DukeNUS Medical School

THE COST-EFFECTIVENESS OF TEMPORARY SINGLE-PATIENT ROOMS TO REDUCE THE RISK OF HAI

Nicholas Graves, PhD

Hosted by Jane Barnett
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www.webbertraining.com September 14, 2022

1993 to 2002 — London School of Hygiene & Tropical Medicine

2002 to 2019 — QUT Queensland University of Technology

2019 - — SingHealth DukeNUS Academic Medical Centre

Health Economics

Cost Effectiveness

Value based care

generate data to show how to improve the performance of health services

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Objectives:

- Introduce the principles of cost effectiveness as applied to infection prevention initiatives

- Review some key papers on the topic

- Present findings of recent studies on the cost-effectiveness of using temporary single-patient rooms in UK, Australia & Singapore

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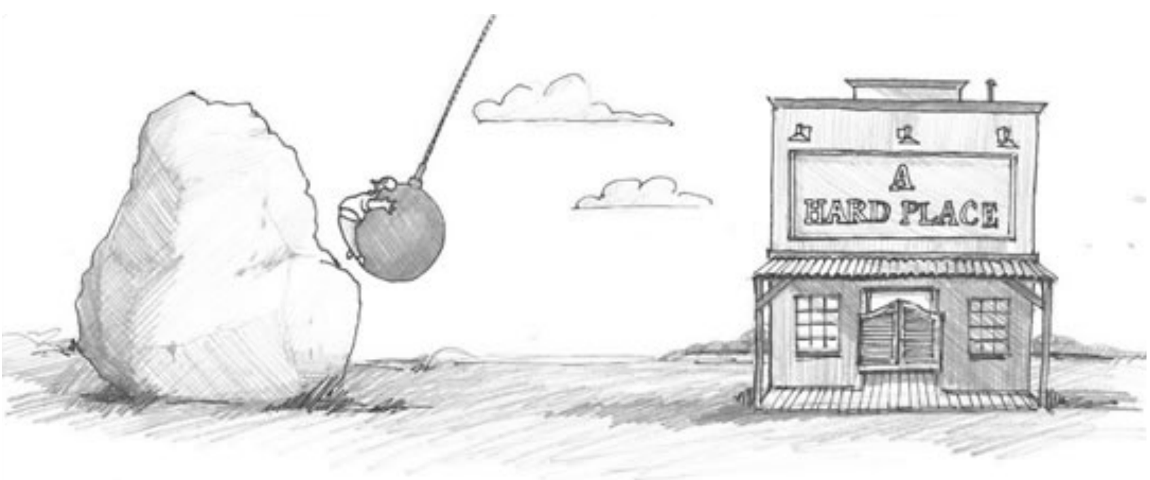
Why do we need cost-effectiveness research?



New demand & new supply

Non increasing budgets

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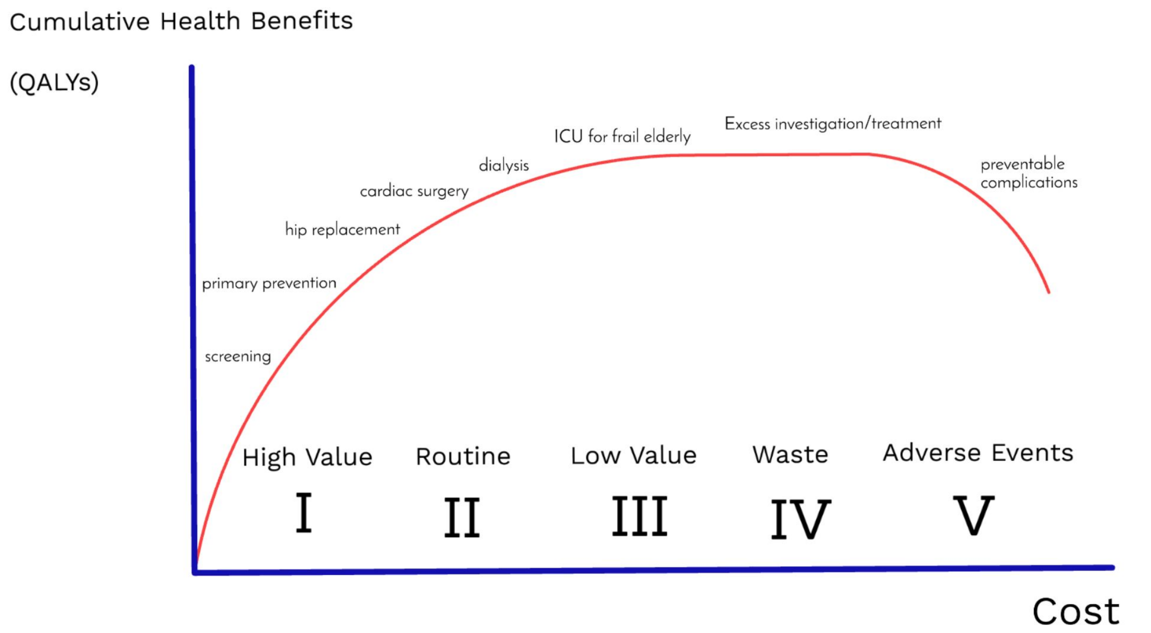

