PREVENTION OF HEALTHCARE-ASSOCIATED INFECTIONS: KEY CHALLENGES AND FUTURE DIRECTIONS

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Thanks to the following for some slides: Lauren DiBiase, Emily Sickbert-Bennett

LECTURE TOPICS

- Tribute to Dr. William Rutala
- Importance of the changing healthcare environment
  - Aging population, growth of nursing homes, introduction of MDROs from community into the hospital
- Meeting CMS and Societal Expectations
  - Expectation of a "0" HAI infection rate, lack of risk adjustment, lack of validation of surveillance data
- Device-associated infections: A tale of poor engineering
  - Phacoemulsifier, heater-cooler units, duodenoscopes
- The threat of antibiotic/germicide resistant pathogens
  - C. difficile, norovirus, Candida auris
- The growing importance of non-device associated infections
HE STANDS FOR TRUTH, RESEARCH AND THE SCIENTIFIC WAY!

It’s A Bird…..It’s A Plane…..No It’s Superman
Who is disguised as William A. Rutala

32+ YEARS OF COLLABORATION!
Rutala WA, Weber DJ – PubMed Citations (206 & counting)

Number 1, 1985, JAMA
Obesity as a Predictor of Poor Antibody Response to Hepatitis B Plasma Vaccine
David J. Weber, MD, MPH; William A. Rutala, PhD, MPH; Gregory P. Santos, MS;
Jane E. Sentton, RN; Stanley M. Leon, MD

Number 100, 2007, ICHE
Compliance With Isolation Precautions at a University Hospital
David J. Weber, MD, MPH; Emily E. Sickbert-Bennett, MS; Vickie M. Brown, RN, MPH; Rebecca H. Brooks, RN;
Irene P. Kittrell, RN; Brenda J. Featherston, RN;
Tina L. Adams, RN; William A. Rutala, PhD, MPH

Number 150, 2013, AJIC
Disinfectants used for environmental disinfection and new room decontamination technology
William A. Rutala PhD, MPH; David J. Weber, MD, MPH

Number 200, 2017, AAC
A Prolonged Outbreak of KPC-3-Producing Enterobacter cloacae and Klebsiella pneumoniae Driven by Multiple Mechanisms of Resistance Transmission at a Large Academic Burn Center
Hajime Kanamori, MD, Christian M. Farrelly, MD, Jonathan J. Julliano, MD, David van Dine, MD,
Bruce A. Cama, MD, David J. Weber, MD, William A. Rutala, MD

5/4/2017
WILLIAM A. RUTALA, PhD, MPH

Award and Honors
- Only person to have named awards by both APIC and SHEA
- Editorial Board, ICHE
- Advisor to CDC, FDA, EPA, FTC, US Congress
- Carole M DeMille Lifetime Achievement Award, APIC, 1999
- Barr Distinguished Alumni Award, UNC SPH, 2012
- SHEA Lectureship, 2012
- Kelsey Lecture, UK, 2001 and 2012
- Favero Lectureship, APIC, 2009

Accomplishments
- ~40 years in infection prevention
- >600 publications
- World’s leading authority on sterilization and disinfection (author of CDC Guideline on S/D)
- Developed SPICE Program which has trained the IPs at >90% of all NC hospitals
- >370 invited presentations at state, national and international symposia

FAMILY IS IMPORTANT TO A SUCCESSFUL CAREER
INTRODUCTION OF HAND HYGIENE TO REDUCE HAIs BY IGNAZ SEMMELWEIS

PERSONAL IMPACT OF INTRODUCING HAND HYGIENE ON DR. SEMMELWEIS
CLEARLY BILL HAS WEATHERED HOSPITAL EPIDEMIOLOGY BETTER THAN SEMMELWEIS

Unlike Semmelweis, Bill will spend his future enjoying his family, traveling (goal=100 countries), continuing to direct SPICE, and conducting infection prevention research.

