Should we go **waterless** in intensive care units?

Yves LONGTIN
TIBDN
May 7th 2026

Objectives

- Present an overview of the current evidence
- Identify gaps in knowledge
- Present a potential research project

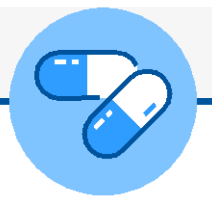
Disclosures

- No conflicts to declare

Antimicrobial Resistance (AMR)

- Declared by the WHO as one of the top ten threats to global public health
- Identified by Canada's Ministry of Health as one of the greatest concerns of our time,
- Leading players in healthcare and research are mobilizing to combat AMR

Misalignment ☠️ vs 💰



Antibiotics

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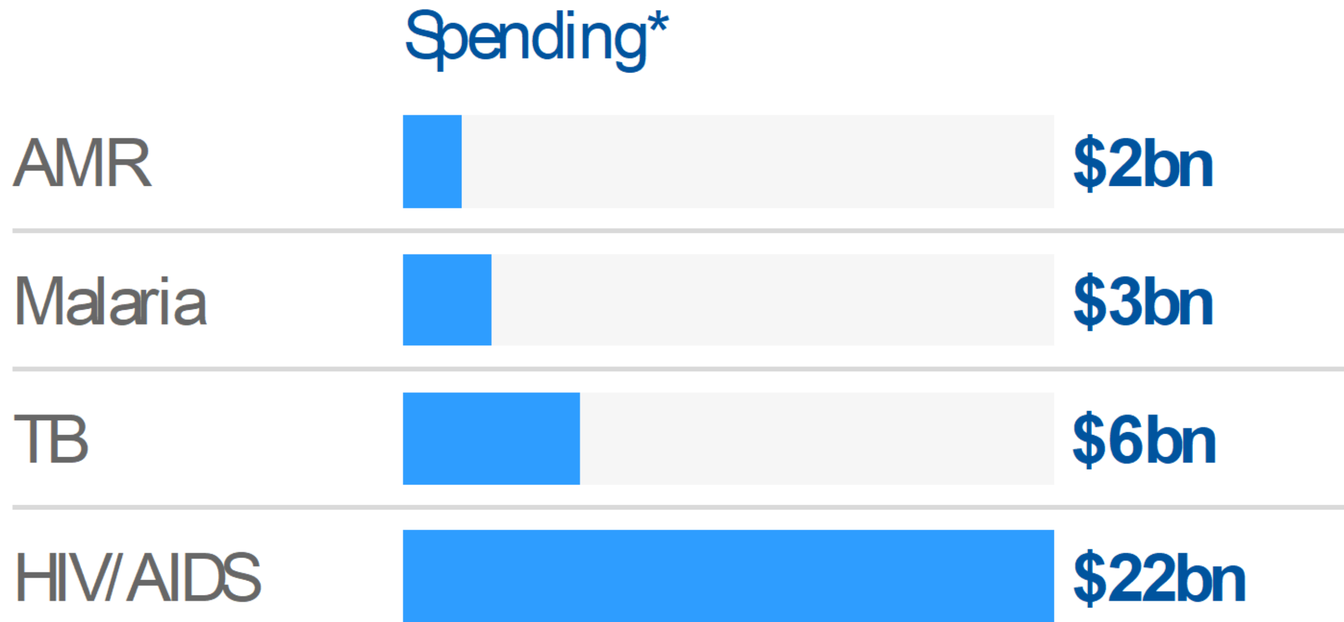
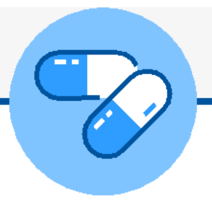


*Average spending, 2017 to 2021; † Estimated global deaths in 2019; ‡ Associated deaths

https://www.thelancet.com/pb-assets/Lancet/infographics/antibiotic-resistance-2024/antibiotic-resistance2024-1720780667507.pdf

Misalignment ☠️ vs 💰



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	Spending*	Annual deaths†
AMR	$2bn	4·95m‡ (Attributable death, 1.3M)
Malaria	$3bn	0·6m
TB	$6bn	1·3m
HIV/AIDS	$22bn	0·7m

*Average spending, 2017 to 2021; †Estimated global deaths in 2019; ‡Associated deaths

https://www.thelancet.com/pb-assets/Lancet/infographics/antibiotic-resistance-2024/antibiotic-resistance2024-1720780667507.pdf

Areas harboring GNR

https://doi.org/10.1007/s10096-018-3428-y

ORIGINAL ARTICLE

What pathogens are most worrisome in ICUs?

Table 1 Weighting of the criteria and the scores for the priority list of resistant microorganisms at intensive care units

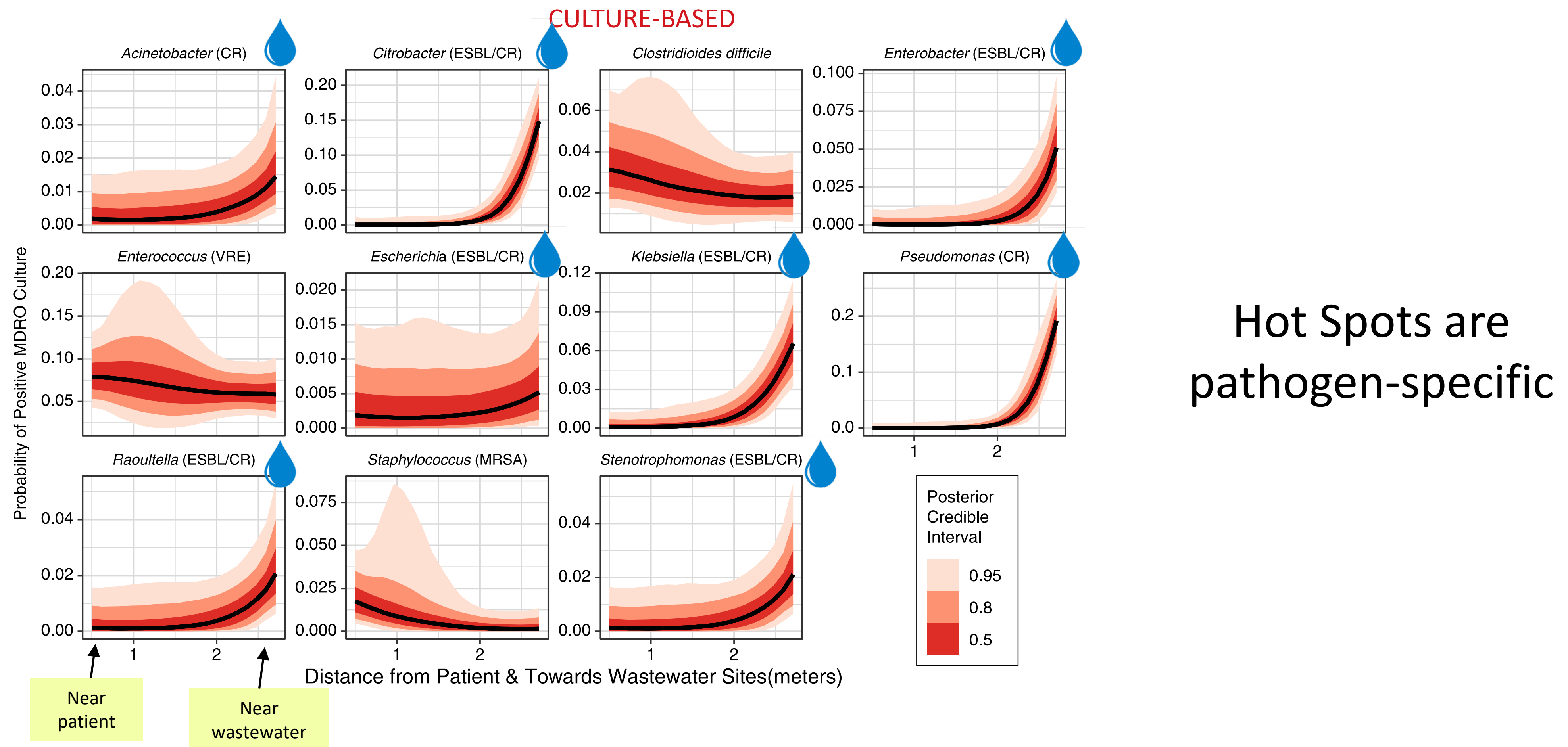
	Pathogen list	Rank order of criteria (mean score)										Priority level
		Mortality (19)	Treatability (19)	Cost of treatment (15)	Health care burden (13)	Prevalence of resistance (12)	Preventability (10)	Transmissibility (7)	Current pipeline (7)	Community burden (5)	Sum score	
CRAB	Carbapenem-resistant *A. baumannii*	144.88	137.75	112.50	87.75	67.50	60.00	52.50	47.25	26.25	736.38	Critical
CRKP	Carbapenemase expressing-*K.pneumoniae* (KPC)	147.25	130.63	114.38	92.63	52.50	77.50	29.75	47.25	24.29	716.16	
MDR-PA	Multidrug-resistant *P. aeruginosa*	147.25	125.88	110.63	95.88	70.50	57.50	44.63	32.38	25.71	710.34	
CRPA	Carbapenem-resistant *P. aeruginosa*	144.88	125.88	116.25	68.25	57.00	58.75	33.25	52.50	18.75	675.50	High
ESBL-Kp	Extended-spectrum beta-lactamase *K. pneumoniae*	102.13	114.00	63.75	91.00	88.50	56.25	38.50	42.88	42.50	639.50	
	Methicillin-resistant *S. aureus* (MRSA)	116.38	85.50	80.63	79.63	84.00	67.50	48.13	39.38	33.13	634.25	
ESBL-Ec	Extended-spectrum beta-lactamase *E. coli*	76.00	90.25	71.25	81.25	97.50	58.75	42.00	42.00	48.75	607.75	
	Vancomycin-resistant *Enterococci* (VRE)	64.13	64.13	71.25	53.63	67.50	42.50	51.63	27.13	21.88	463.75	Medium
ESBL-Sm	Extended-spectrum beta-lactamase *Serratia* spp	57.00	104.50	52.50	48.75	52.50	42.50	29.75	34.13	25.63	447.25	
TR-Sm	TMP/SMX resistant *S.maltophilia*	45.13	73.63	41.25	16.25	24.00	28.75	14.88	20.13	12.50	276.50	

8/10 Priority Organisms can colonize sink drains

Priority organisms in ICU based on mortality, healthcare and community burden, prevalence of resistance and 5-year trend in resistance, transmissibility, preventability, treatability and current drug pipeline

Rello J, Kalwaje Eshwara V, Lagunes L, Alves J, Wunderink RG, Conway-Morris A, Rojas JN, Alp E, Zhang Z. A global priority list of the TOp TEn resistant Microorganisms (TOTEM) study at intensive care: a prioritization exercise based on multi-criteria decision analysis. Eur J Clin Microbiol Infect Dis. 2019 Feb;38(2):319-323. doi: 10.1007/s10096-018-3428-y. Epub 2018 Nov 13. PMID: 30426331.