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We need to systematically evaluate change to costs and health benefits from competing uses of scarce resources

Primary Prevention T2D

Expanding cardiac surgery

New neo natal ICU

Screening for cancers

Robotic surgery

Adolescent mental health interventions

New drugs for Parkinson's disease

6

We need to systematically evaluate change to costs and health benefits from competing uses of scarce resources

Antimicrobial stewardship

Asepsis technique/bundles

Screening and decolonisation

Prophylaxis with antibiotics

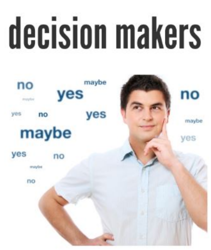
Improving hand hygiene

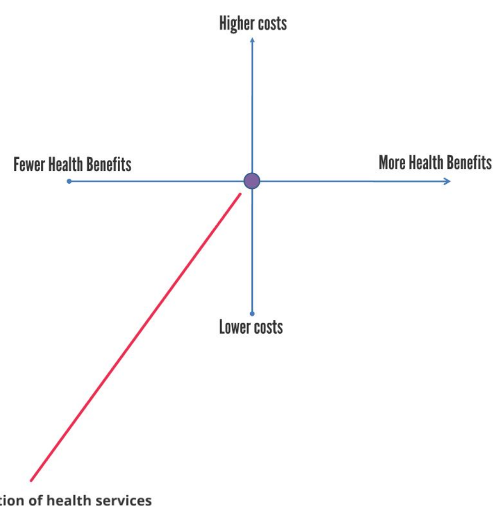
Environmental cleaning

Enhanced Surveillance

7

We need to systematically evaluate change to costs and health benefits from competing uses of scarce resources





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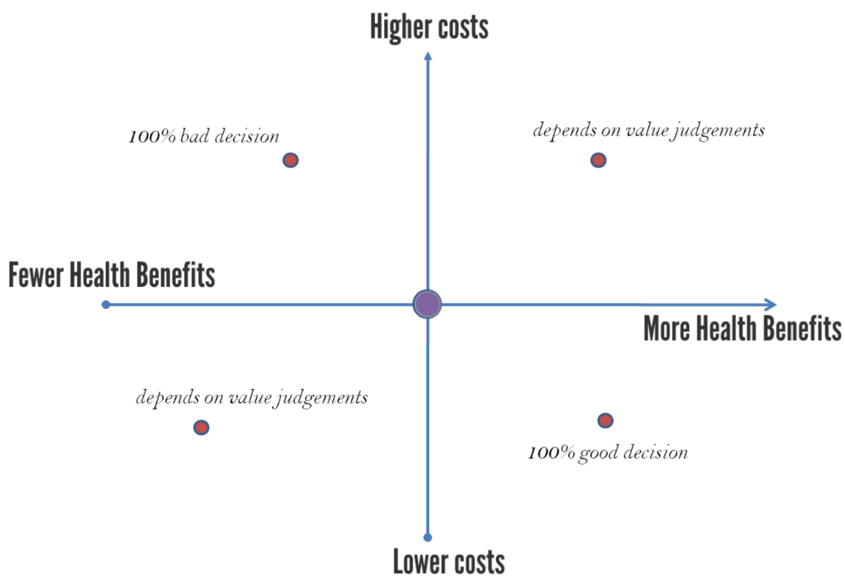
We need to systematically evaluate change to costs and health benefits from competing uses of scarce resources



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We need to systematically evaluate change to costs and health benefits from competing uses of scarce resources

HEALTH ECONOMICS
Health Econ. (2009)
Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/hec.1481

INTERNATIONAL SURVEY ON WILLINGNESS-TO-PAY (WTP) FOR ONE ADDITIONAL QALY GAINED: WHAT IS THE THRESHOLD OF COST EFFECTIVENESS?

