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

William A. Rutala, Ph.D., M.P.H., C.I.C.
Director, Statewide Program for Infection Control and Epidemiology
and Professor of Medicine, University of North Carolina at Chapel Hill, NC, USA

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

- 30.7%
- 17.7%
- 6.7%
- 0.3%
- 0.7%
### COST ESTIMATES FOR HEALTHCARE-ASSOCIATED INFECTIONS (HAIs)

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

Costs based on literature review 1985-2005; adjusted to US 1995 dollars
MOST PREVALENT PATHOGENS
CAUSING HAI


• 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>
<thead>
<tr>
<th>Type of Infection</th>
<th>Infections Identified in Survey</th>
<th>Surveyed Patients with Type of Infection</th>
<th>Estimated Infections in the United States*</th>
</tr>
</thead>
<tbody>
<tr>
<td>All health care-associated infections</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumonia</td>
<td>110</td>
<td>24.3 (20.6–28.5)</td>
<td>157,500 (50,800–281,400)</td>
</tr>
<tr>
<td>Surgical-site infection</td>
<td>110†</td>
<td>24.3 (20.6–28.5)</td>
<td>157,500 (50,800–281,400)</td>
</tr>
<tr>
<td>Gastrointestinal infection</td>
<td>86</td>
<td>19.0 (15.6–22.8)</td>
<td>123,100 (38,400–225,100)</td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>65</td>
<td>14.4 (11.4–17.9)</td>
<td>93,300 (28,100–176,700)</td>
</tr>
<tr>
<td>Primary bloodstream infection</td>
<td>50</td>
<td>11.1 (8.4–14.2)</td>
<td>71,900 (20,700–140,200)</td>
</tr>
<tr>
<td>Eye, ear, nose, throat, or mouth infection</td>
<td>28‡</td>
<td>6.2 (4.2–8.7)</td>
<td>40,200 (10,400–85,900)</td>
</tr>
<tr>
<td>Lower respiratory tract infection</td>
<td>20</td>
<td>4.4 (2.8–6.6)</td>
<td>28,500 (6900–65,200)</td>
</tr>
<tr>
<td>Skin and soft-tissue infection</td>
<td>16</td>
<td>3.5 (2.1–5.6)</td>
<td>22,700 (5200–55,300)</td>
</tr>
<tr>
<td>Cardiovascular system infection</td>
<td>6</td>
<td>1.3 (0.5–2.7)</td>
<td>8,400 (1200–26,700)</td>
</tr>
<tr>
<td>Bone and joint infection</td>
<td>5</td>
<td>1.1 (0.4–2.4)</td>
<td>7,100 (1000–23,700)</td>
</tr>
<tr>
<td>Central nervous system infection</td>
<td>4</td>
<td>0.9 (0.3–2.1)</td>
<td>5,800 (700–20,700)</td>
</tr>
<tr>
<td>Reproductive tract infection</td>
<td>3</td>
<td>0.7 (0.2–1.8)</td>
<td>4,500 (500–17,800)</td>
</tr>
<tr>
<td>Systemic infection</td>
<td>1</td>
<td>0.2 (0.01–1.1)</td>
<td>1,300 (0–10,900)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>721,800 (214,700–1,411,000)</td>
</tr>
<tr>
<td>Infections in non-neonatal intensive care units</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Catheter-associated urinary tract infection</td>
<td>25</td>
<td>5.5 (3.7–7.9)</td>
<td>35,600 (9100–78,000)</td>
</tr>
<tr>
<td>Central-catheter–associated primary bloodstream infection</td>
<td>11</td>
<td>2.4 (1.3–4.2)</td>
<td>15,600 (3200–41,500)</td>
</tr>
<tr>
<td>Ventilator-associated pneumonia</td>
<td>35</td>
<td>7.7 (5.5–10.5)</td>
<td>49,900 (13,600–103,700)</td>
</tr>
<tr>
<td>Surgical-site infections attributed to Surgical Care Improvement Project procedures‡</td>
<td>46</td>
<td>10.2 (7.6–13.2)</td>
<td>66,100 (18,700–130,300)</td>
</tr>
<tr>
<td>Hospital-onset infections caused by specific pathogens</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Clostridium difficile</em> infection‡</td>
<td>56</td>
<td>12.4 (9.6–15.7)</td>
<td>80,400 (23,700–155,000)</td>
</tr>
<tr>
<td>MRSA bacteremia†</td>
<td>7</td>
<td>1.5 (0.7–3.0)</td>
<td>9,700 (1700–29,600)</td>
</tr>
</tbody>
</table>

Sources of Healthcare-Associated Pathogens

• 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

• Changing population of hospital patients
  ■ Increased severity of illness
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  ■ 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)
RISK FACTORS FOR HEALTHCARE-ASSOCIATED INFECTIONS
More HCPs and more invasive devices = higher HAI rates
AGING POPULATION, US
Nosocomial Infections in the Elderly


Infection incidence for all categories of HAI per decade of life

![Graph showing infection incidence per decade of life](image)

Figure 2. Infection incidence rates for all categories of nosocomial infection per decade of life.
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 pathogens and emerging pathogens

• Lack of compliance with hand hygiene and other infection preventive measures (e.g., endoscope)
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!!
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
CRE: FREQUENCY OF ENVIRONMENTAL CONTAMINATION

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

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

<sup>a</sup>Considered positive if ≥1 of the 5 Rodac plates had positive growth (ie, area sampled = 120 cm<sup>2</sup>).

