We have met the enemy ... and he is us:

Can we change?

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Sinai Health System, University of Toronto

Hosted by Nicole Kenny
Webber Training Inc

www.webbertraining.com September 16, 2021

We have met the enemy

And he is us

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Objectives

- To convince you of what the future will be if we do not accelerate change in hospital infection prevention
- To persuade you that it is possible to change this future
- To discuss what we need to do to get there

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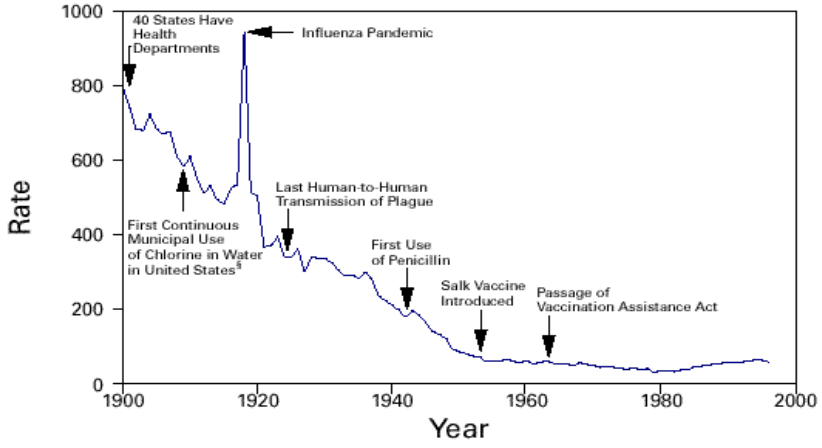
FIGURE 1. Crude death rate* for infectious diseases — United States, 1900–1996†



*Per 100,000 population per year.
†Adapted from Armstrong GL, Conn LA, Pinner RW. Trends in infectious disease mortality in the United States during the 20th century. JAMA 1999:281;61–6.
§American Water Works Association. Water chlorination principles and practices: AWWA manual M20. Denver, Colorado: American Water Works Association, 1973.

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No Antimicrobials – What Would That Mean?

- "If antibiotics stopped working, we would find that instead of 7% of deaths being related to infection at the moment in the developed world, it would go back up to about half (50%) of deaths."

  Dame Sally Davies, UK Chief Medical Officer (Feb 2015)

- "In a world with few effective antibiotics, modern medical advances such as surgery, transplants, and chemotherapy may no longer be viable due to the threat of infection"

  US National Strategy for Combating Antibiotic-Resistant Bacteria (Sep 2014)

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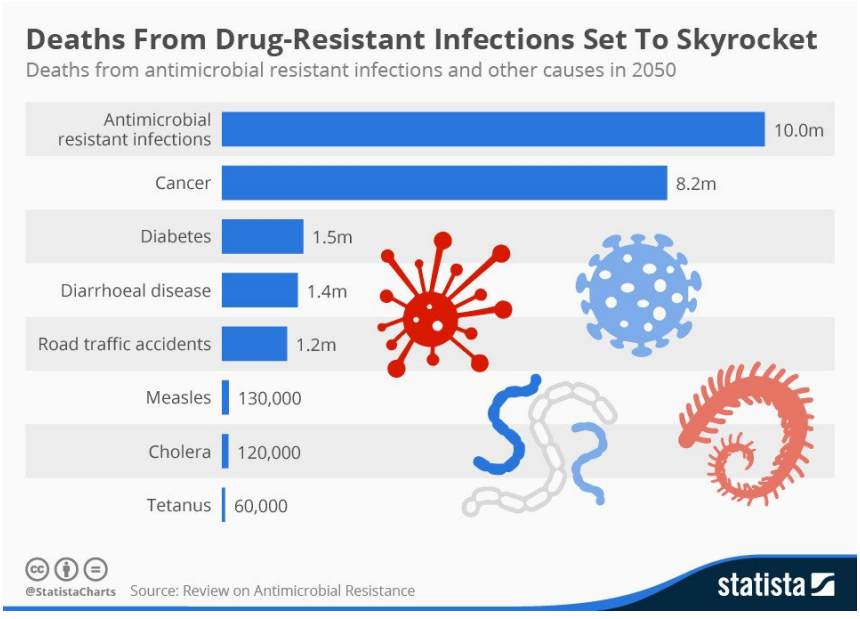

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- *"Without policies to stop the ..spread of AMR, today's already large 700,000 deaths every year would become an extremely disturbing 10 million every year, more people than currently die from cancer."*
- *"The cost in terms of global production between now and 2050 would be an enormous 100 trillion USD if we do not take action"*

Jim O'Neill, Chair, UK review on antimicrobial resistance, 2016

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Most common bacteria causing infection

- *Staphylococcus aureus*
- *Escherichia coli*
- *Streptococcus pneumoniae*
- *Klebsiella pneumoniae*
- *Clostridium difficile*

- *Salmonella, Campylobacter spp.*
- *Chlamydia, T. pallidum, N. gonorrhea*
- Group A streptococcus, Group B streptococcus, *H. influenza,* Legionella
- *Mycobacterium tuberculosis*
- Enterococci, *P. aeruginosa, Acinetobacter spp.*
- *N. meningitides*

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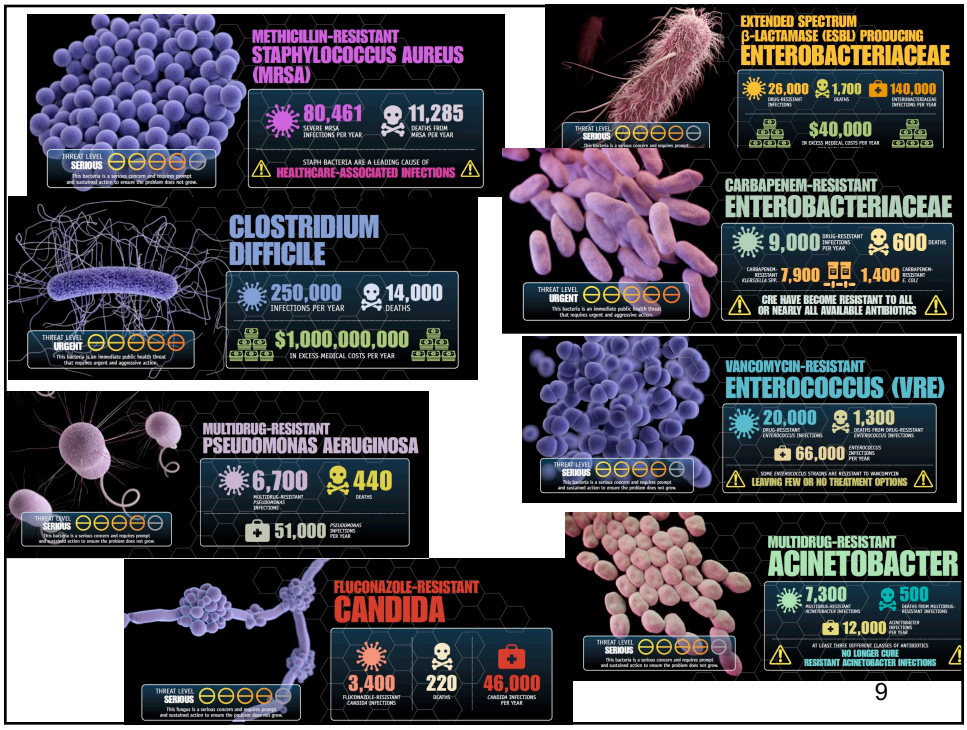