TAKERU SHIROIWA[a,*], YOON-KYOUNG SUNG[b], TAKASHI FUKUDA[c], HUI-CHU LANG[d], SANG-CHEOL BAE[b] and KIICHIRO TSUTANI[a]

Country	Threshold ($US)
Japan	$41,000
Republic of Korea	$74,000
Taiwan	$77,000
United Kingdom	$36,000
Australia	$47,000
United States	$62,000

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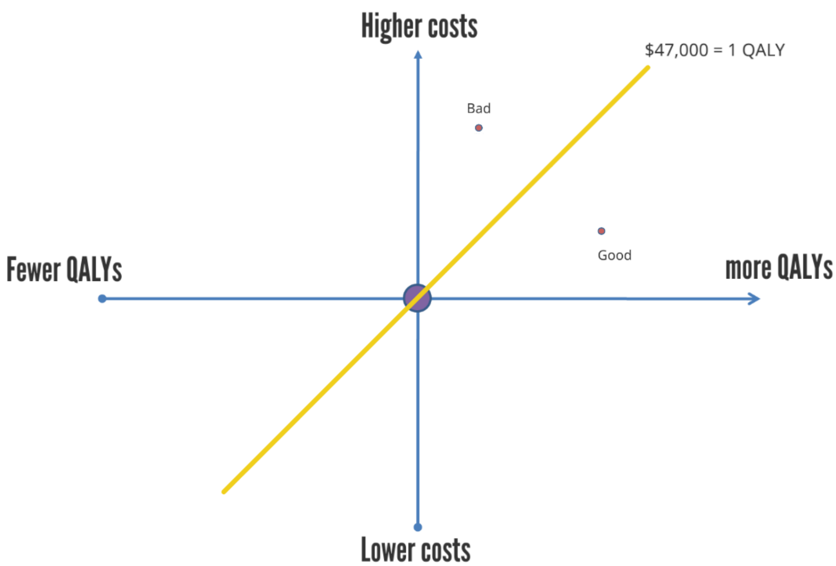
We need to systematically evaluate change to costs and health benefits from competing uses of scarce resources



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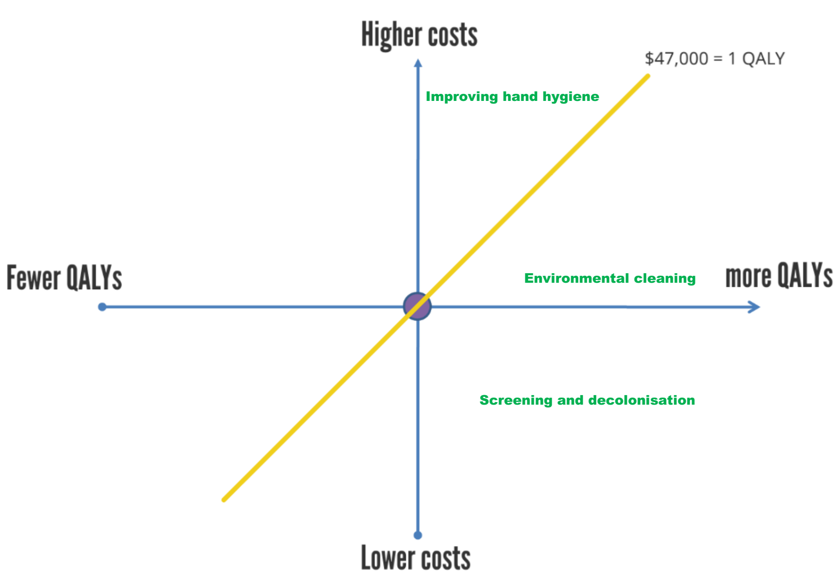
We need to systematically evaluate change to costs and health benefits from competing uses of scarce resources



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Economics and Preventing Hospital-acquired Infection

Nicholas Graves*

Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 10, No. 4, April 2004

The economics of preventing hospital-acquired infections is most often described in general terms. The underlying concepts and mechanisms are rarely made explicit but should be understood for research and policy-making. We define the key economic concepts and specify an illustrative model that uses hypothetical data to identify how two related questions might be addressed: 1) how much should be invested for infection control, and 2) what are the most appropriate infection-control programs? We aim to make explicit the economics of preventing hospital-acquired infections.

