Healthcare Associated Infections Past to Present: How Much is Preventable and How Hard Should We Try?

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Chairman- Division of Infectious Diseases
Hospital Epidemiologist
Disclosures

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  – Biovigil LLC
  – Vestagen Technologies
  – Cardinal Healthcare
  – Molnlycke Health Care
  – AO (Orthopedic) Foundation Grant
Outline

• HAIs past to present
• Getting to Zero- soundbite
• Challenges and new threats in infection prevention
  – Implementation of process measures
  – Controversies in infection prevention
  – Hand Hygiene
  – Surveillance/overdiagnosis/system gaming
  – Human beings as chaotic systems
  – Executive leadership
• HAIs: How much can we prevent and how hard should we try?
Infection Prevention Timeline

Big Bang
10 billion-20 billion years ago

Hotel-Dieu:
Paris hospital founded in the 7th century

Many uneventful years elapse

Circa 600 AD
Contagion: Miasma Theory of Disease- 2000+ years

- Disease- caused by noxious form of "bad air" (e.g. malaria)
- Miasmas- emanated from rotting organic matter
History: Florence Nightingale and Louis Pasteur, Ignaz Semmelweis

1800s: Importance of unsanitary hospital conditions and post operative complications

Developed the germ theory of disease in the late 1800s

1800s: Importance of Hand washing with chlorinated lime
Semmelweis and Hand Hygiene

Maternal Mortality Rates
General Hospital of Vienna
Physicians and Midwives

Physicians routinely performed deliveries w/o washing hands after performing necropsies

Hand Hygiene Intervention

Semmelweis IP, 1861

World Health Organization
Patient Safety
SAVE LIVES
Clean Your Hands

VCU Medical Center
Infection Control Timeline: *The Modern Era*

**First antibiotics, sulfonamides & penicillin, developed in the late 1930s**

**Robert Haley, MD**
1970’s SCENIC Study Hospitals with active infection control programs have a 32% lower incidence of nosocomial infections

**R.P Wenzel MD, MSc**
1980: Founded Society of Healthcare Epidemiology; applied epidemiologic techniques to infection control
Status of Mandatory Reporting Legislation for Nosocomial Infections

Healthcare-Associated Reporting Laws and Regulations

- **States with study laws**
- **Mandates public reporting of infection rates**
- **Mandates reporting only to state government**
- **Voluntary**

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Source: APIC, February 2008
The Modern Hospital

- Sicker patients
  - Chronic conditions
- Immune modifying treatments
  - Chemotherapies, BMT/SOT
- Invasive devices and procedures
- Extensive antibiotic use
- Threat from our own microbiome
Source of Pathogens in the Hospital Setting

- HCW hands 20-40%
- Endogenous (patient) 40-60%
- Environment/other 20%


Slide courtesy of MB Edmond
What is the current HAI Burden?
Changes in Prevalence of Health Care–Associated Infections in U.S. Hospitals

- 2011 point prevalence survey of US hospitals: 4% of hospitalized patients with an HAI
- 2015 point prevalence survey of US hospitals: 3.2% of hospitalized patients with an HAI
- Risk of having an HAI: 16% lower in 2015 than in 2011

## Health Care–Associated Infections

A Meta-analysis of Costs and Financial Impact on the US Health Care System

Eyal Zimlichman, MD, MSc; Daniel Henderson, MD, MPH; Orly Tamir, PhD, MSc, MHA; Calvin Franz, PhD; Peter Song, BSE; Cyrus K. Yamin, MD; Carol Keohane, BSN, RN; Charles R. Denham, MD; David W. Bates, MD, MSc

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CAUTI</td>
<td>&gt; $27,000,000</td>
</tr>
<tr>
<td>CLABSI</td>
<td>&gt; $1,000,000,000</td>
</tr>
<tr>
<td>C. difficile</td>
<td>&gt; $1,000,000,000</td>
</tr>
<tr>
<td>SSI</td>
<td>&gt; $3,000,000,000</td>
</tr>
<tr>
<td>VAP</td>
<td>&gt; $3,200,000,000</td>
</tr>
</tbody>
</table>

