Infection control, what on the horizon?

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Thanks to Claire Kilpatrick, Bala Hota and Tcheun-How
« To see far is one thing – going there is another »

Constantin Brancusi, 1876–1957
What I am not going to cover...

(... although highly relevant topics)
Unexpected events & challenges for global infection control in the future
Robot-like devices??

Hydrogen peroxide vapor enhances hospital disinfection of superbugs

Release Date: 12/31/2012

Johns Hopkins to begin decontaminating isolation rooms with robotic, vapor-dispersing devices

Infection control experts at The Johns Hopkins Hospital have found that a combination of robot-like devices that disperse a bleaching agent into the air and then detoxify the disinfecting chemical are highly effective at killing and preventing the spread of multiple drug-resistant bacteria, or so-called hospital superbugs.

A study report on the use of hydrogen peroxide vaporizers — first deployed in several Singapore hospitals during the 2002 outbreak of severe acute respiratory syndrome, or SARS, and later stocked by several U.S. government agencies in case of an anthrax attack — is to be published Jan. 1 in the journal Clinical Infectious Diseases.

In the study, the Johns Hopkins team placed the devices in single hospital rooms after routine cleaning to disperse a thin film of the bleaching hydrogen peroxide across all exposed hospital equipment surfaces, as well as on room floors and walls. Results showed that the enhanced cleaning reduced by 64 percent the number of patients who later became contaminated with any of the most common drug-resistant organisms. Moreover, researchers found that protection from infection was conferred on patients regardless of whether the previous room occupant was infected with drug-resistant bacteria or not.

http://www.hopkinsmedicine.org/news/media/releases/hydrogen Peroxide vapor enhances hospital disinfection of superbugs
Where does a *Staphylococcus aureus* vaccine stand?

V. G. Fowler Jr\textsuperscript{1} and R. A. Proctor\textsuperscript{2}

1) Division of Infectious Diseases, Duke University Medical Center, Durham, NC, and 2) Department of Medical Microbiology/Immunology and Medicine, University of Wisconsin School of Medicine and Public Health, Madison, WI, USA

Abstract

In this review, we examine the current status of *Staphylococcus aureus* vaccine development and the prospects for future vaccines. Examination of the clinical trials to date show that murine models have not predicted success in humans for active or passive immunization. A key factor in the failure to develop a vaccine to prevent *S. aureus* infections comes from our relatively limited knowledge of human protective immunity. More recent reports on the elements of the human immune response to staphylococci are analysed. In addition, there is some controversy concerning the role of antibodies for protecting humans, and these data are reviewed. From a review of the current state of understanding of staphylococcal immunity, a working model is proposed. Some new work has provided some initial candidate biomarker(s) to predict outcomes of invasive infections and to predict the efficacy of antibiotic therapy in humans. We conclude by looking to the future through the perspective of lessons gleaned from the clinical vaccine trials.

**Keywords:** Biomarker, outcome, protective immunity, review, *Staphylococcus aureus*, vaccine

**Article published online:** 29 January 2014

*Clin Microbiol Infect* 2014; 20 (Suppl. 5): 66–75
Patient involvement in infection control

Patient empowerment and hand hygiene, 1997–2012

M. McGuckin*, J. Govednik

Review article

Patient-centered hand hygiene: The next step in infection prevention

Timothy Landers RN, PhD a,*, Said Abusalem RN, PhD b, Mary-Beth Coty RN, PhD b, James Bingham MS c

a College of Nursing, The Ohio State University, Columbus, OH
b School of Nursing, University of Louisville, Louisville, KY
GOJO Industries, Inc, Akron, OH

Agenda

- Health-economic focus
- Use of social media
- IT support / CDSS
- Individual risk profiling
- Microbiome research
- Rapid tests and advanced genotyping
2006 Annual Report of The Chief Medical Officer
On the State of Public Health

Dirty hands... the human cost

MAIN FEATURES
Healthcare-Associated Infection
Organ Transplants
Radiotherapy
Intrapartum-Related Deaths
Women in Medicine
Challenging conventional wisdom

1. Excess length of stay & costs related to HCAI
The importance of good measurement: costs

What does one nosocomial infection cost?

