Budget constraints vs HAI costs:

How reduced environmental cleaning drives infections and long-term healthcare expenditure

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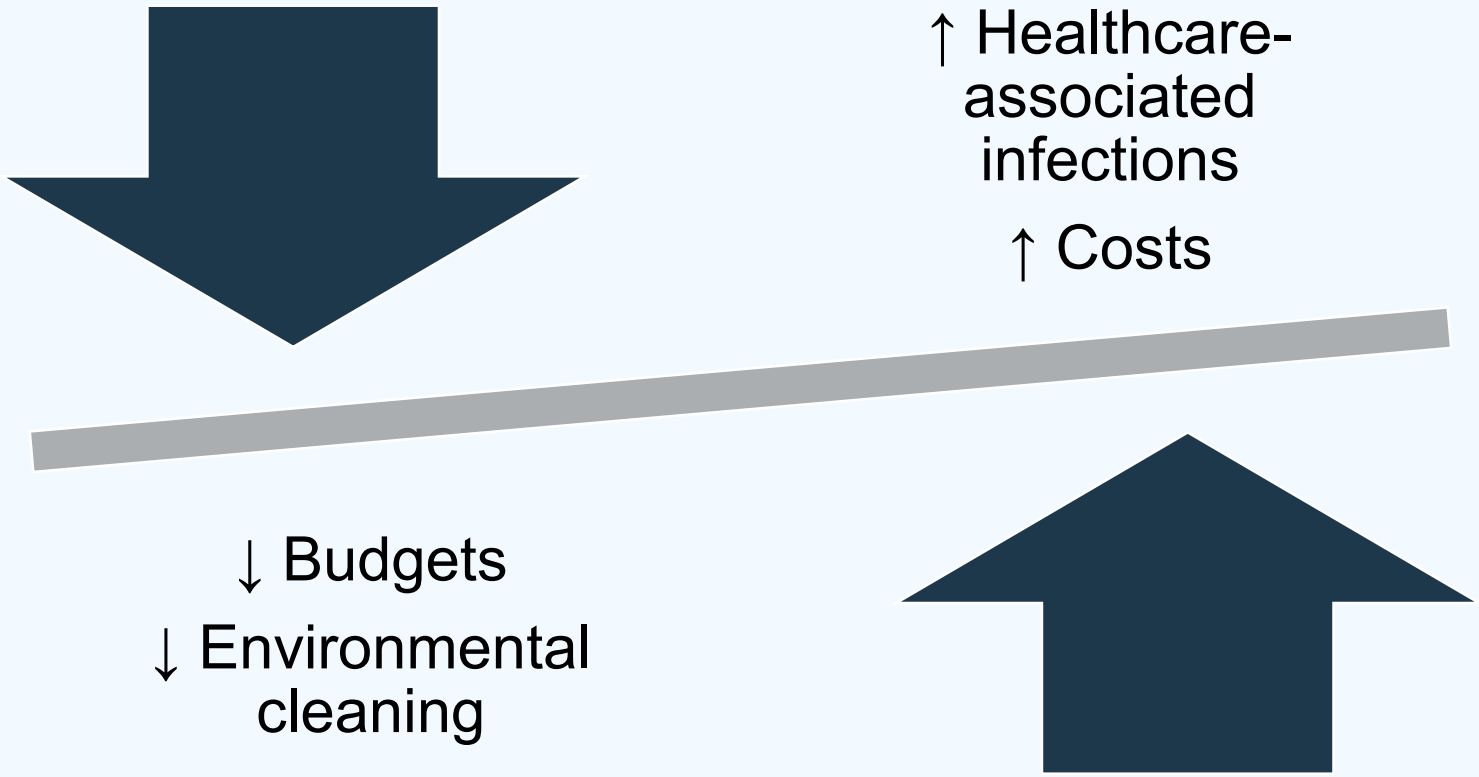
No disclosures

9TH APRIL, 2026

Department of **Health**

Tasmanian Government



Pathogens transmitted via the healthcare environment → Cleaning removes/reduces pathogens → Less transmission, less HAIs → Reduced healthcare costs

Funding health is one of the biggest challenges facing Tasmania, as Eric Abetz prepares to hand down his first b[illegible]t

Health budget blows out by $400m

Treasury's Preliminary Outcomes Report in August showed a net operating balance of $1.2 billion in the 2024-25 financial year, with net debt reaching $5.04 billion.

The main blowouts have been in the Health Department, with a $400 million overspend largely on staff, including locums.

Budget to invest nearly $10 million every single day into our health system

> Government policies to rein in spending — such as staff vacancy controls and efficiency measures — are already affecting service delivery, according to the Australian Medical Association (AMA).

Spending more... but getting less

Real public hospital spending grew by average $3 billion (4.5%)/year in the past decade

- Acute admissions make up the largest proportion

Why?

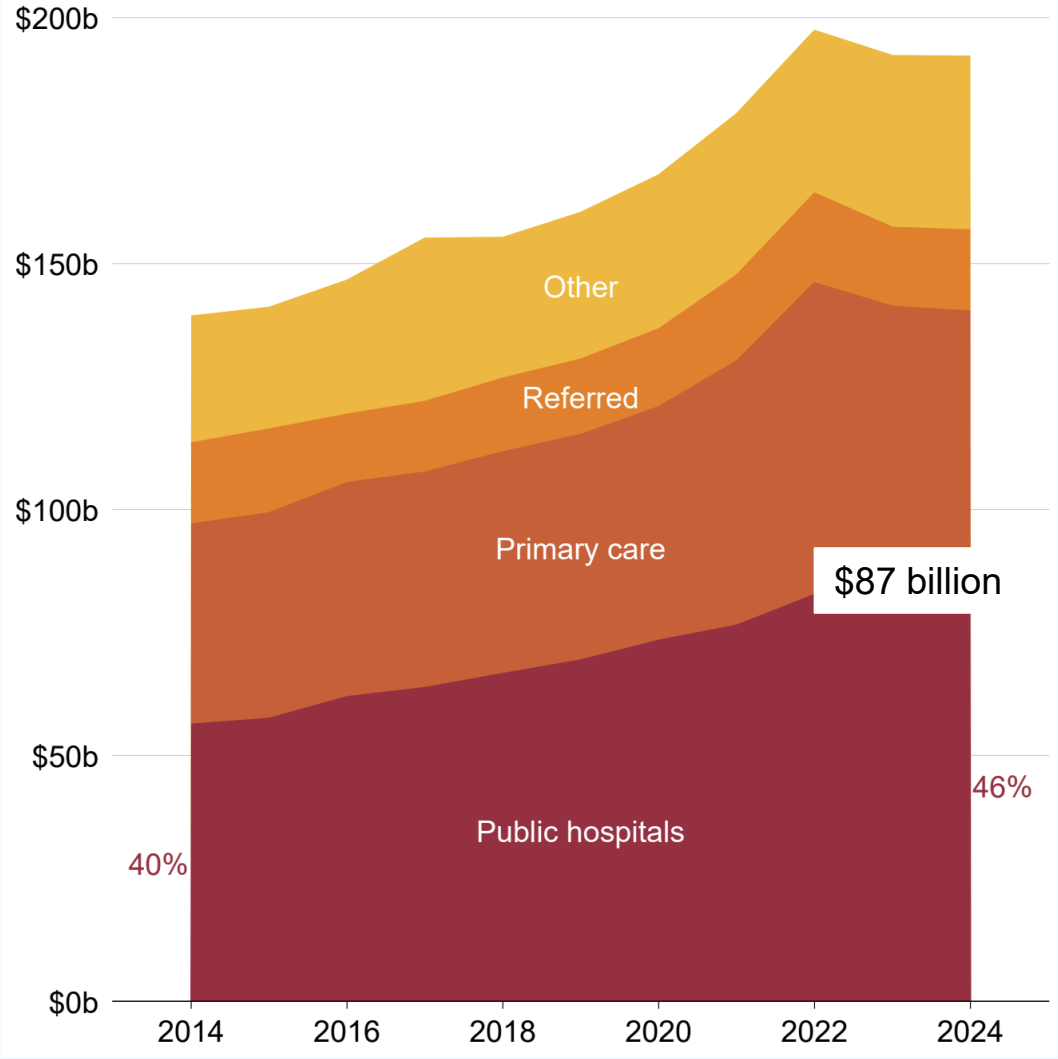
- Rising costs (58%)
- Population growth (35%)
- More hospital use per person (6%)
+ *Post-pandemic changes in practice*

Staffing costs are the biggest expense

- Salaries have not changed much, but ratios have

Figure 1.1: Public hospitals are a large and growing share of health spending

Total government health spending, 2025 dollars



Grattan Institute. Smarter spending: getting better care for every hospital dollar. 2025, https://grattan.edu.au/report/smarter-spending-getting-better-care-for-every-hospital-dollar/

Tassie challenges

Figure 2.5: Costs vary a lot between states
Marginal cost of being treated in each state, relative to weighted national average