Detection of bacterial contamination in the patient room and its relationship to the position of patients and wastewater sites

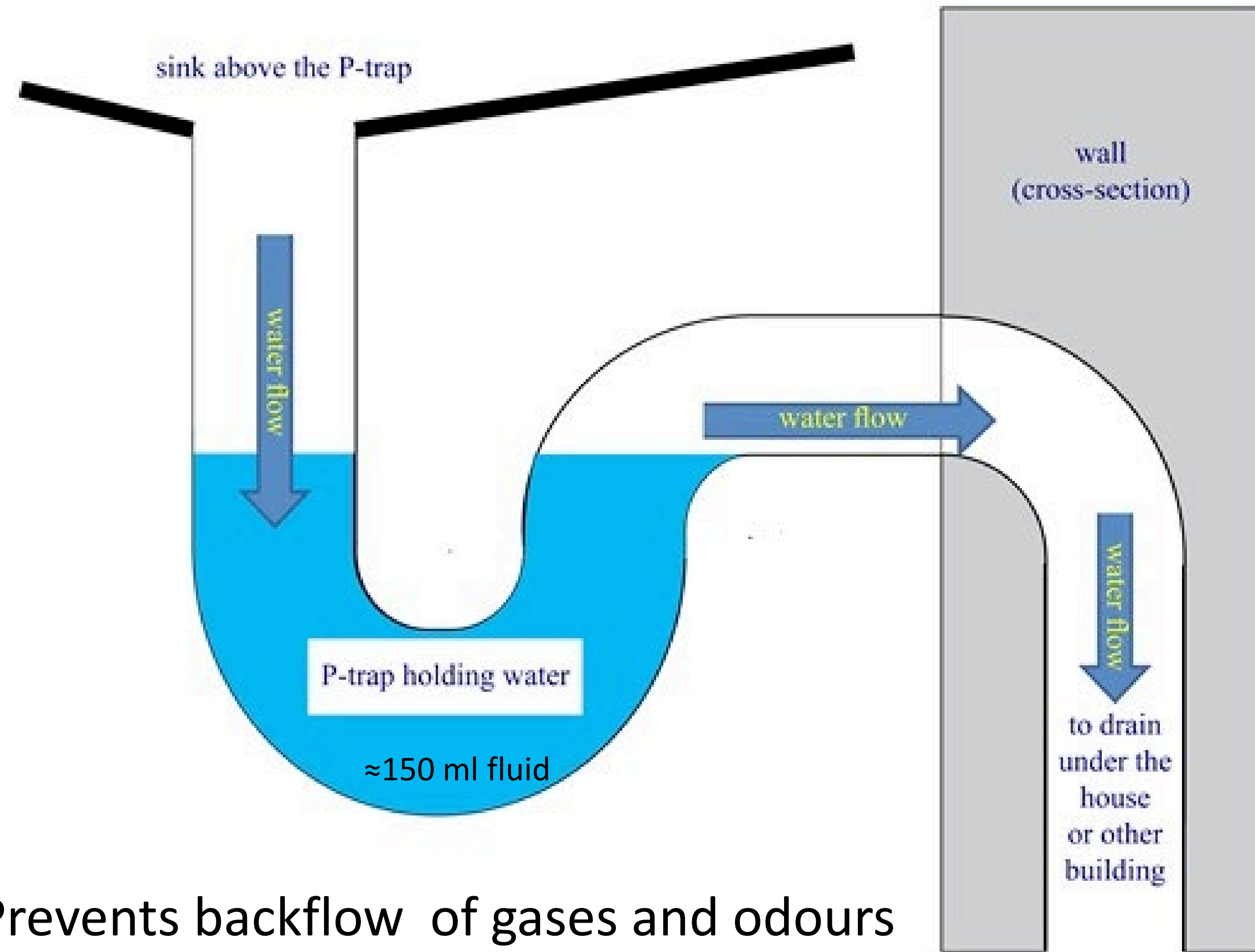


Hot Spots are pathogen-specific

Fig. 1. Impact of distance from the patient on detection of multidrug-resistant organisms (MDROs) in the healthcare environment. Distance from the head of the patient's bed and towards the wastewater sites is shown on the horizontal axis. The vertical axis depicts the probability of MDRO detection by selective culture for each of 11 detected MDROs according to a logistic regression model incorporating a Gaussian process prior for distance. The black line shows the best estimate, and shades of red indicate 50%, 80%, and 95% posterior credible intervals. Note. ESBL, extended-spectrum beta-lactamase; CR, carbapenem-resistant; VRE, vancomycin-resistant *Enterococcus*; MRSA, methicillin-resistant *Staphylococcus aureus*.

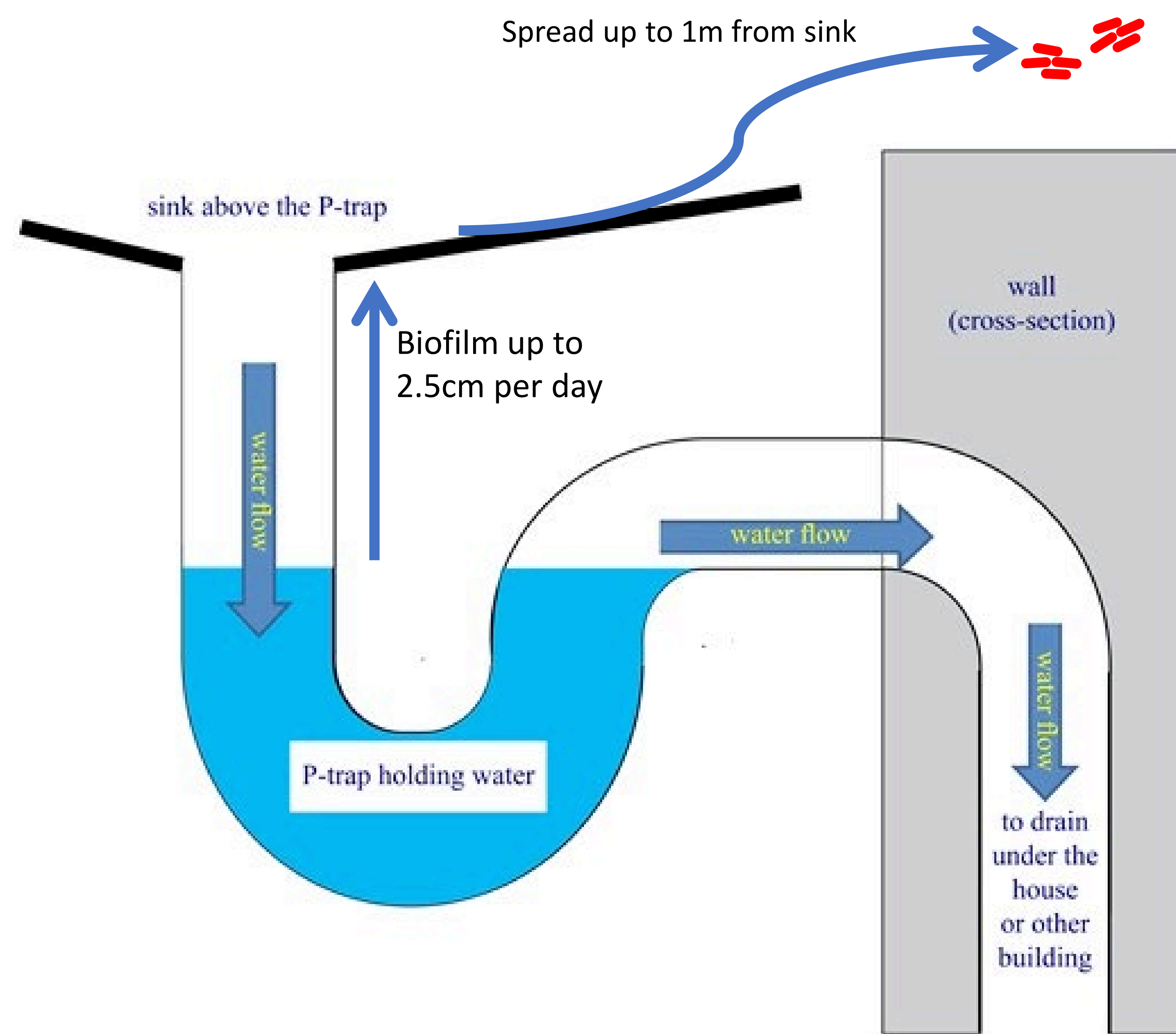
Kelly B et al. Infect Control Hosp Epidemiol. 2021 Aug 24;1-7.

P-Trap 101

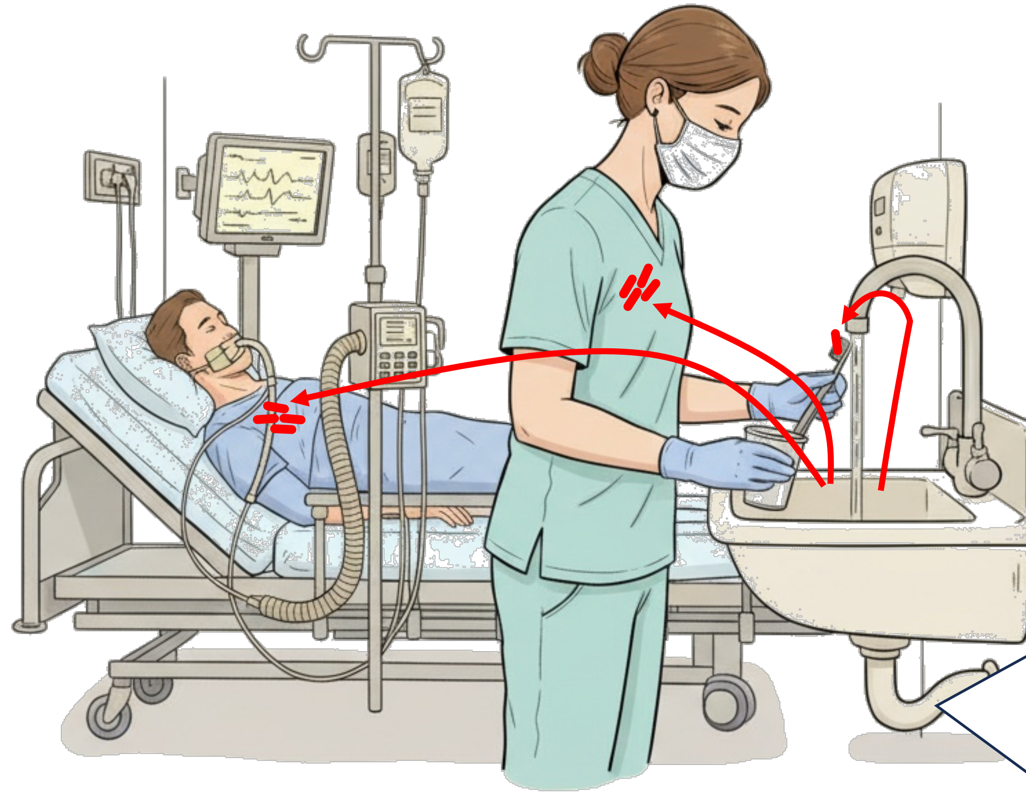


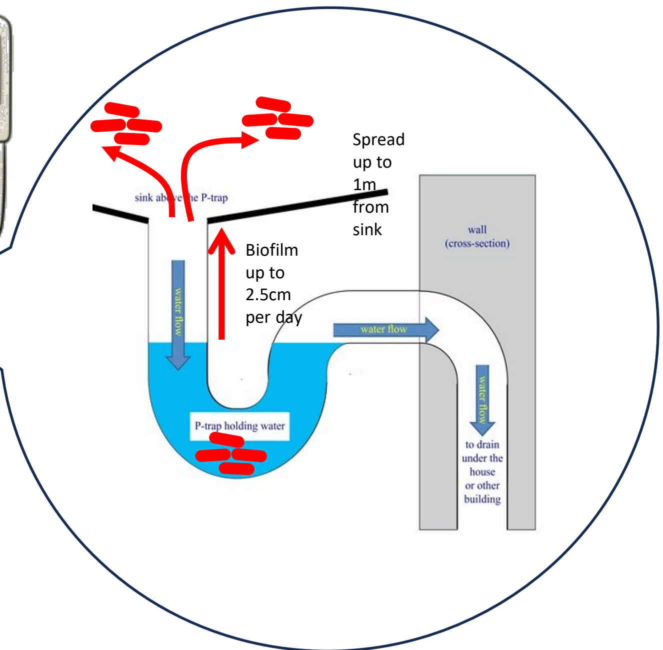
Prevents backflow of gases and odours

- Promotion of biofilm formation
  - Exchange of resistance genes and virulence factors



How do bacteria reach patients?





The Sink Splash Zone

How far could splashes travel?