- Confounding: Are the two patients different?
- Causality: Did the HCAI increase LoS?
- Timing: Does it matter when the infection occurred?

Courtesy: N Graves
## Comparison of methods for evaluation of excess LOS

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Infection type</th>
<th>HAI non-time-varying</th>
<th>HAI time-varying</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>95% CI</td>
<td>95% CI</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Excess LOS Lower</td>
<td>Excess LOS Lower</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Upper</td>
<td>Upper</td>
</tr>
<tr>
<td>Schulgen (2000) - Study I</td>
<td>Germany</td>
<td>Postoperative wound</td>
<td>18.8 15.7 22.0</td>
<td>9.8 5.7 13.8</td>
</tr>
<tr>
<td>Schulgen (2000) - Study II</td>
<td>Germany</td>
<td>Pneumonia</td>
<td>12.3 9.7 14.9</td>
<td>3.4 0.8 6.0</td>
</tr>
<tr>
<td>Roberts (2010)</td>
<td>US</td>
<td>Mixed</td>
<td>8.1 N/A N/A</td>
<td>5.9 N/A N/A</td>
</tr>
<tr>
<td>Barnett (2011)</td>
<td>Argentina</td>
<td>CLABSI, CAUTI, VAP</td>
<td>11.2 10.1 12.4</td>
<td>1.4 0.8 1.9</td>
</tr>
<tr>
<td>De Angelis (2011)</td>
<td>Suisse</td>
<td>Mixed (MRSA)</td>
<td>24.5 14.5 34.5</td>
<td>6.0 0.0 11.9</td>
</tr>
<tr>
<td>Macedo-Vinas (2013)</td>
<td>Suisse</td>
<td>Mixed (MRSA)</td>
<td>15.3 N/A N/A</td>
<td>11.5 7.9 15.0</td>
</tr>
<tr>
<td>Schumacher (2013)</td>
<td>Germany</td>
<td>Pneumonia</td>
<td>21.9 17.6 26.2</td>
<td>6.2 1.3 9.1</td>
</tr>
</tbody>
</table>

**Absolute diff.**  
Schumacher (2013)  15.7
De Angelis (2011)  18.6
Barnett (2010)    2.2
Roberts (2010)    1.9
Macedo-Vinas (2013) 3.8

**Mean**  9.9

*Source: Nelson RE, ICHE 2015; 2015 Sep;36(9):1089-94*
Challenging conventional wisdom

• Excess length of stay related to HCAI

2 • Loss of hospital revenue by HCAI
Relationship Between Occurrence of Surgical Complications and Hospital Finances

- Retrospective analysis of administrative data for surgical discharges during 2010 from a nonprofit 12-hospital system in the southern USA
- Occurrence of surgical complications was associated with higher hospital revenue:
  + $39,017 (private insurance) or + $1,749 (Medicare)
- Depending on payer mix, efforts to reduce surgical complications may result in worsened financial performance

S Eappen et al, JAMA 2013; 309: 1599-1606
Challenging conventional wisdom

- Excess length of stay related to HCAI
- Loss of hospital income by HCAI and MDRO
- Willingness-to-pay by hospital administration
Two methods are used to estimate the cost of a patient-day
- **Accounting cost**: total costs divided by total patient days
- **Opportunity cost**: amount that would be paid to “free-up” a bed

“Willingness-to-pay” survey was completed by senior financial officers within 11 hospitals in Europe
- Survey developed and piloted by Prof N. Graves in Australia

Several scenarios provided
- Respondents asked to provide a contingent valuation of a hospital bed day
- Valuation weighted by the estimated duration that each scenario applies
Willingness to pay (WTP) was computed by asking for the maximum amount CFOs would pay for an IC program that would release 1,500 bed-days per year.

