Critical Site	Head, Lower Limbs, Trunk, Upper Limbs, Catheter Dressing, Patient Clothing, Wound Dressing, Other
Patient Bed	Bedding, Pillow

Gloves: An HCW wearing gloves removes and discards the dressing from a patient's open wound, his gloves contact the open wound, then, without changing gloves, he touches the insertion site of the same patient's urinary catheter.			
Level 1: Locus	Source	Vector	Endpoint
Level 2: Surface	Patient critical site	Gloves	Critical site
Level 3: Surface detail	Open wound	Nonsterile gloves	Urinary catheter

Interobserver match



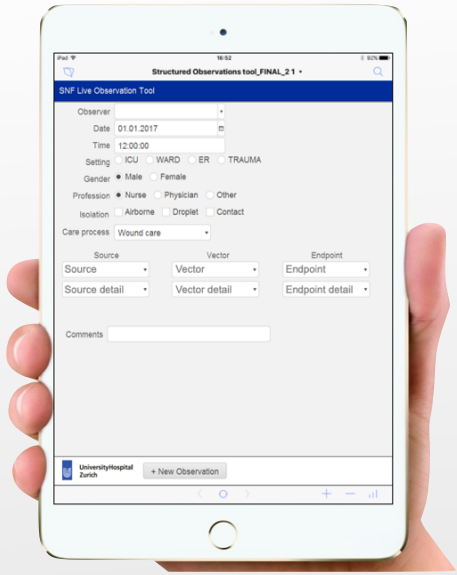
Structured observations

53.77 hours of structured observations
(31.25 hours of active care)

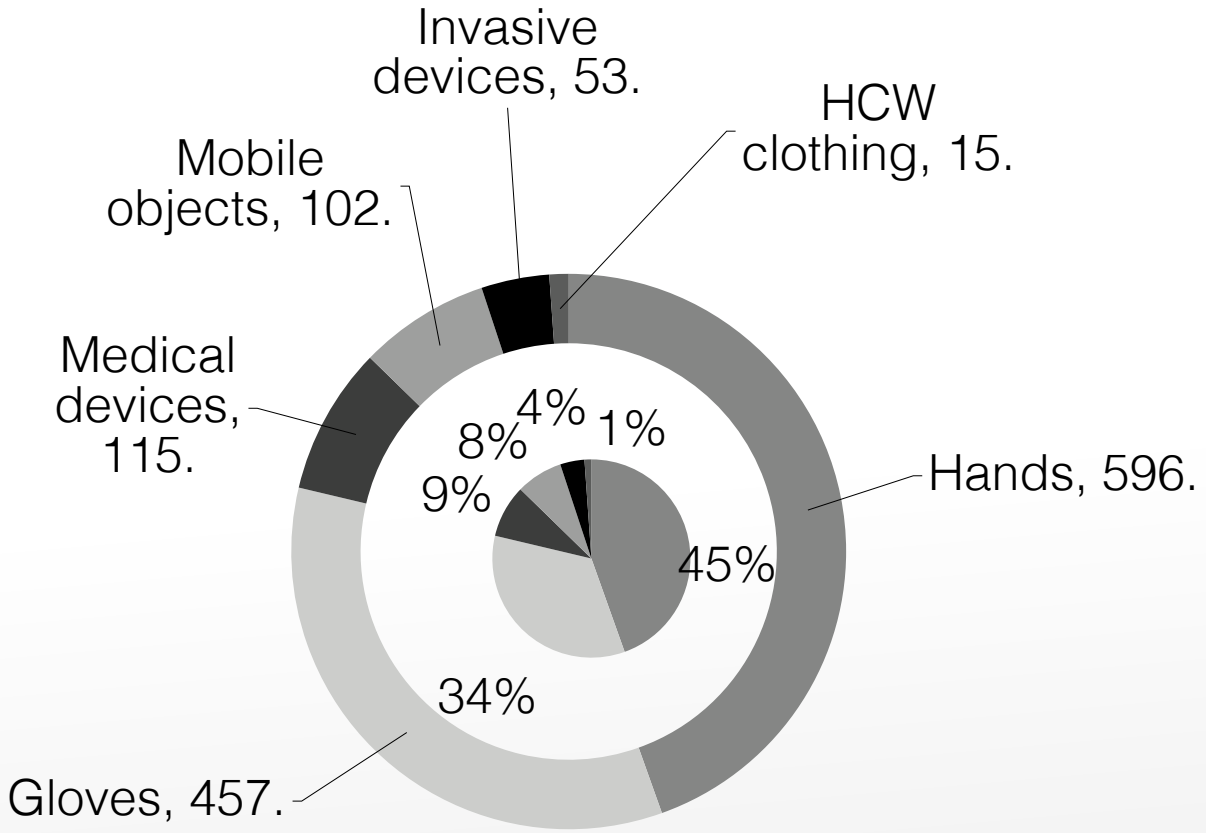
1,338 IRMs | 566 unique IRM →71 main categories

Average IRM density per active care hour:

- 42.8 overall
- 34.9 intensive care
- 36.8 medical
- 56.3 emergency ward



Transmission vectors → patient



25.8% of IRM potential transmission of pathogens to a critical site

143 IRMs (65.90%) involved the lack of disinfection of a device or object prior to patient contact

TABLE 3. Three Most Frequently Occurring Infectious Risk Moments (IRM) per Clinical Setting