Doing Nothing is Not an Option

Regulatory agencies and public reporting obligates us to act on HAI risk reduction.
Hospital Acquired Infections Rate 1998-2008

Infections/1,000 patient days

<table>
<thead>
<tr>
<th>Year</th>
<th>ICUs</th>
<th>Non-ICU</th>
<th>Hospital-wide</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>16.8</td>
<td>0.9</td>
<td>1.4</td>
</tr>
<tr>
<td>1999</td>
<td>15.7</td>
<td>0.9</td>
<td>1.4</td>
</tr>
<tr>
<td>2000</td>
<td>16.5</td>
<td>0.8</td>
<td>1.2</td>
</tr>
<tr>
<td>2001</td>
<td>21.3</td>
<td>0.6</td>
<td>1.1</td>
</tr>
<tr>
<td>2002</td>
<td>19.3</td>
<td>0.6</td>
<td>1.2</td>
</tr>
<tr>
<td>2003</td>
<td>21.4</td>
<td>0.6</td>
<td>1.0</td>
</tr>
<tr>
<td>2004</td>
<td>18.0</td>
<td>0.5</td>
<td>0.7</td>
</tr>
<tr>
<td>2005</td>
<td>13.0</td>
<td>0.5</td>
<td>0.7</td>
</tr>
<tr>
<td>2006</td>
<td>9.4</td>
<td>0.5</td>
<td>0.7</td>
</tr>
<tr>
<td>2007</td>
<td>7.5</td>
<td>0.5</td>
<td>0.7</td>
</tr>
<tr>
<td>2008</td>
<td>5.8</td>
<td>0.4</td>
<td>0.6</td>
</tr>
<tr>
<td>2009</td>
<td>3.3</td>
<td>0.3</td>
<td>0.5</td>
</tr>
<tr>
<td>2010</td>
<td>3.1</td>
<td>0.3</td>
<td>0.5</td>
</tr>
<tr>
<td>2011</td>
<td>2.5</td>
<td>0.3</td>
<td>0.5</td>
</tr>
<tr>
<td>2012</td>
<td>2.9</td>
<td>0.3</td>
<td>0.5</td>
</tr>
<tr>
<td>2013</td>
<td></td>
<td>0.3</td>
<td>0.6</td>
</tr>
</tbody>
</table>

*New surveillance definitions implemented January 1, 2013 (includes IVAC-plus** metric)

**Summary metric which equals IVAC + possible YAP + probable VAP
Zero Hospital Acquired Infections
Global Elimination Has Been Achieved Only for Smallpox!

Source: National Museum of American History - Smithsonian Institution
Zero Hospital-Acquired Infections: Reality Check
Harry G. Frankfurt
Professor of philosophy
(Emeritus)
Princeton University
Bullshit is speech intended to persuade without regard for truth.

The liar cares about the truth and attempts to hide it.

The bullshitter doesn't care if what they say is true or false, but rather only cares whether their listener is persuaded.

Our goal is to make informed decisions and come to informed conclusions free from bullshit.
Getting to Zero is a Soundbite: We Must Discern the Signal from the Noise
• Getting to zero best described as a sound bite:
  – Lacks complexity and nuance
  – Misleading
  – Based on inexact science with suboptimal evidence
  – Results in unrealistic expectations/outcomes

Edmond MB. *Infect Control Hospital Epidemiol.* 2009; 30:74-76
Many infections are inevitable, although some can be prevented.

Each infection is potentially preventable unless proven otherwise.