INFECTION CONTROL AND HOSPITAL EPIDEMIOLOGY FEBRUARY 2007, VOL. 28, NO. 2

ORIGINAL ARTICLE

Economics and Preventing Hospital-Acquired Infection: Broadening the Perspective

Nicholas Graves, PhD; Kate Halton, MSc; David Lairson, PhD

We demonstrate that when infection control interventions reduce economic costs and increase health benefits, they should be adopted without further question. If, however, interventions increase economic costs and increase health benefits, then the trade-off between costs and benefits should be examined. Decision-makers should assess the cost per unit of health benefit from infection control programs, consider the impact on health budgets, and compare infection control with alternative uses of scarce healthcare resources.

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Available online at www.sciencedirect.com
Journal of Hospital Infection
journal homepage: www.elsevier.com/locate/jhin

Review

Estimating excess length of stay due to healthcare-associated infections: a systematic review and meta-analysis of statistical methodology

S. Manoukian[a,*], S. Stewart[b], S. Dancer[c], N. Graves[d], H. Mason[a], A. McFarland[b], C. Robertson[e], J. Reilly[b]

INVITED ARTICLE ANTIMICROBIAL RESISTANCE
George M. Eliopoulos, Section Editor

A Systematic Review of Quasi-Experimental Study Designs in the Fields of Infection Control and Antibiotic Resistance

Anthony D. Harris,[1,2] Ebbing Lautenbach,[3,4] and Eli Perencevich[1,2]

Health Economics

RESEARCH ARTICLE Open Access

Estimating the opportunity costs of bed-days

Frank G. Sandmann, Julie V. Robotham, Sarah R. Deeny, W. John Edmunds, Mark Jit

First published: 06 November 2017 | https://doi.org/10.1002/hec.3613 | Citations: 18

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Objectives:

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- Present findings of recent studies on the cost-effectiveness of using temporary single-patient rooms in UK, Australia & Singapore

- ✓ Single-patient, isolation room that can be deployed in a patient care area or ward.
- ✓ Air-filtered isolation room with hands-free entry and an integrated PPE station.
- ✓ Deployed by a single person in less than 5 min.
- ✓ Canopy is single use and is disposed of.

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Journal of Hospital Infection 116 (2021) 21–28

Available online at www.sciencedirect.com

Journal of Hospital Infection

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

ELSEVIER

Healthcare Infection Society

The cost-effectiveness of temporary single-patient rooms to reduce risks of healthcare-associated infection

N. Graves [a,*], B.G. Mitchell [b], J.A. Otter [c], M. Kiernan [d]

Infection, Disease & Health 27 (2022) 129–135

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: http://www.journals.elsevier.com/infection-disease-and-health/

ELSEVIER

Research paper

A cost-effectiveness model for a decision to adopt temporary single-patient rooms to reduce risks of healthcare-associated infection in the Australian public healthcare system

Nicholas Graves [a,*], Martin Kiernan [b,c], Brett G. Mitchell [b]

PLOS ONE

RESEARCH ARTICLE

Cost effectiveness of temporary isolation rooms in acute care settings in Singapore

Nicholas Graves[1*], Yiying Cai[1], Brett Mitchell[2], Dale Fisher[3,4], Martin Kiernan[2,5]

1 Health Services & Systems Research, Duke-NUS Medical School, Singapore, Singapore, 2 School of Nursing and Midwifery, University of Newcastle, Ourimbah, NSW, Australia, 3 Yong Loo Lin School of Medicine, National University of Singapore, Singapore, Singapore, 4 Department of Medicine, National University Hospital, Singapore, Singapore, 5 Gama Healthcare Ltd, Hemel Hempstead, United Kingdom

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RATIONALE

Clinical guidelines recommend single-room isolation for patients with multidrug-resistant pathogens.

Plausible mechanisms for benefit.

Research evidence is patchy and the marginal effects of isolation are difficult to disentangle from a bundled strategy.

It is challenging to establish by experiment the role of single-room isolation on risks of HAI.

Two systematic reviews provide some evidence that isolation rooms are effective at reducing risks of HAI.

Cooper BS, Stone SP, Kibbler CC, Cookson BD, Roberts JA, Medley GF, et al. Isolation measures in the hospital management of methicillin resistant Staphylococcus aureus (MRSA): systematic review of the literature. BMJ 2004;329:533.