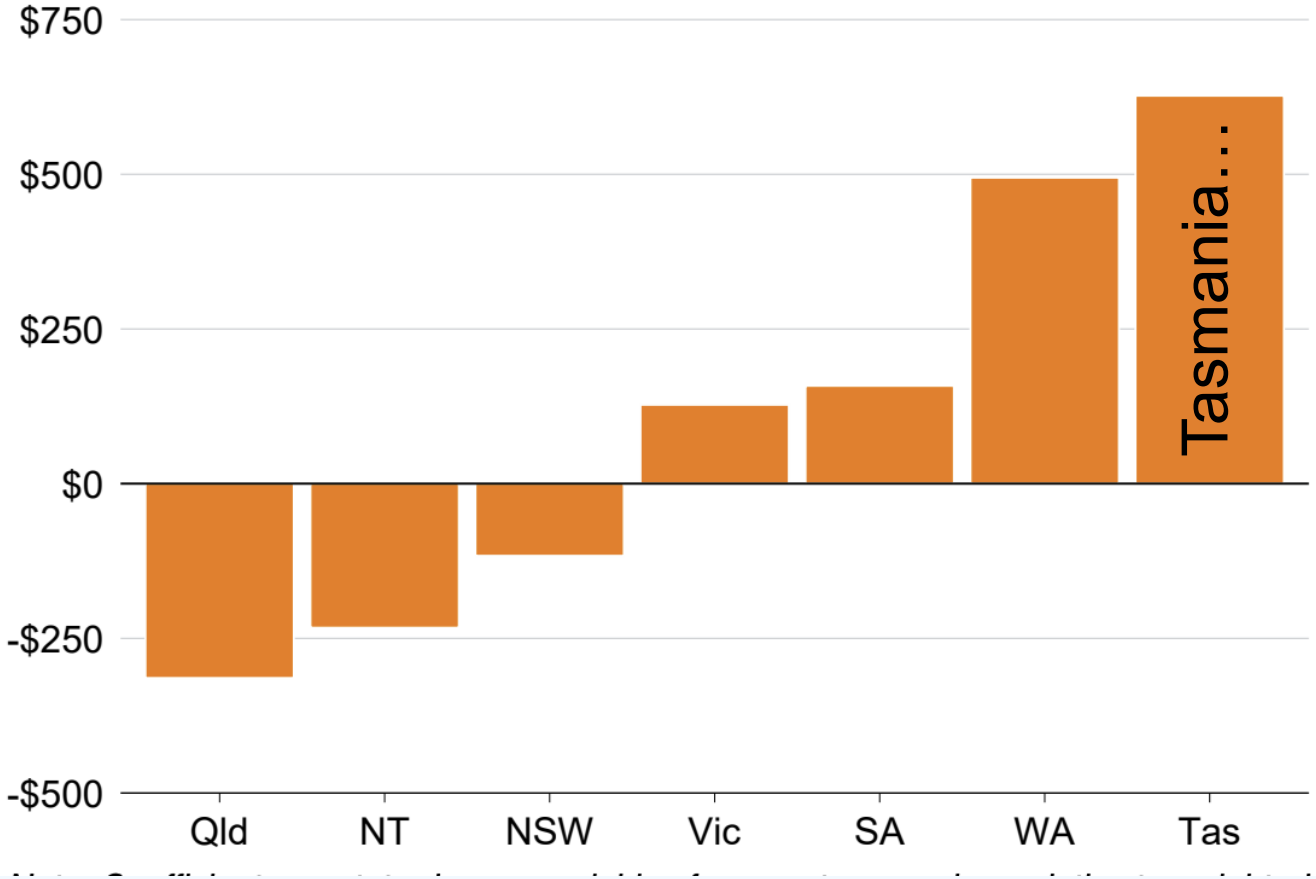
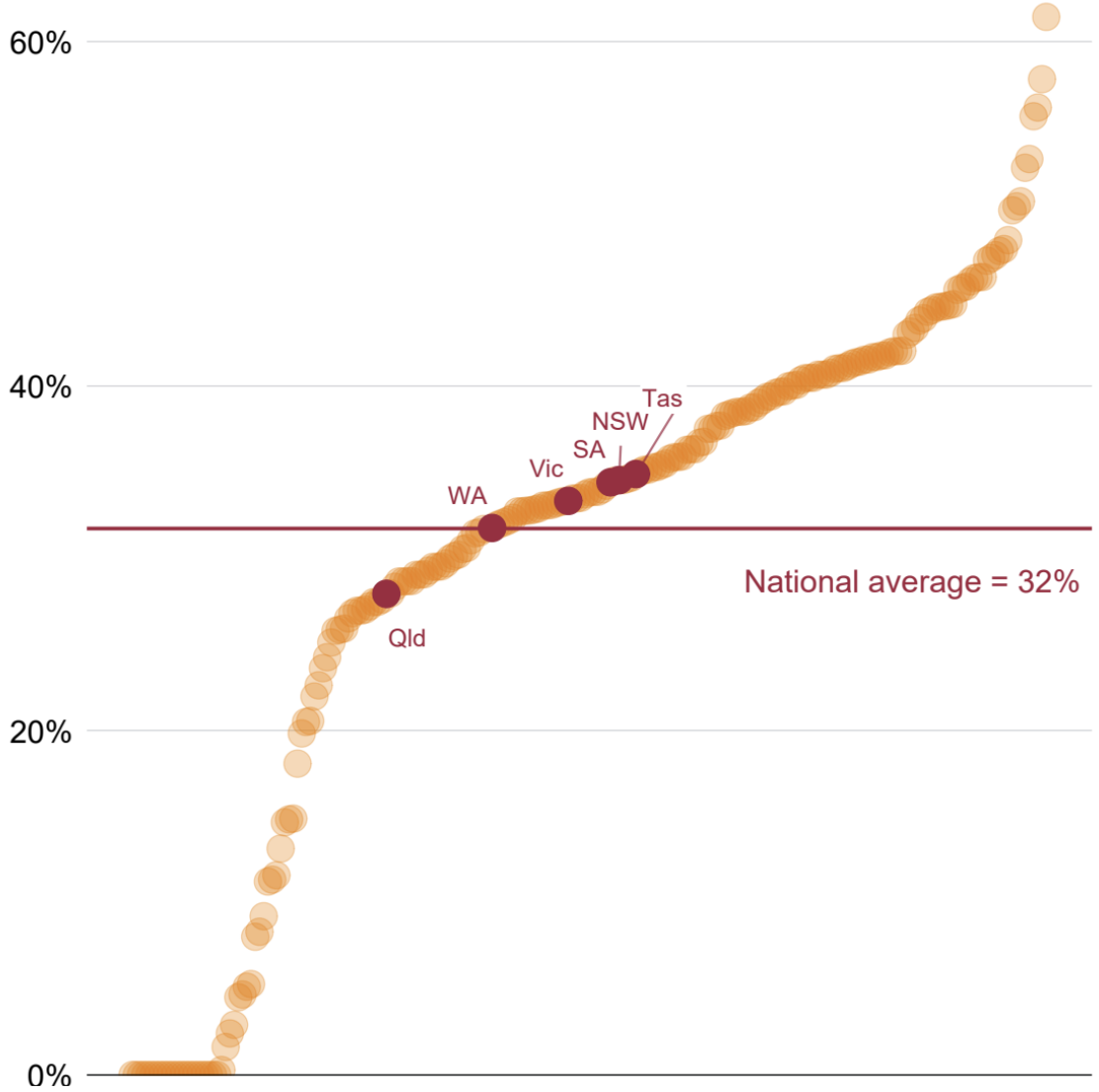


Figure B.1: Some hospitals and states have more elderly patients than average...

