Infection Control and Hospital Acquired Infections

Keith S. Kaye, MD, MPH
Professor of Medicine, Wayne State University
Corporate Medical Director, Infection Prevention, Hospital Epidemiology and Antimicrobial Stewardship
Detroit Medical Center
Detroit, MI

Overview

• Public reporting and fiscal reimbursements
• Hand hygiene and the environment
• Device-related infections, surgical site infection
• Strategies targeting antimicrobial resistance
  – Active surveillance
  – Chlorhexidine bathing
• Looking to the future
HAI: Scope of the Problem

- Approximately 2 million patients acquire HAI each year in the US
  - ~ 10 HAI/1,000 patient days
  - 90,000 deaths
  - ~ 5 billion dollars/year in attributable cost
- Increasing recognition of HAI as patient safety issue
  - Regulatory – Medicare reimbursements
  - Media – Public reporting of hospital infections
  - Lawyers

HAI Reporting Laws and Regulations

States That Have Enacted Laws Relating to Reporting of Healthcare-Associated Infections

- States with study laws
- Mandates public reporting of infection rates
- Voluntary

Copyright 2008 – Association for Professionals in Infection Control and Epidemiology, Inc.
Please contact apic@apic.org for reprint permission and update requests.
Last updated 3/11/08
MRSA Laws & Pending Legislation - 2010

Highlighted States have Pending and/or Enacted MRSA Legislation

- Enacted MRSA Law
- Pending MRSA Legislation
- Enacted MRSA Law & Pending MRSA Legislation
- Legislature Adjourned Without Enactment

R – Reporting Laws or Bills
S – Screening Laws or Bills
O – Other Laws or Bills (e.g., studies, pilots, other infection control requirements)

Copyright 2008 – Association for Professionals in Infection Control and Epidemiology, Inc.
Permission is hereby granted to reproduce this material in its entirety for educational purposes, provided that credit is given to the Association for Professionals in Infection Control and Epidemiology, Inc.

INDUCTION CONTROL AND HOSPITAL EPIDEMIOLOGY JULY 2007, VOL. 26, NO. 7
ORIGINAL ARTICLE
Underresourced Hospital Infection Control and Prevention Programs: Penny Wise, Pound Foolish?

Deverick J. Anderson, MD, MPH; Kathryn B. Kirkland, MD; Keith S. Kaye, MD, MPH; Paul A. Thacker II, RN; Zena A. Kamfan, MD, Grace Anton, MD; Daniel J. Sexton, MD

TABLE 1. Cost Estimates for Specific Healthcare-Associated Infections (HAIs)

<table>
<thead>
<tr>
<th>HAI type</th>
<th>Weight-adjusted cost per HAI, mean ± SE</th>
<th>Range of published estimates of cost per HAI</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 infection</td>
<td>23,242 ± 5,184</td>
<td>6,908-37,260</td>
</tr>
<tr>
<td>Surgical site infection</td>
<td>10,443 ± 3,249</td>
<td>2,527-29,367</td>
</tr>
<tr>
<td>Catheter-associated urinary tract infection</td>
<td>758 ± 41</td>
<td>728-810</td>
</tr>
</tbody>
</table>

Note. HAIs are defined on the basis of Centers for Disease Control and Prevention criteria. Data are in 2005 US dollars.
Hospital-acquired conditions for potential reduced payment: Finalized by CMS August 2008

- Catheter-associated urinary tract infections
- Vascular catheter-associated blood stream infection (BSI)
  - CMS now has a specific code for central-line vascular catheters (CVC)
- Surgical site infection
  - Mediastinitis after CABG surgery. This infection has a specific complication code
- Selected orthopedic surgeries – Spinal fusion and other surgeries of the shoulder and elbow
- Bariatric surgery for morbid obesity - laparoscopic gastric bypass and gastroenterostomy

www.cms.gov

CMS - Value Based Purchasing Program

- P4P program that links Medicare payment to the quality performance of hospitals
- Performance period began July, 2011
- Payments effected beginning FFY 2013
- Will be phased in over a 3 years
- CMS will calculate two scores for each measure
  - An achievement score and an improvement score
  - A final score for each measure will be the higher of the two scores
- Scores based on process of care, patient experience and outcomes