Garvey MI, et al. J Hosp Infect. 2023 May;135:154-156

Circles around water drops

Garvey MI, et al. J Hosp Infect. 2023 May;135:154-156

Sink
activation
w
HH

Garvey MI, et al. J Hosp Infect. 2023 May;135:154-156

The Sink Splash Zone

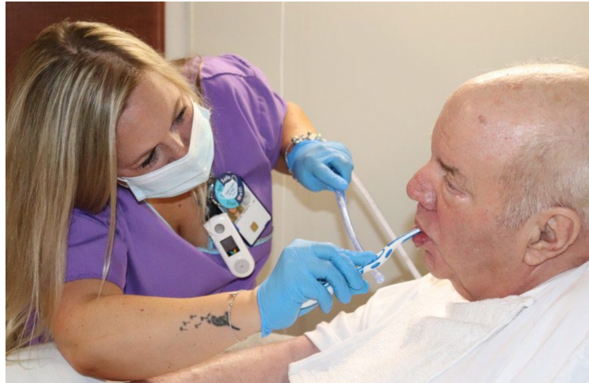
Frequency of presence <2m of sink

Phlebotomy trays…………………65%
Ventilator equipment……………..... 18%
Respiratory equipment………….. 27%
HF and HD material…………….. 12%
Personal care items…………….. 68%
Nutrition/enteral systems………. 33%
ABHRS, gloveboxes…………… 57%
Housekeeping equip……………. 5%
Equip to move patient, bearhugs 43%
Medication and IV pumps…..….. 32%
VACs ………………………….…. 5%
Invasive devices (CVC) ……….. 18%
Monitors………………………….…. 5%
COW…………………………….…48%

Garvey MI, et al. J Hosp Infect. 2023 May;135:154-156

How often are sinks used in ICUs?

Patients constantly exposed to sink water



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RINSING WITH TAPWATER

EMPTYING IN SINK

Journal of Hospital Infection 100 (2018) e115—e122

Characterizations of handwashing sink activities in a single hospital medical intensive care unit

M. Grabowski [a], J.M. Lobo [a], B. Gunnell [b], K. Enfield [c], R. Carpenter [d], L. Barnes [e], A.J. Mathers [f,g,*]

Table I
Action counts and percentages for behaviours occurring at patient room sinks

Group	Action name	Action count	Count per room per day	Percent group	Percent total
Medical patient care	Fill syringe or medication cup[a,b]	590	9.83	32.92	13.24
	Empty syringe or medication cup[b]	337	5.62	18.81	7.56
	Drain IV bag[b]	112	1.87	6.25	2.51
	Medical item cleaned	53	0.88	2.96	1.19
	Medical item placed	297	4.95	16.57	6.66
	Medical item removed	331	5.52	18.47	7.43
	Medical packaging placed	24	0.40	1.34	0.54
	Medical packaging removed	16	0.27	0.89	0.36
	Non-categorized medical liquid emptied	21	0.35	1.17	0.47
	Non-categorized medical behaviour	11	0.18	0.61	0.25
	Total	1792	29.87	100	40.21
Non-medical patient care	Patient care item placed	41	0.68	19.81	0.92
	Patient care item removed	40	0.67	19.32	0.90
	Wetted/wrung patient rag[a,b]	126	2.10	60.87	2.83
	Total	207	3.45	100	4.64
Patient nutrition	Food/beverage placed	68	1.13	19.94	1.53
	Food/beverage removed	61	1.02	17.89	1.37
	Non-water beverage emptied	46	0.77	13.49	1.03
	Tube feed bag filled	23	0.38	6.74	0.52
	Tube feed bag emptied	4	0.07	1.17	0.09
	Water glass filled[a]	37	0.62	10.85	0.83
	Water glass emptied[b]	102	1.70	29.91	2.29
	Total	341	5.68	100	7.65
Hand hygiene	Soap use	194	3.23	23.29	4.35
	Paper towel	444	7.40	53.30	9.96
	Handwash	195	3.25	23.41	4.38
	Total	833	13.88	100	18.69
Environmental care	EVS staff wiped sink	40	0.67	23.39	0.90
	Non-EVS wiped sink	24	0.40	14.04	0.54
	Cleaning supplies placed	43	0.72	25.15	0.96
	Cleaning supplies removed	48	0.80	28.07	1.08
	Wetted/wrung cleaning rag	16	0.27	9.36	0.36
	Total	171	2.85	100	3.84
Additional behaviours	Personal item placed	78	1.30	7.01	1.75
	Personal item removed	78	1.30	7.01	1.75
	Non-categorized item placed	60	1.00	5.39	1.35
	Non-categorized item removed	63	1.05	5.66	1.41
	Water run	313	5.22	28.12	7.02
	Wetted/wrung paper towel	8	0.13	0.72	0.18
	Item washed	46	0.77	4.13	1.03
	Non-categorized liquid emptied	15	0.25	1.35	0.34
	Non-categorized action	452	7.53	40.61	10.14
	Total	1113	18.55	100	24.97
Overall total		4457	74.28		100

IV, intravenous; EVS, environmental services.
[a] Items that were documented going to patients in observations.
[b] Items that were documented coming from patients in observations.

Grabowski M, Lobo JM, Gunnell B, Enfield K, Carpenter R, Barnes L, Mathers AJ. Characterizations of handwashing sink activities in a single hospital medical intensive care unit. J Hosp Infect. 2018 Nov;100(3):e115-e122. doi: 10.1016/j.jhin.2018.04.025. Epub 2018 May 5. PMID: 29738784.

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Collection of water that will be administered to patients: 776 actions (17%) – 12.9 times per day per room

Emptying of grey water, medications and feeds and IV bags into sink: 637 actions (14%) – 10.6 times per day per room

Handwashing: 195 actions (4.3%) – 3.3 times per day per room

Total: 26.8 at-risk events per room per day

Grabowski M, Lobo JM, Gunnell B, Enfield K, Carpenter R, Barnes L, Mathers AJ. Characterizations of handwashing sink activities in a single hospital medical intensive care unit. J Hosp Infect. 2018 Nov;100(3):e115-e122. doi: 10.1016/j.jhin.2018.04.025. Epub 2018 May 5. PMID: 29738784.

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Role of sinks in <u>non-epidemic</u> settings?

Clinical Microbiology and Infection 27 (2021) 1347.e9–1347.e14

Contents lists available at ScienceDirect

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journal homepage: www.clinicalmicrobiologyandinfection.com

CMI CLINICAL MICROBIOLOGY AND INFECTION

ESCMID

ELSEVIER

Original article

A prospective multicentre surveillance study to investigate the risk associated with contaminated sinks in the intensive care unit

Anne-Sophie Valentin [1], Sandra Dos Santos [1], Florent Goube [1], Rémi Gimenes [1], Marie Decalonne [1], Laurent Mereghetti [2], Côme Daniau [3], Nathalie van der Mee-Marquet [1, *] on behalf of the SPIADI ICU group[†]

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[2)] Service de Bactériologie, Virologie et Hygiène, Centre Hospitalier Universitaire, Tours, France
[3)] Unité Infections Associées aux Soins et Résistance aux Antibiotiques, Agence Santé Publique France, Saint Maurice, France

- Prospective observational multicenter study Jan-May 2020 (73 ICUs in France, 16% of all French ICU beds)
- Sinks near patients tested for P. aeruginosa and Enterobacteriaceae
  - Cotton-tipped swab inserted 5-7 cm through the drain, Amies TM
- MDR: EB R 3GCC or CPE, and Pseudo R Imi
- Questionnaire for risk factors for sink colonization

Valentin AS et al. Clin Microbiol Infect . 2021 Sep;27(9):1347.e9-1347.e14.

Clinical Microbiology and Infection 27 (2021) 1347.e9–1347.e14

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CMI CLINICAL MICROBIOLOGY AND INFECTION ESCMID

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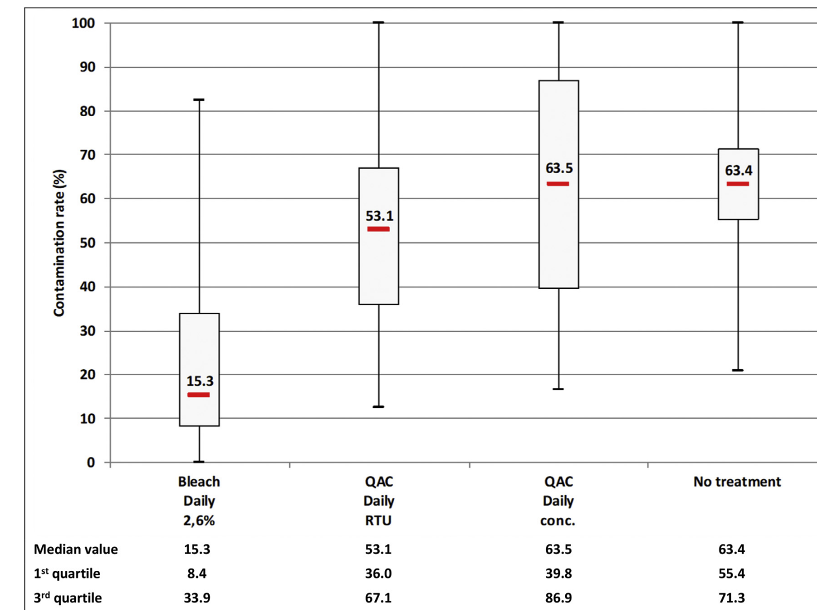
RESULTS

- 39% sinks showed visible splashes during sink use
- 30.5% of sinks were close to the bed (<2m) without barrier
- 50.9% of sinks contaminated by MDR bacteria
  - 3GCR 43.9%; CPE 2.5%; IRPA 7.6%
- Risk colonization higher when sink used for waste disposal than only for HW
  - 41% (HW) vs 55% (Waste disposal) p<0.001

Table 1
Distribution of the MDR Enterobacteriaceae and imipenem-resistant *P. aeruginosa* recovered from the 1191 sink samples

Distribution of the MDR enterobacteriaceae and PA isolated from sink samples	Ceftazidime and/or cefotaxime R	Carbapenemase producers				
		N	bla_{OXA48}	bla_{NDM-1}	bla_{VIM}	Bla_{IMP}
Enterobacteriaceae	833	37	16	17	4	
Klebsiella	254	17	6	9	2	
K. pneumoniae	161	13	5	8		
K. oxytoca	82	4	1	1	2	
other	11					
Enterobacter	315	6	2	4		
E. cloacae	197	3	1	2		
E. asburiae	101	3	1	2		
other	17					
Citrobacter	213	11	6	3	2	
C. freundii	183	10	6	2	2	
Other	30	1		1		
Serratia marcescens	26	2	2			
Escherichia coli	17	1		1		
other Enterobacteriaceae	8					
Imipenem resistant Pseudomonas aeruginosa (n=91)	37	13			9	4



Risk colonization decreased with daily bleach but not with daily quaternary ammonium

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- Contaminated sink associated with increased incidence of MDR-associated BSI
  - Risk factors for BSI rate >0.7/ 1000 pd (mean value for all hospitals):
    1) >51% Sink contamination
    2) >= 14% Sinks with visible splashes
    3) >=21% of sinks close to patients' bed without barrier
    4) No daily bleach treatment
- No association between sink contamination and MDR-VAP

✓ 0-1 or 2 risk factors: 6/30 (20%) with MDR BSI above average

✓ 3 or 4 risk factors: 14/28 (50%) with MDR BSI above average p=0.016

Valentin AS et al. Clin Microbiol Infect . 2021 Sep;27(9):1347.e9-1347.e14.

Sinks associated with increased risk of MDR-GNR BSI outside of epidemics

Could designing better sinks and sink hygiene be a solution?

Current Infectious Disease Reports (2018) 20: 42
https://doi.org/10.1007/s11908-018-0648-3

HEALTHCARE ASSOCIATED INFECTIONS (G BEARMAN AND D MORGAN, SECTION EDITORS)

Sink-Related Outbreaks and Mitigation Strategies in Healthcare Facilities

Leighanne O. Parkes[1] · Susy S. Hota[2,3]

Published online: 20 August 2018
© Springer Science+Business Media, LLC, part of Springer Nature 2018

- Great review on the topic

Parkes LO, Hota SS. Curr Infect Dis Rep. 2018 Aug 20;20(10):42.

Strategies to control contamination

- **Chemical**
  - Bleach, peroxyde, ozone water, peracetic acid, glucoprotamin, quaternary amoniums, NaOH, Pressurized steam
  - Problem: bacteria in biofilm can resist 100 to 1000 higher concentrations, contact time short, organic residues
  - Usually short-lived effect
- **Physical**
  - Change sink (entire, or selected components)
    - Failrues reported (Mathers AJ et al Antimicrob Agents Chemother. 2019 Mar 25)
  - Increase distance of P-trap to sink drain
  - Prevent alignment of faucet and drain
  - Increase depth of sink basin
  - Self disinfecting traps (Heating devices, Vibration devices, UV lights)
  - Copper pipes (Soothill JS J Hosp Infect. 2016 Jun;93(2):152-4
    Covers on hoppers
- **Behavioral**
  - Elimination of storage near sinks
  - Ban use of HH sinks for disposal of body fluids

Parkes LO, Hota SS. Curr Infect Dis Rep. 2018 Aug 20;20(10):42.