How Well Do We Implement Infection Prevention Processes?
Prevention of Nosocomial BSIs
Hopkins Model (Central Line Bundle)

• Creation of a central line insertion cart

• Use of a insertion checklist to ensure:
  – Hand hygiene prior to the procedure
  – Sterile gloves, gown, mask, cap, full-size drape
  – Chlorhexidine skin prep of the insertion site

• Bedside nurse empowered to stop the procedure if a step is missed

Practice Standardization Leads to Major Reduction in ICU CLABSIs


Chlorhexidine Impregnated Sponges

http://www.uwhealth.org/images/ewebeditpro/uploadimages/Piccbiopatchstat.jpg
Chlorhexidine Impregnated Sponges

- Randomized, blinded controlled trial conducted in 7 French ICUs
- CHG sponge vs. standard dressings (controls)
  - Change of dressings
    - 3 days vs. 7 days
- Outcome CR-BSI
  - CHG Sponge vs. controls

Timsit JF et al. JAMA 2009 Mar 25;301(12):1231-41.
Chlorhexidine Impregnated Sponges

<table>
<thead>
<tr>
<th></th>
<th>Standard Dressing</th>
<th>CHG Sponge</th>
<th>HR 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cr-BSI</td>
<td>1.4/1000 DD</td>
<td>0.6/1000 DD</td>
<td>0.39 0.17 vs 0.93</td>
</tr>
</tbody>
</table>

Timsit JF et al. JAMA 2009 Mar 25;301(12):1231-41.
Effect of Daily Chlorhexidine Bathing on Hospital-Acquired Infection

- Multicenter, cluster-randomized, crossover trial:
  - Daily bathing with CHG-impregnated washcloths
- Outcomes:
  - Acquisition of MDROs
  - Incidence of hospital-acquired bloodstream infections

# Effect of Daily Chlorhexidine Bathing on Hospital-Acquired Infection

<table>
<thead>
<tr>
<th></th>
<th>Standard bathing</th>
<th>Chlorhexidine Bathing*</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MDRO Acquisition</strong></td>
<td>6.6 /1000 patient-days</td>
<td>5.1/1000 patient-days</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Hospital Acquired BSI</strong></td>
<td>6.60/1000 patient-days</td>
<td>4.78/ 1000 patient-days</td>
<td>0.007</td>
</tr>
</tbody>
</table>

N= 7727 patients

*No serious skin reactions noted during either study period

How Were Key Infection Prevention Interventions Performed?

<table>
<thead>
<tr>
<th>Study</th>
<th>Measure</th>
<th>Compliance</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berenholtz et al</td>
<td>Compliance with central line checklist</td>
<td>63% global compliance</td>
<td></td>
</tr>
<tr>
<td>Pronovost et al</td>
<td>Compliance with central line checklist</td>
<td>“we did not evaluate compliance with study intervention…”</td>
<td></td>
</tr>
<tr>
<td>Timsit et al</td>
<td>Compliance with central line dressing use</td>
<td>Unclear: “50% of dressing changes were unplanned”</td>
<td></td>
</tr>
<tr>
<td>Climo et al</td>
<td>Compliance with patient bathing per protocol</td>
<td>Not reported</td>
<td></td>
</tr>
</tbody>
</table>

Infection prevention process are (at best) variably implemented.
First step to reducing infection risk as a system: Evaluation of infection prevention processes for 71 hospitals

Mohamad G. Fakih MD, MPH, Michelle Heavens BSN, MHA, RN, Carol J. Ratcliffe DNP, RN, FACHE, Ann Hendrich PhD, RN, FAAN

### Survey of Select Key Infection Prevention Practices Across 71 Hospitals

<table>
<thead>
<tr>
<th>Practice</th>
<th>Count (Hospital)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urinary catheter use- electronic reminders to nurses</td>
<td>10/71</td>
<td>14%</td>
</tr>
<tr>
<td>Pre-operative glucose monitoring &gt; 90% of time</td>
<td>12/66</td>
<td>18%</td>
</tr>
<tr>
<td>Use of Central Line insertion checklist &gt;90% of time</td>
<td>42/71</td>
<td>60%</td>
</tr>
<tr>
<td>Weight based perioperative antibiotic dosing</td>
<td>42/66</td>
<td>64%</td>
</tr>
<tr>
<td>Daily Evaluation of Sedation vacation (VAP)</td>
<td>53/57</td>
<td>93%</td>
</tr>
</tbody>
</table>