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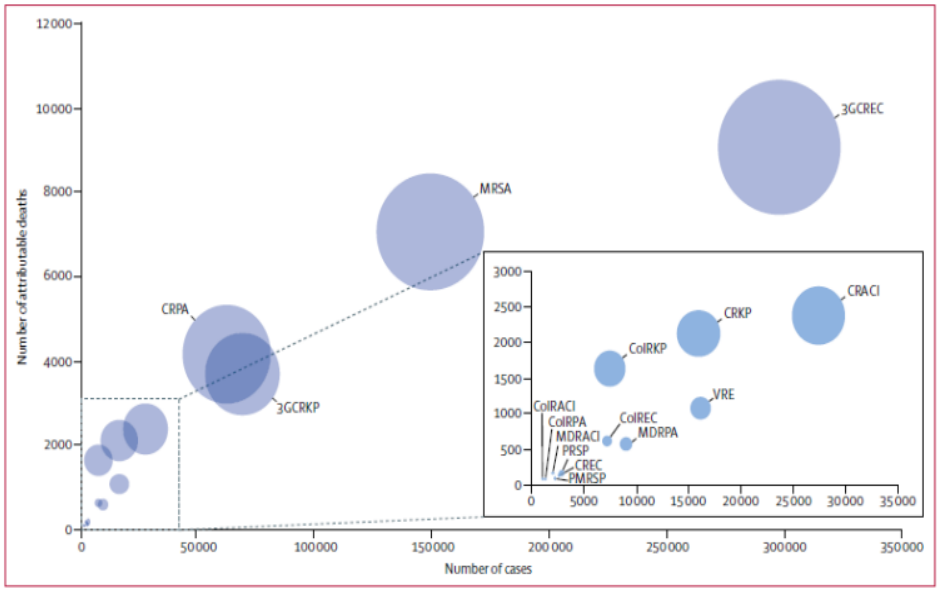
Attributable deaths and disability-adjusted life-years caused by infections with antibiotic-resistant bacteria in the EU and the European Economic Area in 2015: a population-level modelling analysis

Alessandro Cassini, Liselotte Diaz Högberg, Diamantis Plachouras, Annalisa Quattrocchi, Ana Hoxha, Gunnar Skov Simonsen, Mélanie Colomb-Cotinat, Mirjam E Kretzschmar, Brecht Devleesschauwer, Michele Cecchini, Driss Ait Ouakrim, Tiago Cravo Oliveira, Marc J Struelens, Carl Suetens, Dominique L Monnet, and the Burden of AMR Collaborative Group*

10



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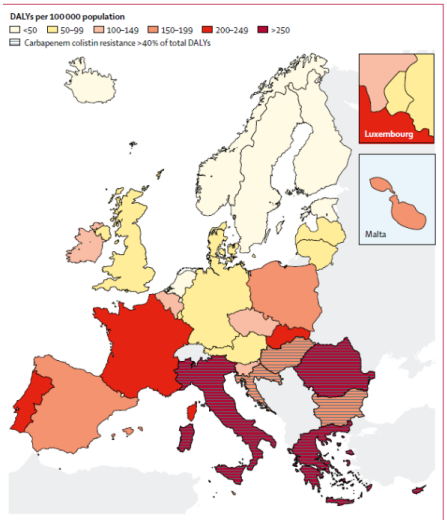
Disability associated life-years due to antibiotic resistance, EU

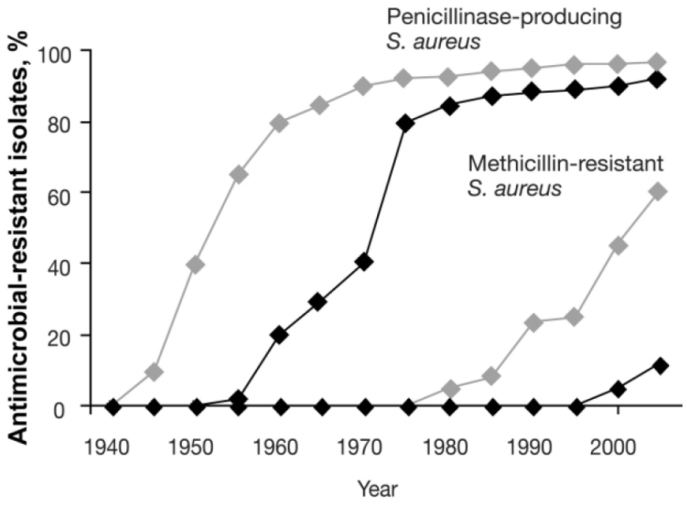


- 65% of AR infections were hospital acquired, representing 127 DALYs per 100,000 population
- Sum of HIV, TB, influenza is 183 DALYss

Cassini LancetID 2019

12

Evolution of penicillin and methicillin resistant *S. aureus, US, 1940-2002*



McDonald LC, Clin Inf Dis 2006

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Science 1993: 259:227-30

Evidence for a Clonal Origin of Methicillin Resistance in *Staphylococcus aureus*

Barry Kreiswirth, John Kornblum, Robert D. Arbeit, William Eisner, Joel N. Maslow, Allison McGeer, Donald E. Low, Richard P. Novick*

Soon after methicillin was introduced into clinical practice in the early 1960s, resistant strains of *Staphylococcus aureus* (MRSA) appeared, bearing a newly acquired resistance gene, *mecA*, that encodes a penicillin binding protein, PBP2a. MRSA have spread throughout the world, and an investigation of the clonality of 472 isolates by DNA hybridization was performed. All 472 isolates could be divided into six temporally ordered *mecA* hybridization patterns, and three of these were subdivided by the chromomosomal transposon Tn*554*. Each Tn*554* pattern occurred in association with one and only one *mecA* pattern, suggesting that *mecA* divergence preceded the acquisition of Tn*554* in all cases and therefore that *mecA* may have been acquired just once by *S. aureus.*

Therefore, that mecA may have been acquired just once by S. aureus

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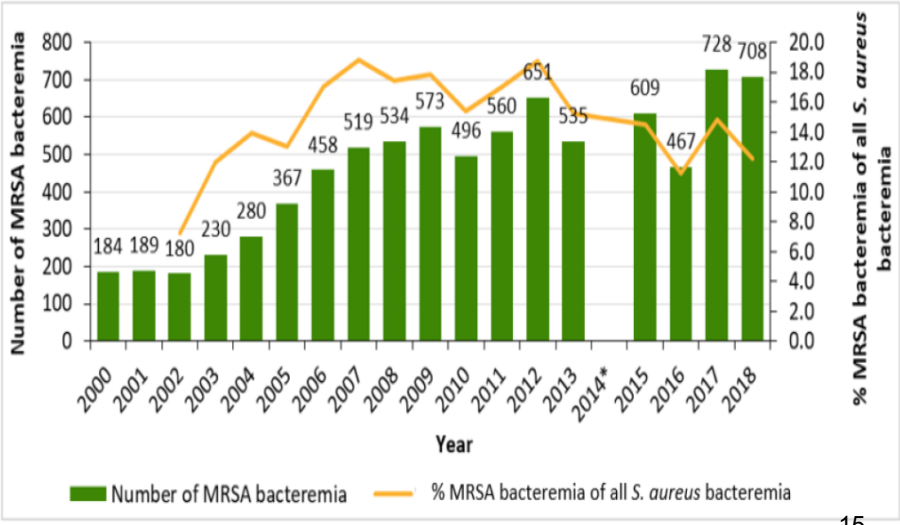
Number of MRSA bacteremias per year, Ontario, 2000-2018



https://www.publichealthontario.ca/-/media/documents/a/2020/aro-survey-2018.pdf?la=en