Share of patients who are older than 70, by hospital

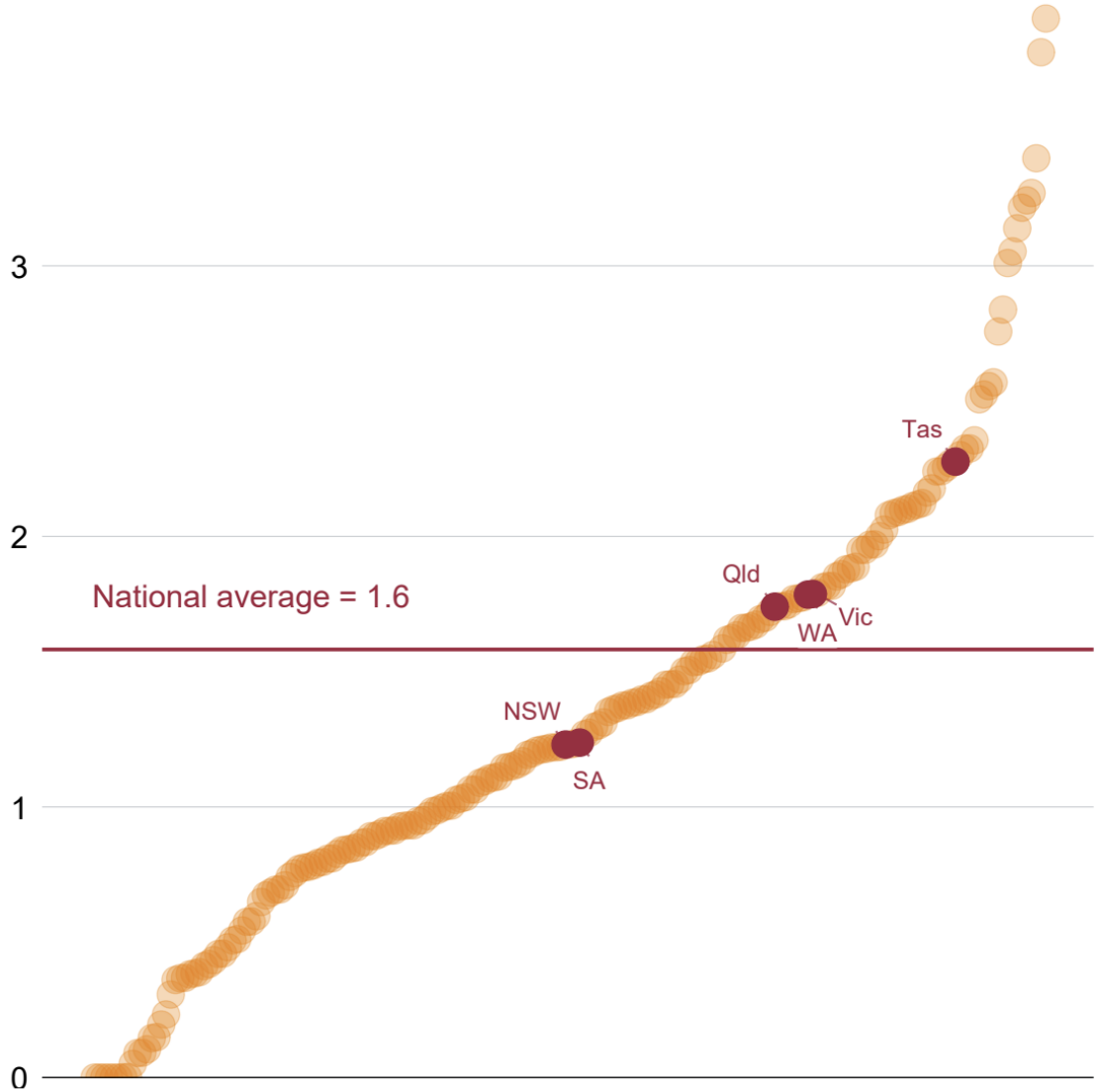


Note: Each orange point represents one hospital, ranked by share of patients older than 70.

Source: Grattan Institute analysis of IHACPA (2025a).

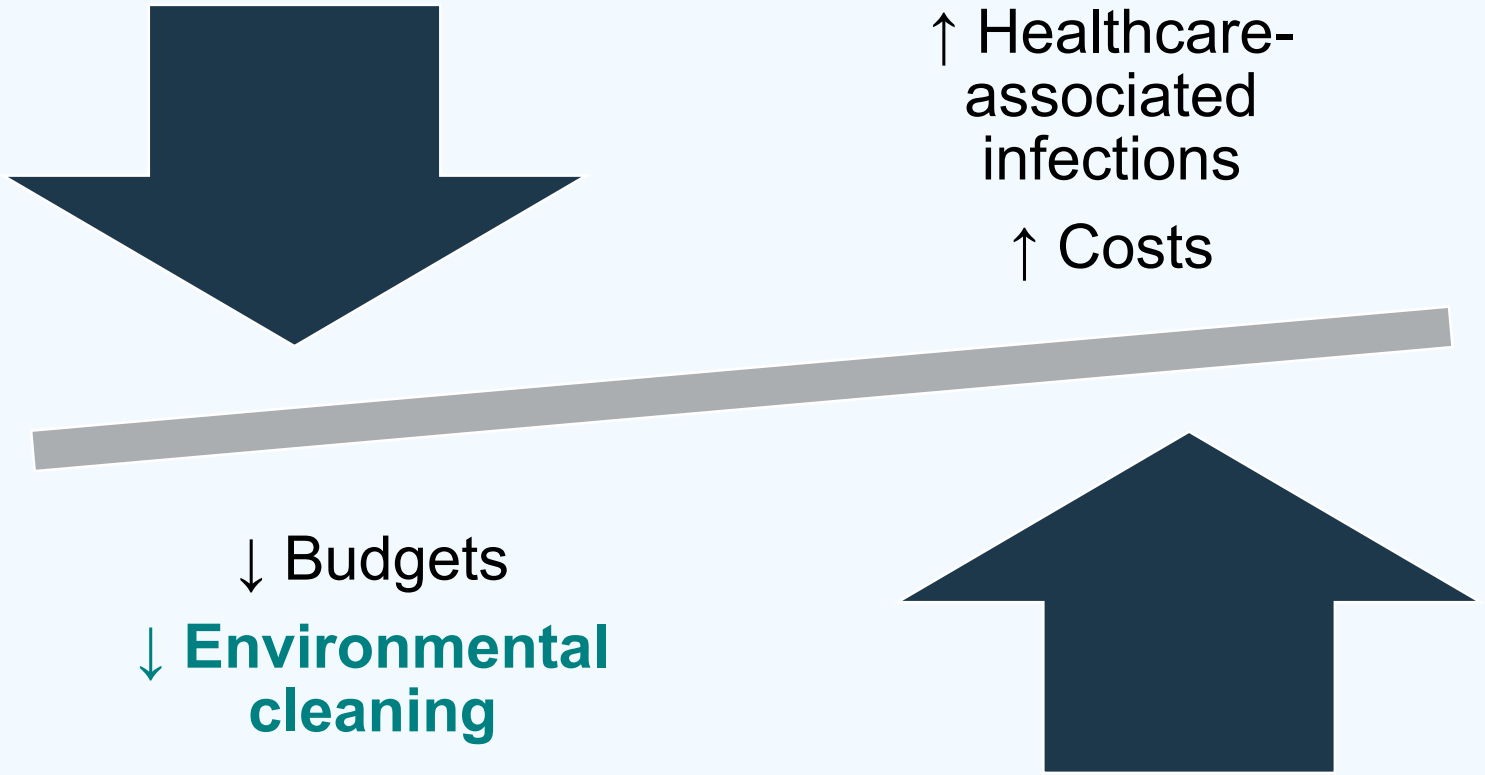
Figure B.2: ... and some have more complex patients than average

Average comorbidity score, by hospital



Note: Each orange point represents one hospital, ranked by average comorbidity score: the Elixhauser score with van Walraven weights.

Source: Grattan Institute analysis of IHACPA (2025).


↑ Healthcare-associated infections
↑ Costs
↓ Budgets
↓ Environmental cleaning

Are we cleaning less?

Hard to say!

Limited literature

Internal audit data important

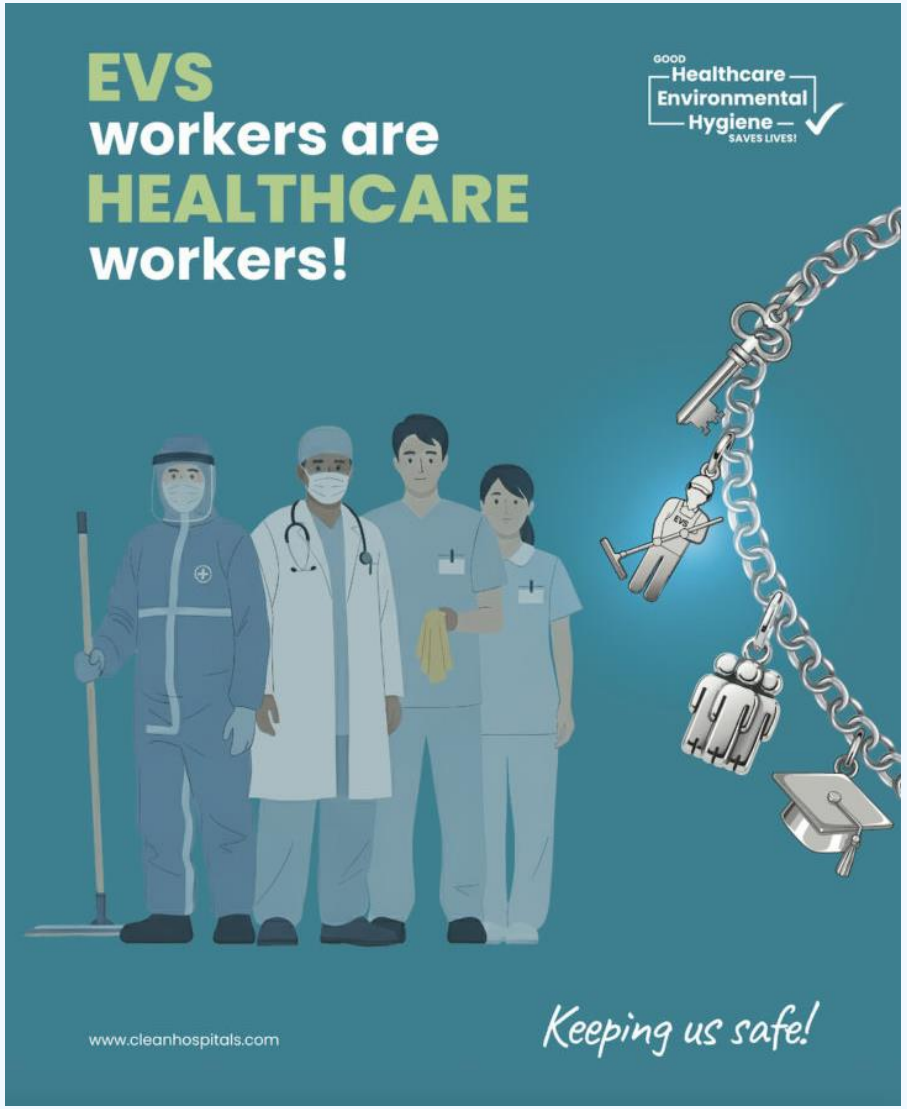
Budgets and staffing levels serve as proxy measures