WELCOME UNC HOSPITALS’ NEW HOSPITAL EPIDEMIOLOGIST, EMILY SICKBERT-BENNETT, PhD, MS

Awards and accomplishments
- 14 years experience in infection prevention
- Adjunct Asst. Professor, Epidemiology
- Research Asst. Professor, Medicine
- Bernard Greenberg Award for Excellence in Doctoral Research, Gillings SPH 2011
- Associate Editor, American Journal of Infection Control
- >45 peer-reviewed publications
IMPORTANCE OF THE CHANGING HEALTHCARE ENVIRONMENT

Aging Population
Growth of extended care facilities
Increased introduction of MDROs from the community into the hospital

HEALTHCARE SYSTEM OF THE PAST

Home Care

Outpatient/Ambulatory Facility

Acute Care Facility

Long Term Care Facility
CURRENT HEALTHCARE SYSTEM

Tranquil Gardens Nursing Home
Home Care
Acute Care Facility
Outpatient/Ambulatory Facility
Long Term Care Facility

PROJECTED US POPULATION, 2050

AGE
>100 = 1,095
95-99 = 2,764
90-94 = 6,030
85-89 = 9,463
80-84 = 12,225
75-79 = 14,407
70-74 = 16,537
65-74 = 19,477
65-79 = 35,541
80+ = 31,577

Numbers in thousands
US Census
AGE-RELATED CHANGES IN 100-km ULTRA-MARATHON RUNNING PERFORMANCE

Knuchtle B, et al. Age 2012;34:1033

IMPACT OF HAIs IN LONG-TERM CARE

- ~3.2 million Americans live in extended care facilities, 2008¹
- ~1.0 million Americans reside in assisted living facilities, 2008¹
- 1.6-3.8 million infections per year²
- Incidence of endemic infections = 1.8-13.5 infections per 1,000 resident days²
- Estimated several thousand outbreak occur per year²
- Infections are the leading reason for hospital transfer²
IMPACT OF HAIs IN NURSING HOMES

Nursing Homes
- Number of nursing homes: 15,600 (2014)
- Proportion of nursing homes with for-profit ownership: 69.8% (2014)
- Number of licensed beds: 1.7 million (2014)
- Number of residents: 1.4 million (2014)

Nursing facilities, alternative residential care places, home care
- 2000=15 million; 2050=27 million

Impact
- 1.6-3.8 million infections per year
- Incidence of endemic infections = 1.8-13.5 infections per 1,000 resident days
- Estimated several thousand outbreak occur per year
- Infections are the leading reason for hospital transfer

CDC

OUTBREAKS OF HEPATITIS B DUE TO GLUCOSE MONITORING, UNS, 2009-10

Table 1. Analysis of Data from Epidemiologic Studies Conducted among Residents of Assisted Living Facilities during HBV Infection Outbreak Investigations Found to Be Associated with AMBG—United States, 2009-2010

<table>
<thead>
<tr>
<th>State</th>
<th>Total number of residents tested</th>
<th>Residents included in epidemiologic study</th>
<th>Not receiving AMBG</th>
<th>Receiving AMBG</th>
<th>RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>Receiving HBV infection (%)</td>
<td>Tested</td>
<td>Acute HBV infection (%)</td>
</tr>
<tr>
<td>NC (14)</td>
<td>61</td>
<td>15</td>
<td>8 (53%); 6 died</td>
<td>25</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>VA (15)</td>
<td>44</td>
<td>5</td>
<td>3 (60%); 1 (20%)</td>
<td>26</td>
<td>1 (4%)</td>
</tr>
<tr>
<td>VA (16)</td>
<td>126</td>
<td>13</td>
<td>12 (92%); 5 died</td>
<td>75</td>
<td>2 (3%)</td>
</tr>
<tr>
<td>FL (17)</td>
<td>48</td>
<td>10</td>
<td>6 (60%); 0 died</td>
<td>38</td>
<td>1 (3%)</td>
</tr>
</tbody>
</table>

* NC = North Carolina; VA = Virginia; FL = Florida
* Includes only residents with acute HBV infection and those susceptible to HBV.