€123 (€91–€150)
Willingness-to-pay survey: conclusions

- The economic value of a bed-day is lower than the accounting value (by 10x)
- Accounting cost: over-estimate of the amount that could be recovered if the infection had been prevented
- Important implications for those who use accounting costs to value bed-days in cost-effectiveness analyses in infection control

Stewardson AJ et al. ICHE (2014)
Agenda

- Health-economic focus
- Use of social media
Ongoing challenge in today’s IC

- Infection control professionals play key roles in the identification and prevention of nosocomial infections
- ICP act as observers, educators and, ultimately, should become agents of change
- Changing behaviour and shifting social norms through the HCW community are among the key challenges of infection control
social media

noun

websites and applications that enable users to create and share content or to participate in social networking.

(Source: The use of Social Media in support of global infection prevention and control by Claire Kilpatrick and Jules Storr)
Ideas on how IPC might use social media

- Raise awareness
- Global outreach
- Campaigning
- Engage partners & collaborate
- Data collection
- Crowd sourcing & research

(Source: The use of Social Media in support of global infection prevention and control by Claire Kilpatrick and Jules Storr)
• International Infection Prevention Week (#IIPW) on Social Media, 18-24 October 2015

• Antimicrobial Resistance awareness raising (#AMR, #AntibioticResistance) for World Antibiotic Awareness Week, 16-22 November 2015
The #safeHANDS campaign

• The campaign was launched by the WHO on 5th May in 2015

• On several social medias
  – Twitter
  – Instagram
  – Youtube

• In order to raise awareness and promote Hand Hygiene all over the world
The campaign reached more than 51M people around the globe

(Source: http://www.symplur.com/)
Examples (2)

**facebook Group**

- Created in October 2015 with the goal to:
  - Build a community around hand hygiene
  - Encourage people to share
Agenda

- Health-economic focus
- Use of social media
- IT support / CDSS
Fitting More into Less

Courtesy of Andreas Voss, MD, PhD
How do we Measure CLABSIs?

Positive Blood Culture → Detected Infection Episodes → Surrogate for all Episodes (unknown & unknowable)

Administrative:
- Case/Isolate finding
- Episode grouping
- De-duplication
- Assignment of location

Classification:
- Contaminant v. infection
- Primary v. secondary
- Assignment of location

Numerator:
Denominator is Central Vascular Catheter Days

Courtesy of Bala Hota (Chicago)
How do we Measure CLABSIs?

Positive Blood Culture

Detected Infection Episodes

Surrogate for all Episodes (unknown & unknowable)

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Fully Manual Review Process

Manual, Paper Based System – Labor Intensive, Time Consuming
May take up to 1-2 full time people per 200 beds

Courtesy of Bala Hota (Chicago)
How do we Measure CLABSIs?

Positive Blood Culture

Positive Blood Culture

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Detected Infection Episodes

Classification
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Surrogate for all Episodes (unknown & unknowable)

AUTOMATED PROCESS

MANUAL PROCESS

Decision Support System – Still requires manual processes

Courtesy of Bala Hota (Chicago)
How do we Measure CLABSIs?

Administrative
- Case/Isolate finding
- Episode grouping
- De-duplication
- Assignment of location

Classification
- Contaminant v. infection
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- Assignment of location

FULLY AUTOMATED REVIEW PROCESS

Algorithmic Electronic Detection System – Because of the consequences of each event, Must be accurate and benchmark well

Courtesy of Bala Hota (Chicago)
Facilitating Communication for Infection Control

Components of MDRO eTracking for Control

- Bar code I.D. for (at risk) patients
- Link of bar code to microbiology database
- Bar code scanners to evaluate patients at discharge, transfer, or (re)admission
- Treatment based on MDRO status
Agenda

• Health-economic focus
• Use of social media
• IT support / CDSS
• Individual risk profiling
Scoring system to predict the risk of surgical-site infection after colorectal resection

P. Gervaz¹, C. Bandiera-Clerc³, N. C. Buchs¹, M.-C. Eisenring⁴, N. Troillet⁴, T. Perneger² and S. Harbarth³

Table 2 Multivariable logistic regression model for prediction of surgical-site infection after colorectal resection