Infection prevention processes are (at best) variably implemented

Controversy in Infection Prevention Strategy: So What is the Best Strategy?
**Contact Precautions: More Is Not Necessarily Better**

Prospective, observational cohort study 2009- across 11 University Hospitals

<table>
<thead>
<tr>
<th>Contact Isolation Burden</th>
<th>Hand Hygiene Compliance</th>
<th>Compliance Contact Precautions Bundle</th>
</tr>
</thead>
<tbody>
<tr>
<td>20% or less</td>
<td>44%</td>
<td>32%</td>
</tr>
<tr>
<td>60% or greater</td>
<td>5%</td>
<td>7%</td>
</tr>
</tbody>
</table>

“Robust measures for the incremental benefit of contact precautions, gowns, gloves, and active detection and isolation strategies for the prevention of cross-transmission in endemic settings are lacking”

Cluster randomized trial-universal gloving and gowning
- 20 medical and surgical ICUs
- 20 US Hospitals

UGG did not reduce primary VRE or MRSA acquisition

UGG reduced secondary MRSA acquisition (colonization) - 40% (relative risk)

No difference in adverse events

Harris AD et al. JAMA. 2013:310 (15): 1571-1580
## Impact of De-escalating Contact Precautions on MRSA/VRE Infection Rates

<table>
<thead>
<tr>
<th></th>
<th>Device Associated Infections</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (rate/1,000 patient days)</td>
<td>Q1 12- Q1 13 (CP)</td>
<td>Q2 13- Q2 14 (No CP)</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td><strong>MRSA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wards</td>
<td>12 (0.060)</td>
<td>9 (0.043)</td>
<td>0.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICUs</td>
<td>3 (0.057)</td>
<td>3 (0.054)</td>
<td>0.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>15 (0.059)</td>
<td>12 (0.046)</td>
<td>0.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>VRE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wards</td>
<td>16 (0.080)</td>
<td>13 (0.063)</td>
<td>0.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICUs</td>
<td>6 (0.057)</td>
<td>4 (0.072)</td>
<td>0.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>22 (0.087)</td>
<td>17 (0.065)</td>
<td>0.91</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Quasi-experimental study
45% Reduction on CP Burden and $700,000 dollars saved cost

More Recently ……
Reconsidering Contact Precautions for Endemic MRSA and VRE- Revisited

• No high quality data supports or rejects use of CP for endemic MRSA or VRE
• Over 30 US hospitals do not use CP for control of endemic MRSA or VRE
• Until more definitive data are available:
  – Use of CP for endemic MRSA/VRE in acute-care hospitals should be guided by local needs and resources

Reconsidering Contact Precautions for Endemic MRSA and VRE: Results

Survey of SHEA Research Network

Survey responses (%)

- CP used currently for MRSA or VRE: 90%
- Interested in alternate options to CP: 60%
- Wish to use CP for symptoms (not MDRO status): 60%
- Wish not to use CP for endemic VRE: 40%
- Wish not to use CP for endemic MRSA: 20%

**Elimination of Routine Contact Precautions for Endemic Methicillin-Resistant *Staphylococcus aureus* and Vancomycin-Resistant *Enterococcus*: A Retrospective Quasi-Experimental Study**

Elise M. Martin, MD; Dana Russell, MPH; Zachary Rubin, MD; Romney Humphries, PhD; Tristan R. Grogan, MS; David Elashoff, PhD; Daniel Z. Uslan, MD, FIDSA, FSHEA

<table>
<thead>
<tr>
<th>Hospital A+B*</th>
<th>Rate Before</th>
<th>Rate After</th>
<th>Rate Ratio</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRSA**</td>
<td>0.40</td>
<td>0.32</td>
<td>0.80</td>
<td>.09</td>
</tr>
<tr>
<td>VRE**</td>
<td>0.48</td>
<td>0.40</td>
<td>0.83</td>
<td>.14</td>
</tr>
<tr>
<td>C. difficile***</td>
<td>11.31</td>
<td>11.06</td>
<td>0.98</td>
<td>.81</td>
</tr>
</tbody>
</table>