Stiller A, Salm F, Bischoff P, Gastmeier P. Relationship between hospital ward design and healthcare-associated infection rates: a systematic review and meta-analysis. Antimicrob Resist Infect Control 2016;5:51.

Research exists on the adverse effects of isolation showing that the mental well-being of patients is affected.

The aim is to model the cost-effectiveness of adding 'Rediroom' into UK National Health Service (NHS) hospitals.

I will also report results from Australia & Singapore

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METHODS

Primary outcomes

'change total costs'

'change health benefits' measured in 'years of life'

from a reduced incidence of HAI from a decision to adopt a temporary isolation room into the acute care setting.

The structure of the model used was simple.

Current rates of HAI outcomes per 100,000 occupied bed-days observed in the NHS used to estimate baseline values for:

- number of patients with an HAI
- number of acute care bed-days used to manage the consequences of HAI
- monetary value of these bed-days
- deaths associated with patients with an HAI
- years of life lost to HAI.

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METHODS

Infection types

- All HAI
- bloodstream infection
- gastrointestinal infection
- lower respiratory tract infection
- pneumonia
- surgical site infection
- urinary tract infection
- other infections

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METHODS

There is no information available for effectiveness

Estimates between zero and 100% were available

If 250 cases of HAI per 100,000 occupied bed-days under baseline conditions… then inputting an effectiveness estimate of 20% would reduce the number of cases by 50.

The model was used to output new values for the outcomes based on the effectiveness scenario chosen.

- number of patients with an HAI
- number of acute care bed-days used to manage the consequences of HAI
- monetary value of these bed-days
- deaths associated with patients with an HAI
- years of life lost to HAI.

The model was also programmed to include the cost of purchasing and maintaining the temporary isolation rooms.

Because the durations of HAI are relatively short use of preference utility weights to show QALYs not done

Two cost-effectiveness thresholds were used

maximum willingness to pay of £20,000 (NICE)

Claxton et al. suggests that an operational value adopted by the NHS is close to £13,000

Claxton K, Martin S, Soares M, Rice N, Spackman E, Hinde S, et al. Methods for the estimation of the NICE cost effectiveness threshold. UK: Centre for Health Economics, University of York; 2013.

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DATA

ECONI

Project Team

Chief Investigator: Professor Jacqui Reilly

GCU Co-investigators: Dr Helen Mason (Yunus Centre)

External Collaborators: Professor Chris Robertson (University of Strathclyde), Professor Nick Graves (Queensland University of Technology)

GCU researchers funded by study: Sally Stewart (Research Project Manager), Dr Sarkis Manoukian (Research Fellow Yunus Centre), Lynne Haahr (Administrator/Data Manager)

Funder: NHS Health Protection Scotland

Objectives

The study had four objectives

1. Determine the incidence and type of HAI in hospital.
2. To estimate the impact of HAI on patient care in hospital.
3. To investigate the impact of HAI on patient care post discharge
4. To develop a framework to support decision making for future investment in Infection Prevention and Control (IPC)

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DATA

Variable	Estimate	Prior distribution	Source
Cases of HAI baseline/100,000 OBD			
Bloodstream	45	Normal (45, 3.19)	[22]
Gastrointestinal	39	Normal (39, 3.10)	
Lower respiratory	42	Normal (42, 3.11)	
Pneumonia	24	Normal (24, 2.32)	
Surgical site	35	Normal (35, 2.86)	
Urinary tract	51	Normal (51, 3.42)	
Other	14	Normal (14, 1.76)	
Excess LOS (days), mean (SD)			
Bloodstream	11.4 (2.8)	Gamma (16.58, 0.69)	[23]
Gastrointestinal	6 (3.4)	Gamma (3.11, 1.93)	
Lower respiratory	7.3 (2.8)	Gamma (6.80, 1.07)	
Pneumonia	16.3 (4.5)	Gamma (13.12, 1.24)	
Surgical site	9.8 (2.7)	Gamma (13.17, 0.74)	
Urinary tract	0		
Other	14 (9.1)	Gamma (2.36, 5.91)	
Log_{10} of relative risk of death			
Bloodstream infection	7.84	Normal (2.06, 0.18)	[23]
Gastrointestinal infection	4.94	Normal (1.6, 0.23)	
Lower respiratory tract infection	5.20	Normal (1.65, 0.2)	
Pneumonia	6.72	Normal (1.91, 0.27)	
Surgical site infection	2.51	Normal (0.92, 0.3)	
Urinary tract infection	2.36	Normal (0.86, 0.26)	
Other	3.46	Normal (1.24, 0.54)	
Other parameters			
Cost per bed-days (mean, SD)	799 (536)	Gamma (2.23, 358.92)	[27]
Mean age of patients (years)	66	Fixed	
Life expectancy		Fixed	[26]
Males	85		
Females	87		