<table>
<thead>
<tr>
<th></th>
<th>Regression coefficient</th>
<th>Odds ratio</th>
<th>P</th>
<th>Score points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contamination class 3–4 (versus 2)</td>
<td>1.20</td>
<td>3.33 (2.08, 5.32)</td>
<td>&lt;0.001</td>
<td>+1</td>
</tr>
<tr>
<td>Obesity</td>
<td>1.08</td>
<td>2.93 (1.71, 5.03)</td>
<td>&lt;0.001</td>
<td>+1</td>
</tr>
<tr>
<td>Laparotomy (versus laparoscopy)</td>
<td>0.80</td>
<td>2.22 (1.01, 4.88)</td>
<td>0.048</td>
<td>+1</td>
</tr>
<tr>
<td>ASA grade III–IV (versus I–II)</td>
<td>0.60</td>
<td>1.82 (1.14, 2.90)</td>
<td>0.012</td>
<td>+1</td>
</tr>
<tr>
<td>COLA score</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1.00 (reference)</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0.88</td>
<td>2.40 (0.70, 8.26)</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>1.40</td>
<td>4.06 (1.18, 13.92)</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>2.64</td>
<td>14.07 (4.11, 48.14)</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>3.63</td>
<td>37.86 (8.71,164.48)</td>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>
Scoring system to predict the risk of surgical-site infection after colorectal resection

P. Gervaz¹, C. Bandiera-Clerc³, N. C. Buchs¹, M.-C. Eisenring⁴, N. Troillet⁴, T. Perneger² and S. Harbarth³
Complications of sepsis: the role of risk prediction rules, biomarkers and host genetics


Gabrielle M Haeusler and Monica A Slavin*

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The Australasian Society for Infectious Diseases Annual Scientific Meeting
Fremantle, WA, Australia, 21–25 March 2012

The subtitle of the Australasian Society for Infectious Diseases Annual Scientific Meeting was ‘Sailing into the Future’, and speakers from both adult and pediatric infectious diseases explored this theme in relation to the management of sepsis. The future will entail better risk prediction tools for patients at risk for sepsis. Such risk prediction tools are likely to incorporate genetic profiling of the host to identify the groups at highest risk for disease and death. Focused diagnostic testing in these patients will include molecular diagnostics for early detection of infection.
Agenda

- Health-economic focus
- Use of social media
- IT support / CDSS
- Individual risk profiling
- Microbiome research
The Human Microbiome

Infection Control in the Multidrug-Resistant Era: Tending the Human Microbiome

Pritish K. Tosh\textsuperscript{1,2} and L. Clifford McDonald\textsuperscript{2}

\textsuperscript{1}Epidemic Intelligence Service, and \textsuperscript{2}Division of Healthcare Quality Promotion, Centers for Disease Control and Prevention, Atlanta, Georgia

Increasing understanding of the normal commensal microorganisms in humans suggests that restoring and maintaining the microbiome may provide a key to preventing colonization and infection with multidrug-resistant organisms (MDROs). Intact communities of commensals can prevent colonization with MDROs through both competition for space and resources and the complex immunologic and biochemical interactions that have developed between commensal and host over millennia. Current antimicrobials, however, exert tremendous collateral damage to the human microbiome through overuse and broadening spectrum, which has likely been the driving force behind the introduction and proliferation of MDROs. The future direction of infection control and anti-infective therapy will likely capitalize on an expanding understanding of the protective role of the microbiome by (1) developing and using more microbiome-sparing antimicrobial therapy, (2) developing techniques to maintain and restore indigenous microbialota, and (3) discovering and exploiting host protective mechanisms normally afforded by an intact microbiome.
Strategies to harness the human microbiome for MDRO prevention

Distinct but Spatially Overlapping Intestinal Niches for Vancomycin-Resistant Enterococcus faecium and Carbapenem-Resistant Klebsiella pneumoniae

Silvia Caballero¹,², Rebecca Carter¹, Xu Ke³, Bože Sušac¹, Ingrid M. Leiner¹, Grace J. Kim⁴, Liza Miller⁴, Lilan Ling⁴, Katia Manova⁵, Eric G. Pamer¹,²,⁴*
Impact of antibiotic treatment on intestinal colonization with VRE / CR *K. pneumoniae* in mice

**VRE / CRE**

10^8 CFU

**No antibiotics**

<table>
<thead>
<tr>
<th>Days post infection</th>
<th>CFU/g feces</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10^7</td>
</tr>
<tr>
<td>3</td>
<td>10^6</td>
</tr>
<tr>
<td>12</td>
<td>10^5</td>
</tr>
</tbody>
</table>

**Ampicillin**

<table>
<thead>
<tr>
<th>Days post infection</th>
<th>CFU/g feces</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10^11</td>
</tr>
<tr>
<td>3</td>
<td>10^10</td>
</tr>
<tr>
<td>12</td>
<td>10^9</td>
</tr>
</tbody>
</table>

VRE

K. pneumoniae
**FMT**

**CONTROL**

**With FMT**
Randomized, open-label, multicenter phase 2 trial

Adults colonized with ESBL-E and/or CRE

N=32

INTERVENTION
5 days colistin & neomycin p.o.
followed by
fecal microbiota transplantation
(nasogastric tube, pooled frozen preparation from 4 donors)

R

N=32

CONTROL
Agenda

• Health-economic focus
• Use of social media
• IT support / CDSS
• Individual risk profiling
• Microbiome research
• Rapid tests and advanced genotyping
Paradigm Shift

Who would have imagined shrinking a huge laboratory filled with people and equipment onto a single chip the size of a matchbox?
Polymerase-chain reaction/electrospray ionization-mass spectrometry for the detection of bacteria and fungi in bronchoalveolar lavage fluids: a prospective observational study

A. Huttner¹, S. Emonet², S. Harbarth¹,², G. Renzi¹,², L. Kaiser² and J. Schrenzel²

¹) Infection Control Programme, Geneva University Hospitals and Faculty of Medicine and ²) Division of Infectious Diseases, Geneva University Hospitals and Faculty of Medicine, Geneva, Switzerland

Transmission and Effect of Multiple Clusters of Seasonal Influenza in a Swiss Geriatric Hospital

Leonardo Pagani, MD, Yves Thomas, PhD, Benedikt Huttner, MD, Valérie Sauvan, RN, Grigori Notaridis, MD, Laurent Kaiser, MD, Anne Iten, MD, Didier Pittet, MD, and Stephan Harbarth, MD

Figure 1. Weekly attack rate of patients affected by the influenza epidemic from February 3 to April 2, 2012, according to floor (n = 73). Each box represents one case. Boxes marked with X indicate community-acquired cases (influenza onset <72 hours after admission).
Influenza nosocomial dynamics
3-C, February 3 to April 2, 2012. By floor and units

4th floor N=17+6 HCWs

3rd floor N=16+1 HCW

2nd floor N=8+1 HCW

1st floor N=24+8 HCWs

Ground floor N=8

Proven nosocomial cases
Positive cases < 72 h on admission
Cases among HCWs

Legend:
- Proven nosocomial cases
- X Positive cases < 72 h on admission
- Cases among HCWs
Conclusions

• Need for Better Outcomes Research
  – Improved health-economic analyses
• Lots of Infection Control to Do
  • Expanding venues for research & service
• Exciting Developments for Infection Control to Explore, Harness, & Adapt
  • Informatics
  • Human microbiome & molecular diagnostics
• Social Media: moving from basic information dissemination to fully interactive information sharing dialogue
And, of course…..

“Prediction is very difficult, especially if it’s about the future”

Niels Bohr (1885-1962)
Danish Physicist

Lawrence “Yogi” Berra (1925-)
Baseball Great

Dan Quayle (1947-)
Former U.S. Vice President