International pilot survey on health care environmental hygiene:

47% agreed *“Healthcare environmental hygiene budget is sufficient”*

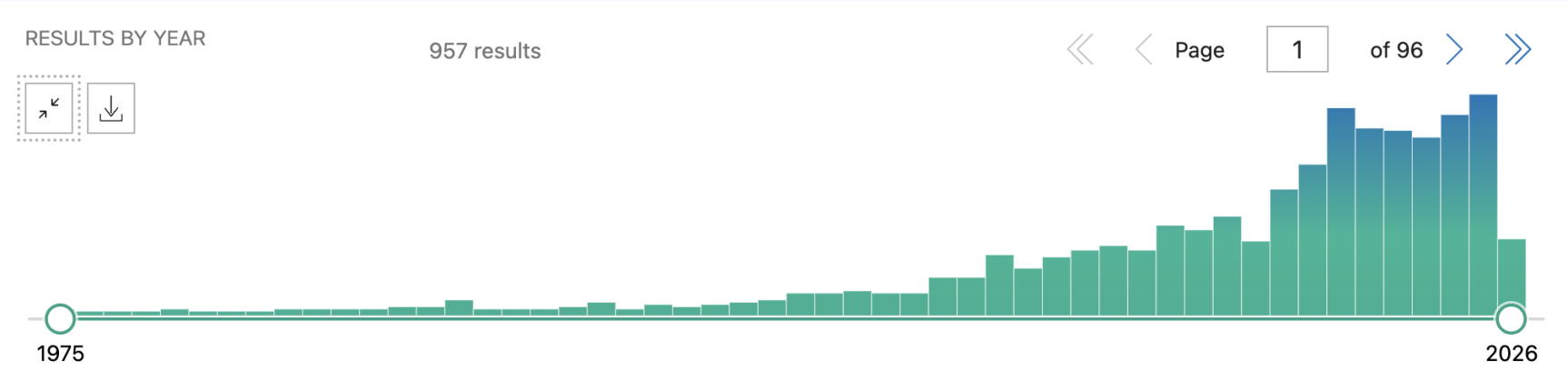
APIC staffing calculator: 79.2% hospitals below expected IPC staffing

Also need to consider building maintenance + upgrades – often first to be cut or delayed



Peters A, Schmid M, Kraker M. Results of an international pilot survey on health care environmental hygiene at the facility level. American Journal of Infection Control, 2022

Are we cleaning less?



Increasing focus on environmental hygiene in last 10-20 years

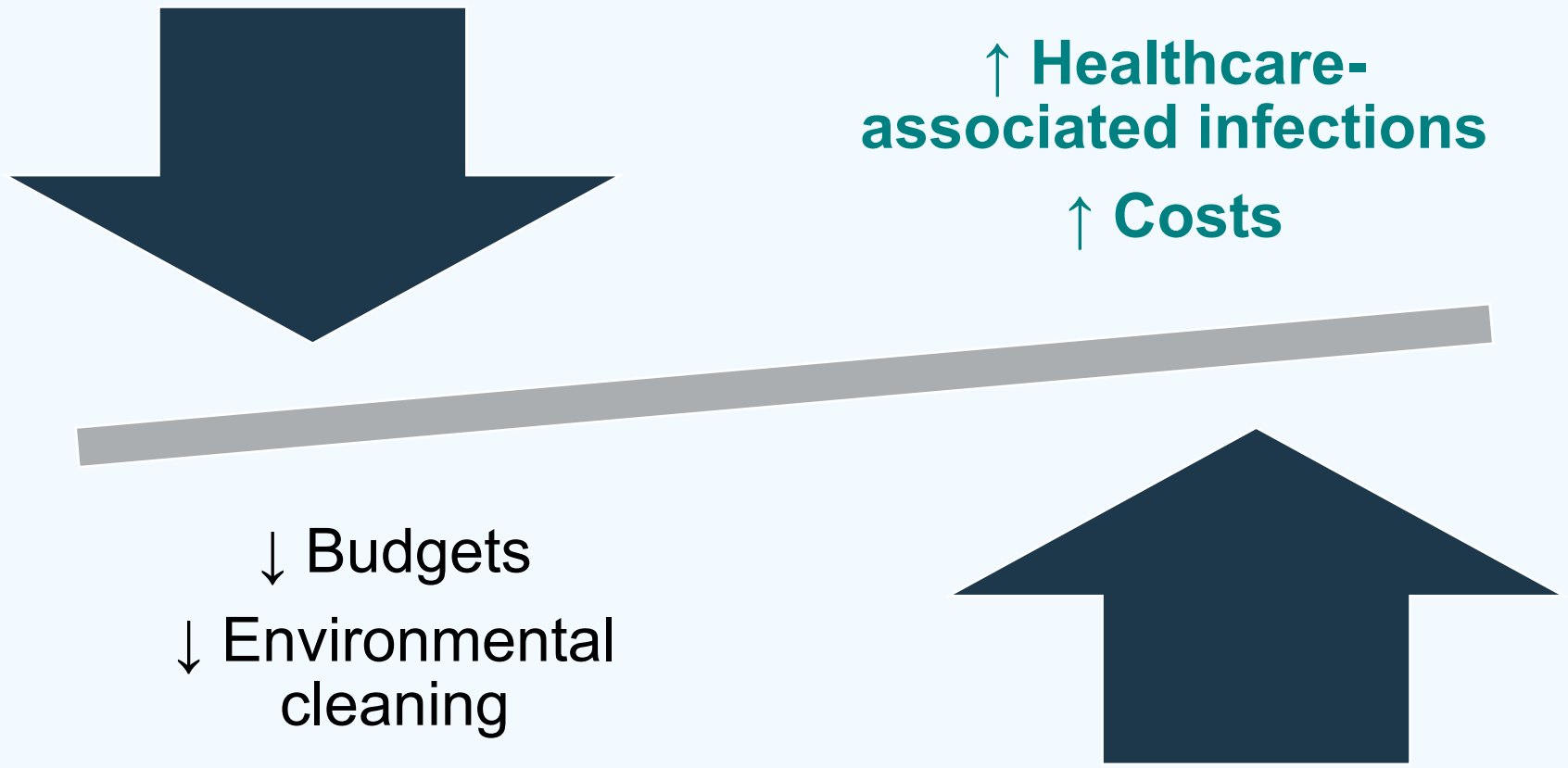
Knowledge, expectations and requirements have increased

Quality of clean is just as important as quantity – importance of auditing

But there are no internationally recognised cleaning benchmarks / standards

And we could always be doing more!

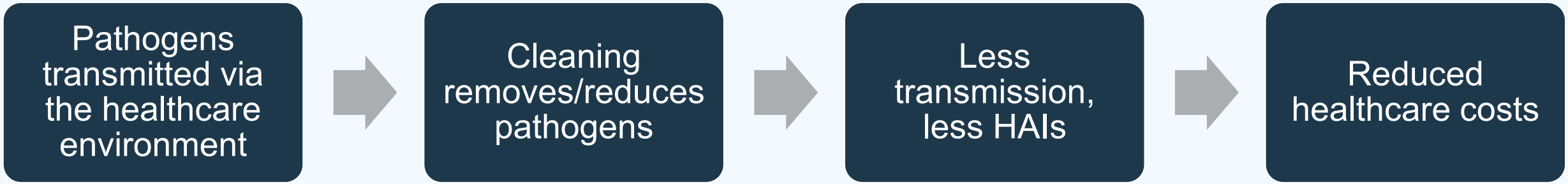
Peters A, Schmid M, Kraker M. Results of an international pilot survey on health care environmental hygiene at the facility level. American Journal of Infection Control, 2022

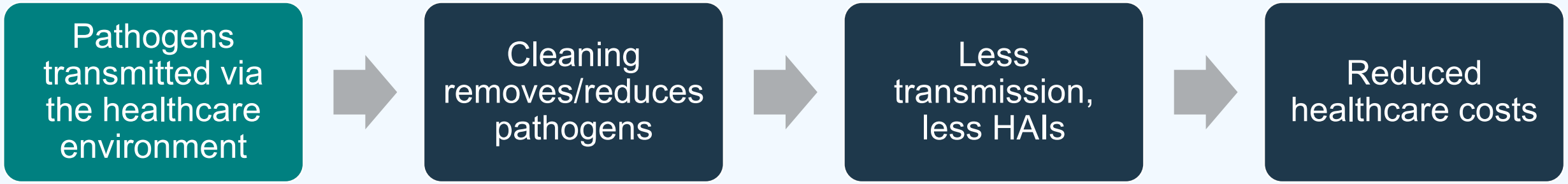


So we are spending more but getting less

Constant pressure to reign in budgets

Environmental hygiene and maintenance are potentially easy targets for budget writers


Pathogens transmitted via the healthcare environment
Cleaning removes/reduces pathogens
Less transmission, less HAIs
Reduced healthcare costs



Estimated 50–70% of all HAI are spread through contaminated hands

Environmental transmission likely accounts for a significant proportion of the remainder

Beyond biological plausibility, what is the evidence for this?

Barnes SL, Morgan DJ, Harris AD, Carling PC, Thom KA. Preventing the transmission of multidrug-resistant organisms: modeling the relative importance of hand hygiene and environmental cleaning interventions. Infect Control Hosp Epidemiol. 2014

Pathogens are persistent

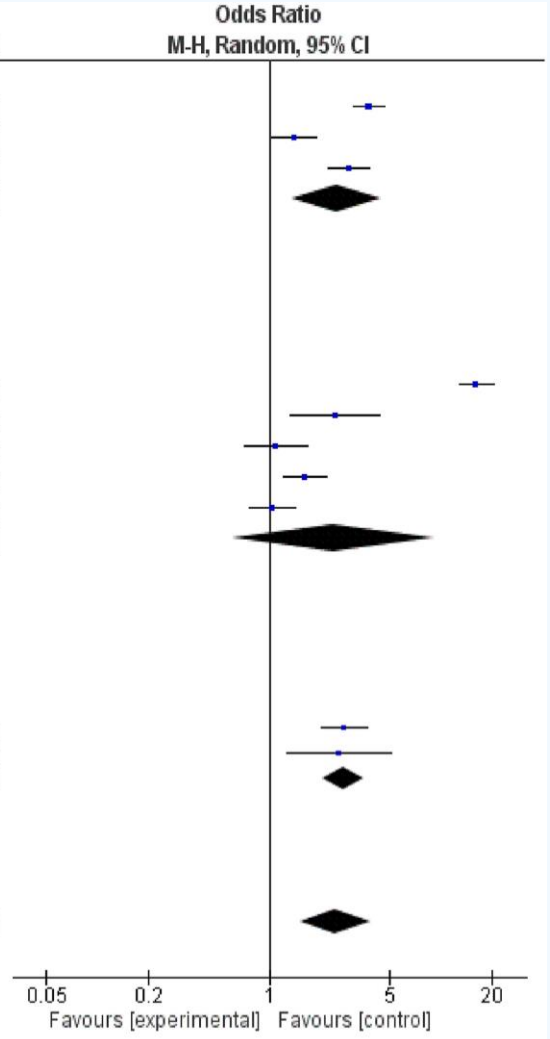
Range of survival by pathogen

	Pathogen	Range of survival in days (unless otherwise indicated)	Studies (references)
Gram positive	*Staphylococcus aureus*	<1 min to 318	[7–32]
	Clostridioides difficile	0.13–140	[33–36]
	Coagulase-negative *Staphylococcus*	<1 min to 28	[12,23,24,37]
	Micrococcus spp.	10–10	[12]
	Streptococcus mutans	0.13–0.2	[21]
	Bacillus spp.	1–28	[22,24]
	Enterococcus spp.	0.02–287	[10,12,14,15,19,22,24,39,43,45,47–49]
Gram negative	*Acinetobacter* spp.	0.04–90	[12,14,15,22,24,29,38–43]
	Burkholderia cepacia	0.13–8	[12,44]
	Citrobacter freundii	0.06–0.11	[45]
	Escherichia coli	<1 min to 56	[8,10,12–15,20–24,43,45,46]
	Klebsiella pneumoniae	0.57–600	[15,43,45,50,51]
	Proteus mirabilis	0.16–0.16	[43]
	Pseudomonas spp.	0.08–7	[8,10,12,15,18,19,22,24,29,43,44,47,52,53]
	Salmonella spp.	0.29–5	[12]
	Serratia spp.	0.29–20	[12,14,15,22,43]
	Stenotrophomonas maltophilia	0.29–1	[12]
	Haemophilus influenzae	1–1	[19]
Fungi	*Candida auris*	14–14	[54]
	Candida spp.	0.13–28	[20–22,36,54,55]
Virus	Animal virus	0.5–7	[56,57]
	Coronavirus	0.04–20	[58–60]
	Cytomegalovirus	<1 min to 0.01	[61]
	Human virus	<1 min to 12	[57,62–66]
	SARS-CoV	1–2	[67]

Porter L, Sultan O, Mitchell B. How long do nosocomial pathogens persist on inanimate surfaces? A scoping review. Journal of Hospital Infection, 2024; 147, 25-31

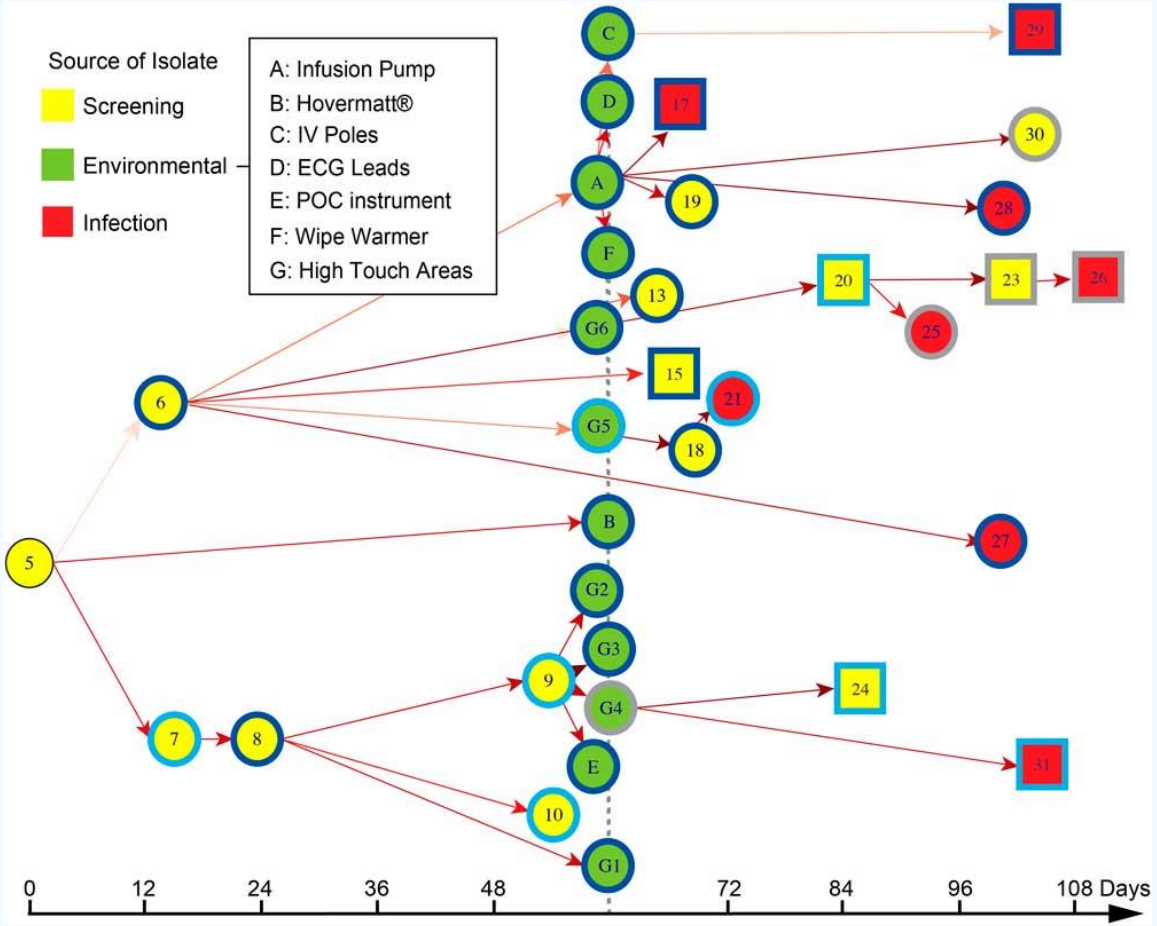
MRO risk increased if previous room occupant was colonised