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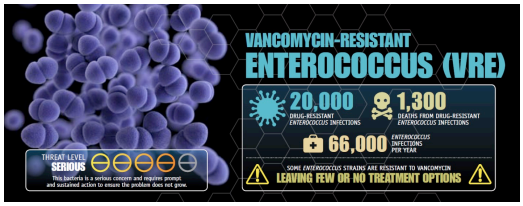

- VRE appeared in the community in northern Europe and Australia in the 1980s in association with the use of avoparcin (an antibiotic related to vancomycin) in animal feed
  - Avoparcin was banned in 1997, with prompt reductions in VRE in food chains
- In North America, VRE were first reported in 1988 in New York City and spread rapidly (400 cases in first 18 months)
  - In Ontario, <5% of reported VRE are thought to be community acquired

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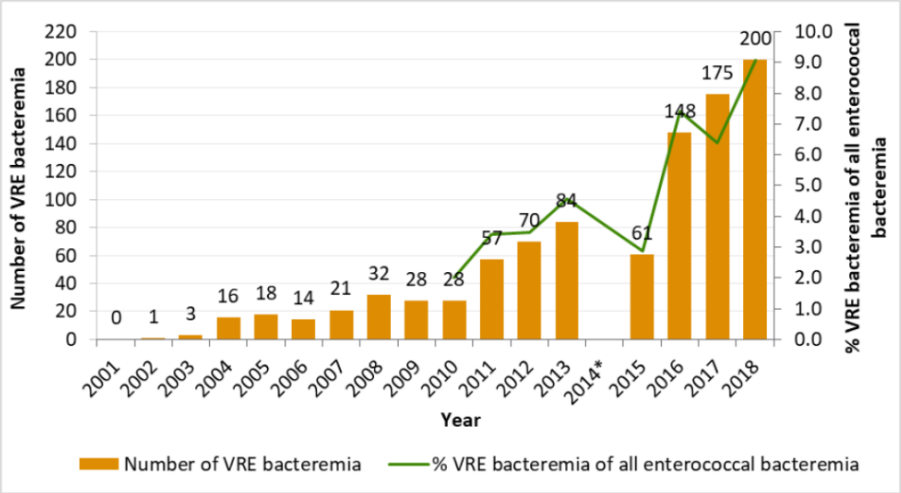
Number of VRE bacteremias per year, Ontario, 2000-2018



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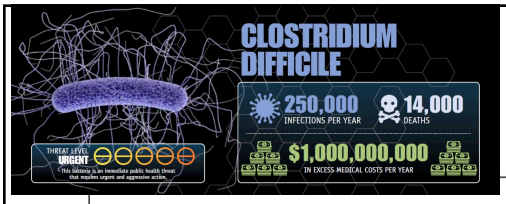
https://www.publichealthontario.ca/-/media/documents/a/2020/aro-survey-2018.pdf?la=en



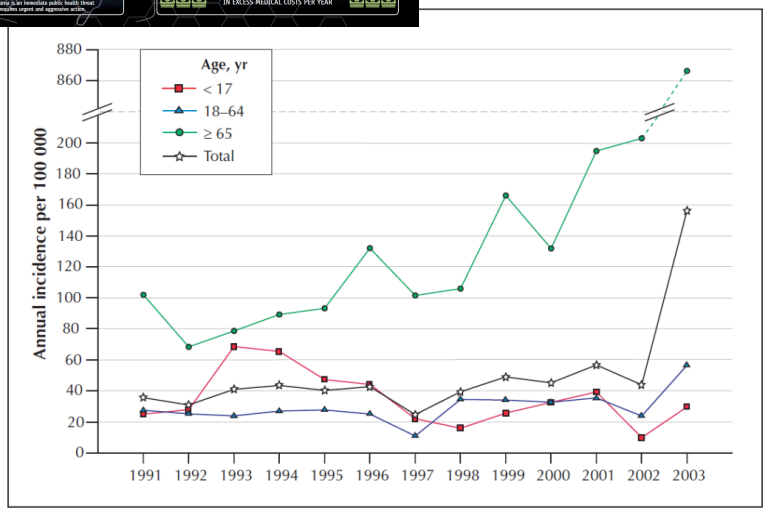


Fig. 1: Annual incidence (per 100 000 population) of *Clostridium difficile*-associated diarrhea (CDAD) in Sherbrooke, Que., 1991–2003.

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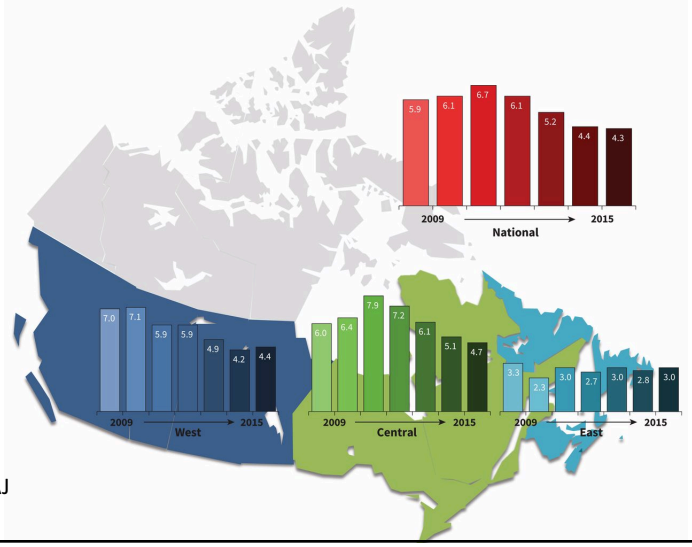
C. difficile infection in CNISP hospitals, 2009-2015



Katz, CMAJ 2019

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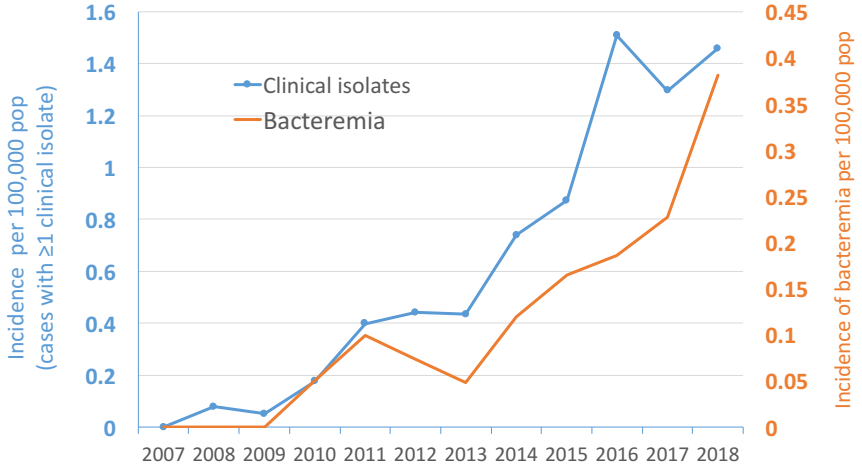
Population incidence of CPE, Toronto/Peel region, 2007-2018



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Whole Genome Sequencing

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How many SNVs different defines an outbreak?