* Quasi-experimental study 1 year pre/post DC of CP with CHG bathing expansion

**Rate for MRSA and VRE are LabID cultures per 100 admissions

***Rate for *C. difficile* is LabID clinical cultures per 10,000 patient days

Reported Cost Saving: $643,776

Hospitals should reconsider best use of contact precautions for endemic MRSA and VRE in the context of a broad approach to infection control targeting the highest-value interventions.
De-escalation of contact precautions: no significant (negative) impact on already decreasing 7-year trends of MRSA and VRE HAIs

De-escalation of contact precautions: no significant (negative) impact on already decreasing 7-year trends of ALL device associated HAIs

VCU De-CP-Pediatrics Quasi-experimental Study: MRSA and VRE Infections CLABSIs

De-escalation of contact precautions in PEDIATRICS: no significant (negative) impact on MRSA and VRE CLABSIs


<table>
<thead>
<tr>
<th>Location</th>
<th>Traditional CPs</th>
<th>Discontinuation of CPs</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACP</td>
<td>3 (0.28)</td>
<td>1 (0.07)</td>
<td>0.24</td>
</tr>
<tr>
<td>PPCU</td>
<td>0 (0)</td>
<td>1 (0.66)</td>
<td>0.61</td>
</tr>
<tr>
<td>PICU</td>
<td>5 (0.55)</td>
<td>2 (0.26)</td>
<td>0.44</td>
</tr>
<tr>
<td>NICU</td>
<td>5 (0.39)</td>
<td>2 (0.12)</td>
<td>0.19</td>
</tr>
<tr>
<td>Total</td>
<td>13 (0.38)</td>
<td>6 (0.15)</td>
<td>0.06</td>
</tr>
</tbody>
</table>

N (number of infections/1,000 central-line days)
The Best Use of Contact Precautions to Control Endemic Pathogens Remains Debatable
Promoting and Measuring Hand Hygiene: The Illusory Goal of Perfection
I Could Start With This Argument….

Hand hygiene doesn't prevent healthcare associated infections

Not all transmission leads to infection and not all infections are preceded by transmission. Hand hygiene prevents transmission, not infection.

...some posts are just hard to write.

One of the persistent beliefs in infectious diseases and infection prevention is that hand hygiene compliance prevents healthcare associated infections. Perhaps this harkens back to Semmelweis and the prevention of puerperal fever through hand disinfection. Of course, if puerperal fever was a CDC HAI and clinicians didn’t wear gloves, we could still say hand hygiene prevents HAI. However, that's not the current reality.

CDC defines HAI as CLABSI, CAUTI, SSI and VAP. We can even consider hospital-onset BSI and almost any other infection we can track using CMS or EMR data and hand hygiene compliance is not a significant component in the causal pathway for the development of an HAI.

Sure, hand hygiene/sterile gloves before catheter insertion and hand antisepsis prior to invasive surgical procedures are standard practice. However, when I talk about hand hygiene compliance, I mean hand hygiene on room entry/exit or following the WHO 5 My 5 Moments during care on medical wards and in ICUs. And yes, there are instances where Moment #2 - before clean/aseptic procedure could potentially reduce CLABSI, but the proportion of CLABSI caused by such breaks in moment #2 pales in comparison to those prevented with the highly effective CLABSI bundle. Otherwise, moment #2 would have been included in the CLABSI bundle.
Let’s Agree on the Following:

• HH is possibly one of the most effective infection prevention interventions
• HH compliance is suboptimal
Our HH Science is Inexact...