Study or Subgroup	Experimental (+ room) Events	Total	Control (-ve room) Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
1.1.1 MRSA						
Anderson	103	11005	725	293386	7.1%	3.81 [3.10, 4.69]
Huang	57	1454	248	8697	7.0%	1.39 [1.04, 1.86]
Mitchell	74	884	163	5344	7.0%	2.90 [2.18, 3.86]
Subtotal (95% CI)		**13343**		**307427**	**21.1%**	**2.50 [1.38, 4.54]**
Total events	234		1136			
Heterogeneity: Tau² = 0.26; Chi² = 31.61, df = 2 (P < 0.00001); I² = 94%						
Test for overall effect: Z = 3.01 (P = 0.003)						
1.1.2 VRE						
Anderson	89	4083	423	307241	7.1%	16.16 [12.83, 20.36]
Drees	19	138	31	500	6.4%	2.42 [1.32, 4.43]
Ford	47	149	89	300	6.8%	1.09 [0.71, 1.67]
Huang	58	1291	256	9058	7.0%	1.62 [1.21, 2.16]
Zhou	69	3556	92	4929	7.0%	1.04 [0.76, 1.43]
Subtotal (95% CI)		**9217**		**322028**	**34.3%**	**2.36 [0.61, 9.15]**
Total events	282		891			
Heterogeneity: Tau² = 2.35; Chi² = 329.40, df = 4 (P < 0.00001); I² = 99%						
Test for overall effect: Z = 1.24 (P = 0.22)						
1.1.5 Clostridioides difficile						
Anderson	43	3797	1278	307890	7.0%	2.75 [2.02, 3.73]
Shaughnessy	10	91	77	1679	6.2%	2.57 [1.28, 5.15]
Subtotal (95% CI)		**3888**		**309569**	**13.2%**	**2.72 [2.05, 3.60]**
Total events	53		1355			
Heterogeneity: Tau² = 0.00; Chi² = 0.03, df = 1 (P = 0.86); I² = 0%						
Test for overall effect: Z = 7.01 (P < 0.00001)						
Total (95% CI)		**28299**		**981865**	**100.0%**	**2.45 [1.53, 3.93]**
Total events	651		3818			
Heterogeneity: Tau² = 0.81; Chi² = 357.84, df = 14 (P < 0.00001); I² = 96%						
Test for overall effect: Z = 3.71 (P = 0.0002)						
Test for subgroup differences: Chi² = 7.84, df = 7 (P = 0.35), I² = 10.8%						



Mitchell B, McDonagh J, Dancer S. Risk of organism acquisition from prior room occupants: An updated systematic review. Infection, Disease & Health, 2023

Sequencing data supportive



Lee AS, White E, Monahan LG, Jensen SO, Chan R, van Hal SJ. Defining the Role of the Environment in the Emergence and Persistence of vanA Vancomycin-Resistant Enterococcus (VRE) in an Intensive Care Unit: A Molecular Epidemiological Study. Infect Control Hosp Epidemiol. 2018

Pathogens transmitted via the healthcare environment → Cleaning removes/reduces pathogens → Less transmission, less HAIs → Reduced healthcare costs

Environmental cleaning: the application of water and detergent, and disinfectant where necessary, to surfaces and non-critical equipment by cleaning staff

How do we assess if cleaning is satisfactory/successful?

Visual inspection

Fluoro-marking

Environmental bioburden measurements

Guidelines are based on weak evidence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journal homepage: www.elsevier.com/locate/jhin
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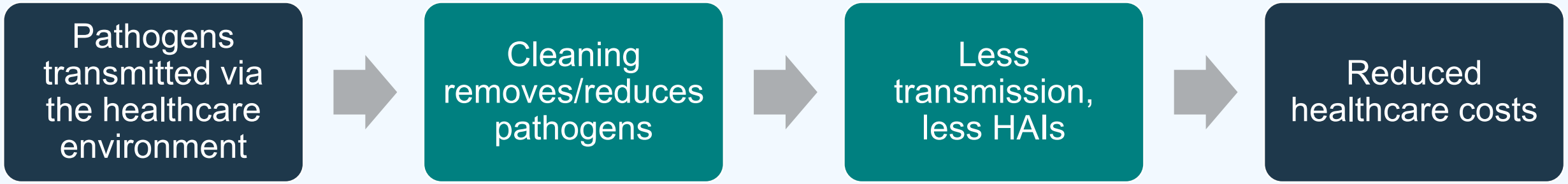
Short Report

Cleaning time and motion: an observational study on the time required to clean shared medical equipment in hospitals effectively

G. Matterson [a], K. Browne [a], P.E. Tehan [a,b], P.L. Russo [a,b,e], M. Kiernan [a,c], B.G. Mitchell [a,b,d,*]



Environmental hygiene literature is heterogenous and often poor quality

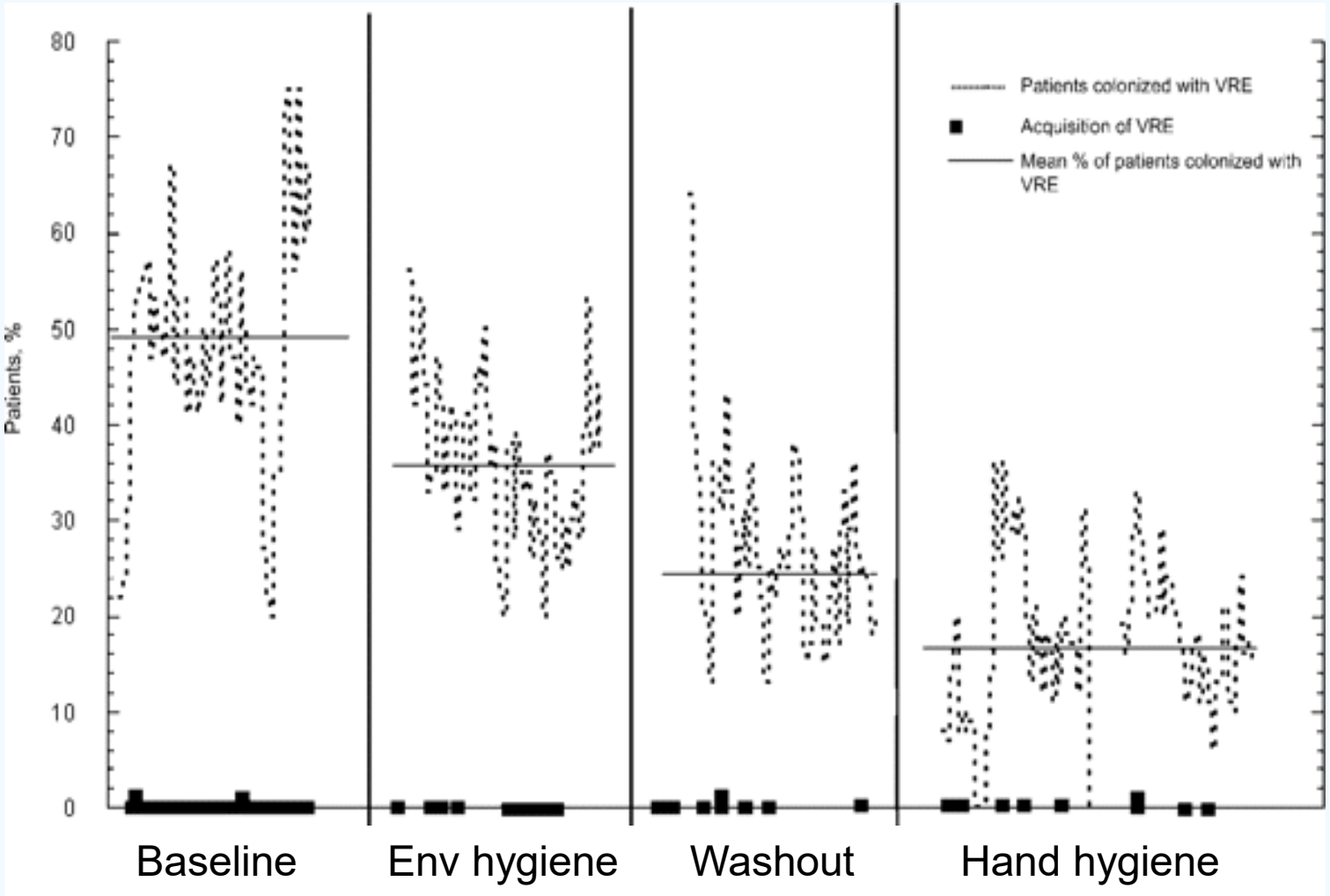
So many factors to consider and assess:

- Substances and equipment used
- Techniques
- Personnel factors (training, staffing time etc)

} Bundles

Control or comparator arms are also varied – standards vary considerably!

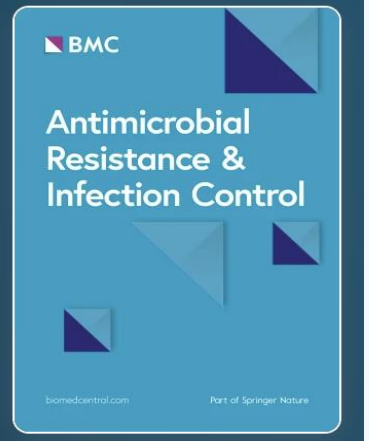
VRE acquisition in ICU



Hayden MK, Bonten MJ, Blom DW, Lyle EA, van de Vijver DA, Weinstein RA. Reduction in acquisition of vancomycin-resistant enterococcus after enforcement of routine environmental cleaning measures. Clin Infect Dis. 2006

Impact of environmental hygiene interventions on healthcare-associated infections and patient colonization: a systematic review

Review | Open access | Published: 19 February 2022



Systematic review

- Studies exploring the effect of a healthcare environmental hygiene intervention on HAI or patient colonization
- Published before 31/12/2019

26 articles included for analysis:

- Mechanical interventions (8)
- Chemical interventions (7)
- Human factors interventions (3)
- Bundled interventions (8)

Most studies (23/26, 88%) reported a decrease of MRO-colonization or HAI for at least one organism