Source and Setting	Vector	Endpoint	Frequency[a]	Density[b]
Intensive care unit				
Environment	Gloves	Critical site	36	3.51
Example: An HCW wearing gloves touches the trolley next to the patient's bed then, without changing gloves, verifies the patient's mechanical ventilator, the gloves come into contact with the patient's mouth.				
Environment	Hands	Noncritical site	34	3.31
Example: An HCW handles the paper charts (medical records) of a sedated patient then, without hand hygiene, proceeds to touch the intact skin on the patient's upper limbs.				
Medical devices	Gloves	Critical site	28	2.73
Example: An HCW wearing gloves manipulates the interface of an infusion pump to program the delivery rate then, without changing gloves, verifies the insertion site of a peripheral venous catheter.				
Medical ward				
Environment	Hands	Noncritical site	91	8.78
Example: After touching the environment outside of the patient's room, an HCW enters a patient's room and, without doing hand hygiene, shakes the patient's hand.				
Healthcare worker	Hands	Noncritical site	40	3.86
Example: An HCW stands with arms crossed, his hands come into contact with his white professional clothing then, without performing hand hygiene, proceeds to examine the patient, touching intact skin on the patient's stomach.				
Environment	Gloves	Critical site	35	3.38
Example: While changing a wound dressing, an HCW wearing gloves touches the surface and drawers of the trolley containing dressing materials, then with the same gloves make contact with the patient's open wound.				
Emergency ward				
Environment	Hands	Noncritical site	104	9.7
Example: After touching the environment outside of the patient's room, an HCW enters a patient's room and, without performing hand hygiene, shakes the patient's hand.				
Medical devices	Gloves	Noncritical site	49	4.62
Example: An HCW wearing gloves touches the electronic interface of an electrocardiography machine (ECG), whose disinfection had not been observed prior to using, then with the same gloves touches the patient's intact skin while applying the ECG nodes to the patient.				
Environment	Gloves	Noncritical site	47	4.43
Example: An HCW wearing gloves pulls closed the curtains that divide patient rooms, then, wearing the same gloves, touches the patient's upper limbs.				

NOTE. This table presents the 3 most frequently occurring main categories of infectious risk moments (IRMs) based on level 2 of the structured taxonomy.

[a]Number of times the IRM was observed in the indicated setting.

[b]Frequency per hour of active patient care in the indicated setting.

What did we learn?

Hands (bare and gloved) are still the most common transmission pathway

Challenge the “patient zone” concept

Moving healthcare items between patients with suboptimal/missing disinfection

Observations were independent of rules

Using the INFORM taxonomy could hence be employed in additional settings, regardless of local guidelines

But what does that mean?

ask microbiology

Transfer of pathogens to and from patients, healthcare providers, and medical devices during care activity—a systematic review and meta-analysis

Aline Wolfensberger MD[1], Lauren Clack MSc[1], Stefan P. Kuster MD[1], Simone Passerini RN[1], Lona Mody MD, MSc[2,3], Vineet Chopra MD, MSc[4,5], Jason Mann MSA[4] and Hugo Sax MD[1]

Conclusions: Recognising the heterogeneity in study designs, the available evidence suggests that pathogen transfer to HCPs occurs frequently. More systematic research is urgently warranted to support targeted and economic prevention policies and interventions.