<sup>b</sup>Mean and range calculated only for CRE culture positive sites.

<sup>c</sup>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 SURFACES

Weber DJ, Rutala WA, et al. ICHE 2015;36:590-593
Efficacy of Disinfectants and Antiseptics against Carbapenem-Resistant Enterobacteriaceae


• $\geq 3 \log_{10}$ 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* 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 is not known
GEOGRAPHICAL DISTRIBUTION OF 
CANDIDA AURIS

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

- $\geq 3 \log_{10}$ 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

- $\leq 3 \log_{10}$ (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

- 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*)

Inoculum spread to cover 20mm diameter steel disk, disk placed 5 feet from UV device
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
  ▪ Increased severity of illness
  ▪ Increased numbers of immunocompromised patients
  ▪ 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)
Center for the Study of Infectious Diseases

Employees must not wash hands before returning to work.
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%.
## ASSOCIATION BETWEEN HAND HYGIENE COMPLIANCE AND HAI RATES

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

*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**


- 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.
Endoscopy 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
  ■ 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

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 multicenter, observational study was to evaluate reprocessing practices, employee perceptions, and occupational health issues. Data were collected utilizing interviews, surveys, and direct observation. Within 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 disinfector and reprocessor. The majority reported health problems (i.e., pain, decreased flexibility, numbness, or blurring). 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**

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

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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 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.
Central Catheter-Associated Bloodstream Infections

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

• 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
• Device-associated infections
• New technology
• Reduced funds for new infection prevention technologies
• 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 hysterecmy in FY2016 (75%) and *C. difficile* and 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
FUTURE OF INFECTION CONTROL

• Limited infection prevention resources
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• Public reporting of HAIs
• State and federal laws legislating care issues
• Greater emphasis on infection prevention by The Joint Commission
• Device-associated infections
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• Reduced funds for new infection prevention technologies
NC Current Surveillance and Prevention

• CLABSIs
• CAUTI
• SSIs (abdominal hysterectomy and colon)
• MRSA (lab-identified bacteremia)
• \textit{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)

![Graph showing SIRs and 95% confidence intervals, Jan-Mar 2018.]

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

<table>
<thead>
<tr>
<th>Unit Type</th>
<th>Observed Infections</th>
<th>Predicted Infections</th>
<th>How Does This Facility Compare to the National Experience?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult/Ped ICUs</td>
<td>9</td>
<td>12</td>
<td>Same</td>
</tr>
<tr>
<td>Adult/Ped Wards</td>
<td>4</td>
<td>4.7</td>
<td>Same</td>
</tr>
<tr>
<td>All reporting units</td>
<td>13</td>
<td>17</td>
<td>Same</td>
</tr>
</tbody>
</table>

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 NHHSN 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)

![Graph showing SIRs and 95% confidence intervals, Jan-Mar 2018.]

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

<table>
<thead>
<tr>
<th>Unit Type</th>
<th>Observed Events</th>
<th>Predicted Events</th>
<th>How Does This Facility Compare to the National Experience?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facility-wide inpatient</td>
<td>5</td>
<td>6.8</td>
<td>Same</td>
</tr>
</tbody>
</table>

Note: SIR = Standardized Infection Ratio. SIR is calculated by #Observed/#Predicted.
Note: Red line represents the NHHSN 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

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
- Public reporting of HAIs
- State and federal laws legislating care issues
- Greater emphasis on infection prevention by The Joint Commission
- Device-associated infections
- New technology
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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

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/ProductsandMedical Procedures/CardiovascularDevices/Heater-CoolerDevices/ucm492583.htm
REDUCING RISK WITH HCUs: RECOMMENDATIONS

- 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

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


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 colleagues2 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-

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 technol-

ogy 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 endo-

scopes than to any other medical device.3,5 However, until now,
Potential Future Methods to Prevent Endoscope-Related Outbreaks


- 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)
FUTURE OF INFECTION CONTROL

- Limited infection prevention resources
- Implementation of guidelines/standards, bundles and new technology demonstrated to reduce HAIs
- Public reporting of HAIs
- 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

Skin organisms
Endogenous flora
Extrinsic sources (e.g. health care worker, contaminated disinfectant)
Invading wound

Contamination of catheter hub
Extrinsic sources (e.g. health care worker)
Endogenous flora (e.g. from the skin)

Contaminated infusate
Fluid or medication
Extrinsic sources
Manufacturer

Contamination of device prior to insertion
Usually extrinsic; rarely manufacturer

Fibrin sheath, thrombus

Hematogenous
From distant 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

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)
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

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, H₂O₂ 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
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
• 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!

www.disinfectionandsterilization.org