Peters A, Schmid MN, Parneix P, Lebowitz D, de Kraker M, Sauser J, Zingg W, Pittet D. Impact of environmental hygiene interventions on healthcare-associated infections and patient colonization: a systematic review. Antimicrob Resist Infect Control. 2022

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Costs of HAI

- Patient management (pathology, treatments, follow-up)
- Length of stay (including single room requirements)
- Missed surgical revenue due to bed capacity
- HAC penalties

Table 3 Extra length of stay (in days) in a standard bed and ICU bed due to a hospital-acquired bloodstream infection

Bloodstream	Standard bed		ICU bed	
Infection	Died	Discharged	Died	Discharged
BSI and Gram positive	1.0 (–3.9 to 5.6)	9.8 (7.7 to 12.6)	4.0 (2.6 to 5.7)	0.9 (0.4 to 1.8)
BSI with SAB				
All	–1.5 (–6.8 to 6.1)	12.1 (6.7 to 15.3)	1.4 (0.5 to 3.0)	0.9 (0.1 to 2.9)
MRSA	–1.6 (–12.6 to 12.6)	12.8 (6.2 to 26.1)	3.1 (0.5 to 7.2)	3.1 (0.4 to 13.2)
MSSA	2.7 (–2.6 to 9.7)	11.0 (6.4 to 14.9)	0.7 (–0.3 to 2.0)	0.4 (0.0 to 0.8)
BSI with CNS	3.5 (–4.0 to 13.4)	9.8 (3.6 to 14.6)	6.0 (3.3 to 10.0)	1.4 (0.6 to 2.5)
BSI and Gram negative				
All	–3.9 (–8.7 to –0.4)	2.7 (–4.1 to 6.1)	3.0 (1.4 to 4.5)	0.6 (0.3 to 1.0)
Escherichia coli	–3.3 (–9.3 to 7.9)	1.1 (–13.2 to 5.7)	2.5 (0.4 to 4.7)	0.5 (–0.1 to 0.9)
Pseudomonas	–5.4 (–11.6 to 9.2)	5.6 (–6.4 to 14.3)	3.2 (0.8 to 7.1)	0.5 (0.3 to 1.2)

Cells show the mean extra length of stay (in days) with 95% CIs in parentheses. Based on nine hospitals with admissions between 1 January 2005 and 31 December 2010. Separate estimates were made for admissions that ended in death and discharge. The total length of stay is the standard bed time plus the ICU bed time (see figure 2).

Barnett AG et al. The increased risks of death and extra lengths of hospital and ICU stay from hospital-acquired bloodstream infections: a case-control study. BMJ Open. 2013
Slawomirski L et al. Financial penalty associated with a decline in hospital-acquired complications in Australia. Health Policy. 2025

HAI BSI costs in Australia

Estimated Bed-day Costs

	Accounting cost, mean (SD)			
	Per infection	**R**	**S**	**R-S**[a]
Bloodstream infections				
S. aureus	9877.8 (999.8)	14 617.7 (1481.5)	9194.8 (926.4)	5422.9 (1744.2)
E. faecium	6236.9 (722.8)	3448.6 (366.1)	8253.6 (838.7)	−4805.0 (916.7)
E. coli	4341 (465.4)	4402.5 (449.9)	4350.7 (453.2)	51.8 (634.2)
K. pneumoniae	5730.3 (589.7)	13 597.6 (1415.1)	5391.6 (554.3)	8206.1 (1516.8)
P. aeruginosa	6224.3 (632.1)	9774.1 (1104.3)	6055.2 (617.7)	3718.9 (1262.2)

Lee XJ, Stewardson AJ, Worth LJ, Graves N, Wozniak TM. Attributable Length of Stay, Mortality Risk, and Costs of Bacterial Health Care-Associated Infections in Australia: A Retrospective Case-cohort Study. Clin Infect Dis. 2021

What do HAIs cost – besides money?

Human costs

- Morbidity and mortality

Opportunity costs

- Hospital staff time

Social cost (reputation)

Antimicrobial resistance

> Hundreds infected by new hospital bug

Mould infection cluster report identifies RPA balcony as likely exposure site, one patient remains in ICU

News | Health

Superbug outbreak costs an NHS hospital one million pounds, says new study

Monash Medical Centre discovers black mould in area where cancer patients treated

Actual expenditures vs. averted expenditures

Hospitals (and funders) need to look beyond actual expenditures

What is the return on investment?

This is hard! Prospect theory = we value financial losses more than gains

Hand hygiene: ROI up to 23 times the initial amount invested

How do we get this data for environmental cleaning?

Chen YC et al. Effectiveness and limitations of hand hygiene promotion on decreasing healthcare-associated infections. PLoS One. 2011

Actual expenditures vs. averted expenditures

Costs of cleaning

- Staffing (and training)
- Consumables
- Equipment (and its maintenance)
- Auditing and feedback
- Replacements – long term corrosion/damage of equipment from cleaning

What are the costs of HAI?

What are the costs of interventions to reduce HAI?

Can we save money?

Can we save money by increasing cleaning?

Design	Within-trial cost-effectiveness analysis of CLEEN – stepped wedge cluster RCT of cleaning shared medical equipment
Participants	10 adult acute care wards in a single tertiary hospital
Intervention	Additional cleaning hours for shared medical equipment, education, audit, and feedback
Comparison	Standard of care
Outcomes	Incremental cost-effectiveness ratio: mean change to costs associated with the intervention divided by the mean change in outcome
Timeline	Study March – Nov 2023, analysis May – October 2024

Brain D et al. Economic Evaluation of Enhanced Cleaning and Disinfection of Shared Medical Equipment. JAMA Netw Open. 2025

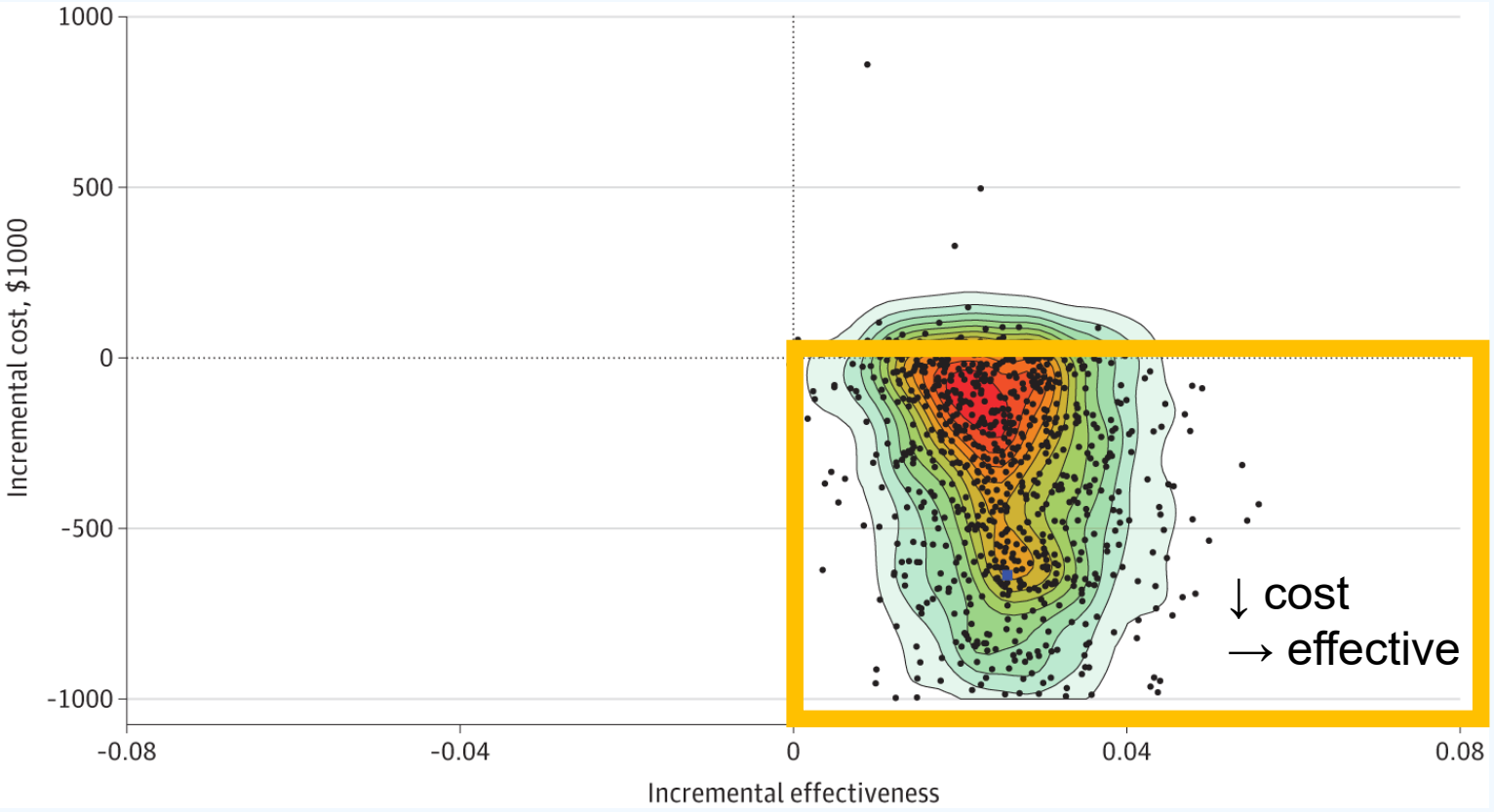
Table 2. Cost-Effectiveness Analysis for 1000 Patients

Group	Total costs, $AUD[a]	Total HAIs	Change in costs, $AUD	HAIs avoided	ICER
Usual care	2 155 310	130	NA	NA	NA
Intervention	1 513 000	100	−642 010	30	Dominant[b]

Abbreviations: ICER, incremental cost-effectiveness ratio; NA, not applicable.