INFECTION CONTROL PRACTICES IN ASSISTED LIVING FACILITIES

- 16% shared glucose monitoring devices (without cleaning) between residents
- 34% did not offer employees HBV vaccine


CHALLENGES IN INFECTION PREVENTION

- Patients
  - Patients frequently have risk factors for infection/colonization
    - Older age, incontinence, poor functional status, malnutrition
    - Chronic diseases: Diabetes, renal dysfunction, neurologic impairment
    - Use of medical devices: Foley catheters
    - Non-intact skin: Decubiti, diabetic foot ulcers
    - Frequent hospital contact (e.g., dialysis)
    - Medications (drugs that affect level of consciousness, immune function, gastric acid secretions, and normal flora)
  - Patients frequently colonized/infected with MDROs
  - Patients frequently receive antibiotics
Infection control
- Patients often housed in multi-bed rooms
- Patients, even if colonized/infected, have contact with each other (e.g., common areas, dining area)
- Limited or no access to hallway sinks or alcohol-based hand rubs
- Facility may not have trained infection preventionist
- Facility unlikely to have an MD infection preventionist
- Likely low compliance with hand hygiene and environmental disinfection
- Limited studies in long-term care facilities on which to base recommendations

Environmental services (EVS)
- Potentially less trained staff
- Lack of infection control leadership (i.e., trained IP and hospital epidemiologist)
- Terminal disinfection occurs infrequently (i.e., most patients long-term)
- Many rooms will be multi-bed limiting use of “no touch” methods
- Product cost likely to be more of an issue than for acute care hospitals
DIVERSE SOURCES OF C. difficile INFECTION IDENTIFIED ON WHOLE GENOME SEQUENCING

Site: Oxfordshire, UK  
2007-2011  
1250 C. difficile cases  
98% sequenced  
Only 33% linked

Of 333 patients with linked cases; 38% had close hospital contact with another patient and 36% had no hospital or community contact with another patient

Eyre D, et al. NEJM 2013;369:1195

MEETING CMS AND SOCIETAL EXPECTATIONS

Expectation of "0" infection rate  
Lack of risk adjustment  
Lack of validation of individual hospitals reporting
VALUE BASED PURCHASING: BENCHMARKS AND THRESHOLDS

Gase K. Presented at SHEA, St. Louis, 2017

LEADING CAUSES OF DEATH, US, 2014

<table>
<thead>
<tr>
<th>Cause</th>
<th>Deaths</th>
<th>Rate</th>
<th>Age-Adjusted Rate 2014, 2010, 2005</th>
<th>% Total Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accidents</td>
<td>136,053</td>
<td>42.7</td>
<td>40.5, 38.0 (+6.1%), 39.5 (+2.5%)</td>
<td>5.2%</td>
</tr>
<tr>
<td>MVA</td>
<td>35,092</td>
<td>10.8</td>
<td>13.1, 10.6 (+19.1%), 8.0 (+38.9%)</td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>76,488</td>
<td>24.0</td>
<td>20.9, 20.8 (+0.5%), 24.9 (-16.0%)</td>
<td>2.9%</td>
</tr>
<tr>
<td>Influenza and pneumonia</td>
<td>55,227</td>
<td>17.3</td>
<td>15.1, 15.1 (0%), 21.0 (-39.3%)</td>
<td>2.1%</td>
</tr>
<tr>
<td>Suicide</td>
<td>42,773</td>
<td>13.4</td>
<td>13.0, 12.1 (+6.9%), 10.9 (+16.1%)</td>
<td>1.6%</td>
</tr>
</tbody>
</table>

HAI = ~75,000 deaths (rank = #8)