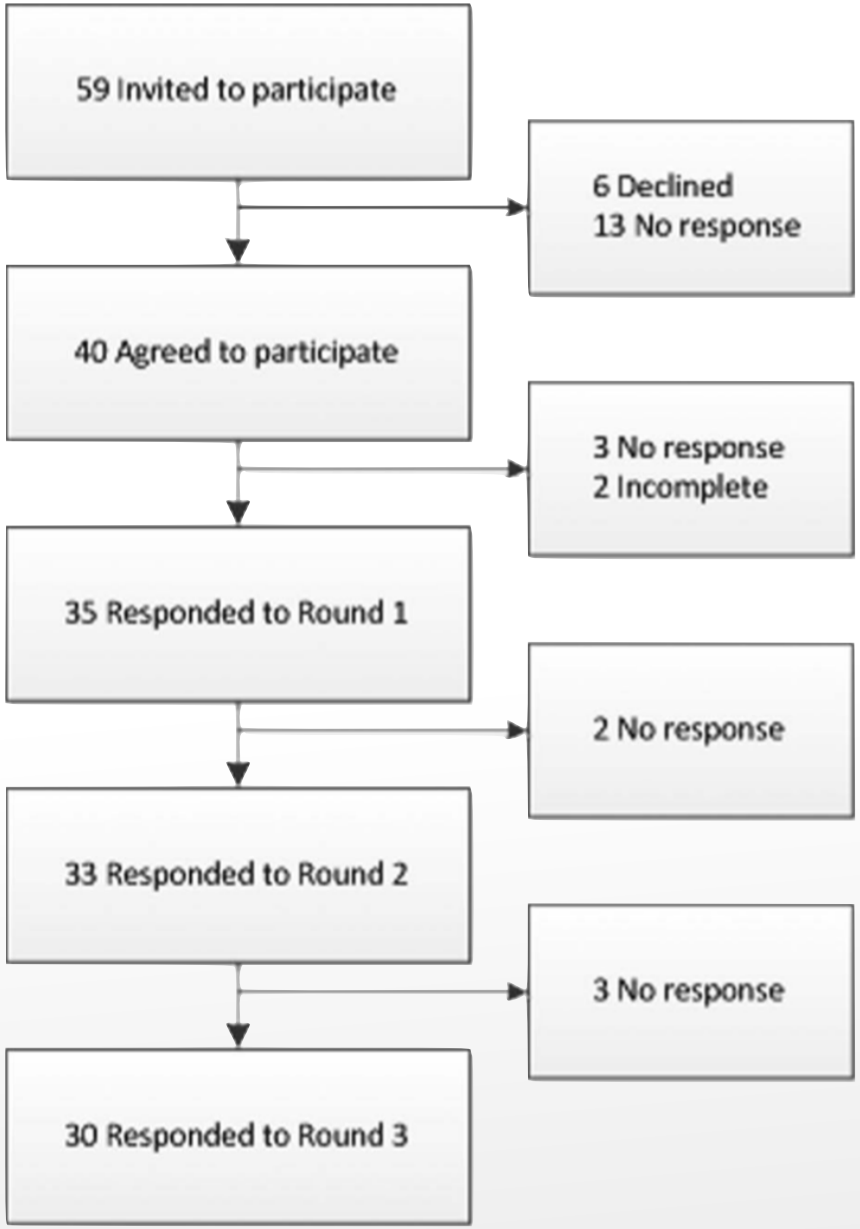
Wolfensberger A, et al. ICHE 2018

ask microbiology

ask experts

Modified Delphi

- **3 online survey rounds** among **global experts** (microbio, ID, IPC)
- **Feedback** of mean ratings and expert comments between rounds
- **52 care scenarios** of observed IRMs
- **6 sections:** hands, gloves, medical devices, mobile objects, invasive procedures, and additional moments.
- **Likelihood** of patient **colonisation** and **infection** scale from 0 to 5 (high)
- Expert ratings were plotted against frequencies of IRMs observed during actual patient care resulting in a **risk index**


59 Invited to participate
6 Declined
13 No response
40 Agreed to participate
3 No response
2 Incomplete
35 Responded to Round 1
2 No response
33 Responded to Round 2
3 No response
30 Responded to Round 3

A big thank you!

Alexander Friedrich, Andie Lee, Andrea Grisold, Andreas Voss, Anita Huis, Anne Bialachowski, Bina Rubinovitch, Birgit Waitschies, Caroline Marshall, Caroline Quach, Charles Frenette, Christina Vandenbroucke- Grauls, Dale Fisher, Elisabeth Presterl, Ester Solter, Florian Salm, Heiman Wertheim, Ina Willemsen, Jan Kluytmans, Jean-Cristophe Lucet, John Ferguson, Jonas Marschall, Joost Hopman, Lindy Ryan, Margreet Vos, Mary Vearncombe, Patrice Savard, Rainer Gattringer, Rhonda Stuart, Sebastian Lemmen, Silvio Brusaferro, Simone Scheithauer, Susan Fitzgerald, Tobias Kramer, Uga Dumpis, Yehuda Carmeli, Yves Longtin

Scenarios from structured observations

TABLE 1. Expert Consensus Ratings Grouped by Vector[a]

ID No.	Scenario	Colonization Likelihood[b]	Infection Likelihood[b]	Source	Endpoint
Invasive device, mean		2.75	2.51		
44	An HCW touches the insertion site (already disinfected) of thoracic tubes with nonsterile gloves that had already been worn for an extended period, touching multiple surfaces, and adjusts the position of the tubes.	**3.45**	**3.06**	Gloves	Critical site
46	Just before inserting a peripheral venous catheter (PVC), the needle comes into contact with nonsterile disposable examination gloves.	**2.70**	**2.88**	Gloves	Critical site
29	A 3-way valve IV line (connected to an IV line) is left open (uncapped) on a patient's bed.	2.83	**2.73**	Environment	Patient bed
42	Disinfected skin is touched several times with nonsterile gloves (to locate anatomic structures), before inserting a central venous catheter.	**2.94**	**2.73**	Patient intact skin	Critical site
47	While inserting a peripheral venous catheter, the same needle is retracted and reinserted several times at slightly different skin sites in search of the vein.	**2.45**	**2.70**	Patient intact skin	Critical site
41	An HCW draws blood from a vein in a patient's foot, which is visibly soiled, without prior skin disinfection.	2.13	**2.63**	Patient intact skin	Critical site
49	An HCW wearing blood-stained, nonsterile disposable examination gloves manipulates a 3-way hub of a patient's central vascular line. (Blood is from the same patient.)	2.80	2.63	Gloves	Critical site
43	Prior to inserting a peripheral line, an HCW uses her bare hands (that had not been immediately disinfected) to palpate the patient's vein after the insertion site had already been disinfected.	**2.67**	**2.61**	Patient intact skin	Critical site
45	A urinary catheter tip is touched with nonsterile disposable examination gloves prior to inserting a urinary catheter.	2.97	2.53	Gloves	Critical site
50	An HCW prepares to replace a mechanical ventilation tube filter. The HCW opens the new sterile filter with nonsterile disposable examination gloves, places the new filter on the patient's bed, removes the old filter, then picks up the new filter from the bed and attaches it to the ventilation tube.	**2.97**	**2.45**	Environment	Critical site
30	A three-way valve is placed on a Moltex absorbent sheet (Fisher Scientific) on a patient's bed. An open lumen of the 3-way valve touches the Moltex sheet. The 3-way valve is then used for an IV line.	**2.70**	**2.39**	Mobile object	Critical site
26	An HCW disconnects a patient's tracheal tube, places the tube on nonsterile patient bedding, then reconnects the tube again.	**2.94**	**2.30**	Environment	Critical site
27	The tube connected to a patient's urinary catheter lies on floor, then the HCW places it on the patient's bed.	**2.64**	**2.07**	Environment	Patient bed
28	An HCW places a used suction catheter (used for suctioning of a mechanical ventilation) on the patient's bed (same patient).	**2.30**	**1.45**	Patient critical site	Patient bed
Hands, mean		3.02	2.19		
6	An HCW cleans a toilet, touching toilet brush handle with bare hands then, without hand hygiene, touches a patient's open wound.	**3.80**	**3.24**	Mobile object	Critical site
2	After caring for a first patient, an HCW touches another patient's open wound without hand hygiene.	**3.76**	**3.20**	Other patient	Critical site
4	An HCW touches her private mobile phone then, without hand hygiene, touches a patient's open wound.	**3.24**	**2.73**	Mobile object	Critical site
10	After touching parts of her own body and her immediate environment (bedside table, phone, and bed linens), a patient touches her own open wound.	**3.17**	**2.70**	Environment	Critical site
9	After touching multiple surfaces in the healthcare environment, a HCW enters a patient's room then, without hand hygiene, prepares and administers intravenous medication.	2.93	**2.33**	Environment	Critical site
8	An HCW touches his face and hair then changes an infusion, without hand hygiene.	**2.76**	**2.21**	Healthcare worker	Critical site
7	An HCW touches the paper patient records then, without hand hygiene, changes an infusion.	**2.48**	**1.91**	Environment	Critical site