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DATA

Mortality due to HAI

Unadjusted relative risks of death due to healthcare-associated infection

Infection	Discharged	Died	RR (95% CI)
Bloodstream	97	44	7.84 (5.50–11.16)
Gastrointestinal	98	24	4.94 (3.17–7.71)
Lower respiratory	115	30	5.20 (3.48–7.75)
Pneumonia	52	19	6.72 (3.98–11.35)
Surgical site	108	12	2.51 (1.39–4.55)
Urinary tract	154	16	2.36 (1.39–4.55)
Other	25	4	3.46 (1.21–9.95)

Costs of adoption/100,000 occupied bed-days

Capital cost of the cart is £400/month

Five-year life span

one canopy costs £300/isolated patient

Proportion of newly admitted patients who would need to be isolated

Range between 3% and 30%

Based on lit for MRSA, carbapenemase-producing Enterobacterales, extended-spectrum b-lactamase Enterobacterales, VRE.

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EFFECTIVENESS

Evidence for the effect of single-room isolation alone on reducing HAI rates is scarce.

This study modelled potential reductions in cases at 30% on average with a standard deviation of 5%.

As guidelines across the world recommend single-room isolation for a range of multidrug-resistant pathogens and pathogens spread via the droplet route, we assumed that there was a substantial benefit.

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UNCERTAINTY, MODEL EVALUATION

Uncertainties in the parameters were included in the model by fitting prior statistical distributions

Subject to 3000 random samples.

Propagated forward uncertainties to output distributions of model outcomes.

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SCENARIO ANALYSES

Halved mortality risks

Found minimum threshold hold for effectiveness at which adoption would be cost-effective

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RESULTS

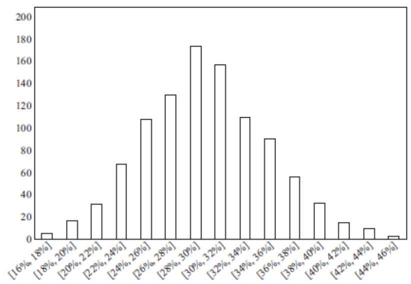

Figure 1. The posterior distribution of the assumed effectiveness parameter.

Table IV
Expected changes to all outcomes arising from this, with uncertainties

Infection	HAI cases avoided	Bed-days saved	Monetary value of bed-days	No. of deaths avoided	Life-years gained
All HAI	75 (13)	584 (348)	£486,280 (£1,297,281)	11.69 (2.38)	184 (38)
Bloodstream	13 (2)	153 (154)	£116,846 (£362,786)	3.71 (1.02)	58 (16)
Gastrointestinal	12 (2)	69 (167)	£53,374 (£216,757)	1.87 (0.65)	29 (10)
Lower respiratory	13 (2)	94 (147)	£76,992 (£252,753)	2.17 (0.68)	34 (11)
Pneumonia	7 (1)	117 (135)	£93,228 (£292,225)	1.71 (0.64)	27 (10)
Surgical site	10 (2)	100 (117)	£81,353 (£255,890)	0.68 (0.36)	11 (6)
Urinary tract	15 (3)	0 (0)	£0,000 (£0,000)	0.88 (0.43)	14 (7)
Other	4 (1)	60 (161)	£48,514 (£200,742)	0.68 (0.43)	11 (7)

All values are mean (standard deviation).

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RESULTS

Figure 2. Uncertainty shown for the cost-effectiveness outcomes with two thresholds: £20,000 and £13,000.

Per 100,000 OBD

- Adoption cost = £1,545,949
- Change to total cost = £1,073,645
- Change to LYG is 184
- Incremental cost per LYG is £5,829
- Probability cost-effective
  - 93% @ £20,000
  - 87% @ £13,000

Where the risk of death with HAI is halved

- Probability cost-effective
  - 79% @ £20,000
  - 67% @ £13,000

If mean value for effectiveness were reduced to 16.5%, then the probability that adoption is cost-effective >50%.