HAI INCIDENCE OVER TIME, UNC

HAZARDS IN THE ICU

DENSITY OF BACTERIA ON THE HUMAN BODY


CONCLUSIONS

- Decrease in HAIs greater than decrease in many other important causes of death
- Reaching “0” HAIs is not possible given the following: large numbers of microbes on body surfaces, inability to sterilize human body surfaces, and need for indwelling devices to provide medical care
- Cost of HAI prevention, per case prevented, will rise as we decrease HAI incidence
# PATIENT LEVEL RISK FACTORS FOR HAIs – ADJUSTMENT BY NHSN

<table>
<thead>
<tr>
<th>CLA-BSI</th>
<th>CA-UTI</th>
<th>SSI</th>
<th>C. difficile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device</td>
<td>Device</td>
<td>Glucose control</td>
<td>Age</td>
</tr>
<tr>
<td>ICU location</td>
<td>Gender</td>
<td>Type of hair removal</td>
<td>Antibiotics</td>
</tr>
<tr>
<td>Prolonged hospitalization prior to catheter</td>
<td>Drainage system</td>
<td>Antibiotic prophylaxis</td>
<td>Broad spectrum antibiotics</td>
</tr>
<tr>
<td>IJ catheter</td>
<td>Age</td>
<td>Temp control</td>
<td>Community colonization</td>
</tr>
<tr>
<td>Femoral catheter</td>
<td></td>
<td>Supplemental O2</td>
<td>Immunosuppression</td>
</tr>
<tr>
<td>Neutropenia</td>
<td></td>
<td>ETOH-antiseptic skin prep</td>
<td></td>
</tr>
<tr>
<td>Prematurity</td>
<td></td>
<td>Wound protectors (GI)</td>
<td></td>
</tr>
<tr>
<td>Parenteral nutrition</td>
<td></td>
<td>Diabetes*</td>
<td></td>
</tr>
<tr>
<td>Blood transfusion (kids)</td>
<td></td>
<td>ASA score*</td>
<td></td>
</tr>
<tr>
<td>Reduce RN to Pt ratio, ICU</td>
<td></td>
<td>Gender*</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>BMI*</td>
<td>* Included in for some ops</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Duration*</td>
<td>Risk factors based on SHEA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Scope *</td>
<td>Guidelines</td>
</tr>
</tbody>
</table>

## Risk factors for COLO and HYST

<table>
<thead>
<tr>
<th>NHSN operative procedures</th>
<th>Risk factors included in SIR logistic regression model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colon surgery (COLO)</td>
<td>Age, anesthesia, ASA, duration, endoscope, medical school affiliation, location bed size, wound class</td>
</tr>
<tr>
<td>Abdominal hysterectomy (HYST)</td>
<td>Age, anesthesia, ASA, duration, endoscope, location bed size</td>
</tr>
</tbody>
</table>

Limitations of NHSN SSI Risk Adjustment

• Model generated from predictor variables of convenience that exist in NHSN database rather than all known risk factors
  – Patient level variables = Age, gender, wound class, ASA score, and 2-3 other variables
• Predictor variables chosen for inclusion in the model on the basis of statistical parameters alone
  – Unknown relevance of bed size and medical school affiliation
• Study sample over emphasized large hospitals
• Overall change in c-index is modest
  – Only 16 (41%) of procedure-specific models have c-index >0.7

Moehring RW, Anderson DJ. ICHE 2011;32:987

Validation of HAI Surveillance Data
– Where Do We Begin?
“Don’t look, don’t find...”