- Proportionate impact of HH on HAI prevention is debatable
- Significant limitations HH studies:
  - Most HH studies use non-randomized study designs and are underpowered
  - Wide variations in strategies reported
  - Direct head to head comparisons of different strategies are lacking
  - Limited specifics reported on resources required
The Aspirational Hand Hygiene Dashboard:

**Compliance Rate for This Week**
- 60%

**Compliance Rate by HCW Type**
- Nurse: 70%
- Physician: 60%
- Resp Rx: 50%
- Phys Rx: 40%

**Compliance Rate by Floor**

<table>
<thead>
<tr>
<th>Floor</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 East</td>
<td>52%</td>
</tr>
<tr>
<td>2 West</td>
<td>65%</td>
</tr>
<tr>
<td>2 North</td>
<td>72%</td>
</tr>
<tr>
<td>3 East</td>
<td>58%</td>
</tr>
<tr>
<td>3 West</td>
<td>60%</td>
</tr>
<tr>
<td>3 North</td>
<td>62%</td>
</tr>
</tbody>
</table>

**Least Compliance Personnel**

<table>
<thead>
<tr>
<th>Employee</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bruce Filth</td>
<td>25%</td>
</tr>
<tr>
<td>Cindy Don'tcare</td>
<td>35%</td>
</tr>
<tr>
<td>Timmy Tufast</td>
<td>37%</td>
</tr>
</tbody>
</table>

*Figure 3. Example of type of real-time data provided on hand hygiene compliance by electronic hand hygiene monitoring systems.*

Boyce JM. *Infect Control Hosp Epidemiol.* 2011, 32 (10) 1016-28
WHO My 5 Moments for HH

http://www.who.int/gpsc/5may/background/5moments/en/
WHO 5 Campaign Key Elements:

• Multimodal approach:
  – System change
  – Training and education (multi-modal)
  – Observation and feedback
  – Reminders/prompts/nudges
  – Hospital safety climate (executive sponsorship)
How Effective are These HH Strategies in the Real World?
Comparative efficacy of interventions to promote hand hygiene in hospital: systematic review and network meta-analysis

- Meta-analysis of 4 hand hygiene intervention ITS studies
- Comparisons: None (no intervention); single intervention; WHO-5 campaign; and WHO-5+ campaign (WHO-5 with incentives, goal-setting, or accountability)

Luangasanatip N et al. BMJ 2015:351 H3721
Comparative efficacy of interventions to promote hand hygiene in hospital: systematic review and network meta-analysis

The more HH strategy components, the greater the HH Improvement

- Single intervention (System change or education)
- System change, education, feedback, reminders, and institutional safety climate
- WHO-5 plus incentives, goal setting, or accountability

Luangasanatip N et al. BMJ 2015:351 H3721
“Taken together, these results suggest that many interventions to improve hand hygiene work, and that those interventions with more components work better than interventions with fewer components.”

Muller MP *BMJ* 2015 Jul 28;351:h3931

HH for heightened patient safety remains a challenge
Surveillance Can Over-Diagnose HAIs: So What is the Real HAI Incidence?
Goal: Identify the ‘sweet spot’ of test utilization to minimize over-diagnosis (false positives) safely

Caveat: undertesting may lead to potential patient harm

The Diagnostic System Can Be Gamed: Infection Prevention Outcomes are Misleading
Questionable Practices to Reduce Hospital Associated infections and Game the System - False Conclusions About Preventability

<table>
<thead>
<tr>
<th>CAUTI</th>
<th>Screen urine to ensure pyuria and discard samples with &lt; 10 WBC/mm3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLABSI</td>
<td>Use midline catheters instead of PICC Lines</td>
</tr>
<tr>
<td></td>
<td>Only perform single blood cultures within 48 hours</td>
</tr>
<tr>
<td>SSI</td>
<td>Schedule follow up 30 days post procedure</td>
</tr>
<tr>
<td></td>
<td>Avoid the term ‘purulent’ when describing a wound</td>
</tr>
</tbody>
</table>

Horowitz HW. American Journal Infect Control. 44 (2016) 1075-7
Human Beings as Chaotic Systems: The Cause and Effect Caveat
The Human Body
Human Beings as Chaotic Systems
By Crystal Ives