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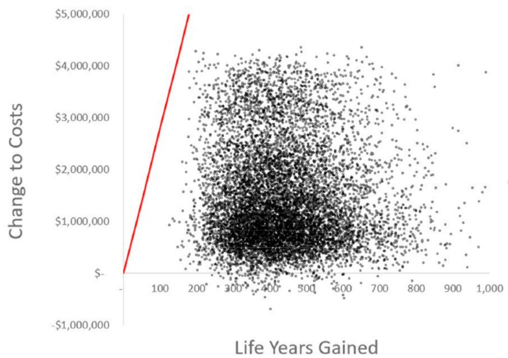
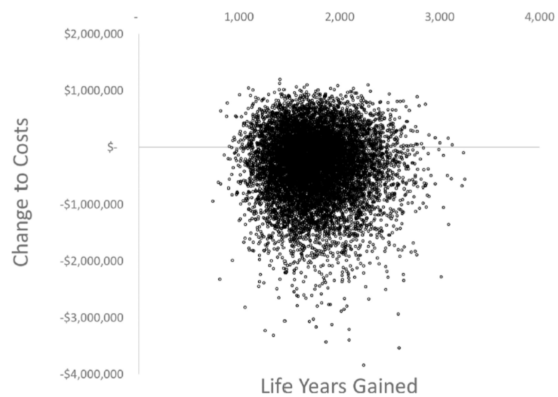
RESULTS

Australia



Singapore



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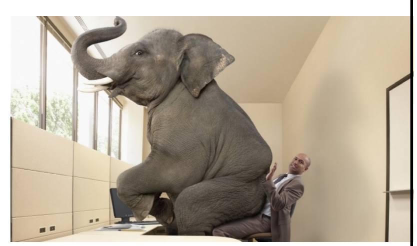
DISCUSSION

Some evidence that the adoption of single portable isolation rooms will be a cost-effective decision.

Most data used were quite good

Mortality data were tested

Our effectiveness parameter is, however, based on expert opinion and not real data



Can a definitive study be done?

Do we even need it?

- ✓ Korean study found that strict isolation reduced VRE by 48%
- ✓ Prob of MRSA and VRE without isolation >5% to 20% in 7d.

YoonChang SW, Peck KR, Kim OS, Lee JH, Lee NY, Oh WS, et al. Efficacy of infection control strategies to reduce transmission of vancomycin-resistant enterococci in a tertiary care hospital in Korea: a 4-year follow-up study. Infect Control Hosp Epidemiol 2007:28:493–5.

Hotchkiss JR, Strike DG, Simonson DA, Broccard AF, Crooke PS. An agent-based and spatially explicit model of pathogen dissemination in the intensive care unit. Crit Care Med 2005;33:168–76. discussion 253–4.

Stiller A, Salm F, Bischoff P, Gastmeier P. Relationship between hospital ward design and healthcare-associated infection rates: a systematic review and meta-analysis. Antimicrob Resist Infect Control 2016;5:51.

Cooper BS, Stone SP, Kibbler CC, Cookson BD, Roberts JA, Medley GF, et al. Isolation measures in the hospital management of methicillin resistant Staphylococcus aureus (MRSA): systematic review of the literature. BMJ 2004;329:533.

Should we adopt now or wait for a definitive study?

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Questions

… jane@webbertraining.com

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www.webbertraining.com/schedulep1.php

September 15, 2022	INFLUENZA: WHAT WE CAN EXPECT Speaker: **Prof. Rodney Rohde**, Texas State University
September 20, 2022	*(European Teleclass)* RESERVOIRS OF PATHOGENS: THE MICROBIOLOGICAL RISKS OF RESPIRATORY MEDICAL DEVICES Speaker: **Professor Colum Dunne**, University of Limerick, Ireland
October 11, 2022	*(European Teleclass)* ADDRESSING MRSA BACTERAEMIA IN A HIGHLY ENDEMIC HOSPITAL – A BEHAVIOUR CHANGE APPROACH Speaker: **Prof. Michael Borg**, Mater Dei Hospital, Malta
October 13, 2022	BUILDING (ENHANCING) EVIDENCE-BASED ANIMAL-ASSISTED THERAPY PROGRAMS IN HUMAN HEALTHCARE Speaker: **Prof. Jason Stull**, College of Veterinary Medicine, The Ohio State University

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