DEVICE-ASSOCIATED INFECTIONS:
A TALE OF POOR ENGINEERING

Phacoemulsifier
Heater-Cooler Units
Duodenoscopes
**P. aeruginosa-RELATED POSTOPERATIVE ENDOPHTHALMITIS LINKED TO A CONTAMINATED PHACOEMULSIFIER**

**Table 1. Clinical Characteristics of Patients Who Underwent Cataract Extractions on the Outbreak Day**

<table>
<thead>
<tr>
<th>Clinical Characteristics</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic features</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (y)</td>
<td>74</td>
<td>73</td>
<td>63</td>
<td>64</td>
<td>64</td>
<td>61</td>
<td>66</td>
<td>48</td>
<td>85</td>
</tr>
<tr>
<td>Sex</td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Male</td>
<td>Male</td>
<td>Male</td>
<td>Male</td>
</tr>
<tr>
<td>Operative features</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eye involved</td>
<td>Right</td>
<td>Left</td>
<td>Right</td>
<td>Left</td>
<td>Right</td>
<td>Left</td>
<td>Right</td>
<td>Left</td>
<td>Right</td>
</tr>
<tr>
<td>Lens implanted</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Cataract extraction method</td>
<td>Phaco</td>
<td>No</td>
<td>Phaco</td>
<td>Yes</td>
<td>Phaco</td>
<td>No</td>
<td>Phaco</td>
<td>Yes</td>
<td>Phaco</td>
</tr>
<tr>
<td>Phacoemulsification time (min)</td>
<td>52</td>
<td>42</td>
<td>44</td>
<td>46</td>
<td>56</td>
<td>50</td>
<td>50</td>
<td>22</td>
<td>NA</td>
</tr>
<tr>
<td>Evaluation</td>
<td></td>
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<tr>
<td>Cultures</td>
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<tr>
<td>Staphylococcal aureus</td>
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<tr>
<td>Flora</td>
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<tr>
<td>Results</td>
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<tr>
<td>Intravitreal antibiotic therapy</td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without antibiotic</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>With antibiotic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Visual acuity</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Postoperative</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive Wound</td>
<td>5/50</td>
<td>20/100</td>
<td>NA</td>
<td>20/50</td>
<td>20/40</td>
<td>NA</td>
<td>20/40</td>
<td>NA</td>
<td>20/40</td>
</tr>
<tr>
<td>Skot</td>
<td>25/30</td>
<td>25/30</td>
<td>NA</td>
<td>25/30</td>
<td>25/30</td>
<td>NA</td>
<td>25/30</td>
<td>NA</td>
<td>25/30</td>
</tr>
</tbody>
</table>

*ACOM = isolates type 3 dimeric antibiotic; Phaco = cataract extraction using a mechanical aspiration; PM = postoperative day; PM = Phaco maculosa (3 colonies); PR = PirabojEight (2 colonies); AC = anterior chamber; PC = posterior chamber (fused tip); RG = no growth; PA = Pseudomonas aeruginosa; HM = facultative; NA = data not applicable.

The operative order is the same as the patient number.

In addition, s. tercicae is phylogenetically related to Erwinia. Species that grew from the broth only.

**Conclusion**

- Poorly designed device which allowed contamination of internal channels.

Hoffmann KK, Weber DJ, Gergen MF, Rutala WA. AMA

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**P. aeruginosa-RELATED POSTOPERATIVE ENDOPHTHALMITIS LINKED TO A CONTAMINATED PHACOEMULSIFIER**

- **Background**: Cataract extraction is common medical procedure
- **Outbreak**: SPICE notified in 1999 about a cluster of postoperative endophthalmitis (AR = 5 of 7; all right eye)
- **Evaluation**:
  - Cultures of all medications negative
  - Scrub sink = *P. aeruginosa* (not outbreak strain)
  - Phacoemulsifier internal channel = *P. aeruginosa* (outbreak strain by PFGE)
- **Conclusion**
  - Poorly designed device which allowed contamination of internal channels.
**M. CHIMAERA OUTBREAK ASSOCIATED WITH CONTAMINATED HEATER-COOLER UNITS**

- July 2015: Invasive *M. chimaera* reported in 6 patients who underwent cardiac surgery with implants, 2008-2012, at one hospital in Zurich, Switzerland
- Investigations revealed *M. chimaera* in the water tanks of heater-cooler units (HCU); air sampling also positive for *M. chimaera* when the units were running
- Additional cases confirmed in several European countries and in US
- Studies suggest NTM from the HCU aerosolized from contaminated water in the device into the air
- Risk of disease not entirely clear
  - 0.39 cases per 10,000 person-years (5 year risk) (Chand M, et al. CID 2017;64:335-42)
  - If hospital has had 1 case, patient risk between 0.1% and 1% (CDC)
  - Risk higher if prosthetic material implanted
  - Mortality >50%
- Impact of outbreak: >250,000 cardiac bypass procedures done each year in US using HCU (CDC 2016).