. . .

52 scenarios from structured observations

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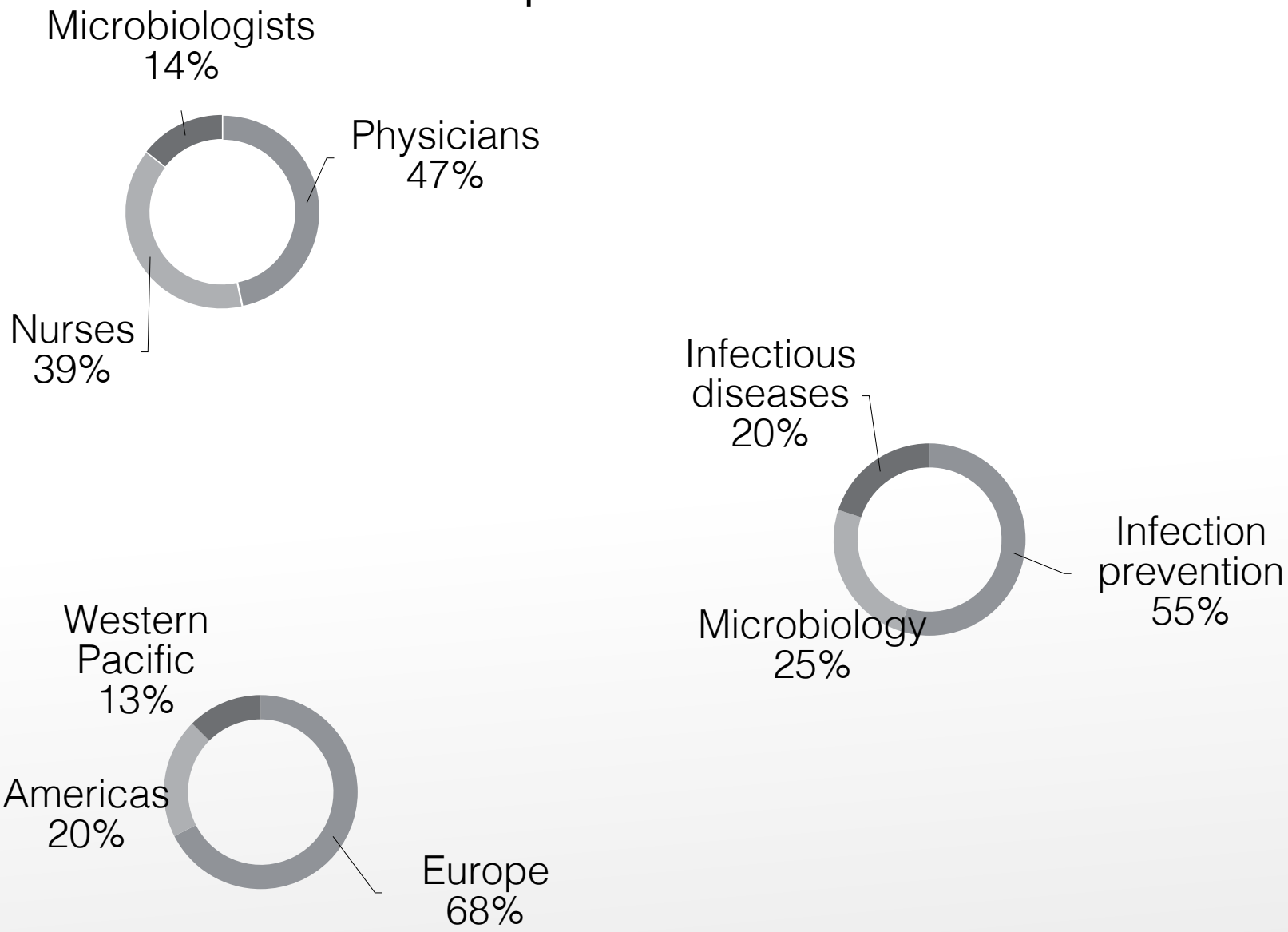
A HCW touches the insertion site (already disinfected) of thoracic tubes with nonsterile gloves that had already been worn for an extended period, touching multiple surfaces, and adjusts the position of the tubes.