Type of transmission	No. (%) clusters (n=62[a])	Median (IQR, range) no. cases in cluster	Median (IQR) time between first and last case isolates, in days
Person-person transmission only	50 (81)	5 (2-12, 2-31)	158 (55-362)[b]
Person-environment/environment-person transmission only	7 (11)	1 (1-2, 1-3)	53 (10-215)[c]
Combination of person-environment/environment-person/person-person transmission	5 (8)	17 (4-18, 3-89)	280 (183-456)
All	62 (100)	4 (2-12, 1-89)	162 (53-362)

Jamal, unpublished

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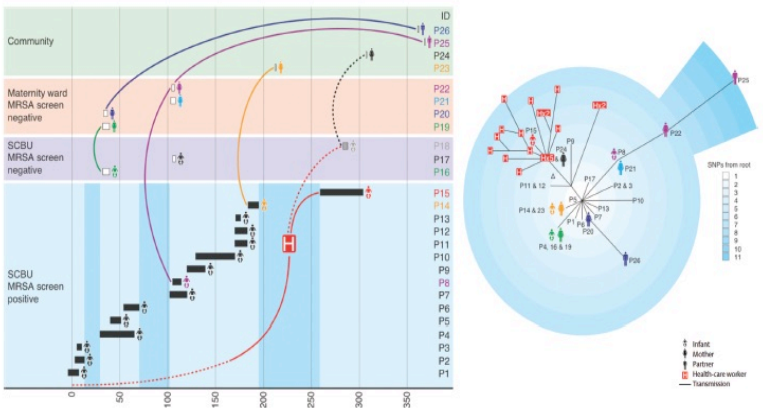
MRSA transmission



Peacock *et al.*, *Microbiology* 2018;164:1213–1219

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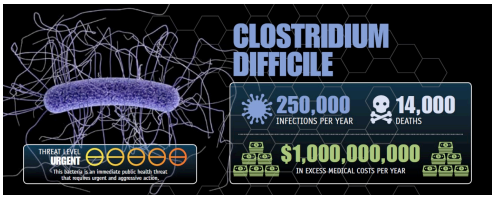

34% of *C. difficile* is community acquired

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Burden of *Clostridium difficile* Infection in the United States

Fernanda C. Lessa, M.D., M.P.H., Yi Mu, Ph.D., Wendy M. Bamberg, M.D., Zintars G. Beldavs, M.S., Ghinwa K. Dumyati, M.D., John R. Dunn, D.V.M., Ph.D., Monica M. Farley, M.D., Stacy M. Holzbauer, D.V.M., M.P.H., James I. Meek, M.P.H., Erin C. Phipps, D.V.M., M.P.H., Lucy E. Wilson, M.D., Lisa G. Winston, M.D., Jessica A. Cohen, M.P.H., Brandi M. Limbago, Ph.D., Scott K. Fridkin, M.D., Dale N. Gerding, M.D., and L. Clifford McDonald, M.D.

Lessa NEJM 2015;372;825;

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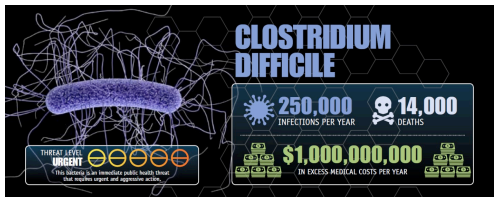
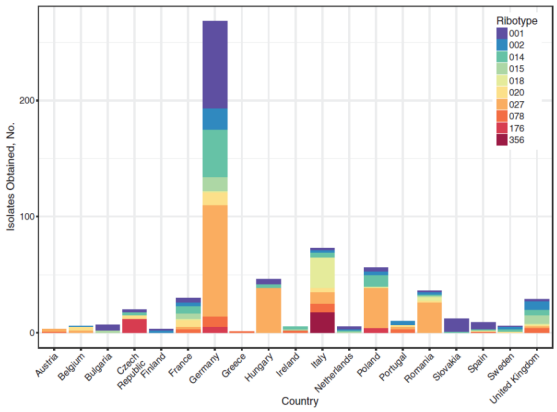


~33% of *C. difficile* is community acquired



- 7297 in-patient diarrheal samples from 2 sampling days at 482 hospitals in 20 EU countries
- 1211 *C. difficile* isolates
  - 624 represent the most common 10 ribotypes

Lessa NEJM 2015;372;825; Eyre CID 2018;67:1035

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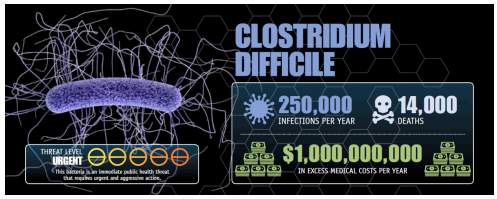

~33% of *C. difficile* is community acquired

Table 3. Extent of Within-hospital Clustering by Ribotype

Ribotype	SNPs Between Isolates, Median (IQR)			Within-hospital/Different Hospital Median SNP Ratio	Expected Ratio, 95% CI[a]	Compatible With Hospital-based Clustering
	Within Country	Within Hospital	Within Country, Different Hospital			
020	52 (34–104)	40 (31–105)	54 (35–104)	0.74	.51–2.04	No
014	147 (59–173)	32 (0–137)	148 (60–173)	0.21	.42–1.17	Yes
002	69 (59–88)	3 (0–21)	69 (60–88)	0.05	.65–1.36	Yes
015	296 (29–364)	2 (0–2)	296 (41–365)	0.01	.14–1.47	Yes
078	56 (29–129)	125 (1–250)	56 (32–128)	2.26	.15–3.86	No
027	49 (17–71)	8 (3–26)	50 (19–71)	0.16	.42–0.56	Yes
001/072	37 (23–199)	9 (4–31)	38 (24–201)	0.23	.70–1.09	Yes
176	6 (4–8)	7 (2–8)	6 (4–8)	1.17	.66–1.17	Limited total diversit
018	28 (17–38)	7 (4–11)	29 (17–38)	0.23	.52–1.38	Yes
356	9 (5–12)	7 (0–7)	9 (5–12)	0.78	.22–1.56	Limited total diversit

Abbreviations: CI, confidence interval; IQR, interquartile range; SNP, single-nucleotide polymorphism.
[a]CIs were based on permutation tests (see Methods).