**Global outbreak of HCU-associated *M. chimaera***

- Switzerland
- Germany
- France
- Spain
- Netherlands
- United Kingdom
- Hong Kong
- Australia
- Canada

Worldwide case count unknown, >110
HOW HCU WORK

HCD = device used to control the temperature of the fluid entering and leaving the heart-lung machine

Sommerstein et al. EID 2016;22(6)

Figure 2. Video image captures showing effect of heater–cooler unit orientation on smoke dispersal in a cardiac surgery room and transmission of Mycobacterium chimaera during cardiac surgery despite an ultraclean air ventilation system (video, http://www.cdc.gov/EID/article/22/6/16-0045-V1.htm). The device was switched on and began to ventilate 10 s after the start of the video. Frames on the left show an overview including unit placement. Frames on the right provide a lateral view of the operating field under the laminar airflow. Simultaneously recorded videos in the upper 2 frames show the first scenario, in which the main ventilation exhaust was directed away from the operating field. Simultaneously recorded videos in the lower 2 frames show the second scenario, in which the main ventilation exhaust was directed toward the operating field.

**RECENT DUODENOSCOPE-RELATED OUTBREAKS OF MRDO WITHOUT REPROCESSING BREACHES**

<table>
<thead>
<tr>
<th>MDRO</th>
<th>Resistance</th>
<th>No. Pts (infected)</th>
<th>Propagated Outbreak</th>
<th>Positive Scope(s)</th>
<th>Molecular Link</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>K. pneumoniae</em></td>
<td>CRE (blaKPC-2)</td>
<td>15 (6)</td>
<td>No</td>
<td>No</td>
<td>PCR*, PFGE</td>
<td>Wendorf KA, 2015</td>
</tr>
<tr>
<td><em>E. coli</em></td>
<td>CRE (blaKPC-2)</td>
<td>35</td>
<td>No</td>
<td>Yes (2)</td>
<td>PCR*, PFGE</td>
<td>Wendorf KA, 2015</td>
</tr>
<tr>
<td><em>K. pneumoniae</em></td>
<td>CRE (blaKPC-2)</td>
<td>12</td>
<td>Yes</td>
<td>No</td>
<td>PCR*, PFGE</td>
<td>Kola A, 2015</td>
</tr>
<tr>
<td><em>P. aeruginosa</em></td>
<td>VIM-2</td>
<td>22</td>
<td>Yes</td>
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<td>Smith Z, 2015</td>
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<td><em>K. pneumoniae</em></td>
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<td>Yes</td>
<td>PCR*, PFGE</td>
<td>Carbonne A, 2010</td>
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</table>

PCR*, PCR for resistance gene; CRE, carbapenem-resistant enterobacteriaceae; WGS, whole genome sequencing

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**Endemic Transmission of Infections Associated with GI Endoscopes May Go Unrecognized**

- Inadequate surveillance of outpatient procedures for healthcare-associated infections
- Long lag time between colonization and infection
- Low frequency of infection
- Pathogens "usual" enteric flora
- Risk of some procedures might be lower than others (colonoscopy versus ERCP where normally sterile areas are contaminated in the latter)