- Most natural systems play by the rules of chaos and are not linear
- Despite homeostasis the human body is aperiodic and unpredictable in the long term
- Human body is a chaotic non-linear system
  - CAVEAT: Simple cause/effect of an intervention preventing an outcome is not always reliable

http://www.fractal.org/Life-Science-Technology/Publications/Human-beings-as-fractal-systems.pdf
Infection prevention interventions, like medical treatments, are subject to variable outcomes and do not always prevent infection.
Hospital Senior Leadership: Safety Starts at the Very Top
Hospital-Acquired Infections Under Pay-For-Performance Systems: An Administrative Perspective on Management and Change

Critical Role of Hospital Executive Leadership
Includes:

Without robust executive sponsorship no infection prevention strategy will reach its stated goals. Keeping leaders engaged is an ongoing challenge.

So How Much Can We Prevent HAIs and How Hard Should We Try?
‘…the only foolproof way to ensure zero HAIs is not to admit patients to the hospital’
Systematic review of interventions to reduce HAIs over last 10 years

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<th>Expected impact of current evidence based strategies</th>
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<td>65% -70% reduction</td>
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Umscheid CA et al. *Infection Control and Hosp Epidemiol*, 2011 Feb;32(2):101-14
• Systematic review and meta-analysis:
  – Potential HAI reduction of 35%-55% with current infection prevention science
  – Preventable proportion of HAIls reduces with improvements in safety - phenomenon of infection prevention diminishing returns

The Satisfice Approach: Nobel Laureate- Herbert Simon

Nobel Prize speech: “..decision makers can satisfice either by finding optimum solutions for a simplified world, or by finding satisfactory solutions for a more realistic world.”
Infection control: the case for horizontal rather than vertical interventional programs

Richard P. Wenzel *, Michael B. Edmond

‘We suggest that horizontal programs should form the platform of all infection control programs...’

Strategic Approaches to Infection Prevention

**Vertical**
- Interventions aimed at reducing risk from a single pathogen
- Involve a microbiologic testing component
- Examples: Active detection & isolation of MRSA, VRE

**Horizontal**
- Multipotent interventions aimed at reducing risk from all pathogens transmitted in the same mechanism
- Hand hygiene, chlorhexidine bathing, central line insertion bundle, ventilator bundle, urinary catheter bundles

Preventable vs Un-Preventable Hospital Acquired Infections?

~70% ~30%

HAIs Potentially Preventable: When Risk Reduction Measures Implemented

(Apparently Un-Preventable) HAI: infection despite every agreed upon measure for infection prevention being followed

Umscheid CA et al. *Infection Control and Hosp Epidemiol*, 2011 Feb;32(2):101-14
Dellinger E. P. Surgical Infections. 17 (4): 2016, 422-426
“Public health is an essential trust, between government and its people, in a pursuit of health for all…”

Includes: “…a healthcare system that follows the primary maxim of medicine- do no harm.”

Healthcare systems that fail to relentlessly pursue infection prevention betray the maxim of medicine and the public trust.
Hospital IP programs are neither staffed nor empowered for administrative oversight
- IP sets collaborative standards and identifies barriers to processes and outcomes

Managers, chief medical, quality, and nursing officers are responsible for accountability of both the system and the individual, with ultimate oversight from chief executive officers.

Prevention of Hospital-Acquired Infections

E. Patchen Dellinger

• Relentlessly strive for zero ‘potentially preventable’ HAIs- *primum non nocere*
  – Focus on modifiable risk factors
  – For each HAI- Investigate if every agreed upon measure for prevention was followed:
    • If so- “apparently unpreventable” HAI
    • If not- “opportunity for HAI prevention improvement”

Dellinger E. P. Surgical Infections. 17 (4): 2016, 422-426
• Perhaps up to 55-70% of HAIs are potentially preventable
  • This is subject to a law of diminishing returns as the preventable proportion of HAIs may reduce over time with improvements in patient safety
• As the first tenet of medicine is first do no harm-
  • Infection prevention programs should relentlessly pursue reliable, sustainable, and practical strategies for heightened patient safety

Beware of New Threats to Hospital Infection Prevention
Some colleagues envision the end of health care-associated infections, a “getting to zero” program. But with the existing knowledge of the microbiome, the emergence of drug-resistant bacteria and the fragile immune system of patients, this currently is impossible.