Lessa NEJM 2015;372;825; Eyre CID 2018;67:1035

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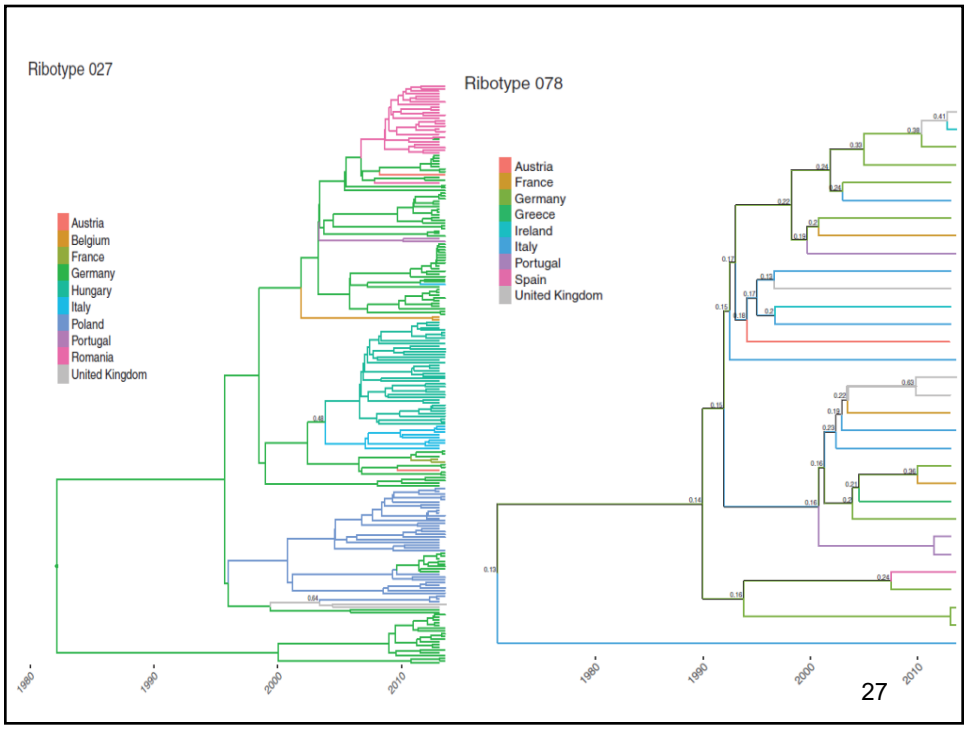
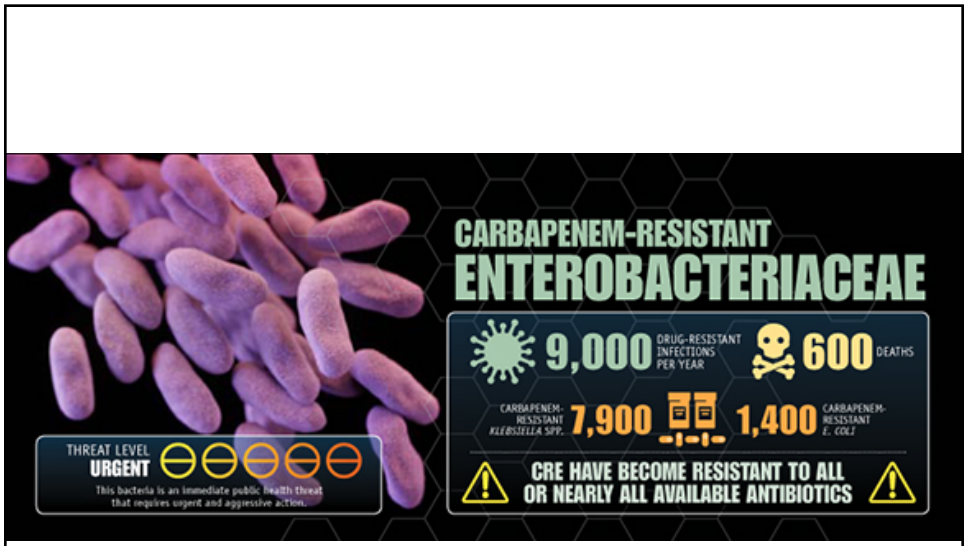

Ribotype 027
Austria
Belgium
France
Germany
Hungary
Italy
Poland
Portugal
Romania
United Kingdom
1980
1990
2000
2010
Ribotype 078
Austria
France
Germany
Greece
Ireland
Italy
Portugal
Spain
United Kingdom
1980
1990
2000
2010

27


CARBAPENEM-RESISTANT
ENTEROBACTERIACEAE
9,000 DRUG-RESISTANT INFECTIONS PER YEAR
600 DEATHS
CARBAPENEM-RESISTANT KLEBSIELLA SPP. 7,900
1,400 CARBAPENEM-RESISTANT E. COLI
CRE HAVE BECOME RESISTANT TO ALL OR NEARLY ALL AVAILABLE ANTIBIOTICS
THREAT LEVEL
URGENT
This bacteria is an immediate public health threat that requires urgent and aggressive action.

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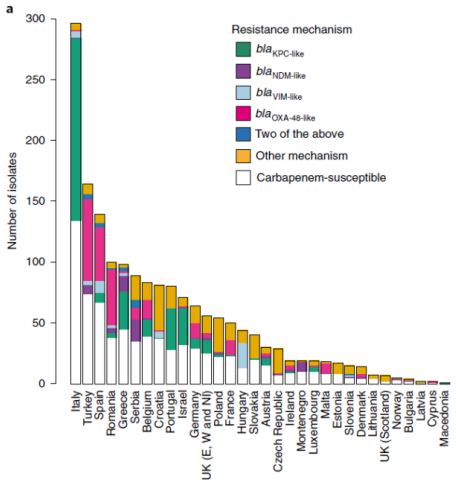
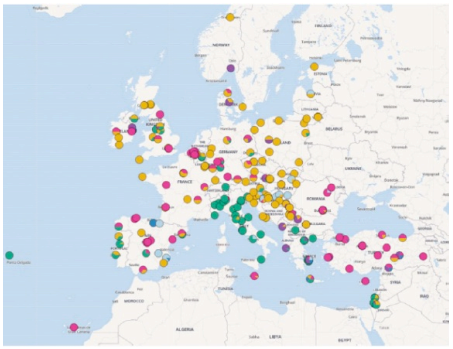
European Survey of Carbapenemase-Producing Enterobacteriaceae
(EuSCAPE)

- 1717 isolates
- 244 hospitals
- 32 countries





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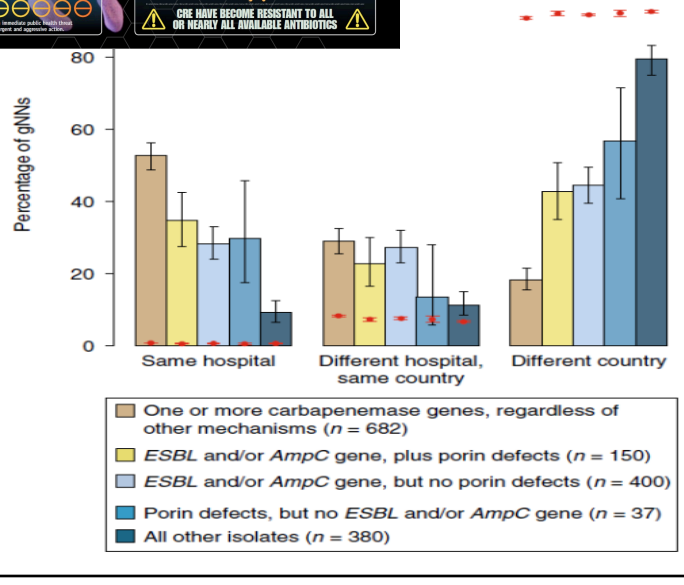
European Survey of Carbapenemase-Producing Enterobacteriaceae
(EuSCAPE)



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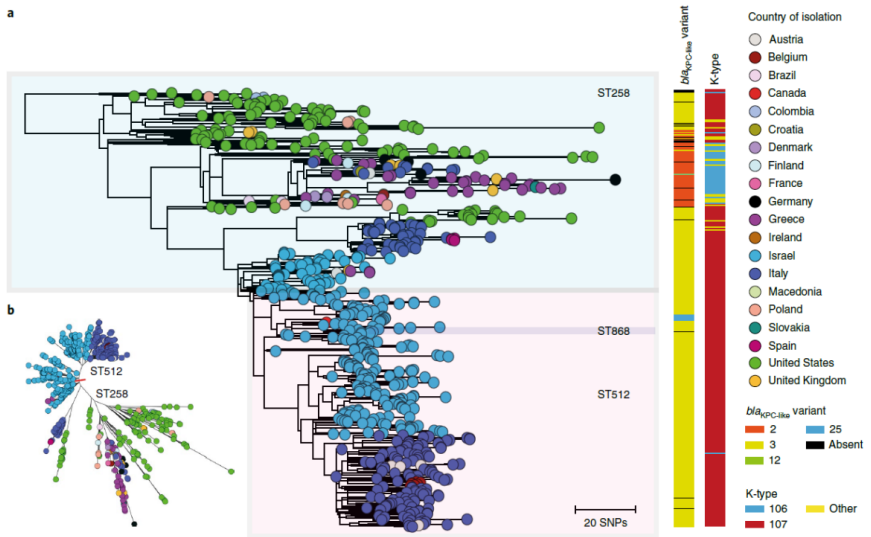
K. pneumoniae ST258 phylogenetic tree



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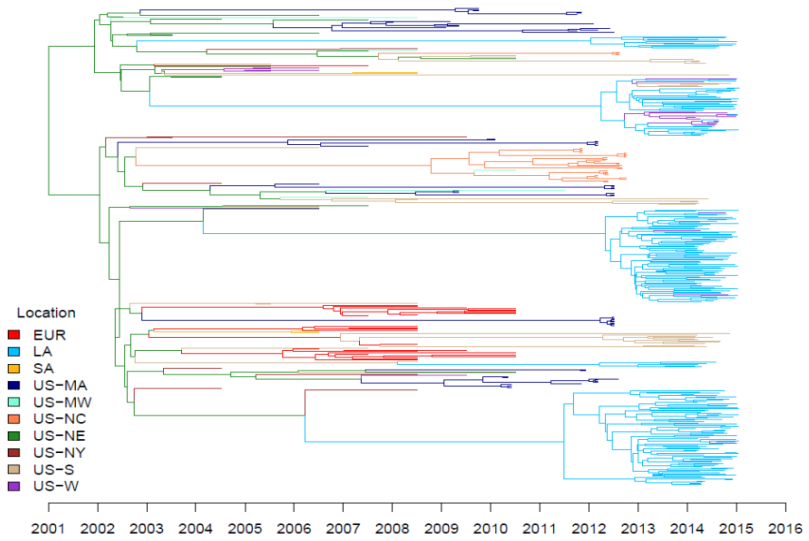
CP-KP in long-term acute care, Los Angeles



Han AAC 2019 (ahead of print)

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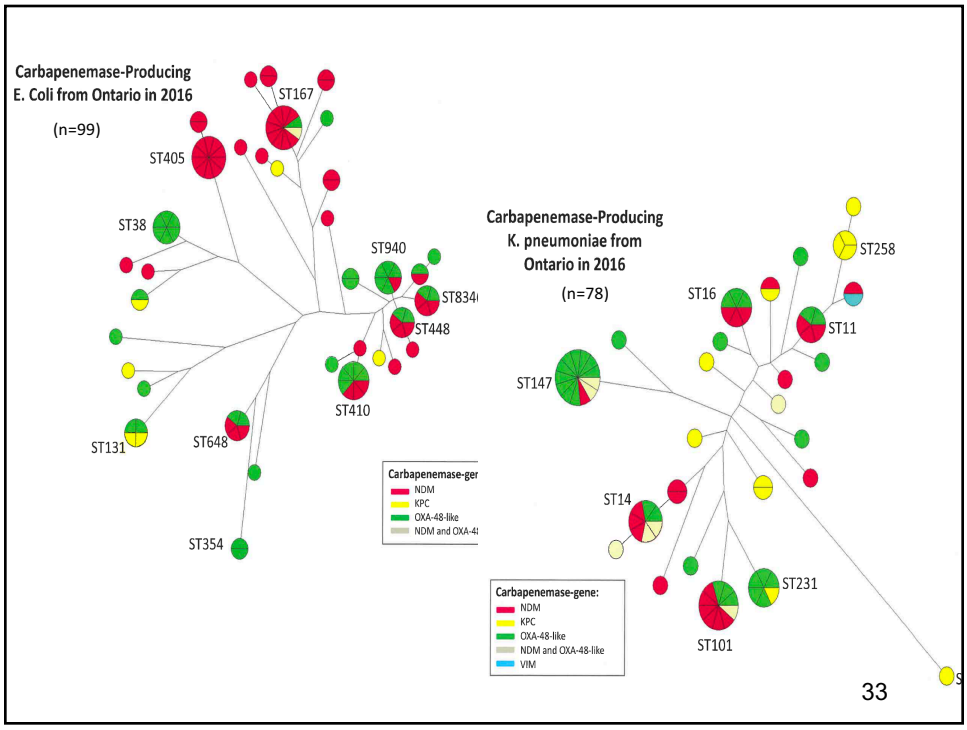

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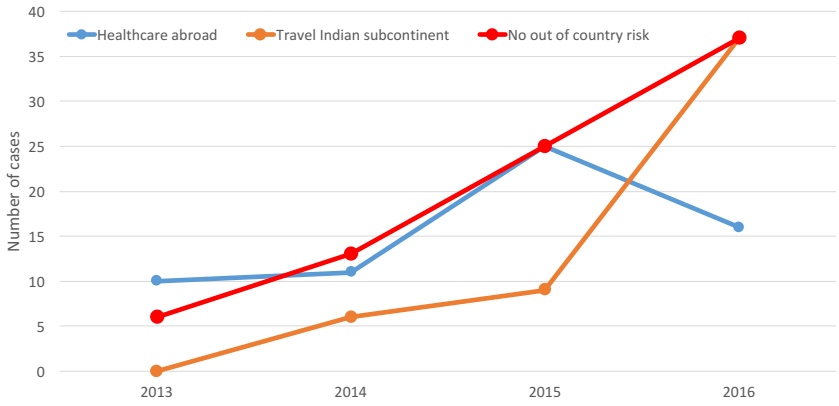
Identified risk factors, CPE colonized/infected patients, by year



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We have met the enemy and he is hospitals

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How do we stop transmission of AROs in hospitals?

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Antibiotic resistant organisms

- All these organisms are primarily transmitted from patient to patient via the hands of staff, or the environment (including the "mobile" environment)
- Colonized patients are as likely to transmit as those who are infected (except for *C. difficile*)
- Many infections are device-related
- Antibiotic exposure increases the risk of acquisition

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Additional issues

- Seeing the benefits of prevention
- Accepting hospital acquired infections as "normal"
- Interpreting evidence when you can't randomize hospitals or regions

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What do we need?

- Reduction in overall infection risk
  - Better hand hygiene (electronic monitoring)
  - Reduced risk of device-related infections
  - Better environmental cleaning
- Transmission control programs
  - Screening to identify colonized patients
  - Private rooms/additional precautions/cleaning to reduce transmission
  - Investigation of transmission/on-going evaluation
  - Funding for laboratories

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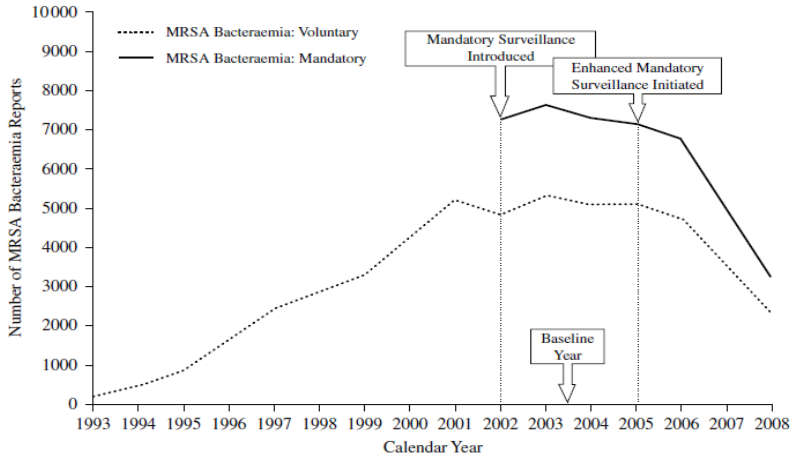
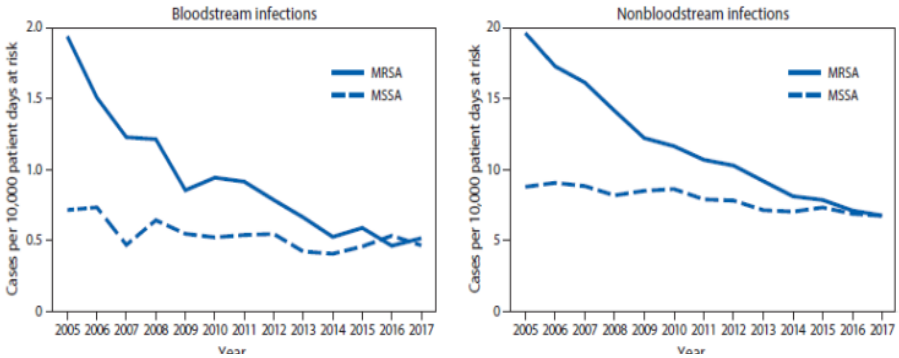
MRSA Bacteremia - England



Pearson, J Antimicrob Chemother 2009

40

Incidence of hospital onset *S. aureus* infections, VA medical system, 2005-2017



Jones, MMWR 2019

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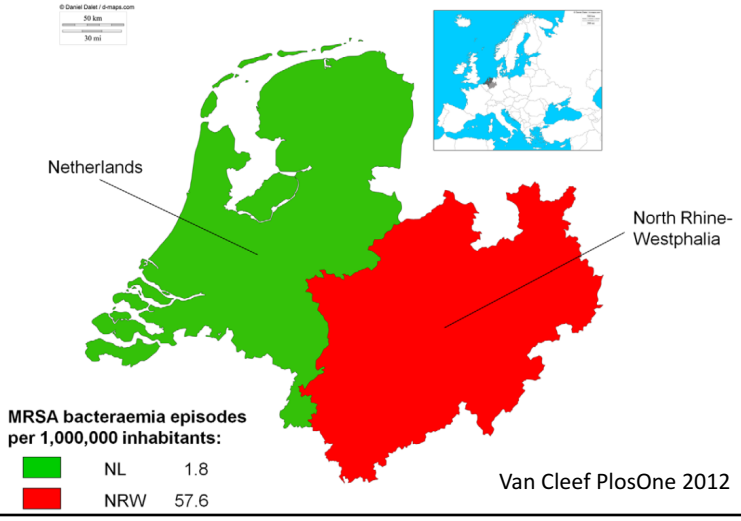
MRSA bacteremia rates in adjacent regions of the Netherlands and Germany, 2009

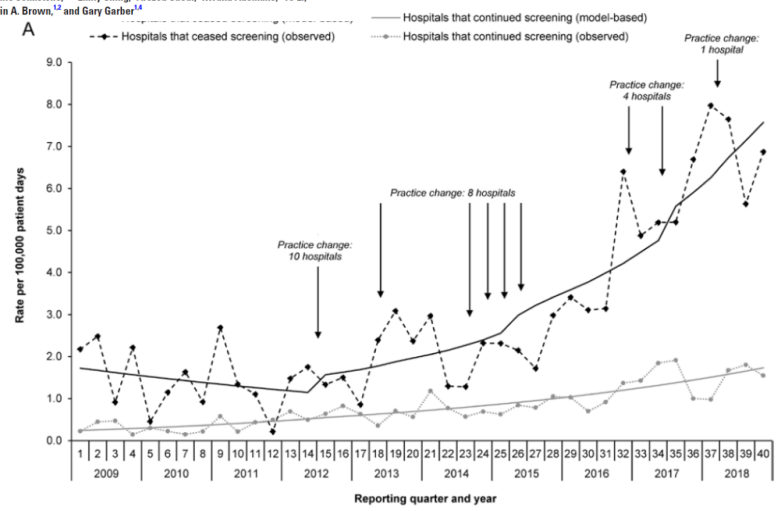


Van Cleef PlosOne 2012

42

Discontinuing Contact Precautions for Vancomycin-Resistant *Enterococcus* (VRE) Is Associated With Rising VRE Bloodstream Infection Rates in Ontario Hospitals, 2009–2018: A Quasi-experimental Study

Jennie Johnstone,[1,2,3] Emily Shing,[1] Arezou Saedi,[1] Kwaku Adomako,[1] Ye Li,[1] Kevin A. Brown,[1,2] and Gary Garber[1,4]



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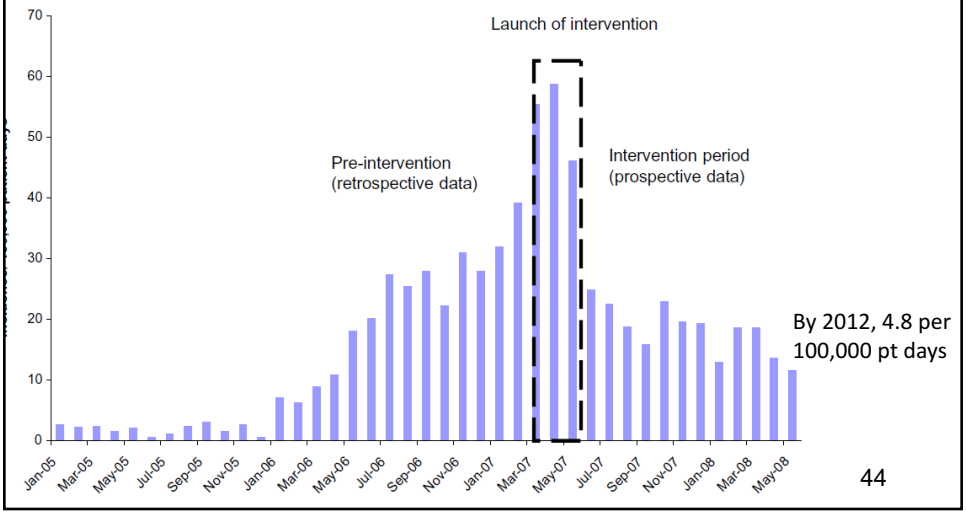
Incidence of CPE clinical cultures in Israeli acute care hospitals, 2005-2008



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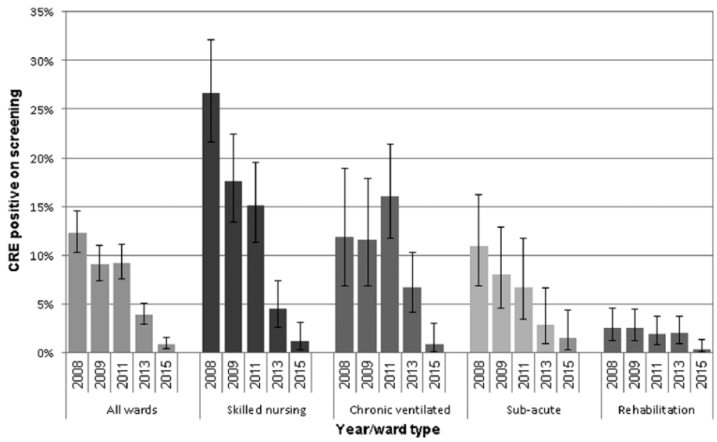
Reduction in prevalence of CPE colonization, long term care, Israel



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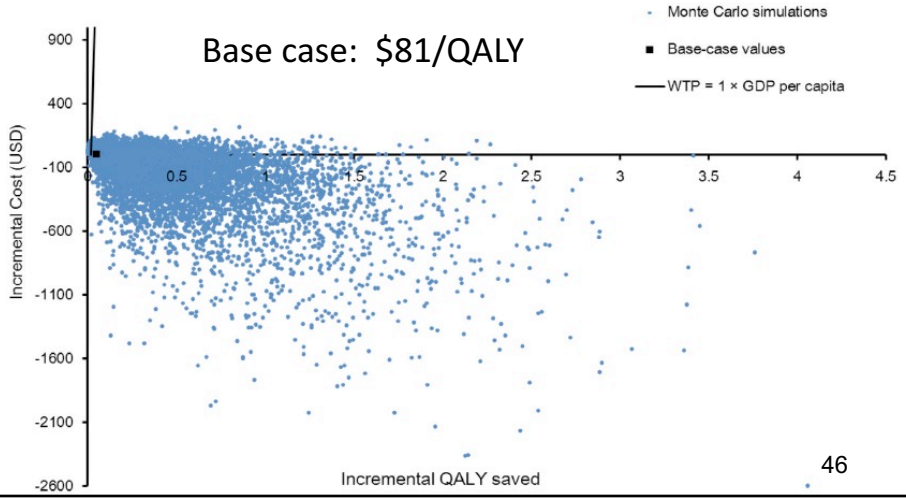
Major article

Active surveillance of carbapenem-resistant Enterobacteriaceae in intensive care units: Is it cost-effective in a nonendemic region?

Ka-wai Ho BPharm [a], Wai-tong Ng BPharm [a], Margaret Ip FRCPath, FRCP(Glasg) [b], Joyce H.S. You PharmD, BCPS (Infectious Diseases) [a,*]

[a] *School of Pharmacy, Faculty of Medicine, The Chinese University of Hong Kong, Hong Kong, China*
[b] *Department of Microbiology, Faculty of Medicine, The Chinese University of Hong Kong, Hong Kong, China*

Base case: $81/QALY



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Prevalence, % colonized	Incremental cost ($)	Incremental effectiveness (QALYs)	ICER
0.001	29.62	0.000019	1,570,303
0.01	28.71	0.00019	152,322
0.1	19.70	0.0019	10,533
0.6	−27.37	0.0107	Screening dominates
1	−61.60	0.0173	Screening dominates
10			Screening dominates

QALY

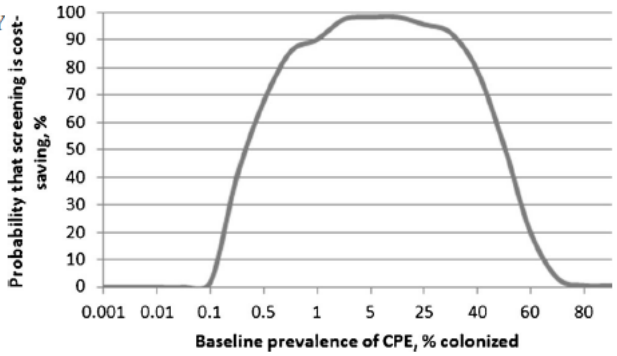

Fig. 4 The probability of screening being cost-saving at different CPE prevalence levels

Lapointe-Shaw
EJCMID 2017

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What can individuals do?

- Work at believing the evidence for prevention
- Don't normalize hospital acquired infections
- Support electronic monitoring for hand hygiene
  - Are your hands clean EVERY time before you touch a patient?
- Join a patient safety team, or the anti-microbial stewardship team
- Ask questions:
  - Are hospital acquired infection rates are on the QUIP? – if not, why not?
  - How well is the hospital environment, especially mobile equipment, being cleaned?
- Advocate for your patients

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September 23, 2021	TRIDEMICS OF INFLUENZA, COVID, AND NOW RSV Speaker: **Prof. Robert T. Ball**, Medical University of South Carolina
September 27, 2021	*(FREE European Teleclass - Broadcast live from the Infection Prevention Society conference)* Cottrell Lecture ... INFECTION PREVENTION: THROUGH A DIFFERENT LENS Speaker: **Prof. Heather Loveday**, Richard Wells Research Centre, University of West London
September 29, 2021	*(FREE European Teleclass - Broadcast live from the Infection Prevention Society conference)* Ayliffe Lecture ... PAST, PRESENT AND FUTURE Speaker: **Peter Hoffman**, Public Health England
October 7, 2021	INFECTION CONTROL AND PREVENTION IN LONG-TERM CARE FACILITIES AND HEALTHCARE LAUNDRY Speaker: **John Scherberger**, Healthcare Risk Mitigation, Spartanburg, SC
October 14, 2021	COMMON FEATURES OF WATERBORNE PATHOGENS IN HEALTHCARE FACILITIES: WHY ARE THEY SO CHALLENGING? Speaker: **Prof. Joseph O. Falkinham, III**, Department of Biological Sciences, Virginia Tech
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