---

CRE and ESBLs

*INFORMATION:*

- **CRE** and **ESBLs**
- **Inadequate surveillance of outpatient procedures for healthcare-associated infections**
- **Long lag time between colonization and infection**
- **Low frequency of infection**
- **Pathogens "usual" enteric flora**
- **Risk of some procedures might be lower than others (colonoscopy versus ERCP where normally sterile areas are contaminated in the latter)**
PREVENTING INFECTIONS ASSOCIATED WITH ENDOSCOPY (especially ERCP)

Current Enhanced Methods for Reprocessing Duodenoscopes

Hospitals performing ERCPs should do one of the following (priority ranked); doing nothing is not an option:

1. Ethylene oxide sterilization after high level disinfection with periodic microbiologic surveillance
2. Double high-level disinfection with periodic microbiologic surveillance
3. High-level disinfection with scope quarantine until negative culture
4. Liquid chemical sterilant processing system using peracetic acid (rinsed with extensively treated potable water) with periodic microbiologic surveillance
5. High-level disinfection with periodic microbiologic surveillance
Potential Future Methods to Prevent GI-Endoscope Related Outbreaks

- Steam sterilization for GI endoscopes
- Disposable sterile GI endoscopes (disposable bronchoscopes available)
- Improved GI endoscope design (to reduce or eliminate challenges noted earlier)
- Use of non-endoscope methods to diagnosis or treat disease (e.g., capsule endoscopy, blood tests to detect GI cancer, stool DNA test)
- New low temperature sterilization methods proving SAL 10^{-12} achieved (or optimizing current LTST)

Rutala WA, Weber WA. Infect Control Hosp Epidemiol 2015, In press

DEVICE-ASSOCIATED OUTBREAKS: SOLUTIONS

- FDA responsibilities
  - Ensure that all medical devices are safe and effective
  - Ensure that all manufacturer’s of a re-usable medical device provide a validated method for cleaning and disinfection/sterilization
  - Require that all re-usable semicritical devices (e.g., duodenoscopes, arthroscopes) that enter sterile tissue/body spaces can be sterilized
- Manufacturer’s responsibilities
  - Develop new devices that eliminate hazards associated with heater-cooler units and duodenoscopes
  - Demonstrate safety and efficacy (i.e., reduction in HAIs) in RCTs
THE THREAT OF ANTIBIOTIC/GERMICIDE RESISTANT PATHOGENS

Germicide resistant
- C. difficile
- HPV
- Norovirus
- Candida aureus

Antibiotic resistant
- MRSA
- VRE
- MDR-Acinetobacter
- MDR-P. aeruginosa
- Extended-spectrum beta-lactamase producers (ESBLs)
- Carbapenem-resistant Enterobacteriaceae (CRE)
MAJOR NOSOCOMIAL PATHOGENS OF THE 20TH AND 21ST CENTURIES

Streptococci
Staphylococci
Gram-negative rods
MDROs
MRSA
VRE
ESBL, CRE,
Acinetobacter,
Pseudomonas
VISA, VRSA

Courtesy of Dr. Robert Weinstein

UNC RATES OF MULTIDRUG RESISTANT PATHOGENS, 2003-2016

Healthcare Associated Infection Rates for Multi Drug Resistant and Other Epidemiologically Important Pathogens

Year
Infection Rate (Number of Infections per 1000 Patient Days)
0.0 0.2 0.4 0.6 0.8 1.0
VRE Infection Rate
MRSA Infection Rate
Ceftazidime-Resistant Enterobacteriaceae Infection Rate
MDR GNR Infection Rate
Acinetobacter Infection Rate
Ceftazidime-Resistant Enterobacteriaceae Infection Rate
TRANSMISSION MECHANISMS INVOLVING THE SURFACE ENVIRONMENT


EFFICACY OF ALCOHOL AS A HAND HYGIENE AGENT AGAINST C. difficile

- Probability of heavy contamination (TNTC) following different HH interventions: warm water and plain soap = 0, cold water and plain soap = 0, warm water and antibacterial soap = 0, antiseptic hand wipe = 0.05, alcohol-based handrub = 0.43, and no hand hygiene = 1