No method universally effective!

Making sinks safer in healthcare

- Designing better sinks
  - Deep basin
  - Sloped profiles
  - Offset drains
  - Sensor activated faucets

- Designing safer peri-sink areas
  - Splashguards
  - Avoiding stocking medical material near sinks
- Drain biofilm containment technologies
  - Trap heaters
  - Trap US
  - Trap valves

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  - Copper pipes
  - Trap valves

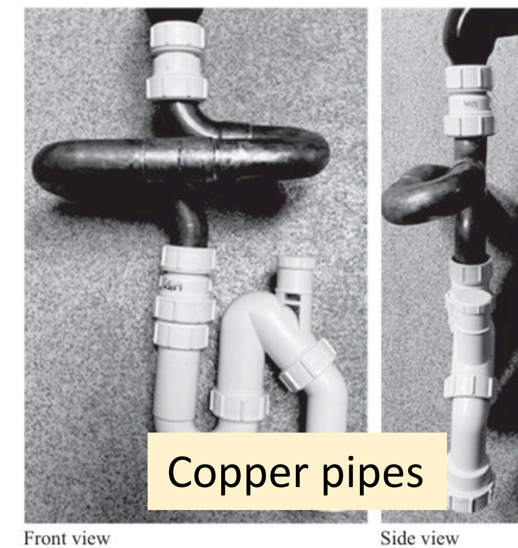


Figure 1. Tuba Drain assembled out of standard copper parts joined to standard plumbing.

Evidence mainly microbiological
Lack of clinical outcome data

Electromechanical vibrations

Infection Control & Hospital Epidemiology (2019), **40**, 254–266
doi:10.1017/ice.2018.318

SHEA
The Society for Healthcare Epidemiology of America

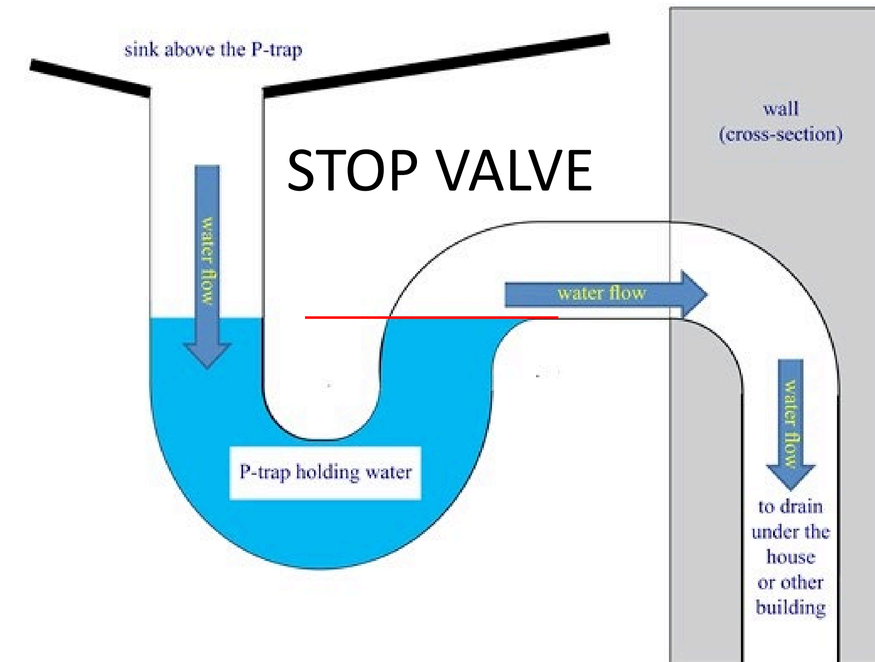
Letter to the Editor

Use of a stop valve to enhance disinfectant exposure may improve sink drain disinfection

Jennifer L. Cadnum BS[1], Scott H. Livingston BS[1,2], Scott A. Gestrich MD[1], Annette L. Jencson BS, CIC[1], Brigid M. Wilson PhD[3] and Curtis J. Donskey MD[2,3]

[1]Research Service, Louis Stokes Cleveland VA Medical Center, Cleveland, Ohio, [2]Case Western Reserve University School of Medicine Cleveland, Ohio and [3]Geriatric Research, Education, and Clinical Center, Louis Stokes Cleveland VA Medical Center, Cleveland, Ohio

Install a stop valve and fill pipe with disinfectant;
Let disinfectant sit x 1 hour and then open the valve



Cadnum JL et al. Infect Control Hosp Epidemiol. 2018 Dec 18:1-3.

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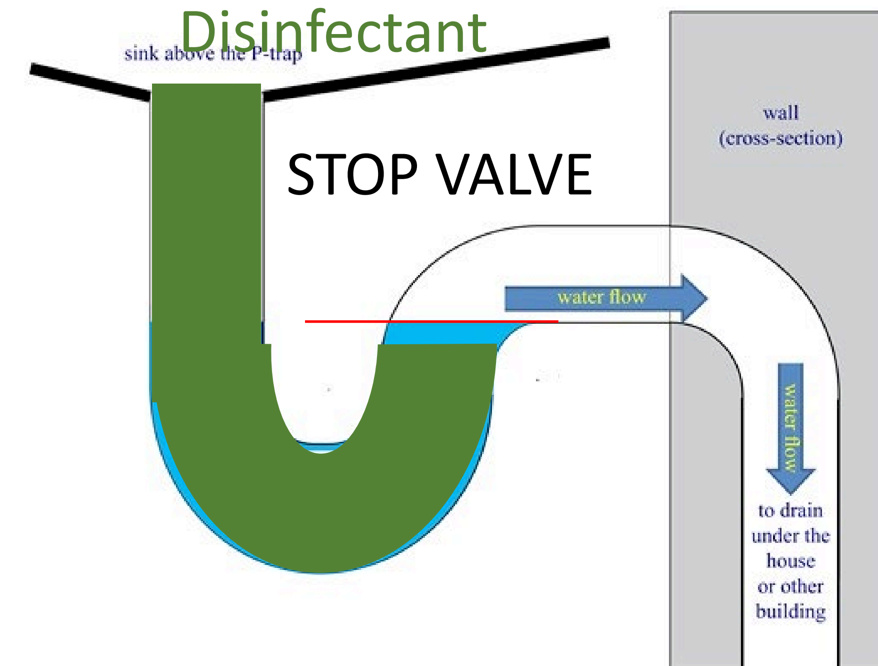

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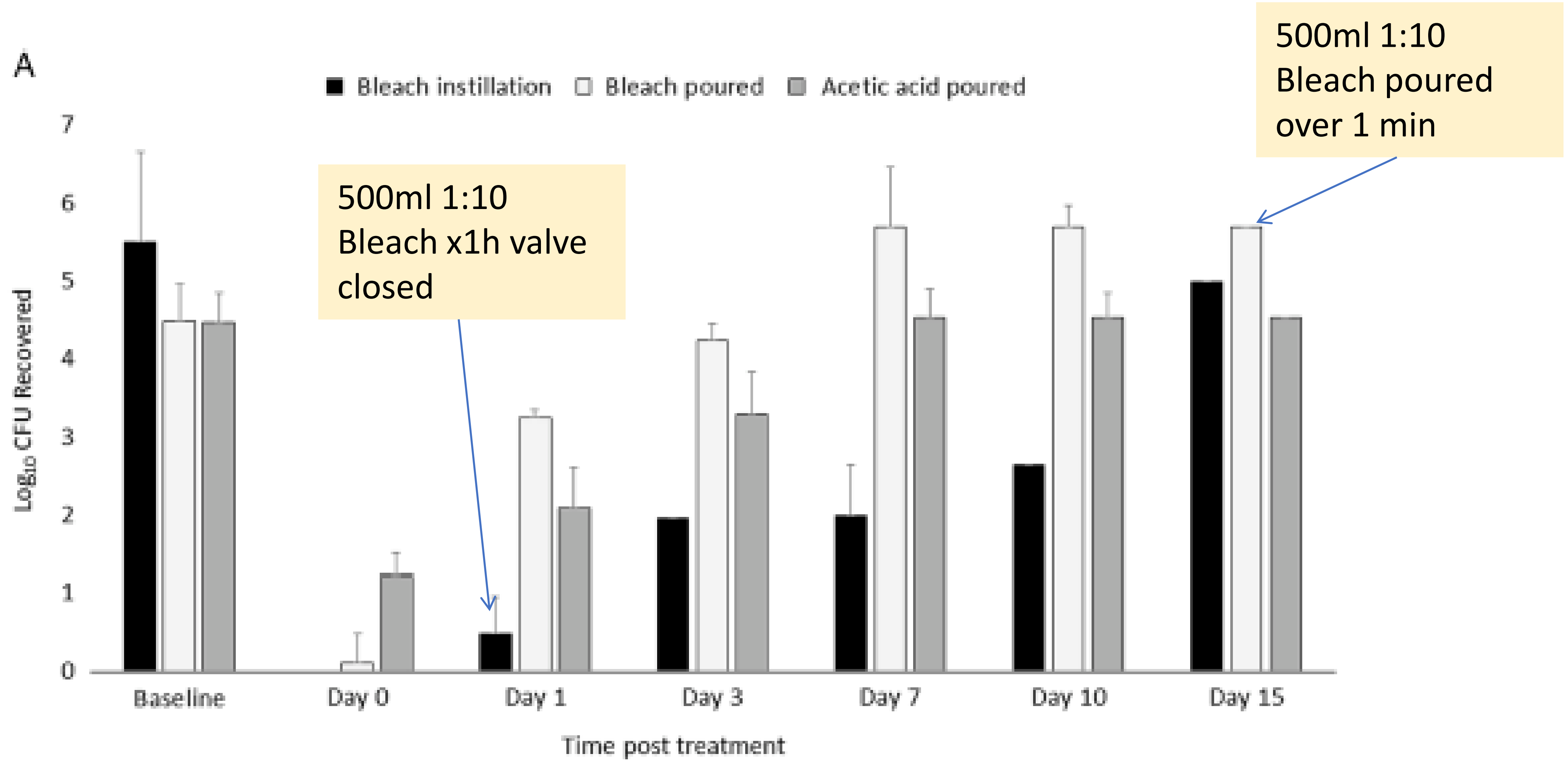


Research lab sink

Cadnum JL et al. Infect Control Hosp Epidemiol. 2018 Dec 18:1-3.

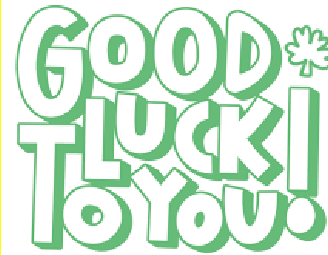
GNR CFU

4 patient room sinks (2 per arm)

Cadnum JL et al. Infect Control Hosp Epidemiol. 2018 Dec 18:1-3.

Sinks associated with increased risk of MDR-GNR BSI outside of epidemics

Sink hygiene would be a solution, but good luck with implementation, compliance and sustainability



If you have a choice between a behavioral intervention and an engineering one, go for the engineering!

ANOTHER SOLUTION?

Banning sinks in ICUs?

Yes, it’s possible!
Sinks are not ESSENTIAL

100%

Yes, it leads to 100% adherence once implemented

Once implemented, HCWs don’t want to go back

Cut the SINK, Cut the RISK

How to make an off-the-grid ICU

Table 1 'Water-free' patient care activities

Patient care-related action	New method with 'water-free' working
Gloves and gowns	Universal gloving and gowning (pre- and post-intervention period)
Hand washing after visual contamination	'Quick & Clean', (Alpheios B.V., Heerlen, The Netherlands) wipes to remove extensive contamination from hands. Followed by disinfection with alcohol-based hand rub
Medication preparation	Dissolving of medication in bottled water (SPA reine, Spa, Belgium)
Drinks	Bottled water (SPA reine, Spa, Belgium)
Canula care	Disposable materials
Hair washing	Rinse-free shampoo cap (Comfort Personal cleansing products, USA)
Washing	Moistened disposable wash gloves, (D-care,Houten, The Netherlands)
Dental care	Bottled (SPA reine, Spa, Belgium)
Shaving	Electric shaving, or with warm bottled water (SPA reine, Spa, Belgium)

Hopman J et al. Antimicrob Resist Infect Control. 2017 Jun 10;6:59.

Banning sinks?

RESEARCH Open Access

Reduced rate of intensive care unit acquired gram-negative bacilli after removal of sinks and introduction of 'water-free' patient care

Joost Hopman[1*†], Alma Tostmann[1†], Heiman Wertheim[1], Maria Bos[1], Eva Kolwijck[1], Reinier Akkermans[3], Patrick Sturm[1,4], Andreas Voss[1,2], Peter Pickkers[5] and Hans vd Hoeven[5]

- 2-year pre-post quasi-experimental study
- Measure: Risk of colonization by GNR by ICU patients (**passive** monitoring using micro database)
- Overall decrease in acquisition GNR
  - 26.3 to 21.6 per 1000 ICU days (IRR, 0.82; p=0.02)
- Strong association with duration ICU stay

Hopman J et al. Antimicrob Resist Infect Control. 2017 Jun 10;6:59.

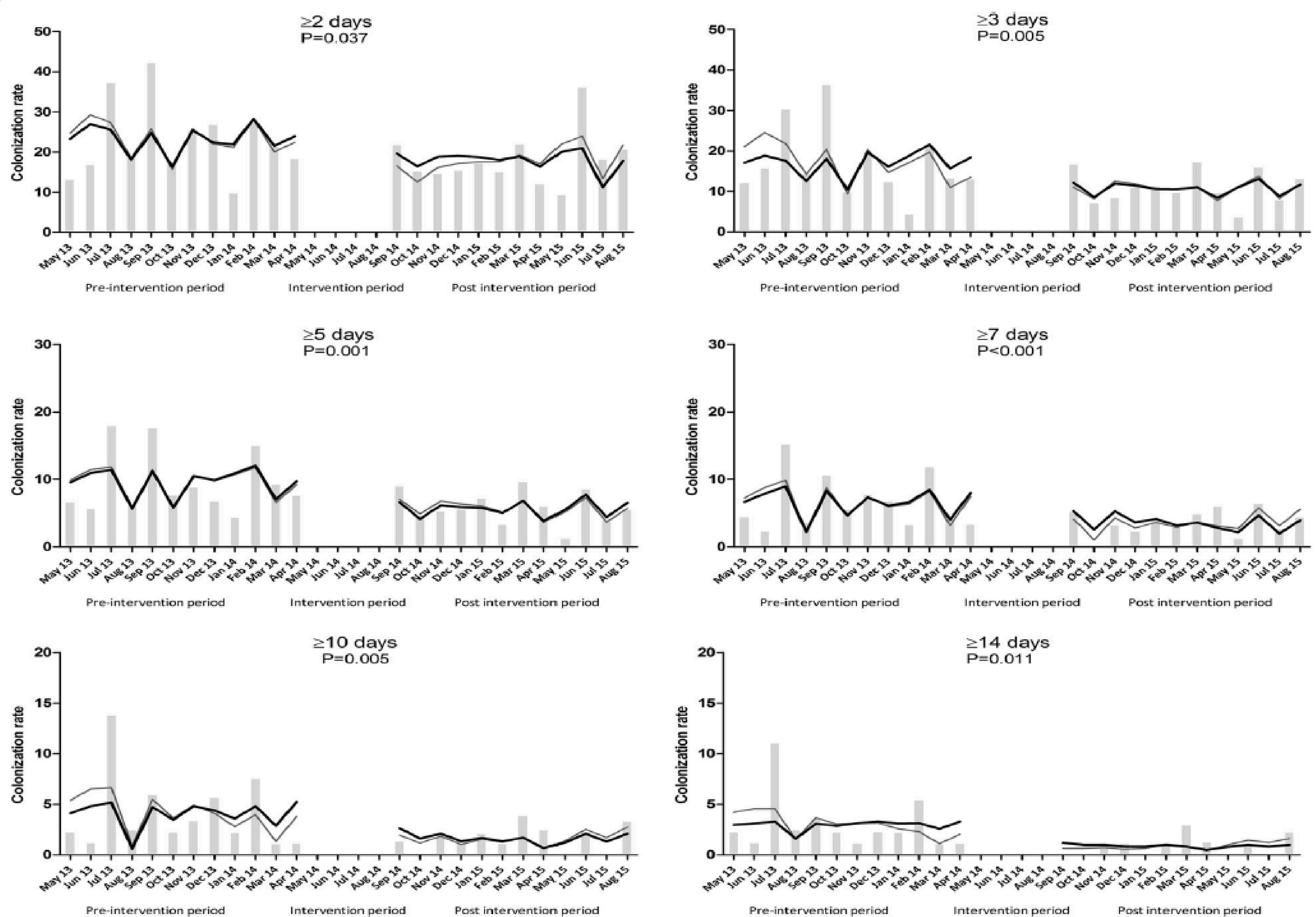


Fig. 2 Monthly gram-negative bacilli (GNB) colonization rates. Legend: Monthly GNB colonization rates (bars), the predicated rate based on the full model (*grey line*) and the predicted rate based on the parsimonious model (*black line*). β2 level change *p*-values are shown in 2A to 2F, where β2 stands for the level change in the monthly colonization rate immediately after the intervention. Section A to F refer to GNB identified in ICU patients with a length of stay of ≥2, ≥3, ≥5, ≥7, ≥10 or ≥14 days after ICU admission

The longer the ICU stay, the more marked the effect

Hopman J et al. Antimicrob Resist Infect Control. 2017 Jun 10;6:59.

Log scale

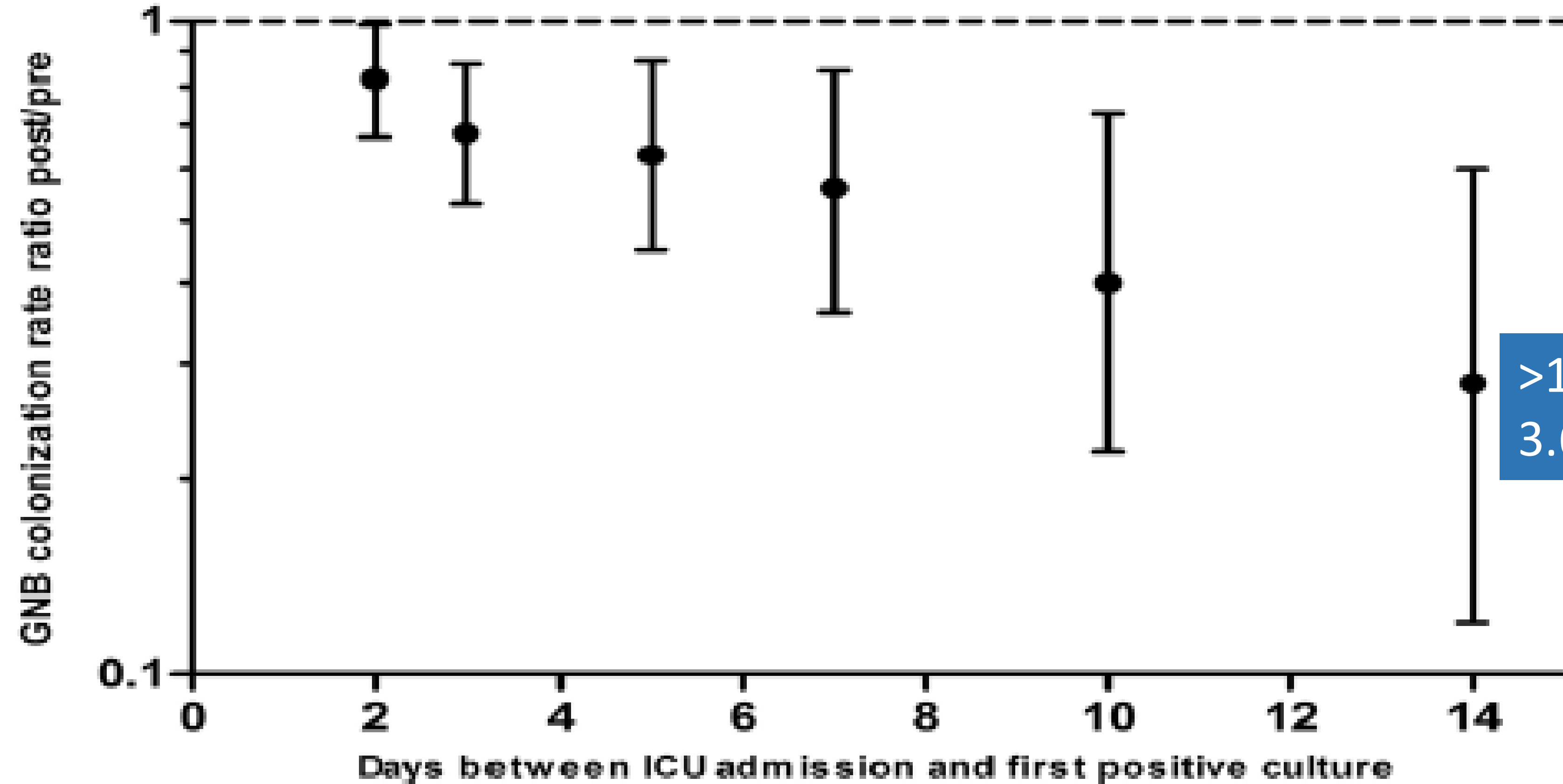


Fig. 3 Colonization rate ratios related to ICU-LOS. Legend: Colonization rate ratios (with 95%CI) were calculated to investigate the effect of ICU-LOS on the effect of the intervention. GNB identified in ICU patients with a length of stay of ≥2, ≥3, ≥5, ≥7, ≥10 or ≥14 days after ICU admission were analyzed

>14days:
3.6-fold decrease

Hopman J et al. Antimicrob Resist Infect Control. 2017 Jun 10;6:59.

- 6-year before and after study
  - Single center (700-bed teaching hospital)
  - Two 12-bed ICUs in the same hospital
  - 43 months pre-intervention and 29 months post intervention

- Intervention
  - Removal of all sinks (except 2 in the central nursing station)
    - These central sinks were equipped with filters and the p-traps were changed q 3 months. This filtered water was used for patient care PRN
    - Grey water disposal was done outside of patient care area (unclear exactly)
  - Needed to close the wards to remove sinks!!!
  - Outcomes:
    - ICU-acquired MDR GNR bacteria (colonization or infection)
  - Confounders
    - CHG wipes implemented in 2015 (during intervention)
    - UV disinfection in 2016

Journal of Hospital Infection 98 (2018) 275–281

Available online at www.sciencedirect.com

Journal of Hospital Infection

journal homepage: www.elsevier.com/locate/jhin

Control of endemic multidrug-resistant Gram-negative bacteria after removal of sinks and implementing a new water-safe policy in an intensive care unit

E. Shaw [a,b,*], L. Gavaldà [c], J. Càmara [d], R. Gasull [e], S. Gallego [e], F. Tubau [d,f], R.M. Granada [e], P. Ciercoles [a], M.A. Dominguez [d,b,g], R. Mañez [e], J. Carratalà [a,b,g], M. Pujol [a,b]

[a] Department of Infectious Diseases, Hospital Universitari de Bellvitge—IDIBELL, Barcelona, Spain
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[c] Department of Preventive Medicine, Hospital Universitari de Bellvitge—IDIBELL, Barcelona, Spain
[d] Department of Microbiology, Hospital Universitari de Bellvitge—IDIBELL, Barcelona, Spain
[e] Department of Intensive Medicine, Hospital Universitari de Bellvitge—IDIBELL, Barcelona, Spain
[f] CIBER de Enfermedades Respiratorias, Instituto de Salud Carlos III, Madrid, Spain
[g] University of Barcelona, Barcelona, Spain

Shaw E, Gavaldà L, Càmara J, Gasull R, Gallego S, Tubau F, Granada RM, Ciercoles P, Dominguez MA, Mañez R, Carratalà J, Pujol M. Control of endemic multidrug-resistant Gram-negative bacteria after removal of sinks and implementing a new water-safe policy in an intensive care unit. J Hosp Infect. 2018 Mar;98(3):275-281. doi: 10.1016/j.jhin.2017.10.025. Epub 2017 Nov 28. PMID: 29104124.

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- Results
  - Decrease in ICU-acquired MDR-GNR from 9.15 to 2.20 per 1000pd
    - RR 0.24 (95% CI 0.17 to 0.34)

Shaw E, Gavaldà L, Càmara J, Gasull R, Gallego S, Tubau F, Granada RM, Ciercoles P, Dominguez MA, Mañez R, Carratalà J, Pujol M. Control of endemic multidrug-resistant Gram-negative bacteria after removal of sinks and implementing a new water-safe policy in an intensive care unit. J Hosp Infect. 2018 Mar;98(3):275-281. doi: 10.1016/j.jhin.2017.10.025. Epub 2017 Nov 28. PMID: 29104124.

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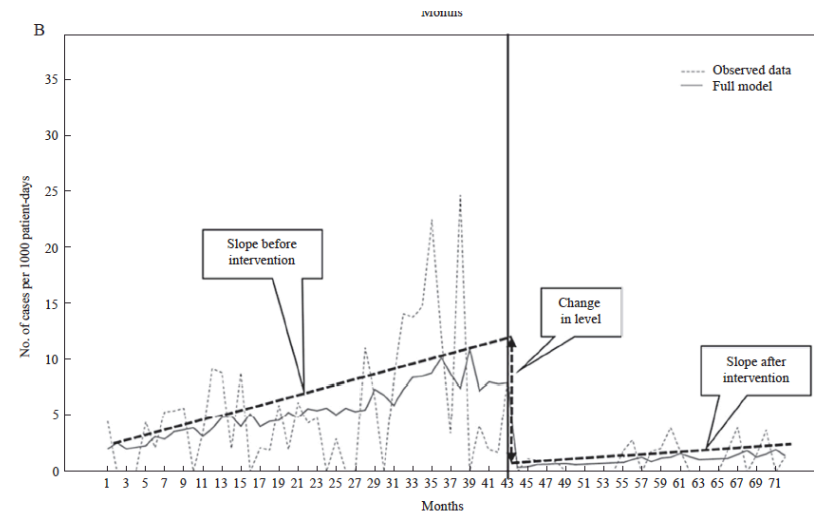
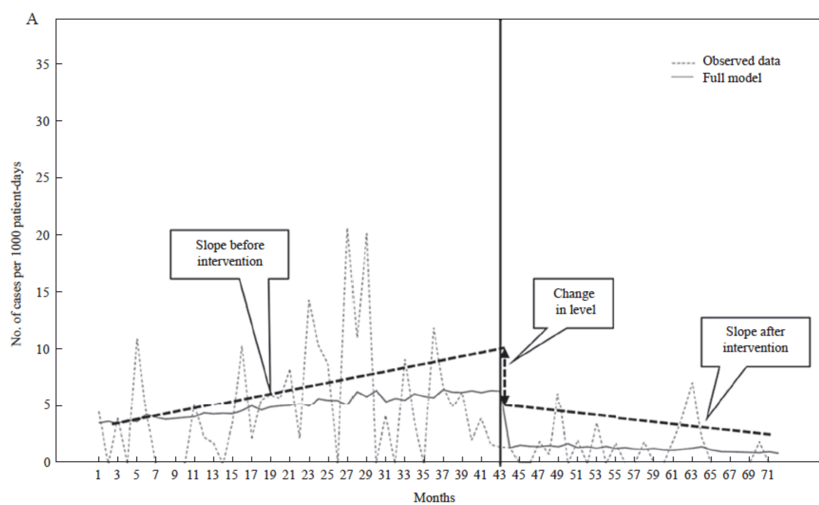
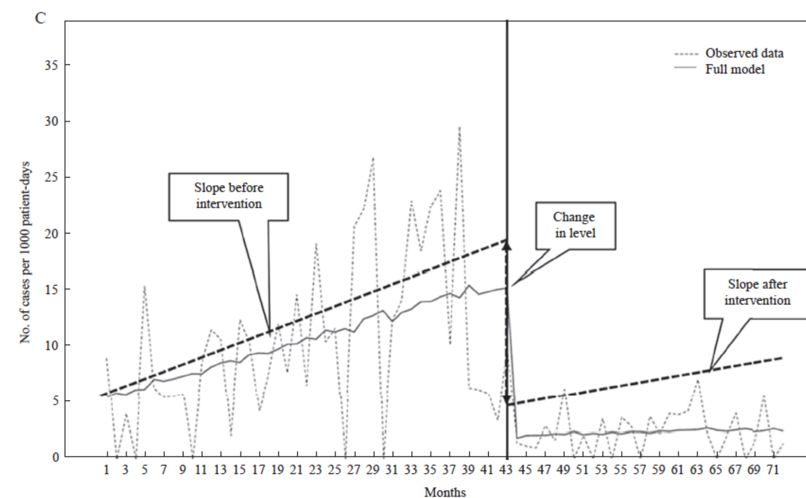


MDR K. pneumoniae



MDR P. aeruginosa



Overall MDR GNR

Figure 2. Changes in the incidence rates of multidrug-resistant bacteria in the intensive care units. (A) Multidrug-resistant *Pseudomonas aeruginosa*. (B) Multidrug-resistant *Klebsiella pneumoniae*. (C) Overall multidrug-resistant Gram-negative bacteria.

Shaw E, et al. J Hosp Infect. 2018 Mar;98(3):275-281. doi: 10.1016/j.jhin.2017.10.025. Epub 2017 Nov 28. PMID: 29104124.

Med Clin (Barc). 2019;152(7):261–263

MEDICINA CLINICA
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Brief report

Impact of removing sinks from an intensive care unit on isolations by gram-negative non-fermenting bacilli in patients with invasive mechanical ventilation☆

Gonzalo de-las-Casas-Cámara[a,b,*], Carolina Giráldez-García[c], Maria Isabel Adillo-Montero[c], María Carmen Muñoz-Egea[d], María Dolores Martín-Ríos[e]

[a] Servicio de Medicina Preventiva, Hospital Universitario Rey Juan Carlos, Móstoles, Madrid, Spain
[b] Facultad de Ciencias de la Salud, Universidad Francisco de Vitoria, UFV, Pozuelo de Alarcón, Madrid, Spain
[c] Servicio de Medicina Preventiva, Hospital Universitario Infanta Elena, Valdemoro, Madrid, Spain
[d] Servicio de Microbiología y Parasitología, Hospital Universitario Infanta Elena, Valdemoro, Madrid, Spain
[e] Servicio de Medicina Preventiva, Hospital Universitario Fundación Jiménez, Madrid, Spain

- Single-center before and after study (8-bed ICU)
  - Pre-intervention 2014-2016
  - Post-intervention: 2016-2018
- Outcome: recovery of NFGNB from bronchoaspirates in intubated patients
- Result: Decrease in incidence of NFGNB from 11.3 to 1.9 per 1000 days ($p=0.003$)

de-Las-Casas-Cámara G, et al Med Clin (Barc). 2019 Apr 5;152(7):261-263. English, Spanish. doi: 10.1016/j.medcli.2018.06.023. Epub 2018 Aug 23. PMID: 30146354.

Table 1
Patient distribution, flow of sample/patient, hospitalisations, ID per 1000 days of IMV and isolates per period.

	Pre-intervention		Post-intervention
	2014–2015	2015–2016	2016–2017
N patients	300	301	350
Flow of samples/patients evaluated			
BAS with isolates/patients	156/54	233/66	209/63
BAS with NFGNB/patients	32/17	50/16	14/4
BAS with NFGNB-RHC/patients	29/14	45/13	8/3
BAS with NFGNB-RHC/patients, incidents	15/14	14/13	2/2
Days hospitalised	1.932	2.174	2.092
Days hospitalised with VMI	1.197	1.375	1.047
ID of incident cases RHC	11.69	9.45	1.91
ID of incident isolates RHC	12.53	10.18	1.91
NFGNB isolates			
Pseudomonas aeruginosa	5	3	
Chryseobacterium indologenes	3	1	
Elizabethkingia meningoseptica		1	
Acinetobacter baumannii	1	1	
Burkholderia cepacia	1	2	
Stenotrophomonas maltophilia	5	5	2
Pseudomonas putida		1	

BAS: bronchial aspirate; NFGNB: non-fermenting gram-negative bacilli; ID: incidence density; RHC: related to health care; IMV: invasive mechanical ventilation.

Pre-intervention:
15 NFGNR isolated/year

11.3 per 1000 ventilation-days

Post-intervention:
2 NFGNR isolated/year

1.9 per 10000 ventilation days (p=0.003)

de-Las-Casas-Cámara G, et al Med Clin (Barc). 2019 Apr 5;152(7):261-263. English, Spanish. doi: 10.1016/j.medcli.2018.06.023. Epub 2018 Aug 23. PMID: 30146354.

Systematic Review

Journal of Hospital Infection 150 (2024) 61–71

Available online at www.sciencedirect.com
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Review

The impact of sink removal and other water-free interventions in intensive care units on water-borne healthcare-associated infections: a systematic review

J.M. Low[a,b,*], M. Chan[c], J.L. Low[d], M.C.W. Chua[a,b], J.H. Lee[e,f]

- Identified 7 studies
  - All quasi-experimental
- 5/7 implemented in context of outbreaks (threat regression to the mean)
- Outcomes
  - 4/7 MDR-GNB
  - 2/7 Pseudomonas only
  - 1 MOTT

Low JM et al. Journal of Hospital Infection 150 (2024) 61e71

Journal of Hospital Infection 150 (2024) 61–71

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J.M. Low[a,b,*], M. Chan[c], J.L. Low[d], M.C.W. Chua[a,b], J.H. Lee[e,f]

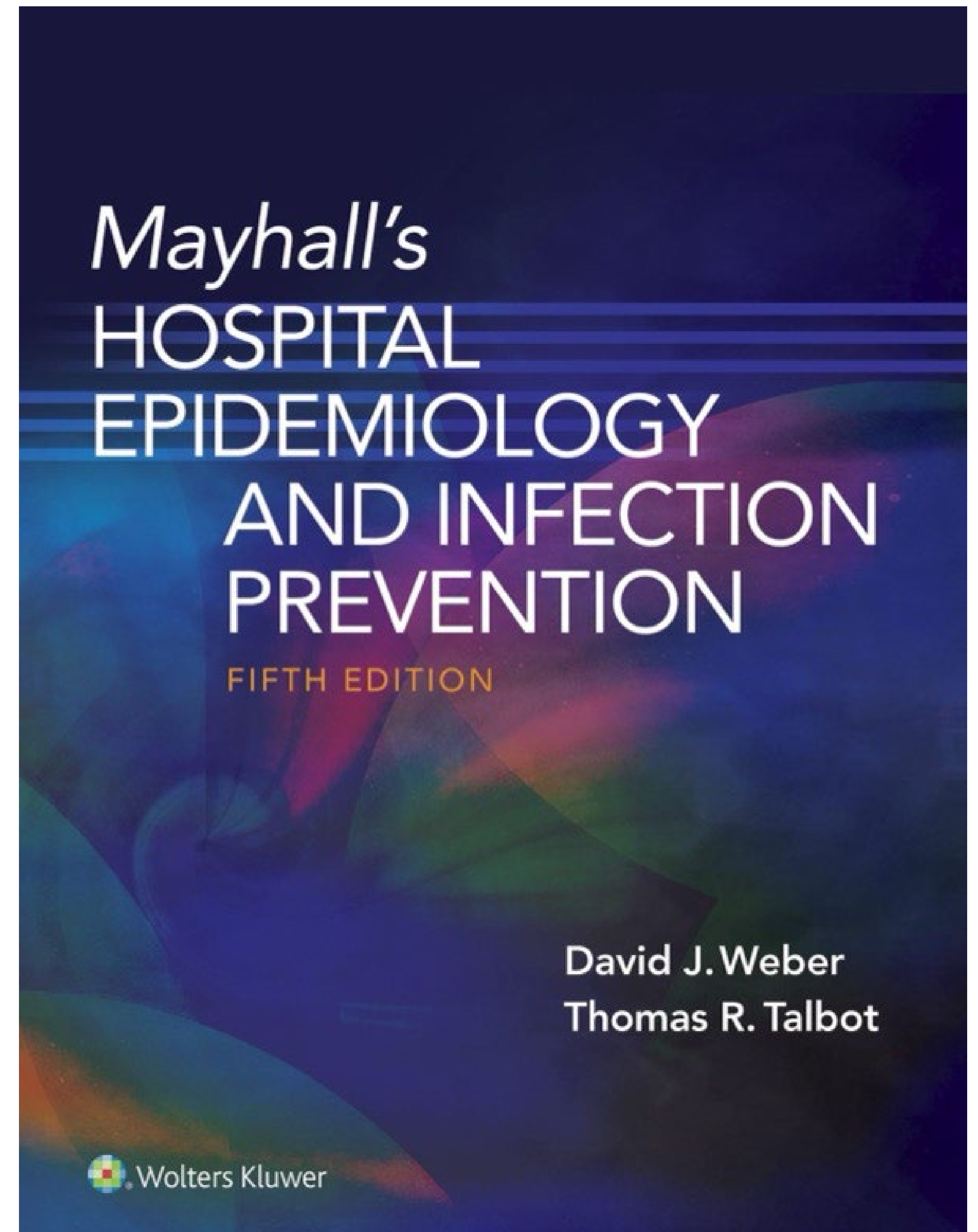
		Primary outcome	Limitations
Scharer 2023	Outbreak of MDR PSeudomonas	0 cases of MDR Pseudo post-implementation	short duration 9 months
Baker 2021	Outbreak of MOTT	Incidence colonization of MOTT from 41 to 9.9 per 10,000 pd	
CAtho	Outbreak of MDR Pseudomonas	0 cases of MDR Pseudo post-implementation	short duration 8 months
Tracy	NICU outbreak of MDRGNB	Resolution of oubtreaks, only sporadic cases of MDRGNB after implementation	
de-Las-Casas-Camara 2019	Non-outbreak setting	Incidence of NFGNB from 11.3 to 1.9 per 1000pd	
Shaw 2018	Non-outbreak setting MDRGNB	Incidence of MDRGNB acquisition from 9.2 to 2.2 per 1000pd	Other co-interventions (UV disinfection, patient cohorting)
Hopman 2017	Outbreak of MDRGNB	Incidence from 26.3 to 21.6 per 1000pd (RR 0.82, p=0.02)	See previous slides

Low JM et al. Journal of Hospital Infection 150 (2024) 61e71

Mayhall

- Hospital wastewater has been increasingly recognized as a GNB reservoir, as GNB are particularly well-suited to survive in moist environments.
- The most commonly identified water sources in CR-GNB outbreaks have been sink drains, sink surfaces, and faucets.

- Prevention: Sink hygiene and improved sink design, but no mention of benefit of sink elimination



CSA standards

7.5.12.2 Hand hygiene sinks

7.5.12.2.1

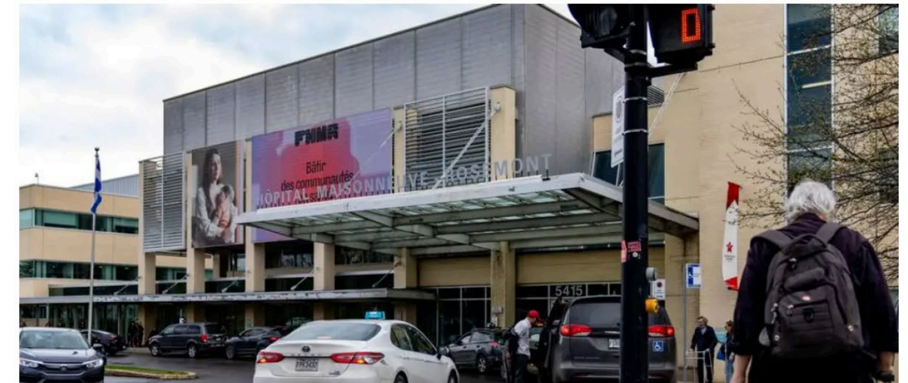
A hand hygiene sink shall be installed in each of the following locations:

a) inside each inpatient bedroom, adjacent to the entrance;

The Gazette

Long-awaited work begins on Maisonneuve-Rosemont Hospital expansion

Health Minister Christian Dubé stood alongside Geneviève Biron, the head of Santé Québec, as they marked the start of construction with a new multi-level car park.



Canadian Standards Association. CSA Z8000: Canadian Health Care Facilities—Planning, Design and Construction. Toronto (ON): CSA Group; 2023

What we know

- ✓MDRGNR is an urgent threat to control
- ✓Sinks well documented source of GNR outbreaks in ICU
- ✓Role in non-epidemic setting increasingly recognized

Knowkledge gap

- ✗ Current evidence of sink avoidance limited to quasi-experimental studies
    - ✗ No RCT performed and none under way (clinicaltrials.gov)
- ✗ Impact on preventing AMR, BSI, UTI, VAP unclear
- ✗ Current evidence insufficient to change recommendations
- ✗ Need to develop high-level evidence that could support changes in policy and standards (CSA)

Next logical Step?

Next logical step

- A formal study with rigorous study design should be performed to:
  - Confirm or infirm previous findings
  - Determine cost-benefit, NNT
  - Quantify risks

- Key considerations
  - Focuses on communicable disease: cluster design essential
  - Complexity of implementing intervention in Canadian hospitals unknown

Suspending the Use of Sinks and Drains in Intensive Care Units to Lower Healthcare Associated Acquisition of Gram-negative bacteria (SinkLess)
A Cluster Randomized Controlled Feasibility Trial

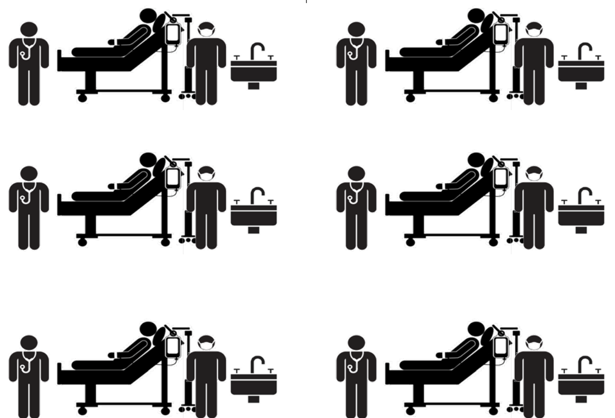
Identification of 6 ICUs

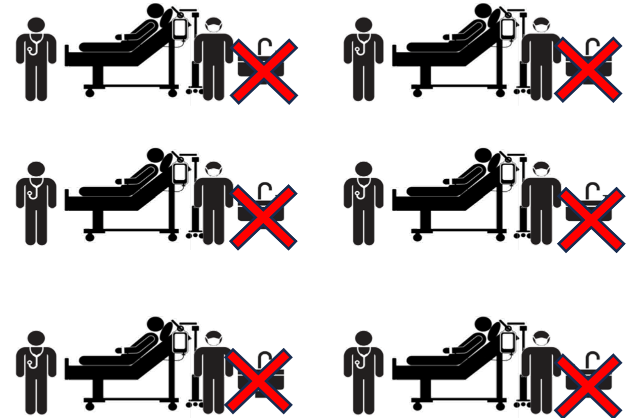
Selection of 2 clusters of 6 ICU beds in each ICU

Randomization 1:1

Control group
Standard of care

Intervention group
Waterless protocol





Entire cluster (including patients and healthcare workers) included

Entire cluster (including patients and healthcare workers) included

REPLACES TAP WATER

PATIENT HYGIENE

BODY FLUID MANAGEMENT

List of GNR of nosocomial importance

Box 1. List of MDR-GNB of Interest to patients in ICU
Enterobacteriaceae[1] resistant to 3rd generation cephalosporins
Enterobacteriaceae resistant to carbapenems
Pseudomonas aeruginosa resistant to 3rd generation cephalosporins and/or carbapenems
Acinetobacter baumannii
Stenotrophomonas maltophilia

1. Includes *E. coli*, *Klebsiella* spp. *Serratia* spp. *Enterobacter* spp. *Citrobacter* spp. and others.

Choice of MDR-GNB is a BALANCE between:

- ✓ Likelihood of being nosocomially acquired
- ✓ Clinical relevance as a problematic pathogen
- ✓ Capacity to be detected by culture

Journal of Hospital Infection 148 (2024) 77–86

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Healthcare Infection Society

Epidemiology of healthcare-associated *Pseudomonas aeruginosa* in intensive care units: are sink drains to blame?

C. Volling [a,*], L. Mataseje [b], L. Graña-Miraglia [c], X. Hu [c], S. Anceva-Sami [a], B.L. Coleman [a], M. Downing [d], S. Hota [e], A.J. Jamal [a], J. Johnstone [a], K. Katz [f], J.A. Leis [g], A. Li [a], V. Mahesh [a], R. Melano [h], M. Muller [i], S. Nayani [a], S. Patel [j], A. Paterson [a], M. Pejkovska [a], D. Ricciuto [k], A. Sultana [a], T. Vikulova [a], Z. Zhong [a], A. McGeer [a], D.S. Guttman [c,l], M.R. Mulvey [b]

Community acquired carriage on admission: an incompressible confounder

- 48.6% of HA-PA HAI are nosocomially acquired (not colonized on admission)
- Only 6.9% of HA-PA could be traced to ICU sink
- Prevalence of Pseudomonas on admission: 212/888 (24%)

Reported prevalence of Pseudomonas colonization in perforated diverticulitis community: 6-40%

SINKLESS Feasiblity Trial

Inclusion criteria	(1) Presence of sinks in patient zone (i.e. <3 meter from the bed) in >80% of rooms that are routinely used for patient care; (2) capacity to establish the interventions; (3) capacity to screen and monitor patients for the outcomes of interest, (4) support from hospital leadership (i.e. the gatekeeper) to participate
Exclusion criteria	(1) pediatric or neonatal ICUs; (2) specialized ICUs (burn units, cardiac ICUs); (3) clusters in hospitals planning to enrol subjects in other studies that aim to prevent contamination of sinks in the ICU or other management strategies that aim to affect the colonization or infection rate with MDR-GNB

OUTCOMES

Primary outcomes	Metric	Green - proceed	Yellow - modify	Red – fail to proceed
	FEASABILITY			
Protocol adherence	Proportion of patients treated as per attributed intervention during intervention period	>=80%	50-79%	<50%
Adherence with Screening protocol	Proportion of patients who undergo screening on admission and discharge divided by the number of admitted patients during the intervention period	>=80%	50-79%	<50%
completeness of outcome data	% eligible patients with completed assessment of primary outcome of definitive trial	>=80%	50-79%	<50%
	SAFETY and quality of care			
Adverse events	Frequency of Trial-related adverse events	Sinkless <2%	Sinkless 2-5%	Sinkless >5%

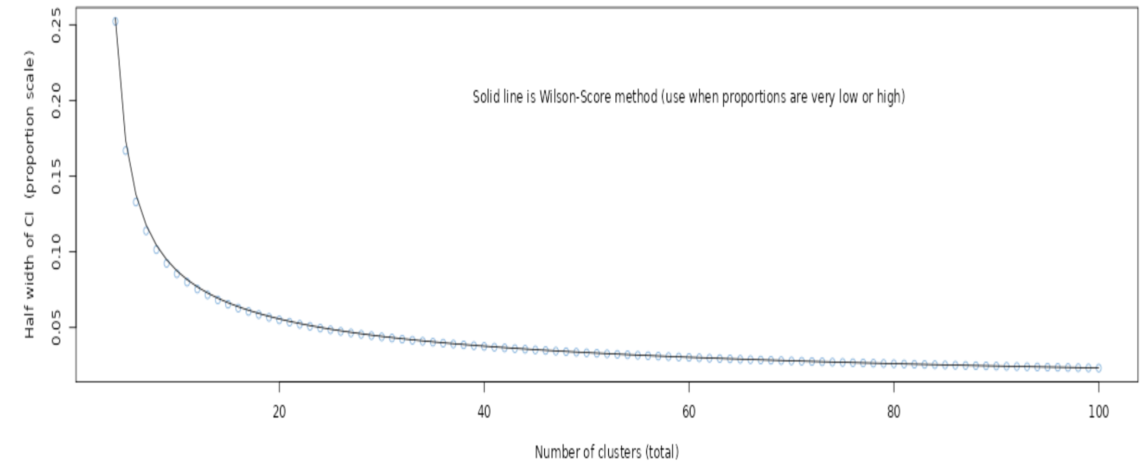
OUTCOMES

Secondary outcomes	Metric
FEASABILITY	
Primary outcome of definitive trial	incidence of MDR-GNB healthcare-associated infections (population-level, per 10,000 bed days): BSI, CLABSI, CAUTI, VAP incidence of MDR-GNB colonization incidence of MDR-GNB acquisition per 10,000 patient-days
Tolerability	Assessment of skin integrity of patients (Eczema Area and Severity Index (EASI) for patient dermatitis, Braden scale for risk of pressure ulcer) HCWs: Hand Eczema Severity Index for dermatitis
Incidence of other MDR-GNB	Rate of recovery from clinical samples of MDR-GNB and select Gram-negative bacteria that are not included in the MDR-GNB list (Burkholderia, Chryseobacterium spp, Sphingomonas spp, and Achromobacter spp);
Protocol deviation	Frequency and causes
Acceptability	Assessed through qualitative interviews with ICU staff and patients to examine perceptions of safety, practicality, and impact on care delivery to identify barriers and facilitators to implementation and inform refinement of the intervention
	PROCESS INDICATORS and CONFOUNDERS
Antimicrobial use	
Medical device use	central venous catheters, urinary catheters, endotracheal tubes
Environmental contamination	
Potential unexpected AE	C. difficile infection incidence Hand hygiene compliance

Screening for colonization

- Rectal swab
- Schedule
  - Admission
  - Discharge
  - Q weekly
- Microbiologic methods
  - Plated on chromogenic agar (Chromagar C3GR plate)
- Blinded
  - Not reported to clinicians (can be batched, will not influence patient management)

Sample size



- Sample size based on precision of primary outcome
  - E.g. <10 percentage point precision
  - Ideally should confirm feasiblity of primary outcome

- Dedicated sample size calculator for feasiblity CRCT
- Cluster size: 325
- Coeff variation 0.5
- ICC: 0.12
- Feasiblity threshold 80%
- Anticipated compliance 90%
- Sample size = 10, increased to 12 to account for dropouts
- Approx 3700 patients (incl run-in)

	Cluster_Size	Coefficient_Variation	N_Clusters	ICC	Proportion	CI_width	CI_half_width	Anticipated_LCI	Anticipated_UCI
1	325	0.5	4	0.12	0.9	0.504415016505	0.2522075082525	0.6477924917475	1.1522075082525
2	325	0.5	5	0.12	0.9	0.333701216778136	0.166850608389068	0.733149391610932	1.06685060838907
3	325	0.5	6	0.12	0.9	0.265763401391643	0.132881700695821	0.767118299304179	1.03288170069582
4	325	0.5	7	0.12	0.9	0.227805456281521	0.113902728140761	0.786097271859239	1.01390272814076
5	325	0.5	8	0.12	0.9	0.20284067092713	0.101420335463565	0.798579664536435	1.00142033546357
6	325	0.5	9	0.12	0.9	0.184808776633441	0.0924043883167203	0.80759561168328	0.99240438831672
7	325	0.5	10	0.12	0.9	0.170978612817179	0.0854893064085897	0.81451069359141	0.98548930640859
8	325	0.5	11	0.12	0.9	0.159921972963563	0.0799609864817814	0.820039013518219	0.979960986481781
9	325	0.5	12	0.12	0.9	0.150811109824796	0.0754055549123979	0.824594445087602	0.975405554912398
10	325	0.5	13	0.12	0.9	0.143128838089326	0.0715644190446632	0.828435580955337	0.971564419044663

https://clusterrcts.shinyapps.io/RshinyAppPilotStudies/

Economic analysis

- Formal evaluation in definitive trial
- Will pilot cost analysis in feasiblity trial

Cost of going sinkless?

Approximative cost per patient per day

	cost/patient/day	Notes
Bottled water (2L/J)	$2	
Waterless bath	$1	2$ each but every other day
Waterless shampoo	$0.50	$3.50 once a week
Absorbent hygienic liners (2.5 per patient per day)	$0.75	Only for 50% patients
Total	$4.25	

1 day in ICU: 3426$ per day
Approx $50K per year for 32-bed ICU

Bagshaw SM, et al. *JAMA Netw Open*. 2020;3(8):e2013913.

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Approx $50K per year for 32-bed ICU

1 week ceftriaxone: $477
1 week ceftolozane-tazo: $40,000
1 week cefiderocol: $17,000

Bagshaw SM, et al. *JAMA Netw Open*. 2020;3(8):e2013913.

Ecological Impact

- Never assessed so far
- If intervention shown to be effective, then cost-benefit assesement will need to take into account:
    - Benefits
    - Costs
    - Environmental impact
- Social acceptance = ?
    - An averted HAI is worth how much pollution?

Team

- Yves Longtin (JGH)
- Todd E Lee (McGill)
- Emily Mcdonals (McGill)
- Alexander Lawandi (McGill - ID/ICU)
- Vivian Loo (McGill)
- Philippe Lefrancois (Derm - JGH)
- Fannie Bourgeois (ICU RN and IPAC)
- Ewa Rajda (McGill)
- Leighanne Parkes (JGH)
- Allison McGeer (MSH)
- Jennie Johnstone (MSH)
- Nick Danneman (Sunnybrook)
- Matthew Muller (Unity Health)
- Beate Sanders (UofT – Health Economics)
- Dominik Mertz (Hamilton)
- Eve Dubé (Medical Anthropology)
- Blair Schwartz (ICU)

MERCI!

Next steps ?

- Relevance of Research Question?
- Interest to participate?
- Eventual fundability by CIHR?
- Potential preliminary projects
  - Survey of current situation
    - Presence and use of sinks/hoppers in ICUs in Canada
  - Identification of strategies to go sink-less
    - Feasiblity, costs, safety
- Methodological considerations
  - Study design
  - Outcomes? (infections, colonizations, ATB use…)
  - Budget

Example: Stepped wedge multicenter RCT with incidence of colonization as main outcome;

2nd outcomes: GNR infections, ATB consumption

Timeline

- April 2024: First pitch of SINKLESS to CRN
  - Support secured for definitive trial
- October 2024: Presentation CRN
  - Sinkless as definitive trial
  - Unit randomization entire ICU unit
  - Conclusion: uncertainty re. feasiblity, choice of main outcome, costs, sample size
  - Uncertainty re. main outome (acquisition vs infection)
- April 2025
  - Sinkless as feasiblity trial

March 2026

- CIHR submission, awaiting results
- Overarching goal research program: establish the effectiveness of eliminating the use of sinks for patient care in ICUs to prevent colonization or infection due to MDR-GNB
- First step: obtain the feasibility pre-requisites required to plan the subsequent definitive trial across diverse ICU settings, and provide effect size estimates to inform its conception.

SINKLESS Feasiblity Trial

Design	Prospective parallel group open feasiblity cluster randomized trial
Type of pilot	External
Population	Patients admitted to MS-ICU (adult or pediatric)
Intervention	Intervention strategy: sinkless protocol
Control	Standard strategy: SOC
Outcomes	Pilot: Feasiblilty

SINKLESS Feasiblity Trial

Sample size	12 clusters of 6 beds Adult medical, surgical or mixed ICU
Participating centers	JGH, MUHC, MSH, Sunnybrook, Unity Health and Hamilton Health Sciences
Randomization	(1:1) stratified per site
Patient enrollment	Automatic upon admission to participating patient bed
Duration intervention	12 months (including 3 months run-in)

Main outcomes in landmark IPAC studies

Chlorhexidine versus routine bathing to prevent multidrug-resistant organisms and all-cause bloodstream infections in general medical and surgical units (ABATE Infection trial): a cluster-randomised trial

Susan S Huang, Edward Septimus, Ken Kleinman, Julia Moody, Jason Hickok, Lauren Heim, Adrijana Gombosev, Taliser R Avery, Katherine Haffenreffer, Lauren Shimelman, Mary K Hayden, Robert A Weinstein, Caren Spencer-Smith, Rebecca E Kaganov, Michael V Murphy, Tyler Forehand, Julie Lankiewicz, Micaela H Coady, Lena Portillo, Jalpa Sarup-Patel, John A Jernigan, Jonathan B Perlin, Richard Platt, for the ABATE Infection trial team

- ABATE Trial (Huang SS Lancet 2019)
  - CHG bathing vs routine bathing
  - Primary outcome: MRSA or VRE clinical cultures attributed to a participating unit (day 3 after admission to Day 2 after DC). Any clinical culture (not screening samples)
  - Secondary outcomes:
    - Clinical culture for MDR-GNR
    - All-pathogen BSI attributable to unit.
  - Exploratory outcomes
    - UTI, CDI,

Huang SS, et al. *Lancet*. 2019 Mar 23;393(10177):1205-1215

The NEW ENGLAND JOURNAL of MEDICINE

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Targeted versus Universal Decolonization to Prevent ICU Infection

Susan S. Huang, M.D., M.P.H., Edward Septimus, M.D., Ken Kleinman, Sc.D., Julia Moody, M.S., Jason Hickok, M.B.A., R.N., Taliser R. Avery, M.S., Julie Lankiewicz, M.P.H., Adrijana Gombosev, B.S., Leah Terpstra, B.A., Fallon Hartford, M.S., Mary K. Hayden, M.D., John A. Jernigan, M.D., Robert A. Weinstein, M.D., Victoria J. Fraser, M.D., Katherine Haffenreffer, B.S., Eric Cui, B.S., Rebecca E. Kaganov, B.A., Karen Lolans, B.S., Jonathan B. Perlin, M.D., Ph.D., and Richard Platt, M.D., for the CDC Prevention Epicenters Program and the AHRQ DECIDE Network and Healthcare-Associated Infections Program*

- *Targeted versus Universal Decolonization to Prevent ICU Infection*
  - Primary outcome: ICU-attributable MRSA-positive clinical culture (excluding screening tests)
  - Secondary outcomes:
    - ICU-attributable BSI due to MRSA
    - ICU-attributable BSI (all pathogens)
  - Clinical cultures obtained at physician’s discretion

Huang SS n engl j med 368;24

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Effect of Daily Chlorhexidine Bathing on Hospital-Acquired Infection

Michael W. Climo, M.D., Deborah S. Yokoe, M.D., M.P.H., David K. Warren, M.D., Trish M. Perl, M.D., Maureen Bolon, M.D., Loreen A. Herwaldt, M.D., Robert A. Weinstein, M.D., Kent A. Sepkowitz, M.D., John A. Jernigan, M.D., Kakotan Sanogo, M.S., and Edward S. Wong, M.D.

- Cluster crossover 6 ICUs or BMT units
- Daily bathing with CHG vs nonantimicrobial washcloths
- Primary outcome: incidence of MRSA or VRE acquisition (colonization or infection)
- Secondary: rate of HA-BSI, CLABSI,

Climo MW, et al. *N Engl J Med*. 2013;368(6):533-542

Research

Original Investigation

Universal Glove and Gown Use and Acquisition of Antibiotic-Resistant Bacteria in the ICU
A Randomized Trial

Anthony D. Harris, MD, MPH; Lisa Pineles, MA; Beverly Belton, RN, MSN; J. Kristie Johnson, PhD; Michelle Shardell, PhD; Mark Loeb, MD, MSc; Robin Newhouse, RN, PhD; Louise Dembry, MD, MS, MBA; Barbara Braun, PhD; Eli N. Perencevich, MD, MS; Kendall K. Hall, MD, MS; Daniel J. Morgan, MD, MS; and the Benefits of Universal Glove and Gown (BUGG) Investigators

- Universal gloving and gowning to prevent acquisition of MDRO in ICUs
- Cluster RCT in 20 ICUs
- Primary outcome:
    - Acquisition of MRSA or VRE based on surveillance cultures (admission and DC)
        - Blinded to clinicians, batched in central lab
- Secondary outcomes
    - VRE acquisition
    - MRSA acquisition
    - HAI: CLABSI, CAUTI, VAP as per NHSN

Harris AD, et al. JAMA. 2013 Oct 16;310(15):1571-80.