[a] Total costs refer to staff time, education, training, material development, consumables and/or equipment, treatment, medications, and patient length of stay. In usual care, the costs were related to length of stay.

[b] Due to the intervention's reduction in costs and HAIs, usual care is said to be dominated by the intervention.

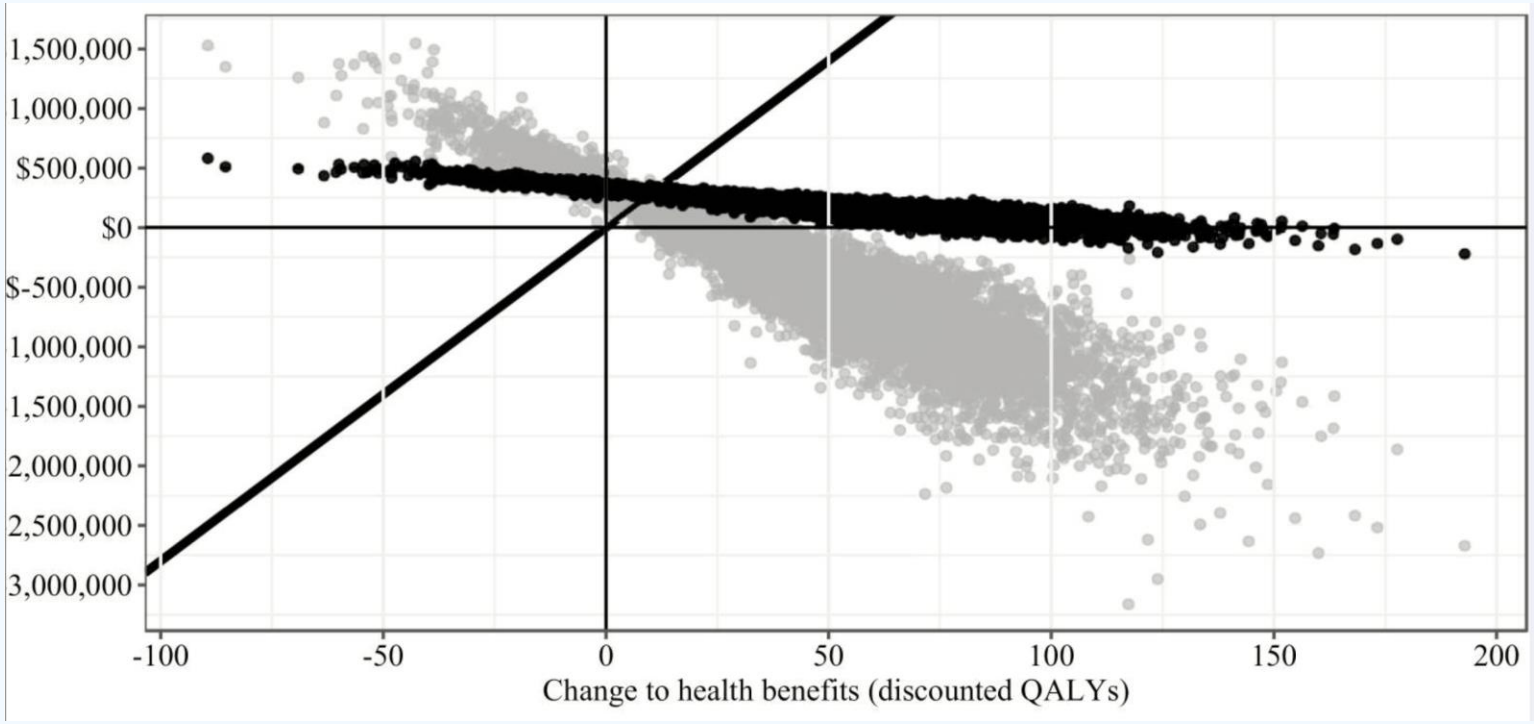


Findings	The intervention reduced HAIs and saved money
Considerations	Single centre Potential underestimate
Bottom line	Cleaning shared medical equipment is a cost-saving endeavour

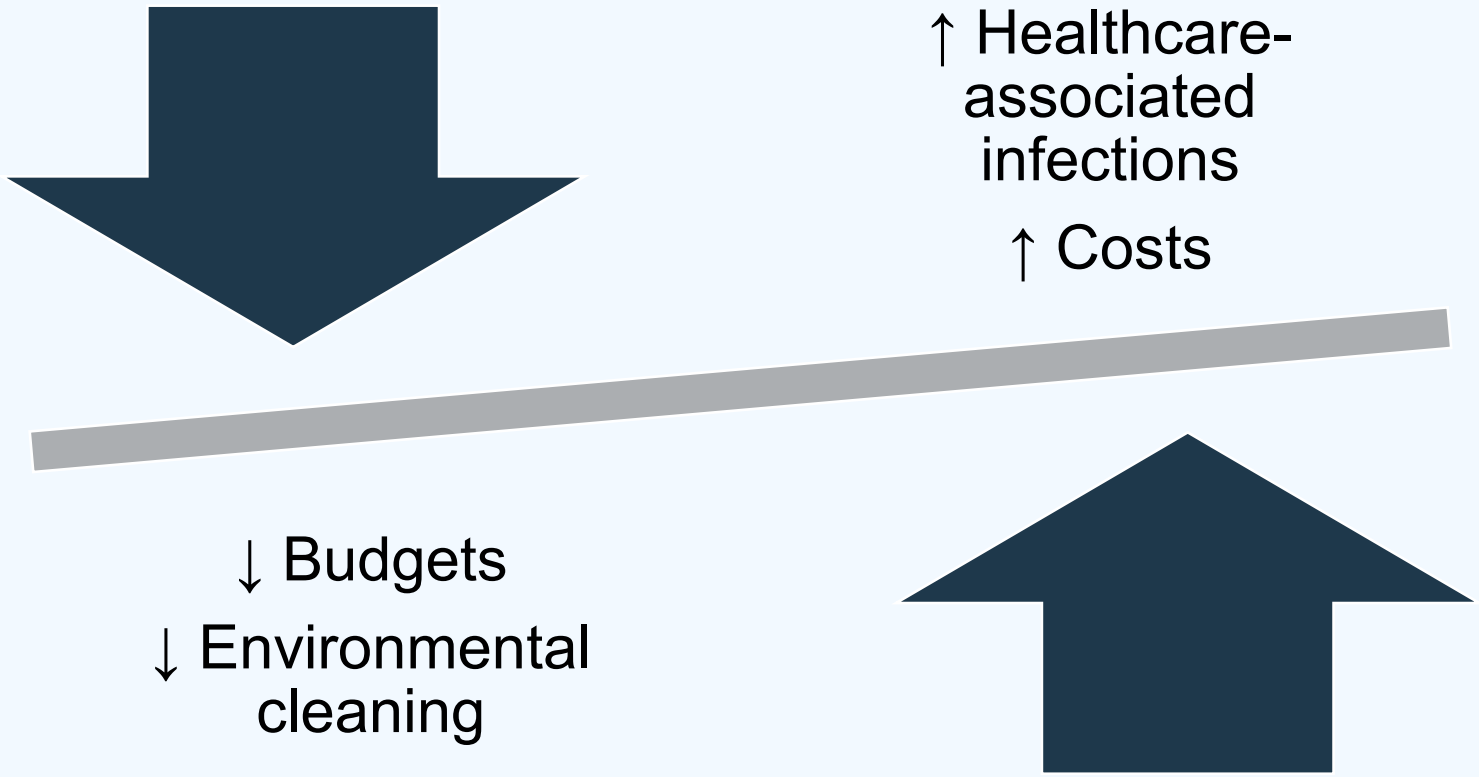
REACH trial

Bundle:
Recommended cleaning agents
Frequency of cleaning
Cleaning techniques
Auditing strategies
Staff training
Hospital-wide commitment

Findings:
Reduced VRE infections (not MRSA/CDI)
Net monetary benefit 1m
Incremental cost-effectiveness ratio $4684/QALY gained



Mitchell B, Hall L, White N et al. An environmental cleaning bundle and health-care-associated infections in hospitals (REACH): a multicentre, randomised trial. The Lancet Infectious Diseases, 2019. White NM et al. Cost-effectiveness of an Environmental Cleaning Bundle for Reducing Healthcare-associated Infections. Clin Infect Dis. 2020



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What can we do?

Understand the evidence behind practice

Local data (audits) have an impact

- Hospital/ward level audits
- Sequencing data

Harness patient/consumer advocacy

Thank you

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