Oughton MT, et al. ICHE 2009;30:939-944
SURFACE DISINFECTION: EFFECTIVENESS OF DIFFERENT METHODS vs C. difficile

<table>
<thead>
<tr>
<th>Product</th>
<th>Saturated cloth</th>
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<th>Spray, wipe, spray (1 min), wipe</th>
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<td>4014</td>
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</tbody>
</table>

Rutala WA, Gergen MF, Weber DJ. ICHE 2012;33:1255-58

ENDOSCOPE REPROCESSING: CHALLENGES

Susceptibility of Human Papillomavirus

- Most common STD
- In one study, FDA-cleared HLD, no effect on HPV
- Finding inconsistent with other small, non-enveloped viruses such as polio and parvovirus
- Further investigation needed: test methods unclear; glycine; organic matter; comparison virus
- Conversation with CDC: validate and use HLD consistent with FDA-cleared instructions (no alterations)

EFFECTIVENESS OF DISINFECTANTS AGAINST CANDIDA AURIS

Cadnum JL, ....Donskey CJ. Poster #243, SHEA, St. Louis, 2017.

NOROVIRUS

- Norovirus outbreaks in healthcare facilities
  - Accounts for >90% of nonbacterial and ~50% of all-cause epidemic gastroenteritis
  - Hospitals and LTCF account for >25% of outbreaks
  - Most common pathogen associated with ward closures (44%)2
  - UNC 2012-2016, ~14% (7/51) outbreaks due to norovirus

- Management issues
  - Stable in the environment - Very low inoculating dose
  - Relatively resistant to ethanol (perform HH with soap and water)
  - Resistant to Quats (use hypochlorites for room disinfection)
  - No evidence any interventions can control outbreak3 – therefore goal is to contain outbreak to single affected ward (limit staff and patient transfers, close ward to admissions, improved HH and environmental cleaning)

**SOLUTIONS**

- MDR pathogens
  - Anti-infective stewardship
  - Develop new anti-infectives
  - Develop non-antibiotic methods to treat infection
  - Vaccine development (e.g., MRSA, *C. difficile*, TB, malaria)
- Germicide resistant or reduced susceptibility pathogens
  - Develop new germicides
  - Revise recommendations to use appropriate cidal agents
  - Develop new methods of killing pathogens (e.g., UV devices, hydrogen peroxide systems)

**IMPORTANCE OF NON-DEVICE ASSOCIATED INFECTIONS**
Significant modifications were made to the NHSN definitions in 2013 and again in 2015 that may have impacted infection rates.
RECOMMENDATIONS TO DECREASE RISK OF VAP, US

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No guideline has any recommendation to reduce HAP!
Adapted from Passaro L, et al. Antimicrobial Resistance Infect Control 2016;5:43

CONCLUSIONS

- Expand surveillance to track non-device associated HAIs
- Determine risk factors for non-device associated HAIs
- Develop interventions to reduce non-device associated HAIs
ADDITIONAL CHALLENGES

- New complex devices (e.g., da Vinci surgery)
- Obtaining behavioral change
- Meeting expectations
- We have moved from seeking percent reductions in HAIs each year to competition to see who can decrease HAIs fastest
- Maintaining preparedness for highly-communicable disease (e.g., Ebola)
- Infection control in ambulatory care
- Maintaining proficiency in disinfection and sterilization
- Lack of new antimicrobials
- Integrating with institutions larger QI concerns
- Xenotransplantation?

NEW TOOLS

- New diagnostics (MACDI-TOF)
- Rapid diagnostics (influenza, RSV, TB, etc.)
- New germicides (e.g., improved hydrogen peroxide)
- New room disinfection technologies (i.e., 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-observed based methods for assessing hand hygiene compliance
HE STANDS FOR TRUTH, RESEARCH
AND THE SCIENTIFIC WAY!

It's A Bird.....It's A Plane.....No It's Superman
Who is disguised as William A. Rutala