. . .

Experts

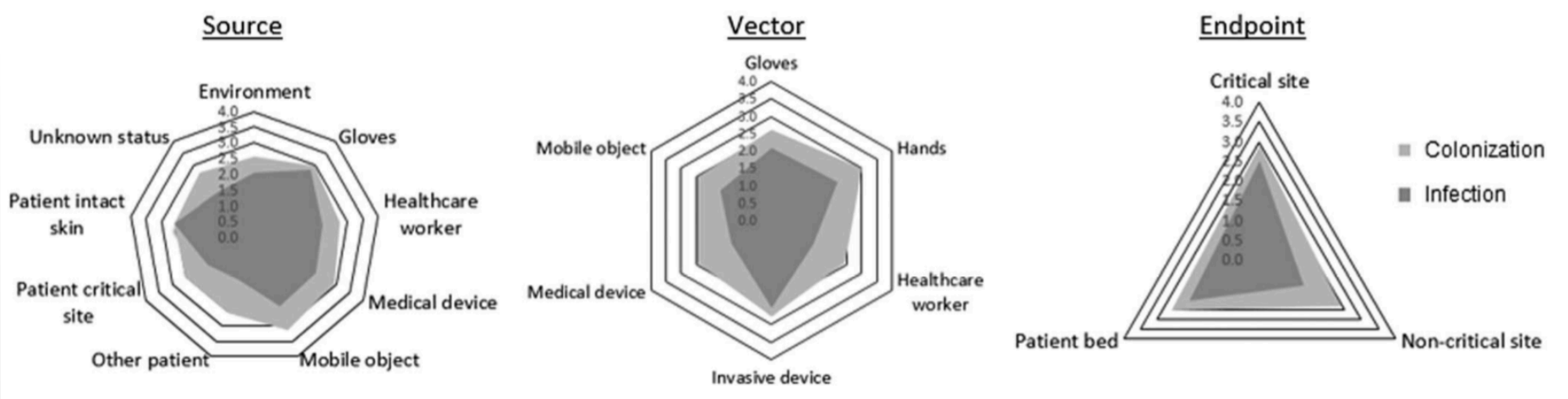

Microbiologists
14%
Physicians
47%
Nurses
39%
Infectious
diseases
20%
Infection
prevention
55%
Microbiology
25%
Western
Pacific
13%
Americas
20%
Europe
68%

Mean expert ratings

Consensus was achieved for 92 of 104 items (88.5%)

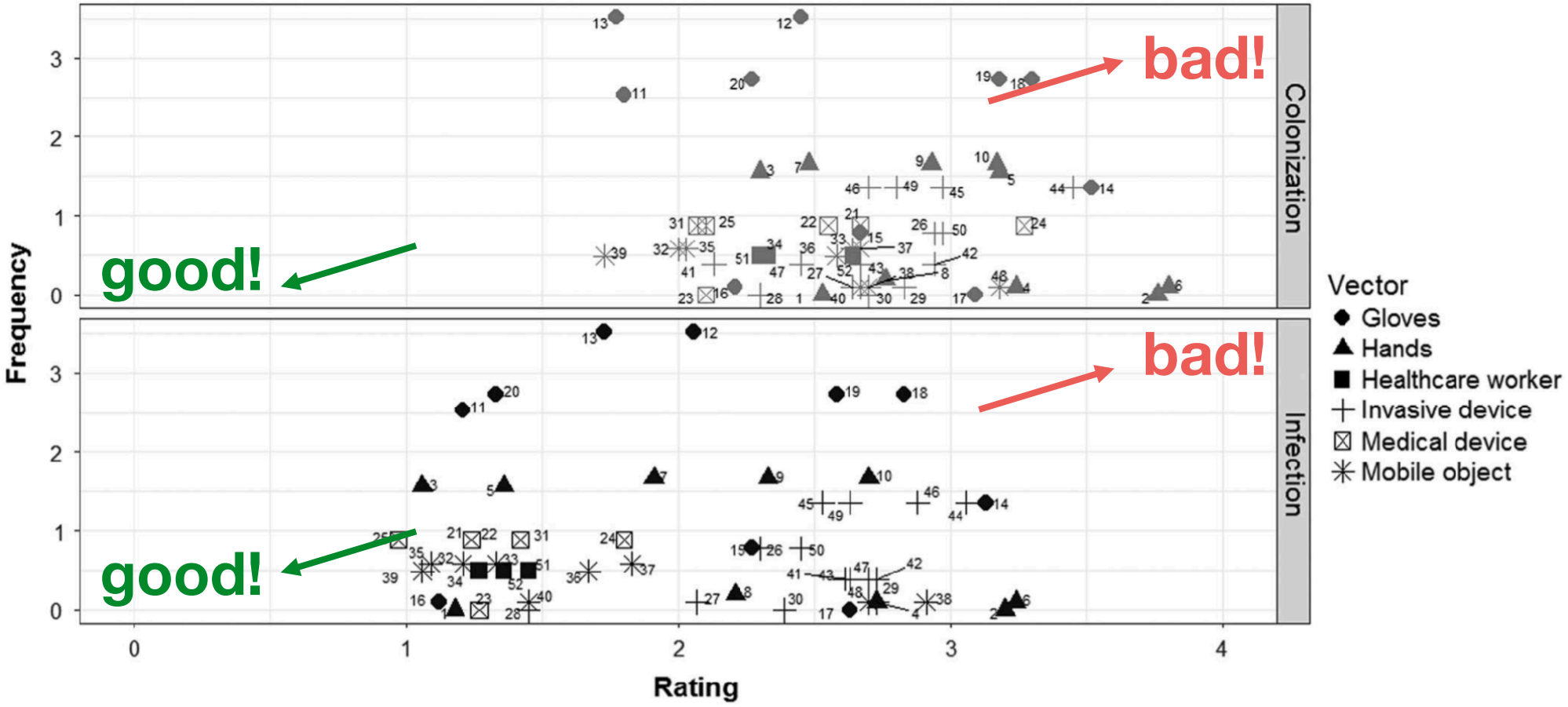
Colonisation	2.68 (95% CI, 1.73–2.02)	p<.00005
Infection	2.02 (95% CI, 0.97–3.24)	