VBP Process of Care Measures

- AMI–7a - Fibrinolytic Therapy Received Within 30 Minutes of Hospital Arrival
- AMI–8a - Primary PCI Received Within 90 Minutes of Hospital Arrival
- HF–1 - Discharge Instructions
- PN–3b - Blood Cultures Performed in the ER Prior to Initial Antibiotic received in hospital.
- PN–6 - Initial Antibiotic Selection for CAP in Immunocompetent Patient
- SCIP–Inf-1 - Prophylactic Antibiotic Received Within 1 Hour Prior to Surgical Incision
- SCIP–Inf-2 - Prophylactic Antibiotic Selection for Surgical Patients
- SCIP–Inf-3 - Prophylactic Antibiotics Discontinued Within 24 Hours After Surgery
- SCIP–Inf-4 - Cardiac Surgery Patients w/ Controlled 6AM Postoperative Serum Glucose
- SCIP–VTE–1 - Surgery Patients with Recommended Venous Thromboembolism Prophylaxis Ordered
- SCIP–VTE–2 - Surgery Patients Who Received Appropriate Venous Thromboembolism Prophylaxis Within 24 Hours Prior to Surgery to 24 Hours After Surgery
- SCIP–Card - Surgery patients on beta blocker prior to arrival that receive a beta blocker during during the preoperative period

VBP Outcome Measures (FFY 2014)

- Mortality Measures
  - AMI 30-day mortality
  - HF 30-day mortality
  - PN 30-day mortality
- AHRQ PSI and IQI Composite Measures
  - Complication/patient safety for selected indicators (composite)
  - Mortality for selected medical conditions (composite)
- HAC Measures
  - Foreign Object Retained After Surgery
  - Air Embolism
  - Blood Incompatibility
  - Pressure Ulcer Stages III & IV
  - Falls and Trauma (fracture, dislocation, intracranial injury, burn, electric shock)
  - Vascular Catheter-Associated Infections
  - Catheter-Associated Urinary Tract Infection (UTI)
  - Manifestations of Poor Glycemic Control
Medicare Payment Cuts and Payment Adjustments

Infection Control-Defined Infections Used as Quality Metrics: Getting to Zero

- CDC definitions developed for surveillance purposes
  - Overly sensitive, not extremely specific
  - Not always clinically relevant
- These definitions are now being publicly reported, used to determine hospital payments
- Reported on administrative dashboards, balanced scorecard
- Now increasing fiscal impact in P4P programs
- Concerns regarding “gaming the system”
- Surveillance benchmarks less meaningful
- Stay tuned
Hand-Hygiene

- Single most important component to prevent spread of pathogens in the hospital
- Waterless hand hygiene products have improved compliance rates, but rates are still too low
- 100% compliance requires behavior change of healthcare providers, particularly in busy settings
- Inherent challenges with monitoring compliance
  - Often inaccurate, inflated rates reported
- Future surveillance methods include RFID/US technology for monitoring


Role of the Environment

• Environmental sources of contamination/infection
  – Increasingly recognized as sources of infection
• Particularly important with pathogens such as *Clostridium difficile*, Norovirus, *Acinetobacter* spp.
• Bleach preparations are more effective for some pathogens (still need cleaning)
• Latest technology being tested: UV light, hydrogen peroxide vapor

Environmental cleaning

• Adequacy of cleaning of patients’ rooms suboptimal
• Improve monitoring and feedback of efficacy of cleaning
  – Direct observation and culturing not efficient, time-consuming and expensive
• Other options: ATP bioluminescence and fluorescent dyes
  – Monitor process, efficacy of cleaning
Improved Cleaning of Patient Rooms Using a New Targeting Method

Philip C. