Future of Infection Control in the 21st Century: Predictions, Warnings and Challenges

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Former Director, Hospital Epidemiology, Occupational Health and Safety, UNC Health Care, Chapel Hill, NC (1979-2017)

Some slides from Dr. David J. Weber

DISCLOSURES

2018

- Consultations
  - ASP (Advanced Sterilization Products), PDI
- Honoraria
  - PDI, ASP
- Scientific Advisory Board
  - Kinnos
- Grants
  - CDC, CMS

DISCUSSION TOPICS

Impact of healthcare-associated infections

Challenges in infection prevention

Future of infection prevention

HEALTHCARE-ASSOCIATED INFECTIONS: IMPACT IN UNITED STATES

- 1.7 million infections per year
- 98,987 deaths due to HAI
  - Pneumonia 35,967
  - Bloodstream 30,665
  - Urinary tract 13,088
  - SSI 8,205
  - Other 11,062
- 6th leading cause of death (after heart disease, cancer, stroke, chronic lower respiratory diseases, and accidents)[1]

[1] National Center for Health Statistics, 2004

INCREMENTAL HOSPITAL DAYS DUE TO COMMON HAIs

MORTALITY RATE OF COMMON HAIs

COST ESTIMATES FOR HEALTHCARE-ASSOCIATED INFECTIONS (HAIs)

HAI	Cost per HAI US$ ± SE	Range
Ventilator-associated pneumonia	25,072 ± 4,132	8,682-31,316
Healthcare-associated bloodstream infections	23,242 ± 5,184	6,908-37,260
Surgical site infections	10,443 ± 3,249	2,527-29,367
Catheter-associated urinary tract infections	758 ± 41	728-810

Anderson DJ, et al. ICHE 2007;28:767-773

Costs based on literature review 1985-2005; adjusted to US 1995 dollars

MOST PREVALENT PATHOGENS CAUSING HAI

Rutala, Weber. Infect Control Hosp Epidemiol. 2014;35:855-865; Weiner et al ICHE 2016;37:1288

- Most prevent pathogens causing HAI (easy to kill)
  - *E. coli* (15.4%)
  - *S. aureus* (11.8%)
  - *Klebsiella* (7.7%)
  - Coag neg Staph (7.7%)
  - *E. faecalis* (7.4%)
  - *P. aeruginosa* (7.3%)
  - *C. albicans* (6.7%)
  - *Enterobacter* sp. (4.2%)
  - *E. faecium* (3.7%)
- Common causes of outbreaks and ward closures (relatively hard to kill)
  - *C. difficile* spores
  - Norovirus
  - Rotavirus
  - Adenovirus

Table 4. **Estimated Numbers of Major Types of Health Care–Associated Infection in the United States in 2011.**

Type of Infection	Infections Identified in Survey	Surveyed Patients with Type of Infection	Estimated Infections in the United States*
	no.	*% (95% CI)*	*no. (95% CI)*
All health care–associated infections			
Pneumonia	110	24.3 (20.6–28.5)	157,500 (50,800–281,400)
Surgical-site infection	110†	24.3 (20.6–28.5)	157,500 (50,800–281,400)
Gastrointestinal infection	86	19.0 (15.6–22.8)	123,100 (38,400–225,100)
Urinary tract infection	65	14.4 (11.4–17.9)	93,300 (28,100–176,700)
Primary bloodstream infection	50	11.1 (8.4–14.2)	71,900 (20,700–140,200)
Eye, ear, nose, throat, or mouth infection	28‡	6.2 (4.2–8.7)	40,200 (10,400–85,900)
Lower respiratory tract infection	20	4.4 (2.8–6.6)	28,500 (6900–65,200)
Skin and soft-tissue infection	16	3.5 (2.1–5.6)	22,700 (5200–55,300)
Cardiovascular system infection	6	1.3 (0.5–2.7)	8,400 (1200–26,700)
Bone and joint infection	5	1.1 (0.4–2.4)	7,100 (1000–23,700)
Central nervous system infection	4	0.9 (0.3–2.1)	5,800 (700–20,700)
Reproductive tract infection	3	0.7 (0.2–1.8)	4,500 (500–17,800)
Systemic infection	1	0.2 (0.01–1.1)	1,300 (0–10,900)
Total			721,800 (214,700–1,411,000)
Infections in non-neonatal intensive care units			
Catheter-associated urinary tract infection	25	5.5 (3.7–7.9)	35,600 (9100–78,000)
Central-catheter–associated primary bloodstream infection	11	2.4 (1.3–4.2)	15,600 (3200–41,500)
Ventilator-associated pneumonia	35	7.7 (5.5–10.5)	49,900 (13,600–103,700)
Surgical-site infections attributed to Surgical Care Improvement Project procedures§	46	10.2 (7.6–13.2)	66,100 (18,700–130,300)
Hospital-onset infections caused by specific pathogens			
Clostridium difficile infection¶	56	12.4 (9.6–15.7)	80,400 (23,700–155,000)
MRSA bacteremia‖	7	1.5 (0.7–3.0)	9,700 (1700–29,600)

Magill SS, et al. New Engl J Med 2014;370:1198

Sources of Healthcare-Associated Pathogens

Weinstein RA. Am J Med 1991:91 (suppl 3B):179S

- Endogenous flora (SSI, UTI, CLABSI): 40-60%
- Exogenous: 20-40% (e.g., cross-infection via contaminated hands [staff, visitors])
- Other (environment): 20%
  - Medical devices
  - Contact with environmental surfaces (direct and indirect contact)

FUTURE OF INFECTION CONTROL

- Changing population of hospital patients
  - Increased severity of illness
  - Increased numbers of immunocompromised/older patients
  - Shorter duration of hospitalization
  - More and larger intensive care units
  - Larger step-down units
- Growing frequency of antimicrobial-resistant and emerging pathogens
- Lack of compliance with hand hygiene and other infection preventive measures (e.g., endoscope)

FUTURE OF INFECTION CONTROL

- Limited infection prevention resources
- Implementation of guidelines/standards, bundles and new technology demonstrated to reduce HAIs
- Health insurance reimbursement and employee incentive payments tied to quality goals
- State and federal laws legislating care issues
- Greater emphasis on infection prevention by TJC
- Device-associated infections
- New technology
- Reduced funds for new infection prevention technologies

FUTURE OF INFECTION CONTROL

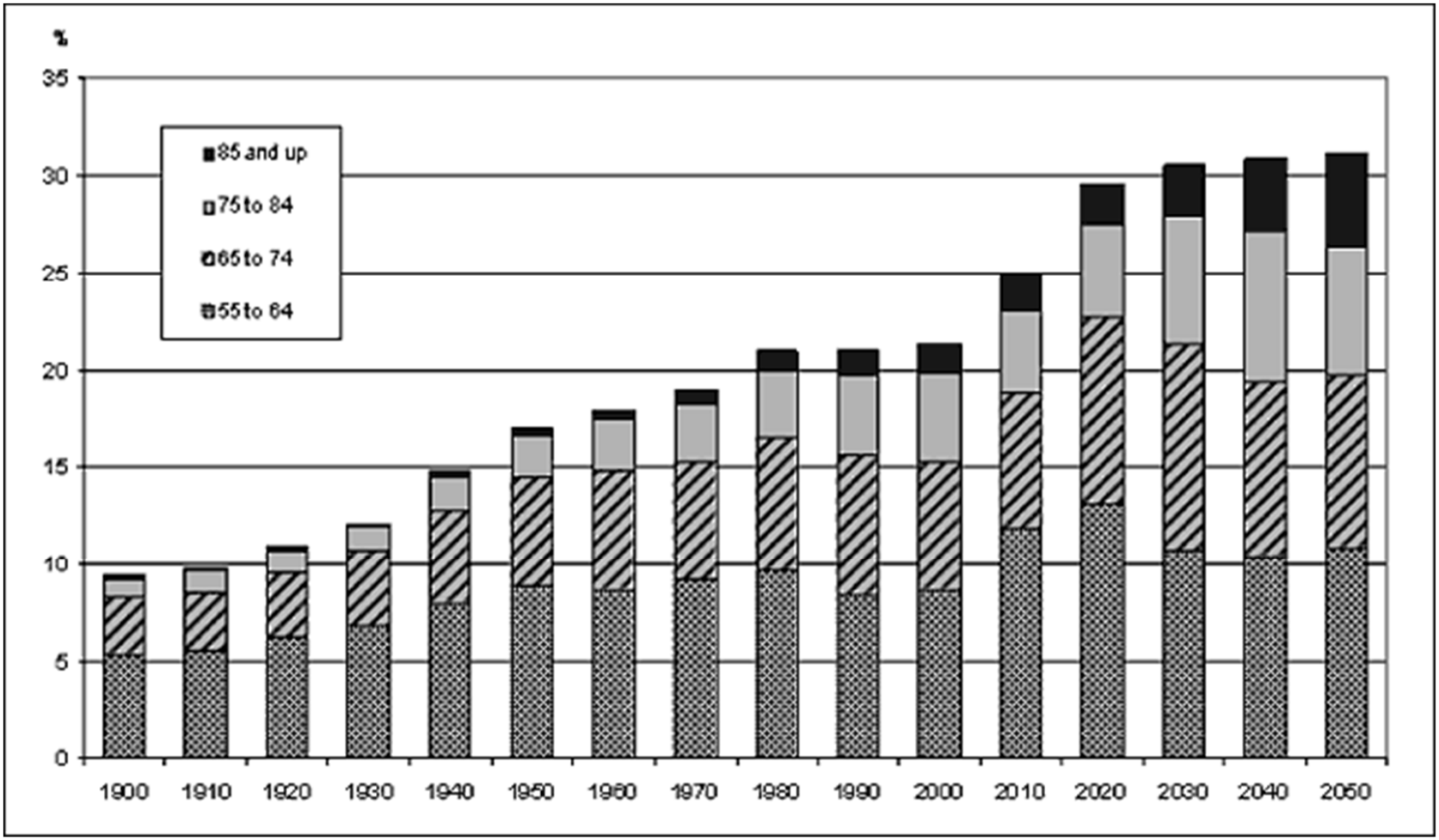
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RISK FACTORS FOR HEALTHCARE-ASSOCIATED INFECTIONS



More HCPs and more invasive devices = higher HAI rates

AGING POPULATION, US



Nosocomial Infections in the Elderly

Saviteer, Samsa, Rutala. Am J Med 1988;84:661

Infection incidence for all categories of HAI per decade of life

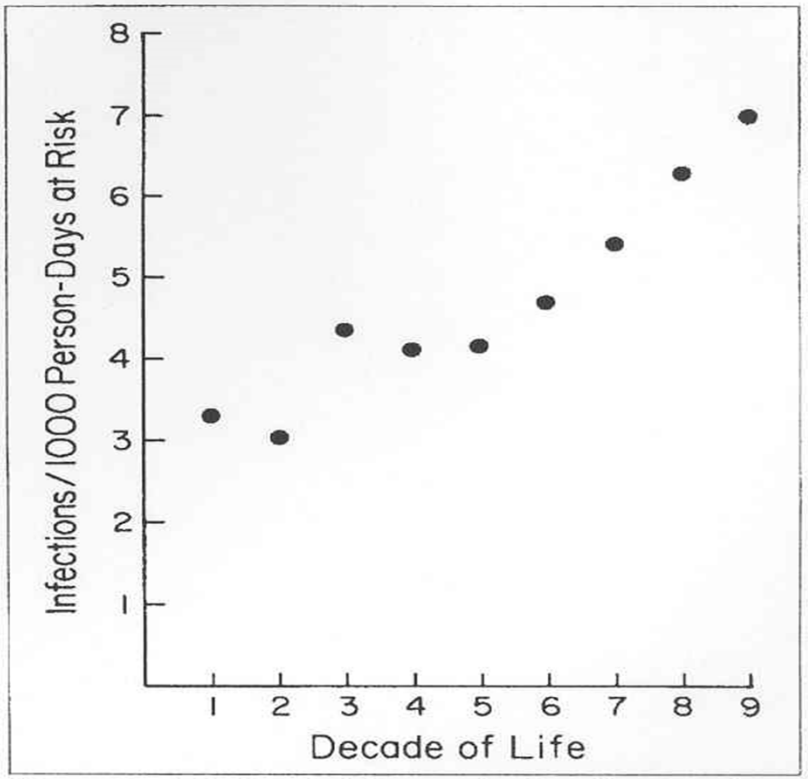
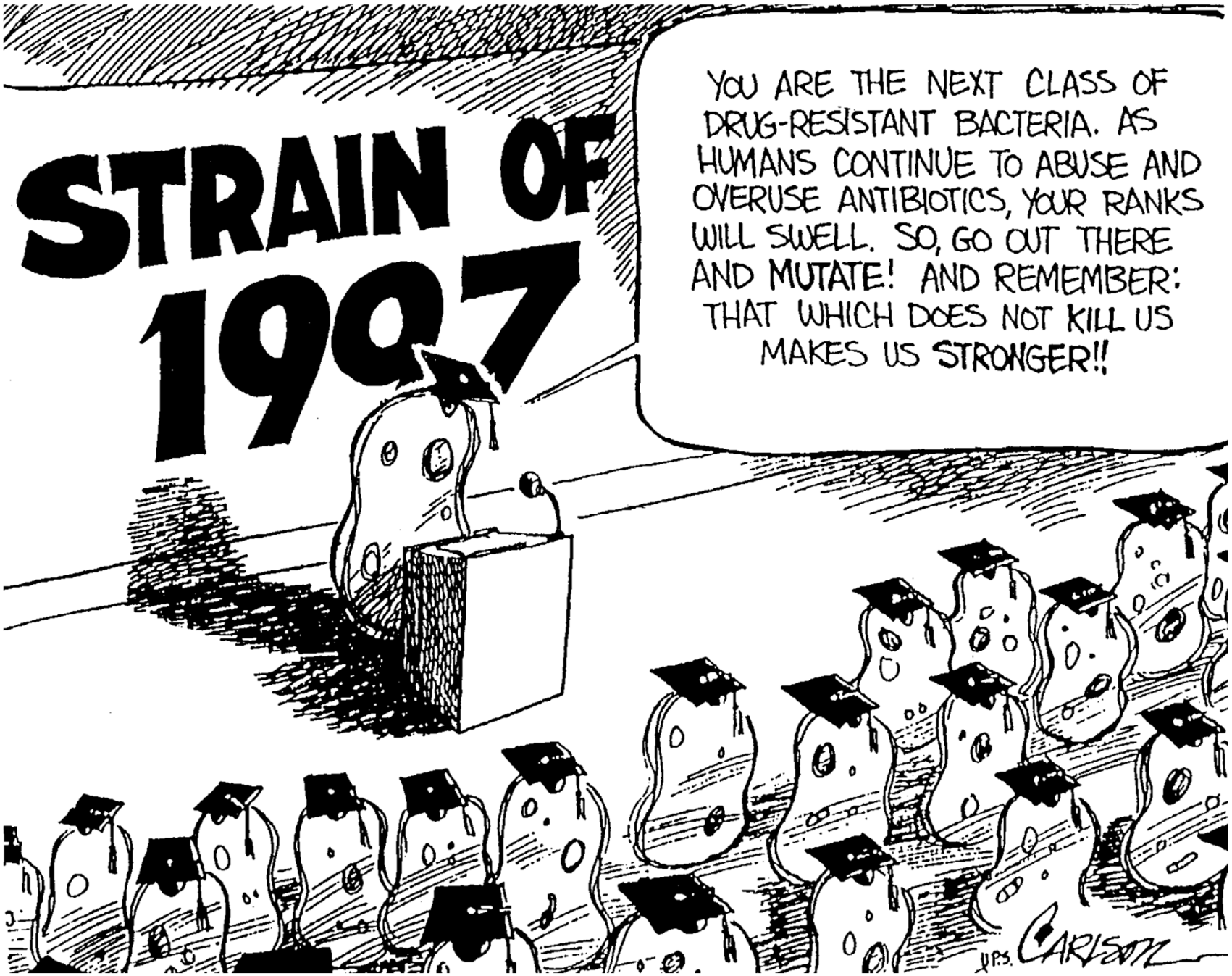


Figure 2. *Infection incidence rates for all categories of nosocomial infection per decade of life.*

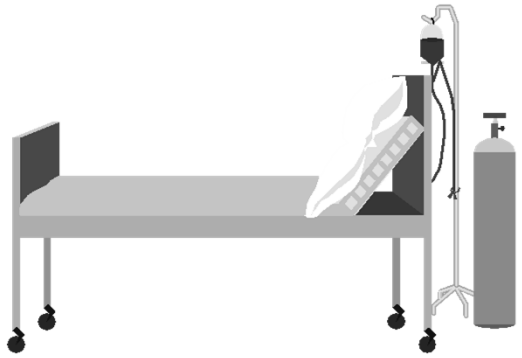
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STRAIN OF 1997
YOU ARE THE NEXT CLASS OF DRUG-RESISTANT BACTERIA. AS HUMANS CONTINUE TO ABUSE AND OVERUSE ANTIBIOTICS, YOUR RANKS WILL SWELL. SO, GO OUT THERE AND MUTATE! AND REMEMBER: THAT WHICH DOES NOT KILL US MAKES US STRONGER!!
J.P.S. CARLSON

EMERGING RESISTANT PATHOGENS: HEALTH CARE FACILITIES

- *Staphylococcus aureus*: Oxacillin (occ. vancomycin, linezolid)
- *Enterococcus:* Penicillin, aminoglycosides, vancomycin, linezolid, dalfopristin-quinupristin
- *Enterobacteriaceae:* ESBL producers, carbapenems CRE
- *Pseudomonas aeruginosa, Acinetobacter* sp: Multi-drug resistant
- *Mycobacterium tuberculosis*: MDR (INH, rifampin), XDR (multiple)



EMERGING INFECTIOUS DISEASES RELEVANT TO THE HOSPITAL

- 1977 (US) – Legionnaire's disease
- 1978 (US) – Staphylococcal toxic shock syndrome
- 1996 (England → US) – Variant Creutzfeldt-Jakob disease (vCJD)
- 2001 (US) - Anthrax (attack via letters)*
- 2002 (US) – Vancomycin-resistant *S. aureus**
- 2002 (Canada → US) – Hypervirulent *C. difficile**
- 2003 (China → worldwide) - SARS*
- 2003 (US) – Monkeypox*
- 2004 (Asia) – Avian influenza (H5N1)*
- 2006 (Worldwide) – XDR-TB*

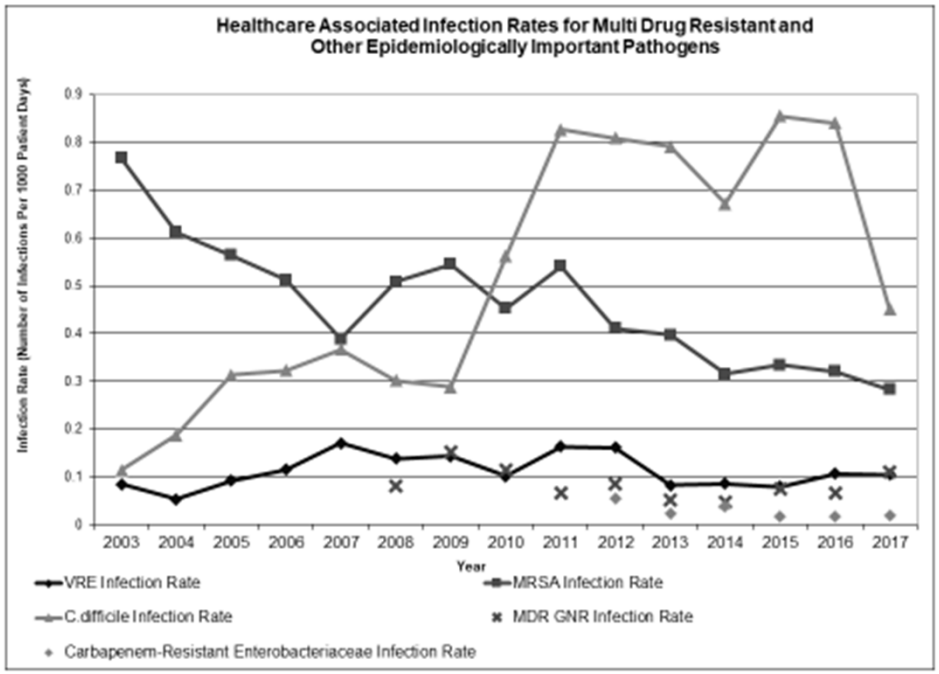
* HCWs at risk for infection

EMERGING INFECTIOUS DISEASES RELEVANT TO THE HOSPITAL

- 2009 -Novel H1N1 influenza
- 2010-2013 KPC-*Klebsiella pneumoniae* carbapenemase (KPC) , New Delhi metallo-beta-lactamase (NDM) *Enterobacteriaceae,* Carbapenem-resistant *Enterobacteriaceae* (CRE)
- 2012-13 (Worldwide) – Middle East Respiratory Symptoms-Coronavirus
- 2013-*Candida auris*
- 2014-Ebola, Enterovirus D68
- 2014-Zika virus

* HCP at risk for infection

HAI Rates for Epidemiologically Important Pathogens, 2003-2017



EMERGING PATHOGENS

CRE

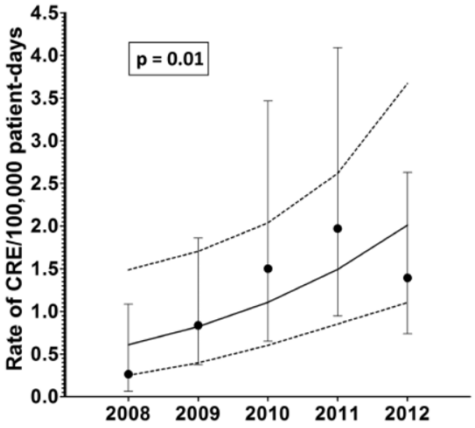
Candida auris

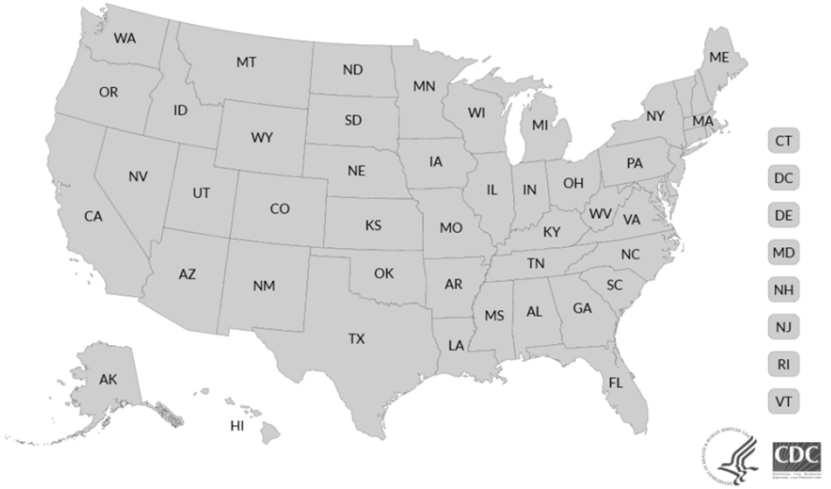
CRE: INFECTION PREVENTION

- Definition (CDC): Carbapenem-resistant *Enterobacteriaceae* (CRE) are resistant to imipenem, meropenem, doripenem, or ertapenem OR documentation that the isolate possess a carbapenemase.
  - This is a phenotypic definition (i.e., based on the antibiotic susceptibility pattern of the organism) and it includes bacteria that are not susceptible to carbapenems via more than one type of mechanism including enzymatic destruction of antibiotics and alterations in the bacteria's cell membrane (e.g., porin mutations)
- Associated with antibiotic failures and higher mortality rate
- Control: Contact isolation; Prevalence surveys for colonization may be indicated

CRE Trend Line, DICON

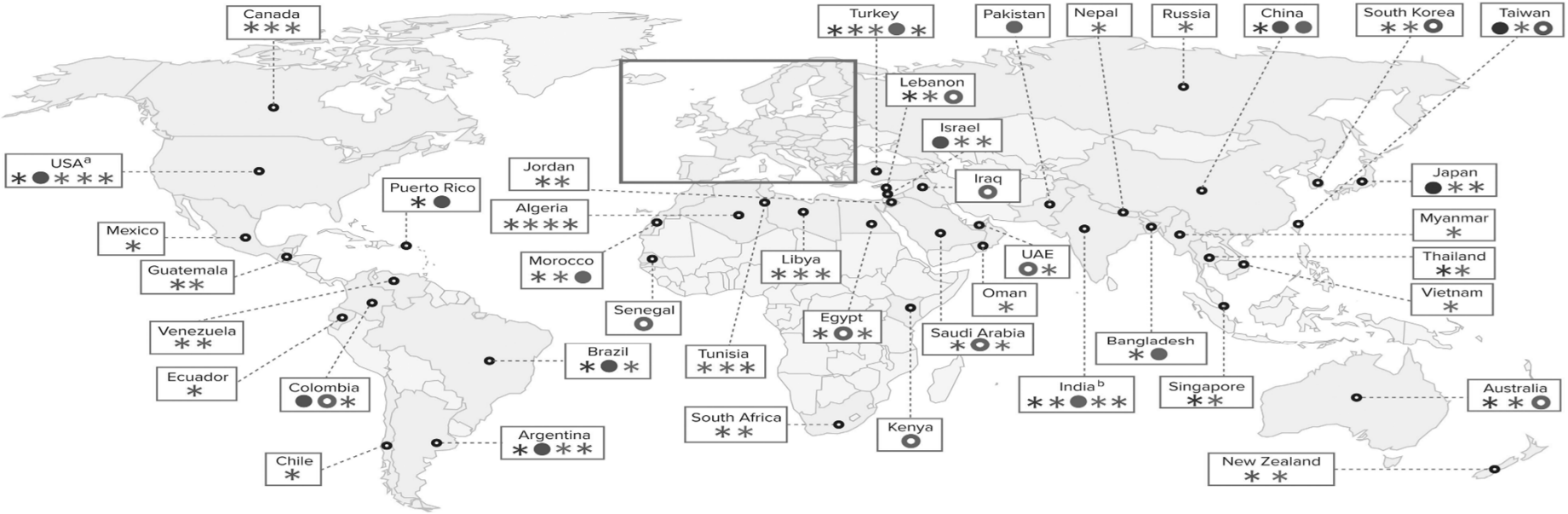
Anderson D, et al
ICHE 2014; 35:978-83

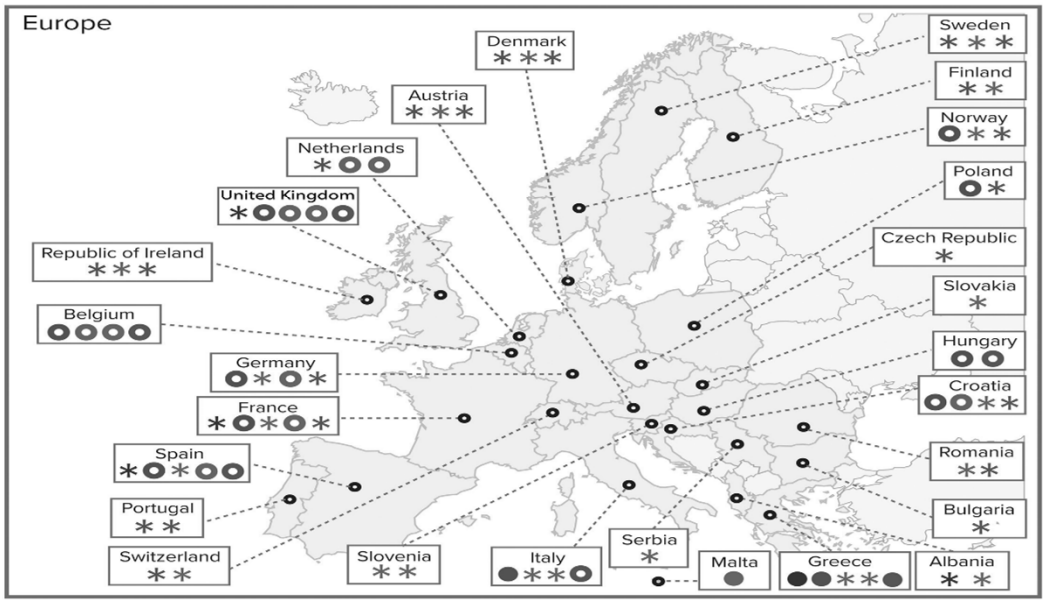




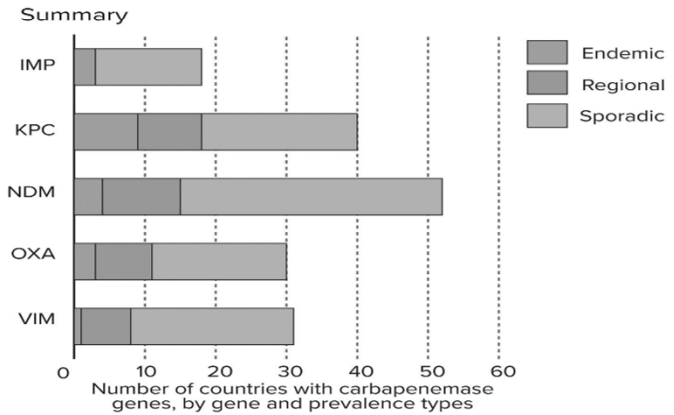
KPC-CRE

GLOBAL DISTRIBUTION OF CARBAPENEMASES IN ENTEROBACTERIACEAE





	IMP	KPC	NDM	OXA	VIM
Endemic/nationwide distribution	●	●	●	●	●
Significant outbreaks/ regional spread	○	○	○	○	○
Sporadic outbreak/ occurences	*	*	*	*	*



Logan LK, Weinstein RA. J Infect Dis 2017;215(S1):S28-36

CRE: FREQUENCY OF ENVIRONMENTAL CONTAMINATION

TABLE 1. Contamination on Surfaces in Rooms Housing a Patient with CRE

Room Site Cultured (No.)	CRE Positive, No. (%)[a]	CRE, mean CFU (range)[b]
Bed rail (15)	2 (13.3)	45 (43–47)
Overbed table (15)	1 (6.7)	3
Chair #1 arm (12)	0 (0.0)	...
Sink (15)	2 (13.3)	14.5 (11–18)
Toilet (11)	2 (18.2)	7 (4–10)
Bathroom floor (10)	1 (10.0)	5
Supply cart (11)	1 (9.1)	2
Linen hamper (12)	0 (0.0)	...
Mobile computer (3)	0 (0.0)	...
Chair #2 arm (3)	0 (0.0)	...
Bedside table (3)	0 (0.0)	...
Toilet cabinet (4)	0 (0.0)	...
Floor outside toilet cabinet (4)	1 (25.0)	2
Ventilator counter (1)	0 (0.0)	...
Total (119)[c]	10 (8.4)	5.1 (2–47)

CFU, colony forming units; CRE, carbapenem-resistant *Enterobacteriaceae*.

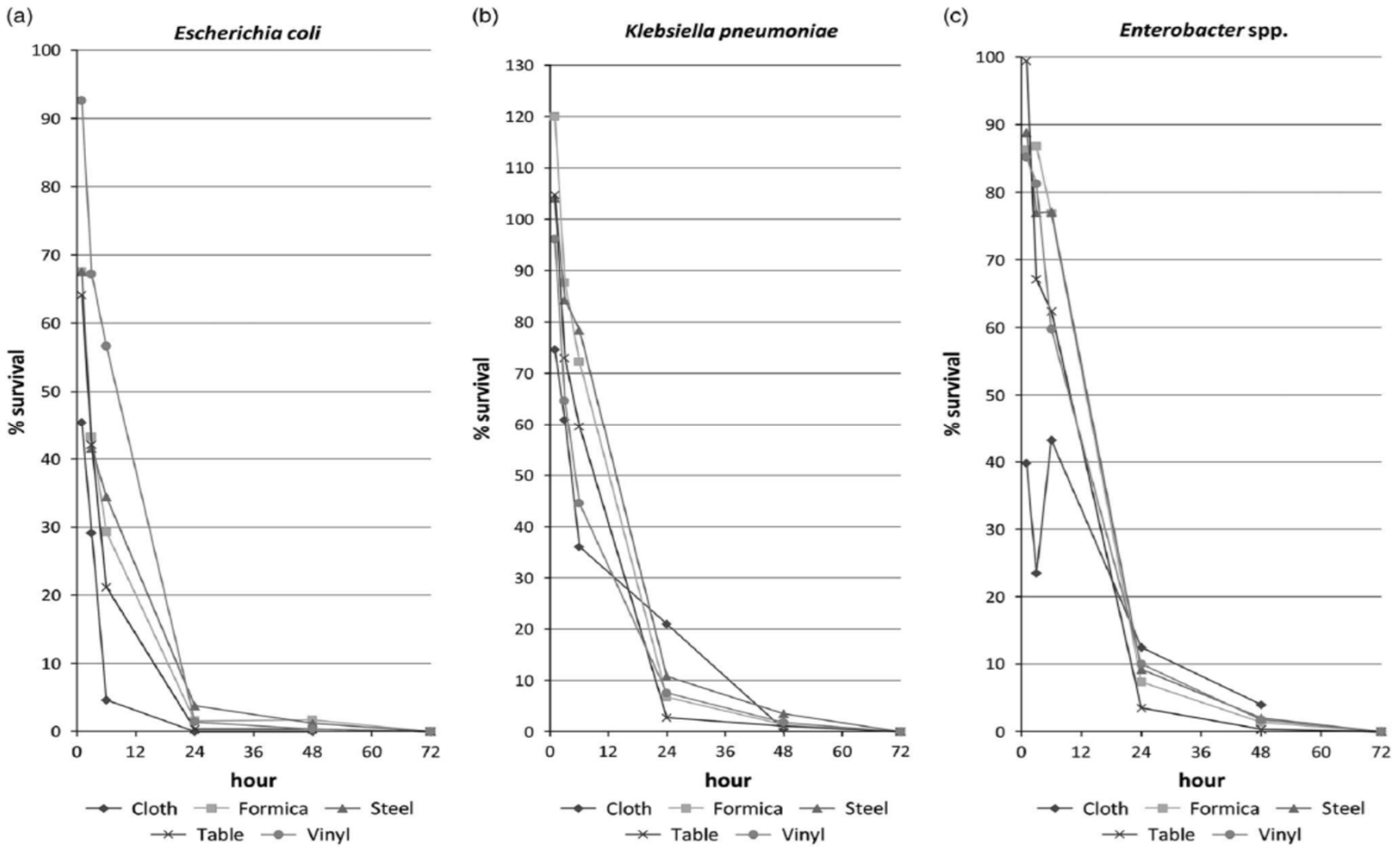
[a]Considered positive if ≥1 of the 5 Rodac plates had positive growth (ie, area sampled = 120 cm^2).

[b]Mean and range calculated only for CRE culture positive sites.

[c]For one site cultured, technical difficulties prevented assessing growth. Thus total was 119 sites instead of 120 sites.

Weber DJ, Rutala WA, et al. ICHE 2015;36:590-593

CRE: SURVIVAL ON ENVIRONMENTAL SUFACES



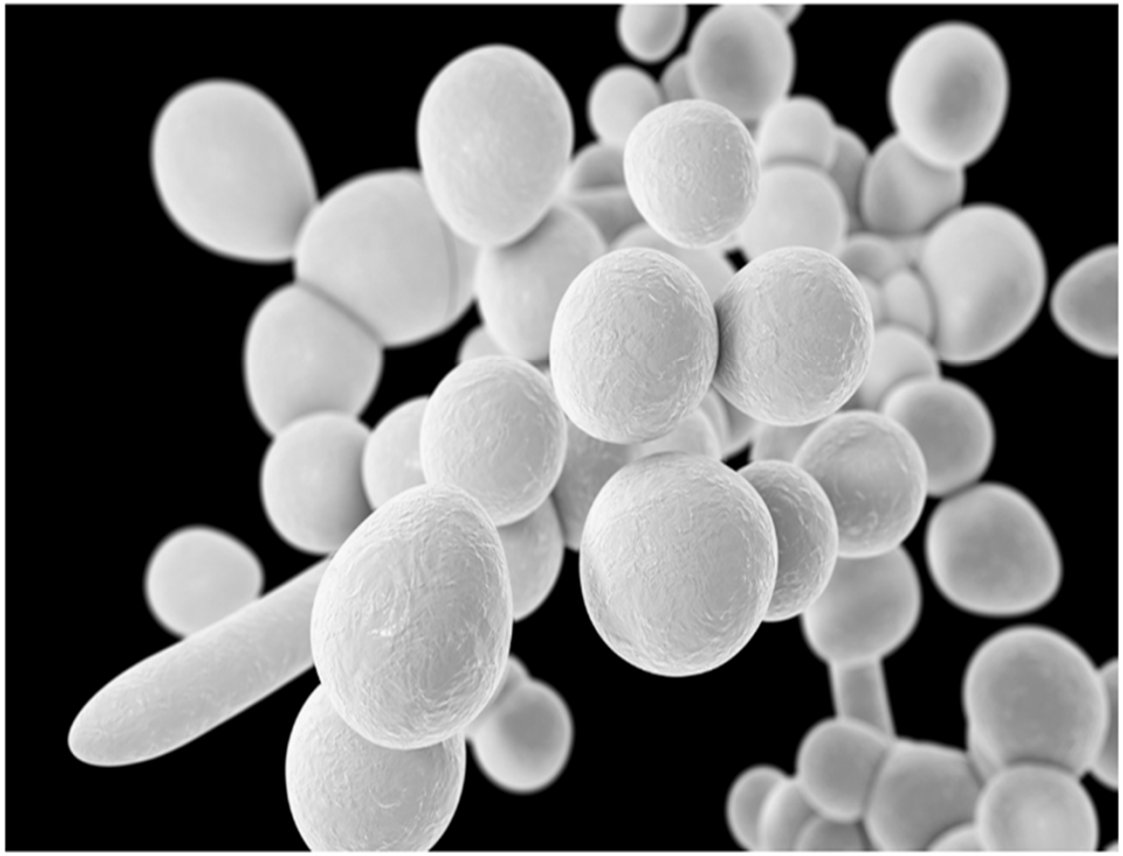
Weber DJ, Rutala WA, et al. ICHE 2015;36:590-593

Efficacy of Disinfectants and Antiseptics against Carbapenem-Resistant *Enterobacteriaceae*

Kanamori, Rutala et al Antimicrob. Agents Chemother 2018. In press

- ≥3 $\log_{10}$ reduction (CRE, 1m, 5% FCS, QCT)
  - 0.20% peracetic acid
  - 2.4% glutaraldehyde
  - 0.5% Quat, 55% isopropyl alcohol
  - 58% ethanol, 0.1% QUAT
  - 28.7% isopropyl alcohol, 27.3% ethyl alcohol, 0.61% QAC
  - 0.07% o-phenylphenol, 0.06% p-tertiary amylphenol
  - ~5,250 ppm chlorine
  - 70% isopropyl alcohol
  - Ethanol hand rub (70% ethanol)
  - 0.65% hydrogen peroxide, 0.15% peroxyacetic acid
  - Accelerated hydrogen peroxide, 1.4% and 2.0%
  - Quat, (0.085% QACs; not *K. pneumoniae*)

Deadly, drug-resistant Candida yeast infection spreads in the US



Candida auris causes multidrug-resistant infections that can result in organ failure

Kateryna Kon/Science Photo Library

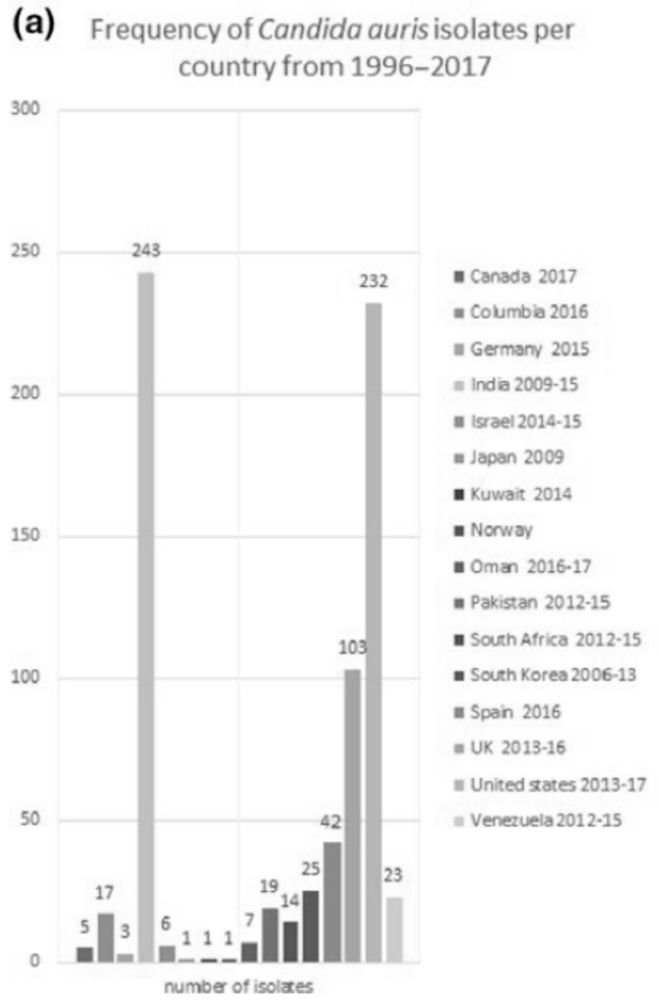
Candida auris

Cadnum et al . ICHE 2017;38:1240-1243

- *Candida auris* is a globally emerging pathogen that is often resistant to multiple antifungal agents
- In several reports, *C. auris* has been recovered from the hospital environment
- CDC has recommended daily and post-discharge disinfection of surfaces in rooms of patients with *C. auris* infection.
- No hospital disinfectants are registered for use specifically against *C. auris*, and its susceptibility to germicides in not known

GEOGRAPHICAL DISTRIBUTION OF *CANDIDA AURIS*





Lamoth FI Kontoyiannis DP. J Infect Dis 2018;217:516-520.
Sekyere JO. Microbiologyopen. 2018 Jan 1 (Epub ahead of print

TRANSMISSION AND PERSISTENCE OF *CANDIDA AURIS*

- Colonization of patients
  - Colonization of patients is common; multiple sites involved (Biswal 2017)
- Role of HCP
  - HCP may be colonized; uncommon (Schelenz 2017)
  - HCP hands may transiently carry *C. auris* (Biswal 2017)
- Role of environment
  - Environmental contamination common (Lesho 2018, Biswal 2017, Schelenz 2017, Valladhaneni 2016): mattresses, furniture, sinks, and medical equipment
  - Prolonged environmental survival on environmental surfaces; >14 days (Piedrahita 2017, Welsh 2017)
  - Prolonged survival (>7 days) on contaminated bedding (Biswal 2017)

Efficacy of Disinfectants and Antiseptics against *Candida auris*

Rutala, Kanamori, Gergen, Sickbert-Bennett, Weber, 2017 ID Week Poster

- ≥3 $\log_{10}$ reduction (*C. auris*, 1m, 5% FCS, QCT)
  - 0.20% peracetic acid
  - 2.4% glutaraldehyde
  - 0.65% hydrogen peroxide, 0.14% peroxyacetic acid
  - 0.5% Quat, 55% isopropyl alcohol
  - Disinfecting spray (58% ethanol, 0.1% QUAT)
  - 28.7% isopropyl alcohol, 27.3% ethyl alcohol, 0.61% QAC
  - 0.07% o-phenylphenol, 0.06% p-tertiary amylphenol
  - 70% isopropyl alcohol
  - ~5,250 ppm chlorine
  - Ethanol hand rub (70% ethanol)
  - Accelerated hydrogen peroxide, 1.4%
  - Accelerated hydrogen peroxide, 2%

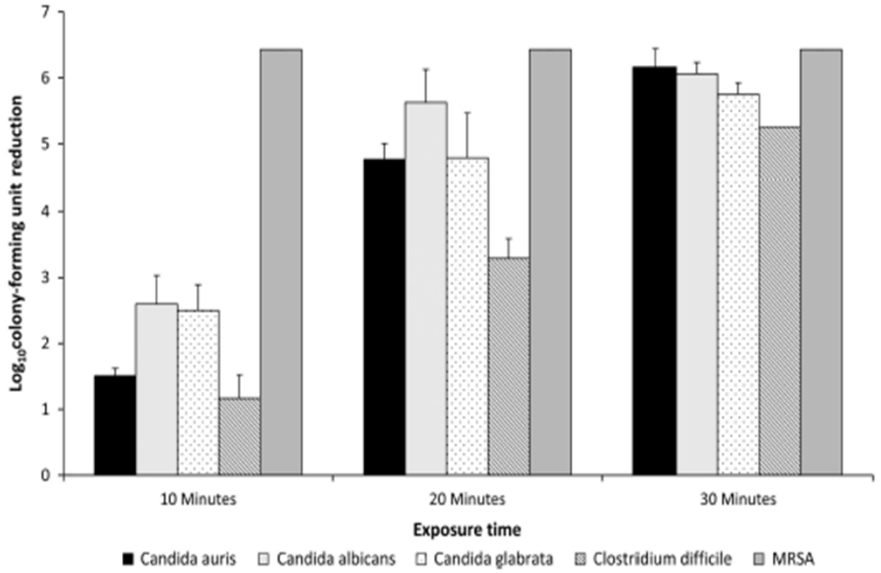
Efficacy of Disinfectants and Antiseptics against *Candida auris*

Rutala, Kanamori, Gergen, Sickbert-Bennett, Weber, 2017 ID Week Poster

- ≤3 $\log_{10}$ (most <2 $\log_{10}$) reduction (*C. auris*, 1m, 5% FCS, QCT)
  - 0.55% OPA
  - 3% hydrogen peroxide
  - Quat, (0.085% QACs)
  - 10% povidone-iodine
  - ~1,050 ppm chlorine
  - 2% Chlorhexidine gluconate-CHG
  - 4% CHG
  - 0.5% triclosan
  - 1% CHG, 61% ethyl alcohol
  - 1% chloroxylenol

Effect of UV-C on Reduction *C. auris* and Other Pathogens

Cadnum et al. ICHE 2017



Inoculum spread to cover 20mm diameter steel disk, disk placed 5 feet from UV device

- Multidrug-resistant *Candida auris* and two other *Candida* species were significantly less susceptible to killing by UV-C than MRSA
- UV-C could be useful as an adjunct to standard cleaning/disinfection
- These results suggest longer cycle times may be beneficial (per *C. difficile*)

C. AURIS: INFECTION PREVENTION

- Place patients in a single room using standard and contact isolation
- Emphasize hand hygiene
- Screen roommates; consider point prevalence surveys (swab patient's axilla and groin)
- Flag patient in case of re-admission
- Environmental infection control
  - EVS should use proper PPE
  - Monitor cleaning practices
  - Avoid quaternary ammonia products for surface disinfection; use a disinfectant EPA registered against *C. difficile* (EPA List K)

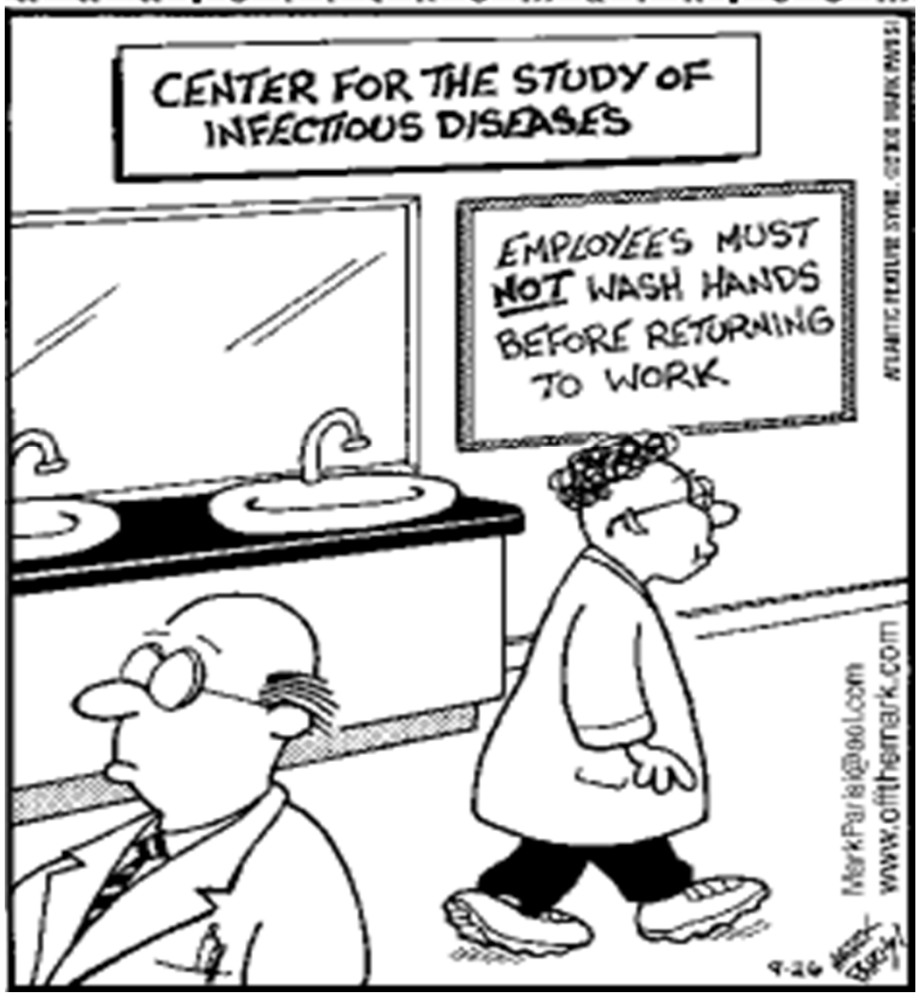
https://www.cdc.gov/fungal/candida-auris/c-auris-infection-control.html#disinfection

FUTURE OF INFECTION CONTROL

- Changing population of hospital patients
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  - Shorter duration of hospitalization
  - More and larger intensive care units
  - Larger step-down units
- Growing frequency of antimicrobial-resistant pathogens and emerging pathogen
- Lack of compliance with hand hygiene and other infection preventive measures (e.g., endoscope)

off the mark by Mark Parisi

www.offthemark.com



RATIONALE FOR HAND HYGIENE

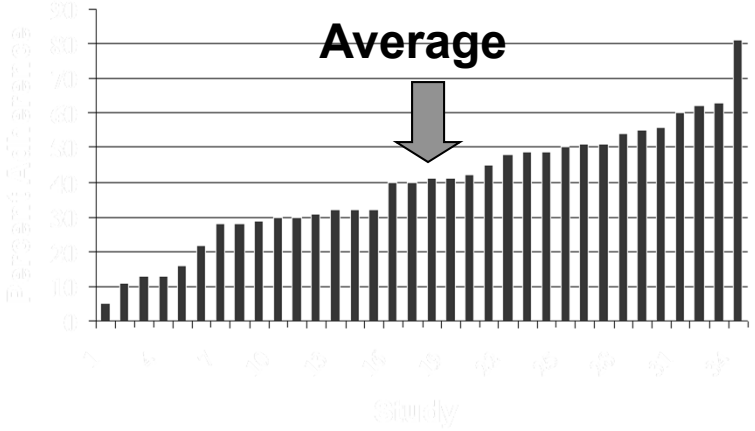
- Many infectious agents are acquired via hand contact with contaminated surfaces
  - Contact transmission: healthcare (MRSA, VRE), day care (MRSA), home (MRSA, “cold viruses”, herpes simplex)
  - Fecal-oral transmission: day care (*Shigella*, *E. coli* O157:H7), home (*Salmonella*, *E. coli* O157:H7, *Cryptosporidium*)
- Hand hygiene effective in reducing or eliminating transient flora
- Hand hygiene demonstrated to be effective in preventing illness (especially fecal-oral diarrheal illnesses) in healthcare facilities, child care centers/homes, and households
- ~40% of healthcare-associated infections due to cross-transmission

WHAT IS OUR TRACK RECORD ON HANDWASHING IN HEALTHCARE FACILITIES?

- A review of 34 published studies of handwashing adherence among healthcare workers found that adherence rates varied from 5% to 81%

- The average adherence rate was only 40%

Average Handwashing Adherence of Personnel in 34 Studies



ASSOCIATION BETWEEN HAND HYGIENE COMPLIANCE AND HAI RATES

Author, year	Setting	Results
Casewell, 1977	Adult ICU	Reduction HAI due to *Klebsiella*
Maki, 1982	Adult ICU	Reduction HAI rates
Massanari, 1984	Adult ICU	Reduction HAI rates
Kohen, 1990	Adult ICU	Trend to improvement
Doebbeling, 1992	Adult ICU	Different rates of HAI between 2 agents
Webster, 1994	NICU	Elimination of MRSA*
Zafar, 1995	Newborn	Elimination of MRSA*
Larson, 2000	MICU/NICU	85% reduction VRE
Pittet, 2000	Hospitalwide	Reduction HAI & MRSA cross-transmission

HAI, healthcare-associated infections

*Other infection control measures also instituted

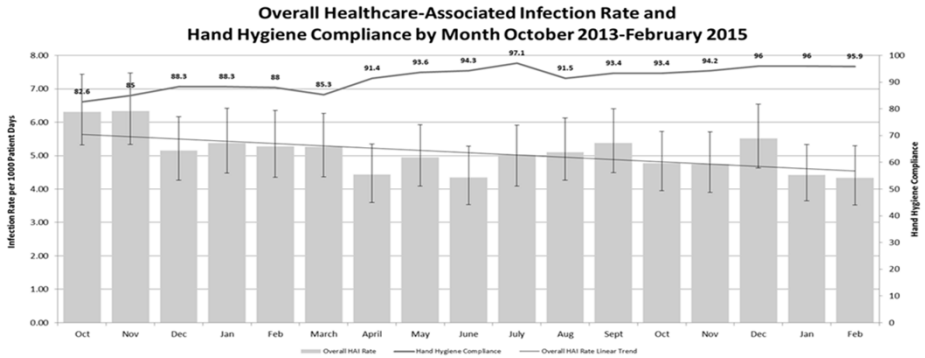
Boyce JM, Pitter D. MMWR 2002;51(RR-16)

HAND HYGIENE ADHERENCE AN INSTITUTIONAL PRIORITY

- Multidisciplinary Program
  - Administrative support (IOC, Executive Staff, Dept Heads)
  - Monitor HCWs adherence to policy and provide staff with information about performance
  - Provide HCWs with accessible hand hygiene (HH) products to include alcohol based hand rubs
  - Education regarding types of activities that result in hand contamination and indications for hand hygiene
  - Reminders in the workplace (e.g., posters)
  - Considering ways to include HH in management standards (loss of hospital privileges, tickets for non-compliance, coffee coupons)

HAI Reductions and Associations with Hand Hygiene

Sickbert-Bennett, DiBiase, Weber, Rutala. Emerg Inf Dis 2016;22:1628-1630.



- Over 17 months, we noted a significantly increased overall hand hygiene compliance rate ($p<0.001$) and significantly decreased overall HAI rate ($p=0.0066$) with 197 fewer infections.
- The association of hand hygiene compliance and HAIs adjusting for unit-level data was $p=0.086$ with a *10% improvement in HH associated with a 6% reduction in overall HAI*.
- The association of hand hygiene compliance and *C. difficile* adjusting for unit-level data was $p=0.070$ with a *10% improvement in HH associated with a 14% reduction in C. difficile HAI.*



Endoscope Reprocessing: Current Status of Cleaning and Disinfection

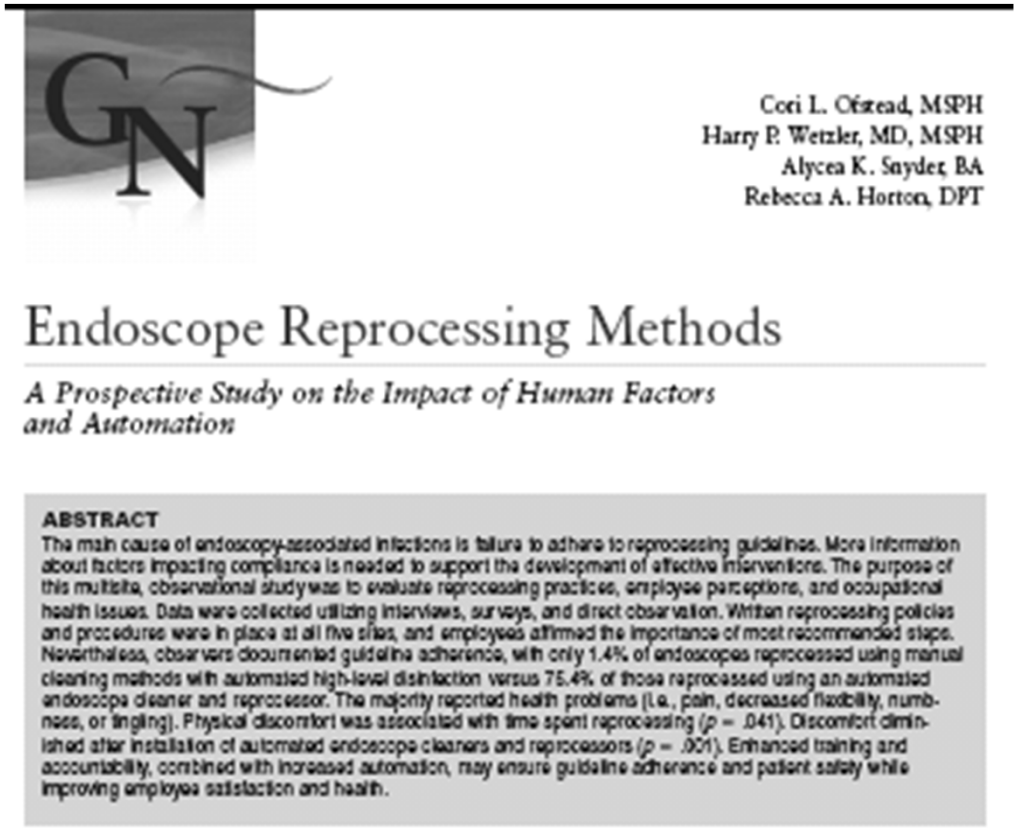
- Guidelines
  - Multi-Society Guideline, 12 professional organizations, 2011
  - Centers for Disease Control and Prevention, 2008
  - Society of Gastroenterology Nurses and Associates, 2010
  - AAMI Technical Information Report, Endoscope Reprocessing, In preparation
  - Food and Drug Administration, 2009
  - Endoscope Reprocessing, Health Canada, 2010
  - Association for Professional in Infection Control and Epidemiology, 2000

ENDOSCOPE INFECTIONS

- Infections traced to deficient practices
  - Inadequate cleaning (clean all channels)
  - Inappropriate/ineffective disinfection (time exposure, perfuse channels, test concentration)
  - Failure to follow recommended disinfection practices (drying, contaminated water bottles, irrigating solutions)
  - Flaws in design/manufacture of endoscopes or AERs

Endoscope Reprocessing Methods

Ofstead , Wetzler, Snyder, Horton, Gastro Nursing 2010; 33:204



Cori L. Ofstead, MSPH
Harry P. Wetzler, MD, MSPH
Alycea K. Snyder, BA
Rebecca A. Horton, DPT

Endoscope Reprocessing Methods

A Prospective Study on the Impact of Human Factors and Automation

ABSTRACT

The main cause of endoscopy-associated infections is failure to adhere to reprocessing guidelines. More information about factors impacting compliance is needed to support the development of effective interventions. The purpose of this multisite, observational study was to evaluate reprocessing practices, employee perceptions, and occupational health issues. Data were collected utilizing interviews, surveys, and direct observation. Written reprocessing policies and procedures were in place at all five sites, and employees affirmed the importance of most recommended steps. Nevertheless, observers documented guideline adherence, with only 1.4% of endoscopes reprocessed using manual cleaning methods with automated high-level disinfection versus 75.4% of those reprocessed using an automated endoscope cleaner and reprocessor. The majority reported health problems (i.e., pain, decreased flexibility, numbness, or tingling). Physical discomfort was associated with time spent reprocessing ($p = .041$). Discomfort diminished after installation of automated endoscope cleaners and reprocessors ($p = .001$). Enhanced training and accountability, combined with increased automation, may ensure guideline adherence and patient safety while improving employee satisfaction and health.

Endoscope Reprocessing Methods

Ofstead , Wetzler, Snyder, Horton, Gastro Nursing 2010; 33:204

Performed all 12 steps with only 1.4% of endoscopes using manual versus 75.4% of those processed using AER

TABLE 3. Documented Completion of Steps During Manual Cleaning With High-Level Disinfection Reprocessing

Observed Activity	Steps Completed (%) (n = 69)
Leak test performed in clear water	77
Disassemble endoscope completely	100
Brush all endoscope channels and components	43
Immerse endoscope completely in detergent	99
Immerse components completely in detergent	99
Flush endoscope with detergent	99
Rinse endoscope with water	96
Purge endoscope with air	84
Load and complete automated cycle for high-level disinfection	100
Flush endoscope with alcohol	86
Use forced air to dry endoscope	45
Wipe down external surfaces before hanging to dry	90

FUTURE OF INFECTION CONTROL

- Limited infection prevention resources
- Implementation of guidelines/standards, bundles and new technology demonstrated to reduce HAIs
- Health insurance reimbursement tied to quality goals
- State and federal laws legislating care issues
- Greater emphasis on infection prevention by The Joint Commission
- Device-associated infections
- New technology
- Reduced funds for new infection prevention technologies

INCREASING DEMANDS ON IPs WITH ACCOUNTABILITY

Public expectation of 0 rate of healthcare-associated infections?

Buy in by legislatures and CMS

IC accountability and attention rich but resource poor

IP ACTIVITIES

- 1975 to 1990
  - Surveillance
  - Outbreak investigations
  - Exposure evaluations
  - Education
  - JCAHO
  - Policy development and review
  - Sterilizer monitoring
  - Dialysis water
- 1991 to 2003 (new)
  - Targeted surveillance
  - OSHA TB
  - OSHA Bloodborne
  - Molecular epidemiology
  - MRSA, VRE
  - BT preparedness
  - Construction rounds

IP ACTIVITIES

- 2004 to 2014
  - IHI bundles
  - CMS core measures
  - NSQUIP (VAs, others)
  - NDNQI (ANA)
  - Other CQI initiatives
  - MRSA active surveillance
  - Unannounced TJC visits
  - Avian influenza preparedness
  - Endoscope sampling
- Recent/Future
  - Public health reporting
  - Mandated influenza vaccine
  - Mandated MRSA surveillance
  - Cost analyses
  - Comprehensive surveillance
  - Transparency
  - Electronic medical records
  - Clinical surveillance software systems
  - Emerging pathogens

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SOURCE OF INFECTION PREVENTION STRATEGIES

- Centers for Disease Control and Prevention
- The Joint Commission
- Centers for Medicare and Medicaid Services
- Institute for Healthcare Improvement (IHI)
- Professional Organizations: APIC, SHEA, AAMI, AORN, SGNA, AIA, ASGE

INFECTION PREVENTION STRATEGIES

- Centers for Disease Control and Prevention
  - Prevention of Catheter-Associated UTI, 2009
  - Guideline for D/S in Healthcare Facilities, 2008
  - Guideline for Isolation Precautions, 2007
  - Management of MDR Organisms, 2006
  - Preventing HA Pneumonia, 2003
  - Environmental Infection Control in HCF, 2003
  - Hand Hygiene in Healthcare Settings, 2002
  - Prevention of Intravascular Device-Related Infections, 2002
  - Prevention of Surgical Site Infections, 1999
  - Management of Occupational Exposure to HBV, HCV, HIV, 2002
  - Infection Control in Healthcare Personnel, 1998

INFECTION PREVENTION STRATEGIES

- SHEA
  - Management of HCWs Infected with HBV, HCV, HIV, March 2010
  - Disinfection and Sterilization of Prion-Contaminated Medical Instruments, February 2010
  - Compendium of Strategies to Prevent HAIs, September 2014
    - Surgical Site Infection
    - CLA-Bloodstream Infection
    - Catheter-Associated UTI
    - Ventilator-Associated Pneumonia
    - *Clostridium difficile*
    - Methicillin-resistant *S. aureus*
    - Hand Hygiene
  - Expert Guidance

INSTITUTE FOR HEALTHCARE IMPROVEMENT VAP AND CA-BSI BUNDLES

VAP Bundle

- Elevation of the head of the bed to between 30 and 45 degrees
- Daily “sedation vacation” and daily assessment of readiness to extubate
- Peptic ulcer disease (PUD) prophylaxis
- Deep venous thrombosis (DVT) prophylaxis (unless contraindicated)

CA-BSI

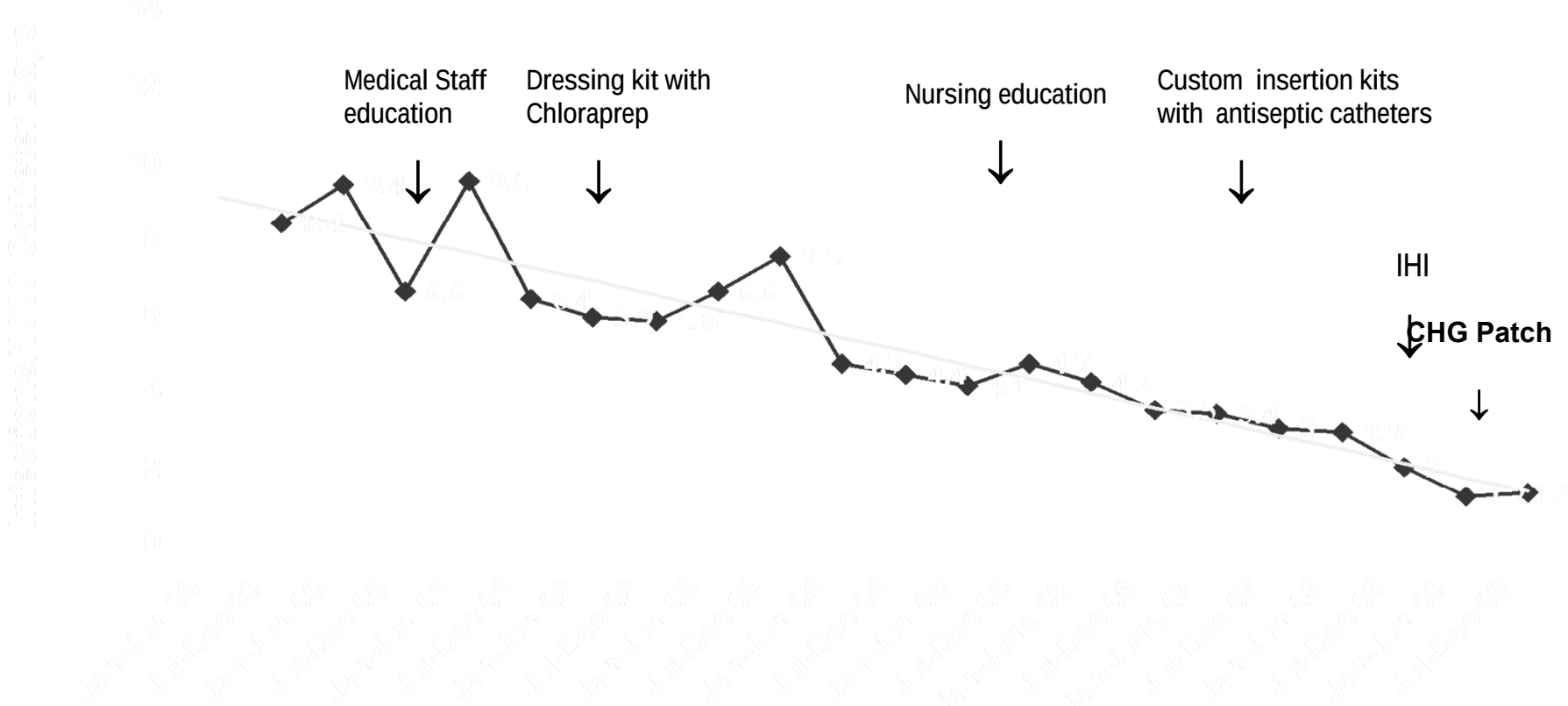
- Hand hygiene
- Maximal barrier precautions
- Chlorhexidine skin antisepsis
- Optimal catheter site selection, with subclavian vein as the preferred site for non-tunneled catheters
- Daily review of line necessity, with prompt removal of unnecessary lines

INFECTION CONTROL INTERVENTIONS

- 2000: Addition of 2% chlorhexidine/70% isopropyl alcohol (ChoraPrep®) to the central line dressing kit.
- 2001: Mandatory training for nurses on IV line site care and maintenance.
- 2003: Full body drape added to central line kit. MD could choose kit containing a catheter impregnated with antiseptic or antibiotic.
- 2005: 2nd generation impregnated catheter included in all central line kits (except for Neonatal ICU).
- 2006: Pilot in MICU of IHI bundle to prevent CLA-BSI.
- 2007: Implementation of the IHI bundle in all ICUs.
- 2008: Implementation of Infection Control Liaison Program
- 2009: Implementation of CHG patch.

UNC HOSPITALS INTENSIVE CARE UNITS, 1999-09
Central Catheter-Associated Bloodstream Infections

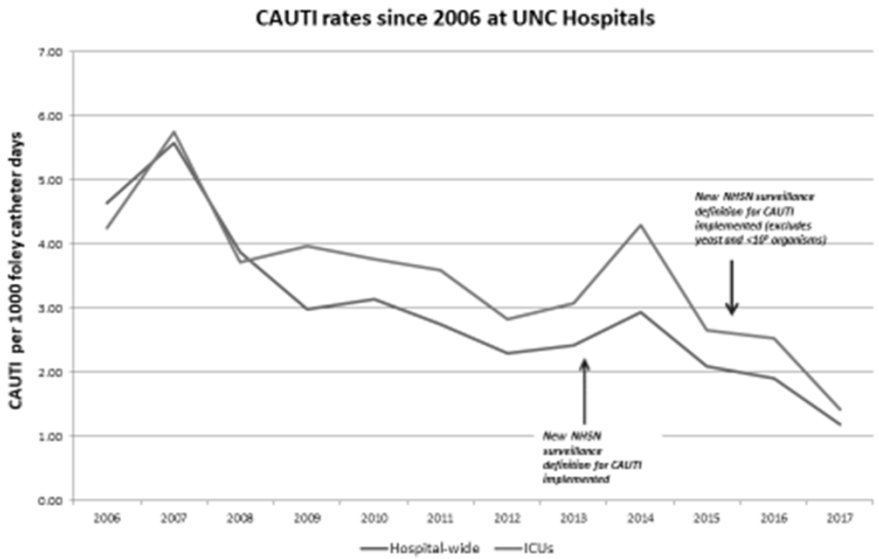
Weber DJ, Brown V, Sickbert-Bennett E, Rutala WA. 2010. ICHE 31:875-877



CA-UTI Prevention-IHI

- Avoid unnecessary catheters
- Insert urinary catheters using aseptic technique
- Maintain urinary catheters based on recommended guidelines
- Review urinary catheters necessity daily and remove promptly when not needed

Prevention of CAUTIs



FUTURE OF INFECTION CONTROL

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- Greater emphasis on infection prevention by The Joint Commission
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- Health insurance reimbursement (e.g., BCBS) tied to meeting quality goals
- Employee incentive package involves metrics that are clinically meaningful and measurable.
  - Patient and employee satisfaction goals
  - Fiscal goals, 4% operating margin
  - Quality goals
    - Ventilator-associated pneumonia, 5-10% below past FY
    - Central-line associated bacteremia, 5-10% below past FY
    - Prophylactic antibiotics within one hour of surgical incision
    - Catheter-associated urinary tract infections, 5% below past FY
    - Hand hygiene compliance, >90%

Infection Prevention Goals (FY2015)

- Clean In, Clean Out-Increase hand hygiene among staff to 90%
  - FY Performance-maintained compliance >90% in inpatient areas
- Clean In, Clean Out-Increase hand hygiene among staff to 90%
  - FY Performance-maintained compliance >90% in outpatient areas
- Reduce SSI infections for colon surgeries and abdominal hysterectomies by 5% below CY rate
  - CY: 5.17 SSIs/100 surgeries; 51 SSIs
  - Target rate: 4.91 SSIs/100 surgeries; 48 SSIs
  - FY Performance: 1.63 infections/100 surgeries

CMS's Final Rule for FY14 Inpatient Payments Penalize Hospitals 1%

- Penalize hospitals with the highest Healthcare Associated Condition rates a full 1% of their inpatient Medicare revenue, starting in FY15
- Use historical data from Hospital Compare
- First domain-Patient Safety; considers AHRQ patient safety indicator score (35%)
- Second domain-Infection rates for CLABSI and CAUTI (65%) in FY2015; colon and abdominal hysterectomy in FY2016 (75%) and *C. difficile*/MRSA rates in FY2017.

CMS Penalty
Potential Problems

- No risk-adjustment for patient populations (i.e., immunocompromised, AIDS, burn) known to be at higher risk for HAIs
  - Large academic medical centers are more likely to fall into the penalty range due to high-risk patients
  - Chances that a large, urban, major teaching hospital that has large numbers of poor patients will get the HAC penalty is 62%
- No clinical significance of HAI data cut-points (relies on arbitrary statistical cut-points-i.e., lowest quartile)
- No validation of surveillance

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NC Current Surveillance and Prevention

- CLABSIs
- CAUTI
- SSIs (abdominal hysterectomy and colon)
- MRSA (lab-identified bacteremia)
- *C. difficile* (lab-identified)

North Carolina Healthcare-Associated Infections Report
Data from January 1 – March 31, 2018
UNC Health Care, Chapel Hill, Orange County

2017 Hospital Survey Information

Hospital Type:	Acute Care Hospital
Medical Affiliation:	Major
Admissions in 2017:	43,367
Patient Days in 2017:	297,245
Total Number of Beds:	914
Number of ICU Beds:	201
FTE* Infection Preventionists:	7.50
Number of FTEs* per 100 beds:	0.82

[*FTE = Full-time equivalent]



Commentary From Facility:

UNC Health Care is pleased that rates of all reported healthcare-associated infections are statistically similar or better than similarly-sized hospitals despite care in a tertiary referral hospital for highly vulnerable populations (e.g., organ transplant, HIV infected, cancer, severely burned, and very premature infants). NC residents should be aware that the reported information is NOT entirely adjusted for the severity of illness of the hospital's patients. UNC Health Care supports the need for the data presented in this report to be validated (i.e., demonstration by independent monitors that the submitted data is correct).

Catheter-Associated Urinary Tract Infections (CAUTI)

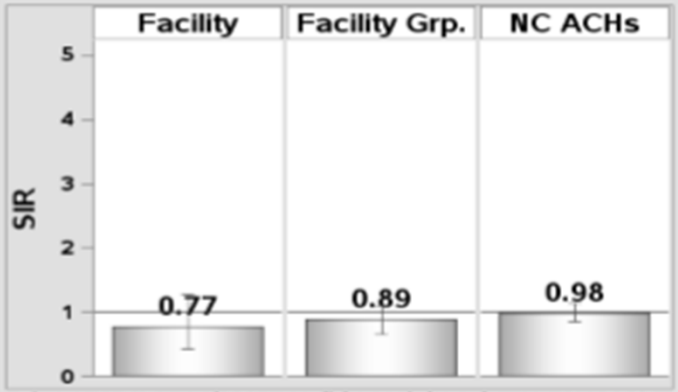


Figure 1: SIRs and 95% confidence intervals, Jan-Mar 2018.

Table 1. Number of Observed and Predicted Infections by ICU and Ward Type, Jan-Mar 2018.

Unit Type	Observed Infections	Predicted Infections	How Does This Facility Compare to the National Experience?
Adult/Ped ICUs	9	12	Same
Adult/Ped Wards	4	4.7	Same
All reporting units	**13**	**17**	**Same**

Note: SIR=Standardized Infection Ratio. SIR is calculated by #Observed/#Predicted.

Note: SIR not calculated if <50 catheter days or <1 predicted infection.

Note: Red line represents the NHSN baseline experience, 2015.

How Does This Facility Compare to the National Experience?

= Same: About the same number of infections as predicted by the national baseline experience

Methicillin-Resistant Staphylococcus aureus Laboratory-Identified Bacteremia (MRSA LabID)

Note: LabID events are based on positive laboratory results only; not all LabID events represent true illnesses. Events reported here may be higher than events based on clinically-defined illness.

Table 2. Number of Observed and Predicted MRSA Events, Jan-Mar 2018

Unit Type	Observed Events	Predicted Events	How Does This Facility Compare to the National Experience?
Facility-wide inpatient	**5**	**6.8**	**Same**

Note: SIR=Standardized Infection Ratio. SIR is calculated by #Observed/#Predicted.

Note: Red line represents the NHSN baseline experience, 2015.

How Does This Facility Compare to the National Experience?

= Same: About the same number of infections as predicted by the national baseline experience

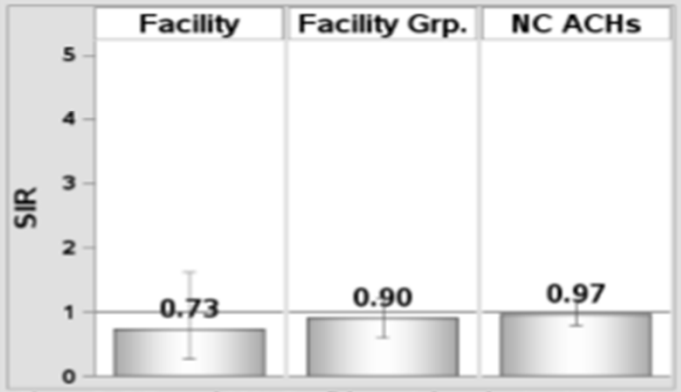


Figure 2: SIRs and 95% Confidence Intervals, Jan-Mar 2018.

Clostridium difficile Laboratory-Identified Infections (CDI LabID)

CHANGING REGULATORY ENVIRONMENT

- New paradigm = All HAIs are preventable
  - Public reporting of HAIs
  - Lack of reimbursement for HAIs
  - Public awareness of the issue
- Problems with paradigm shift
  - Publically reported rates are NOT risk adjusted for patient risk factors
  - Unfunded mandate
  - May impact on accuracy of surveillance
  - No reimbursement for HAIs even if hospital followed all recommended practices

FUTURE OF INFECTION CONTROL

- Limited infection prevention resources
- Implementation of guidelines/standards, bundles and new technology demonstrated to reduce HAIs
- Health insurance reimbursement and employee incentive payments tied to quality goals
- Public reporting of HAIs
- State and federal laws legislating care issues
  - MRSA active surveillance
  - Influenza vaccination
- Greater emphasis on infection prevention by The Joint Commission
- Device-associated infections
- New technology
- Reduced funds for new infection prevention technologies

FUTURE OF INFECTION CONTROL

- Limited infection prevention resources
- Implementation of guidelines/standards, bundles and new technology demonstrated to reduce HAIs
- Health insurance reimbursement and employee incentive payments tied to quality goals
- Public reporting of HAIs
- State and federal laws legislating care issues
- Greater emphasis on infection prevention by The Joint Commission (e.g., do not use evidence-based guidelines for citations, e.g., 7-day endoscope reprocessing; wetness for LLD; 20m Glut)
- Device-associated infections
- New technology
- Reduced funds for new infection prevention technologies

JOINT COMMISSION: NATIONAL PATIENT SAFETY GOALS

- Old
  - Comply with CDC hand hygiene guidelines
  - Manage as sentinel events all HAI-related deaths
- New (2009-2018)
  - Implement evidence-based practices to prevent HAIs due to MDROs (MRSA, VRE, MDR-GNR, *C. difficile*)
  - Implement evidence-based practices to prevent CLA-BSIs
  - Implement best practices to prevent SSIs
  - Prevent CA-UTIs

FUTURE OF INFECTION CONTROL

- Limited infection prevention resources
- Implementation of guidelines/standards, bundles and new technology demonstrated to reduce HAIs
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DEVICE-ASSOCIATED INFECTIONS: A TALE OF POOR ENGINEERING

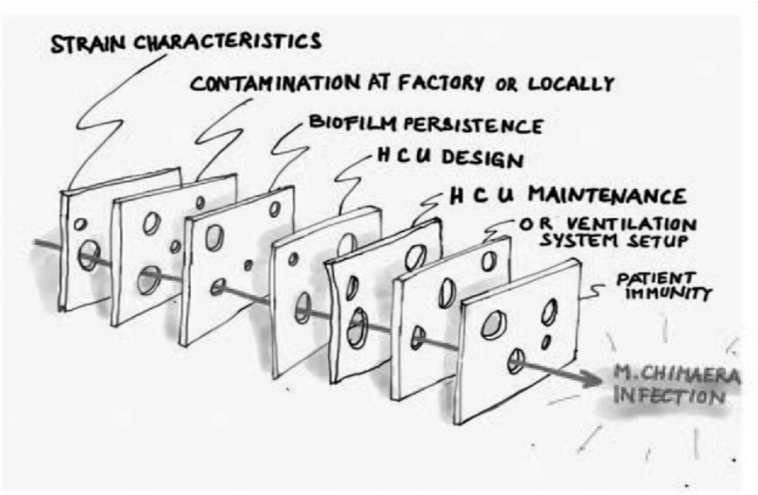
Heater-Cooler Units

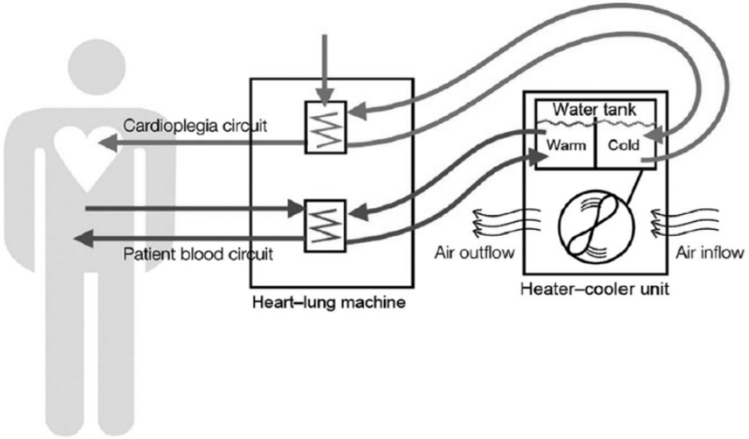
Duodenoscopes (discussed at other symposia)

Other: Sinks, Faucets, Complex surgical equipment

WORLDWIDE OUTBREAK OF *M. chimaera* DUE TO CONTAMINATED HCUs

- Since 2003, >200 cases of *M. chimaera* prosthetic valve endocarditis and disseminated disease reported
- Outbreak linked to intrinsically contaminated heater-cooler unit (HCU) – Stockert 3T HCU (Sorin)
- Internal water channels/tanks intrinsically contaminated; transmission from device to patients via aerosols
- Error = Failure to use disposable channels/tanks and/or inability to disinfect/sterilize internal water tanks
- Problem = Presence of biofilm
- Risk = 0.4-16 per 10,000 Pt-years

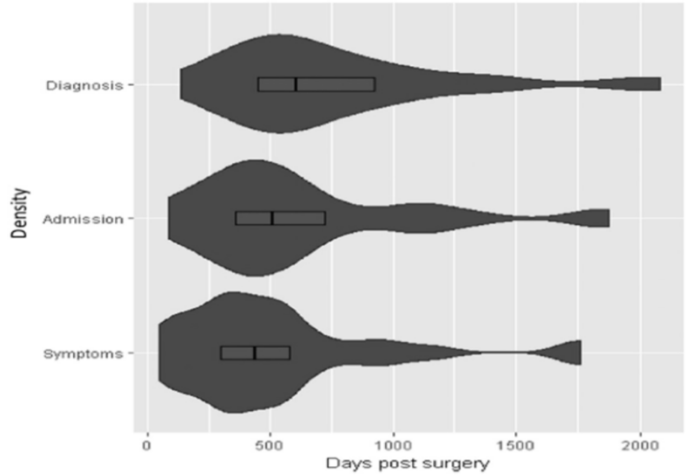




Sommerstein R, et al. ICHE 2017;38:103;
Schreiber PW, Sax H. Curr Opin ID 2017;30:388;

CLINICAL FEATURES AND COURSE OF *M. chimaera* HCU-ASSOCIATED INFECTIONS

- Study goal: Assess HCU associated infections, UK
- Results (30 patients):
  - 28/30 had prosthetic material; prosthetic valve endocarditis (14/30), sternal wound infection (2/30), aortic graft infection (4/30), and disseminated infection (10/30)
  - Mean presentation time = 14 mo (max 5 yrs)
  - 18/30 patients died (60%), a median of 30 mo after initial surgery and 9 mo after initiation of therapy



Clinical findings, *n* (%)	
Fever	24 (80)
Malaise	24 (80)
Weight loss	18 (60)
Arthralgia	6 (20)
Cough	11 (37)
Dyspnoea	10 (33)
Chest pain	6 (20)
Abdominal pain	3 (10)
Back pain	2 (7)
Temperature >38°C	13 (43)
New cardiac murmur	9 (30)
Splinter haemorrhages	0 (0)
Oedema	6 (20)
Crepitations	6 (20)
Pulse oximetry <96%	3 (10)
Lymphadenopathy	1 (3)
Hepatomegaly	6 (20)
Splenomegaly	8 (27)
Sternal wound	4 (13.3)
Skin lesion	2 (7)
Choroiditis	2 (7)

Scriven JE, et al. Clin Microbiol Infect 2018 (Epub)

US FDA GENERAL GUIDANCE

- Strictly adhere to the cleaning and disinfection instructions provided in the manufacturer's device labeling.
- DO NOT use tap water to rinse, fill, refill or top-off heater-cooler water tanks since this may introduce NTM organisms. Use only sterile water or water that has been passed through a filter of less than or equal to 0.22 microns.
- Direct and/or channel the heater-cooler's exhaust vent(s) away from the surgical field and toward an operating room exhaust vent to mitigate the risk of aerosolized heater-cooler tank water reaching the sterile field.
- Immediately remove from service heater-cooler devices that show discoloration or cloudiness in the fluid lines/circuits.
- Consider performing environmental, air, and water sampling and monitoring if heater-cooler contamination is suspected.
- Healthcare facilities should follow their internal procedures for notifying and culturing patients if they suspect infection associated with heater-cooler devices.

http://www.fda.gov/MedicalDevices/ProductsandMedicalProcedures/CardiovascularDevices/Heater-CoolerDevices/ucm492583.htm
https://www.tga.gov.au/alert/infections-associated-heater-cooler-devices

REDUCING RISK WITH HCUs: RECOMMENDTIONS

- Maintain HCU per manufacturer's recommendations
- Maintain strict separation of HCU from air volume of critical medical areas such as operating rooms
  - Keep HCU as far from patient as possible
  - Aim fans and exhausts away from patient
  - If possible place HCU in a separate room
- Ensure traceability of HCU use (i.e., register HCU, patient, and date of use)
- Alert patients if Sorin used for their surgery
- Consider *M. chimaera* in patients s/p cardiac surgery or ECMO with HCU who have unexplained fever or other described symptoms
- Obtain appropriate cultures and histology (granulomatous changes) if indicated

Sommerstein R, et al. Infect Control Hosp Epidemiol 2017;38:103-8

Evidence-Based Recommendation for Sterilization of Endoscopes

(FDA Panel Recommendation for Duodenoscopes, May 2015; more peer-reviewed publications (>150) for the need for shifting from disinfection to sterilization than any other recommendation of AAMI, CDC [HICPAC], SHEA, APIC, SGNA, ASGE)

>130 plus endoscope-related outbreaks

GI endoscope contamination rates of 20-40% after HLD

Scope commonly have disruptive/irregular surfaces

>50,000 patient exposures involving HLD

GI Endoscopes: Shift from Disinfection to Sterilization

Rutala, Weber. JAMA 2014. 312:1405-1406

EDITORIAL

Editorials represent the opinions of the authors and *JAMA* and not those of the American Medical Association.

Gastrointestinal Endoscopes
A Need to Shift From Disinfection to Sterilization?

William A. Rutala, PhD, MPH; David J. Weber, MD, MPH

More than 10 million gastrointestinal endoscopic procedures are performed annually in the United States for diagnostic purposes, therapeutic interventions, or both.[1] Because gastrointestinal endoscopes contact mucosal surfaces, use of a contaminated endoscope may lead to patient-to-patient transmission of potential pathogens with a subsequent risk of infection.[1]

In this issue of *JAMA*, Epstein and colleagues[2] report findings from their investigation of a cluster of New Delhi metallo-β-lactamase (NDM)-producing *Escherichia coli* associated with gastrointestinal endoscopy that occurred from March 2013 to July 2013 in a single hospital in northeastern Illinois. During the 5-month period, 9 pa-

Related article page 1447

First, endoscopes are semicritical devices, which contact mucous membranes or nonintact skin, and require at least high-level disinfection.[3,4] High-level disinfection achieves complete elimination of all microorganisms, except for small numbers of bacterial spores. Because flexible gastrointestinal endoscopic instruments are heat labile, only high-level disinfection with chemical agents or low-temperature sterilization technologies are possible.[3] However, no low-temperature sterilization technology is US Food and Drug Administration (FDA)-cleared for gastrointestinal endoscopes such as duodenoscopes.

Second, more health care-associated outbreaks and clusters of infection have been linked to contaminated endoscopes than to any other medical device.[3,5] However, until now,

Potential Future Methods to Prevent Endoscope-Related Outbreaks

Rutala, Weber. Am J Infect Control. 2016;44:e1-e6; Rutala, Weber ICHE. 2015;36:643.

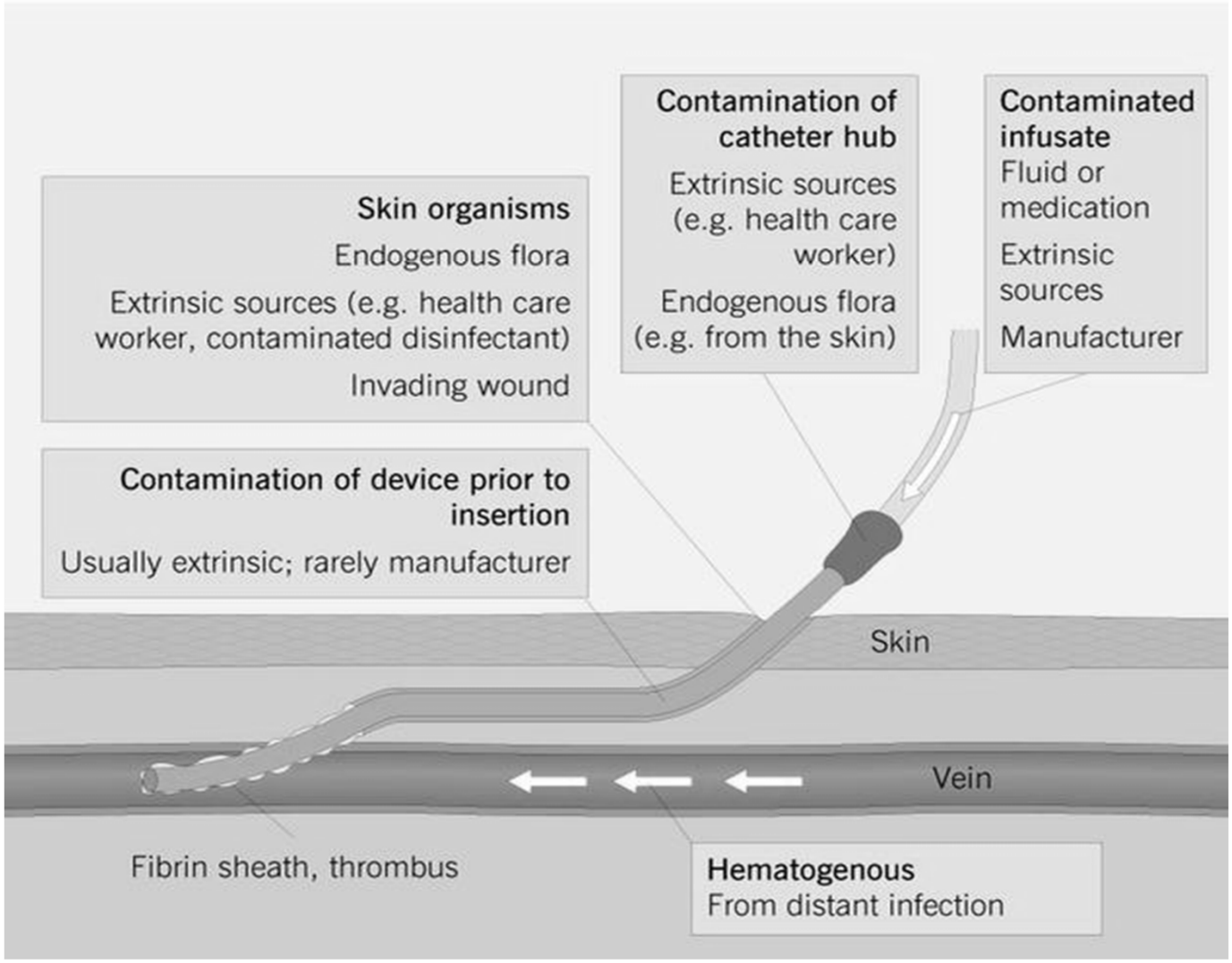
- Optimize current low temperature sterilization methods or new LTST proving SAL 10^{-6} achieved (2 LTS technologies, FDA-cleared)
- Disposable sterile GI endoscopes/bronchoscopes (4 manufacturers)
- Steam sterilization for GI endoscopes (1 bronchoscope manufacturer)
- Use of non-endoscope methods to diagnosis or treat disease (e.g., capsule endoscopy, stool or blood tests to detect GI cancer, stool DNA test)
- Improved GI endoscope design (to reduce or eliminate reprocessing challenges-based on 50y of experience unlikely to resolve problem; closed channel duodenoscopes increased risk)

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- State and federal laws legislating care issues
- Greater emphasis on infection prevention by The Joint Commission
- Device-associated infections
- New technology
- Reduced funds for new infection prevention technologies

Given the choice of changing human behavior (e.g., improving aseptic technique) or designing a better device, the device will always be more successful… Robert A. Weinstein

POTENTIAL ROUTES OF INFECTION



CHG PATCH



PROTECTIVE DISK WITH CHG

- Bacteria can recolonize the skin and CHG suppresses regrowth
- CHG patch provides contact around the insertion site and 7 day continuous release of CHG provides ongoing antimicrobial protection
- Randomized, controlled trials show CHG patch reduces risk of infection (JAMA 2009;301:1231 and Ann Hematol 2009;88:267)

CHG SPONGE EFFICACY: RCT IN ADULT ICU PATIENTS

- Study design: Accessor-blind, 3x3 factorial, randomized clinical trial
- Setting: 7 ICUs in 5 French hospitals (age >18 years)
- Interventions: Use of CHG sponge vs standard dressing; CHG sponge changed every 7 days, standard dressing changed every 3 days
- Study size: 2,095 patients, 3,778 catheters, 28,931 catheter days
- Results
  - CHG sponge reduce catheter-related infection (0.6/1000 Pt-d vs 1.1/1000 Pt-d, p=0.03)
  - CHG sponge reduced CLA-BSIs (0.4/1000 Pt-d vs 1.3/1000 Pt-d, HR=0.24)
  - CHG dressings not associated with increased resistance in skin bacteria
  - Rate of CHG dermatitis = 5.3 per 1000 catheters

Timsit J-F, et al. JAMA 2009;301:1231-1241


4850

Admission to Room Previously Occupied by Patient C/I with Epidemiologically Important Pathogen



- Results in the newly admitted patient having an increased risk of acquiring that pathogen by 39-353%
- For example, increased risk for *C. difficile* is 235% (11.0% vs 4.6%)
- Exposure to contaminated rooms confers a 5-6 fold increase in odds of infection, hospitals must adopt proven methods for reducing environmental contamination (Cohen et al. ICHE. 2018;39:541-546)

“NO TOUCH” APPROACHES TO ROOM DECONTAMINATION

(UV/VHP~20 microbicidal studies, 12 HAI reduction studies; will not discuss technology with limited data)

Weber, Kanamori, Rutala. Curr Op Infect Dis 2016;29:424-431; Weber, Rutala et al. AJIC; 2016:44: e77-e84; Anderson et al. Lancet 2017;389:805-14; Anderson et al. Lancet Infect Dis 2018;June 2018.







Enhanced Disinfection Leading to Reduction of Microbial Contamination and a Decrease in Patient Col/Infection

Anderson et al. Lancet 2017;289:805; Rutala et al. ICHE 2018;38:1118-1121

	Standard Method		Enhanced method	
	Quat	Quat/UV	Bleach	Bleach/UV
EIP (mean CFU per room)[a]	60.8	3.4	11.7	6.3
Reduction (%)		94	81	90
Colonization/Infection (rate)[a]	2.3	1.5	1.9	2.2
Reduction (%)		35	17	4

Comparing the best strategy with the worst strategy (i.e., Quat vs Quat/UV) revealed that a reduction of 94% in EIP (60.8 vs 3.4) led to a 35% decrease in colonization/infection (2.3% vs 1.5%). Our data demonstrated that a decrease in room contamination was associated with a decrease in patient colonization/infection.

FUTURE OF INFECTION CONTROL
Hospitals-budget cuts, job loses

- Hospitals reduce spending (job losses, service reductions) due to reduced revenues (reimbursement for service [2% reduction Medicare], no new volumes)
- Utilizing new technology to improve outcomes is superior to changing behavior
- New technology have played a critical role in reducing HAIs (CHG-Alc for SSI, CHG sponge, antiseptic/antibiotic impregnated central lines)
- Reduced hospital margins will force hospitals to limit investments in new technology (e.g., “no touch” room decontamination)

ADDITIONAL CHALLENGES

- New complex devices (e.g., da Vinci surgery)
- Obtaining and maintaining behavioral change (e.g., high hand hygiene compliance)
- Meeting societal expectations to decrease HAIs
- Maintaining preparedness for highly-communicable disease (e.g., Ebola, Lassa, MERS): Key vulnerabilities; early recognition and isolation, and appropriate use of PPE (especially doffing)
- Infection control in ambulatory care
- Maintaining proficiency in disinfection and sterilization
- Lack of new antimicrobials
- Infection prevention in countries with limited resources: multi-bed rooms leading to enhances person-to-person transmission and impaired disinfection; limited supplies and equipment
- Developing an integrated infection prevention program among hospitals, outpatient clinics/facilities, and extended care/nursing homes
- Xenotransplantation?

NEW TOOLS

- New diagnostics (MALDI-TOF)
- Rapid diagnostics (influenza, RSV, TB, etc.)
- Rapid diagnostic tests to detect antimicrobial resistance
- New germicides (e.g., continuously-active disinfectants)
- New room disinfection technologies (e.g., UV devices, H_2O_2 systems)
- Tools for monitoring room cleaning (e.g., fluorescent dye)
- New tools of molecular epidemiology for assessing outbreaks (e.g., whole genome sequencing)
- Non-observer based methods for assessing hand hygiene compliance (e.g., sniffers)
- Antimicrobial stewardship
- New antibiotics (ceftazidime/avibactam, ceftolozane/tazobactam, meropenem/vaborbactam)

POTENTIAL FUTURE TOOLS

- Algorithms for HAI surveillance using an electronic medical record (under development)
- Vaccines to prevent HAIs: *C. difficile*, MRSA, RSV (all in phase III trials)
- Reducing the contaminated surface environment
  - "Self-disinfecting" surfaces
  - Disinfectants with persistence
  - Continuous room disinfection
- Endoscope-related infections
  - Sterilizable endoscopes
  - Disposable endoscopes

DISCUSSION TOPICS

Impact of healthcare-associated infections

Challenges in infection prevention

Future of infection prevention

CONCLUSIONS

- Current challenges
  - Increased emphasis on preventing HAIs
  - Increased demands on IP time
  - Lack of compliance with hand hygiene and guidelines/policies
  - Institution of IHI bundles and other CQI activities
  - Public reporting, mandated vaccines, mandated practices
  - Multidrug pathogens: VRSA, MDR-GNRs, XDR-TB
  - Emerging pathogens: *C. difficile*, norovirus, MERS-CoV, D68, Ebola
  - Public desire for 0 rate of healthcare-associated infections
  - Older and sicker patient population
  - Insurance reimbursement tied to quality goals (eg, HAI reductions)
  - Reduced hospital margins, reduced investments in new technology

CONCLUSIONS

- Healthcare-associated infections are associated with significant patient morbidity and mortality
- Implementation of bundles (IHI) and products demonstrated to reduce HAIs (e.g., CLA-BSI)
- Compliance with infection prevention recommendations needed to prevent HAIs

THANK YOU!
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