To critical sites:	colonisation 2.88	infection 2.51
To noncritical patient sites:	colonisation 2.39 (p=.001)	infection 1.31 (p<.0005)



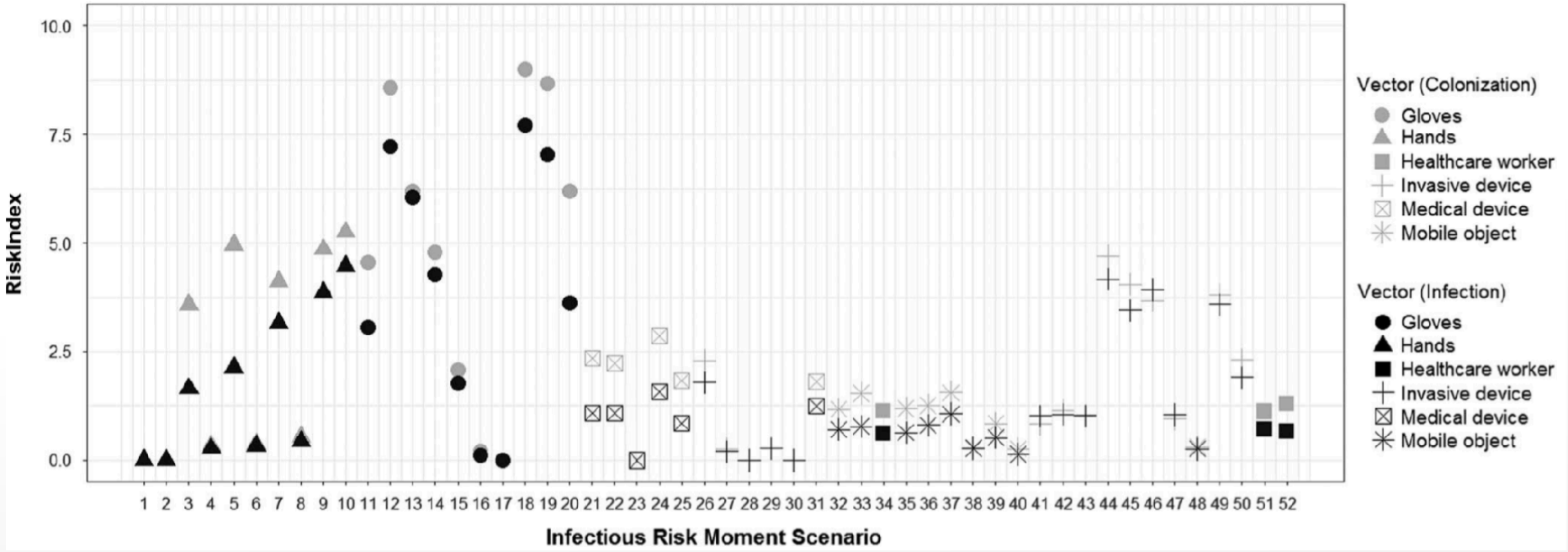
colonisation infection

Risk = Frequency x Impact



colonisation infection

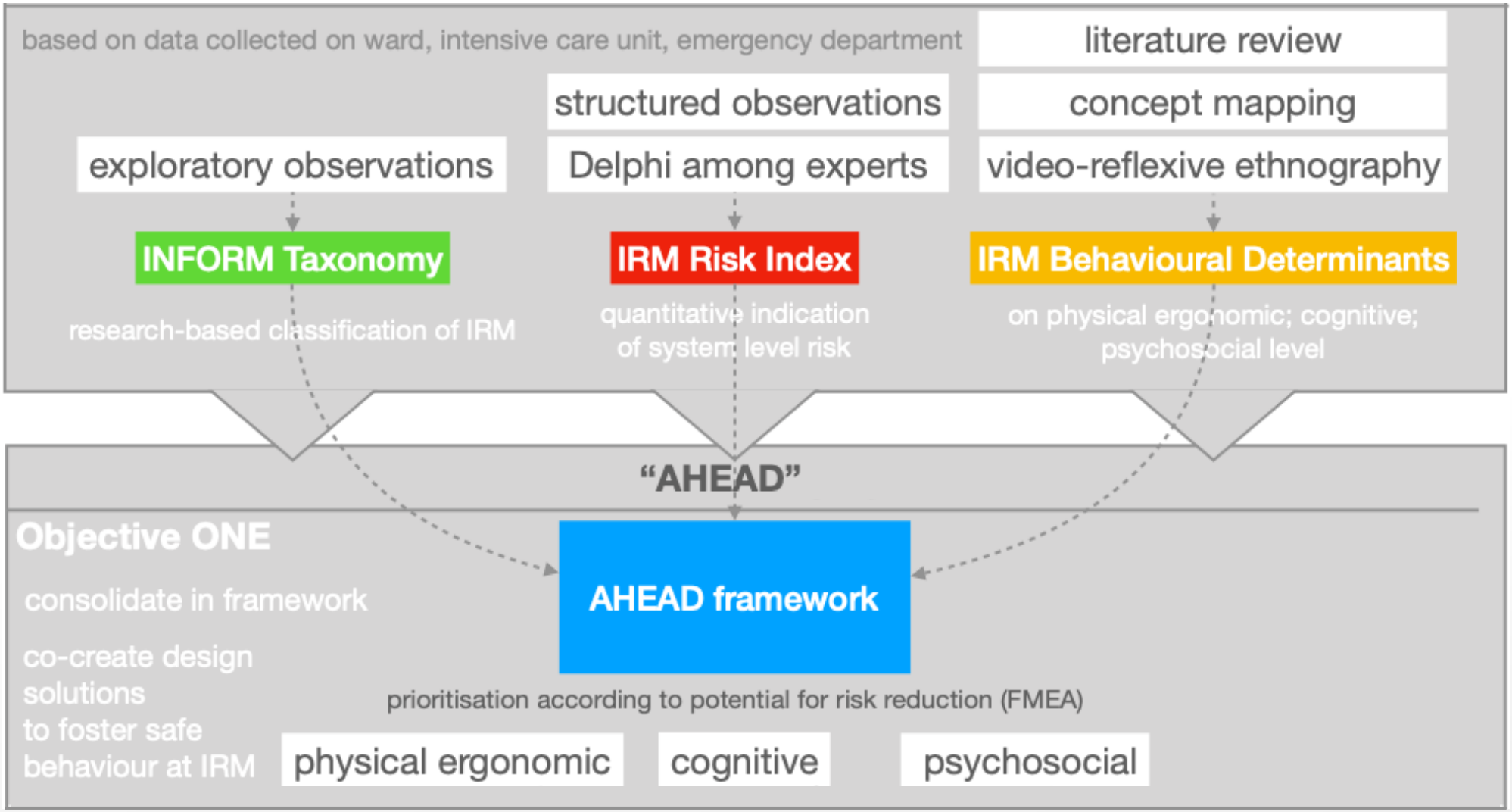
Risk index of the 52 scenarios



colonisation infection

What did we learn?

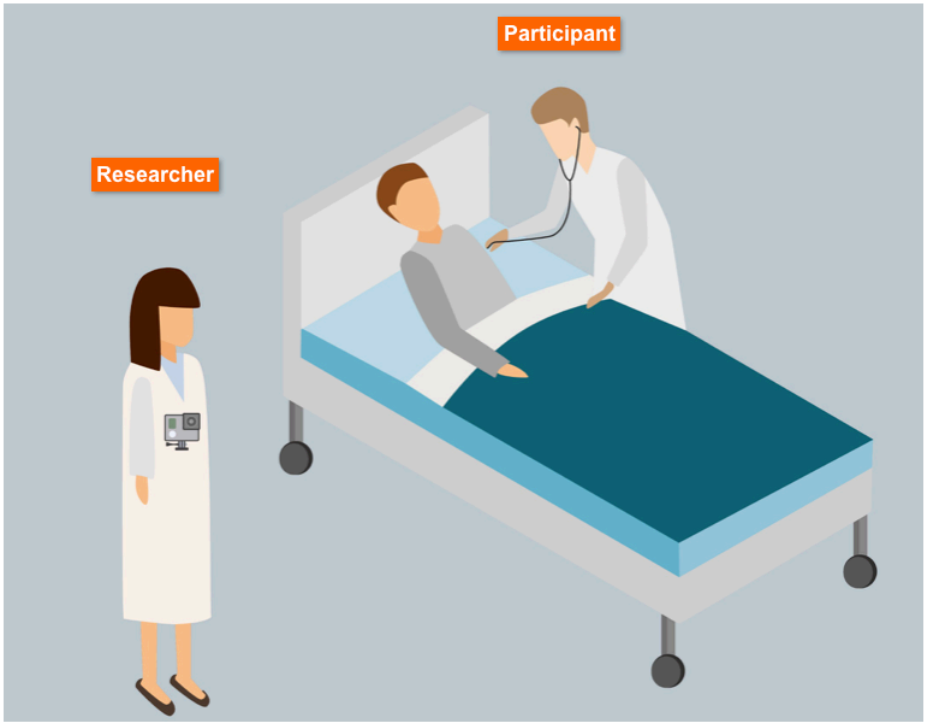
Concerning the source of pathogens, average ratings for likelihood of colonisation were highest among scenarios where mobile objects (3.12), gloves (2.98), and medical devices (2.92) were the sources of pathogens, whereas ratings for likelihood of infection were highest among scenarios where gloves (2.78), the patient's own intact skin (2.59) and the healthcare worker's own body or clothing (2.21) were the source of pathogens. This last finding is of particular interest, given that the patient's own body may be an often-overlooked source of pathogens.