New threats to IP: altered patient microbiome and drug resistant pathogens

The modern pathway for IP requires:
- Aligning funding to ensure new antibiotic drug development
- Improved antimicrobial stewardship
- Adequate staffing of infection prevention programs
- Understanding and controlling the biology of the patient’s microbiome

Failure to communicate the health care infection risk accurately undermines the public trust
Next steps
• Epidemiologists must drive HAI prevention policy:
  – Define best practices for prevention:
    • Specify actionable recommendations
      – With tools to measure and improve compliance with processes
    • Transparency of processes and outcomes

• Future next steps for infection prevention:
  – Increase the use of information technology to monitor and address HAIs
    • Automated surveillance of processes and outcomes
  – Improve the science of infection prevention
    • Focus on implementation science
      – (My interpretation: *Getting things done in the real world*)

Kahn KL et al. *Medical Care*. Volume 52, Number 2 Suppl 1, 2014, S97-100
• Cost/benefit guidance to focus efforts and minimize opportunity costs:
  – There is a “need for stronger health economic analysis in an era when competition for limited healthcare resources is likely to become even fiercer”

The Learning Hospital

• Learning hospital is distinguished by ceaseless evolution of erudition, enhancement and implementation
  – Environment where faculty and learners are engaged in research and the pursuit of scientific advancement
  – Science, informatics, incentives and culture are aligned for continuous improvement
  – Need not be supported by grants or funding from the healthcare system

“Discovery is not necessarily a function of special talent, but a function of hard work, which creates talent, and, low achievement is less commonly from a lack of time and resources, it is more from a lack of willpower.”

Nobel Prize in Physiology and Medicine 1906
Learning Hospital: From Theory to Practice

Hess O, Bearman G et al. The Learning Hospital. In Press. ICHE. 2019
Learning Hospital: From Theory to Practice-Continuous Program Improvement

• Since 2003:
  – 121 Infection prevention publications
    • 3% (4/121) received grant funding
    • 70% (85/121) involved either a student, intern, resident, fellow, infection preventionist (IP), non-IP HIPP staff, or non-IP nurse.
  – Publications rigorously assessed nearly all aspects of our IC platform:
    • HH, *C. difficile*, contact precautions, HCW apparel, BBE, HAIs, SSIs and antimicrobial stewardship

Hess O, Bearman G et al. The Learning Hospital. In Press. ICHE. 2019
Be Clear on the Expectations:
Don’t Oversell Outcomes

Happiness and freedom begin with a clear understanding of one principle. Some things are within your control. And some things are not.

—Epictetus

Infection Prevention for Stoics:
Be clear on what we can and cannot control with respect to reducing healthcare associated infections
Conclusion

• HAIs result in significant morbidity, mortality and cost- obligating us to act

• Getting to Zero HAIs is a soundbite

• Infection prevention science is inexact
  – Even high quality studies have limitations
  – Processes are inconsistently implemented (endemic)
  – Hand hygiene compliance is an ongoing challenge
  – Processes can be controversial
  – Diagnostic strategies and gaming can lead to inexact HAI incidence and false conclusions about preventability
  – Human beings are chaotic systems and do not always respond to linear mechanisms

• Hospital administration is key to achieving safety goals- keeping leaders focused is a challenge
Conclusion

• Perhaps up to 70% of HAIs are preventable
• We should **relentlessly strive** to minimize ‘potentially preventable’ HAIs
  – Consistent with Hippocratic oath *of primum non nocere* and part of the public trust
  – Seek practical (satisfice) solutions for real world
  – Leverage information technology to assist with HAI prevention and surveillance
  – Advocate for sound policies and improvement in infection prevention science
  – Strive for decisions based on cost/benefit (safety)
  – Be aware of new threats to HAI prevention
  – Continuously assess HAI prevention program with rigor
  – Be clear on expected HAI outcomes
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