based on data collected on ward, intensive care unit, emergency department
literature review
structured observations
concept mapping
exploratory observations
Delphi among experts
video-reflexive ethnography
INFORM Taxonomy
IRM Risk Index
IRM Behavioural Determinants
research-based classification of IRM
quantitative indication of system level risk
on physical ergonomic; cognitive; psychosocial level
"AHEAD"
Objective ONE
consolidate in framework
co-create design solutions to foster safe behaviour at IRM
AHEAD framework
prioritisation according to potential for risk reduction (FMEA)
physical ergonomic
cognitive
psychosocial

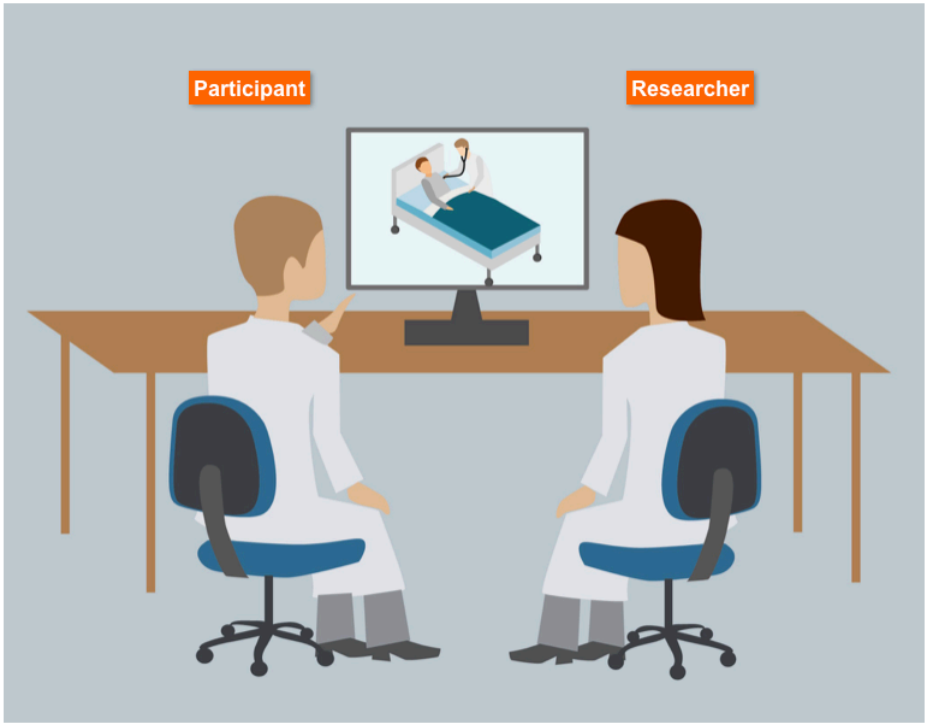
Sneak-peek for **Part 2**.

The behavioural determinants of IRM

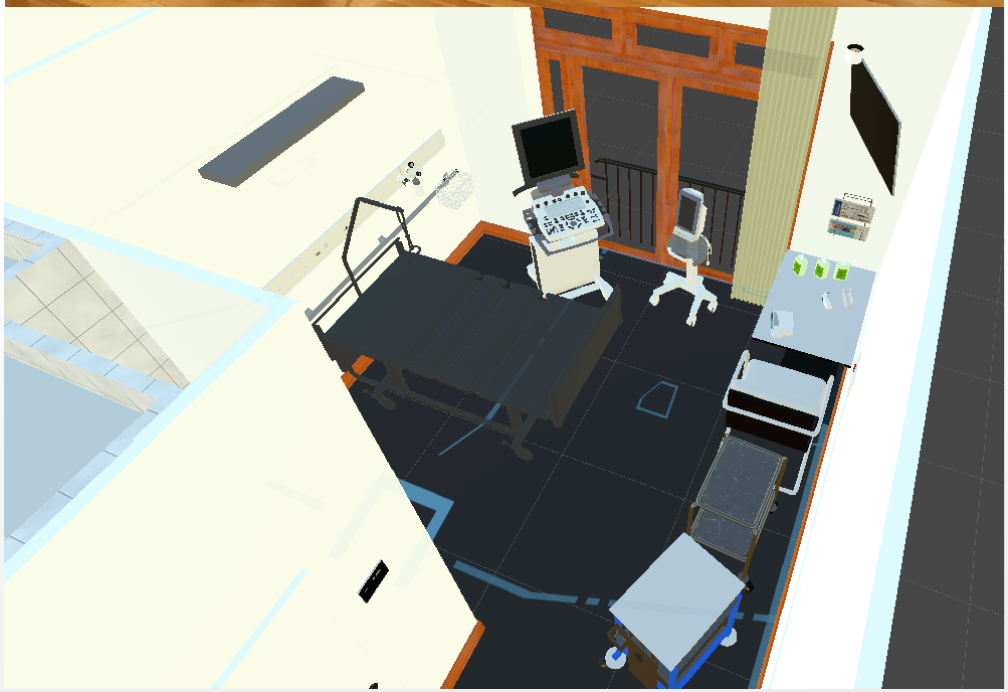
Videoreflexive ethnography



Data collection part 1: Researcher wearing chest-mounted camera films participant during patient care



Data collection part 2: Reflexive interview during which the filmed participant reviews his/her care film is audio-recorded



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Thank you for listening!

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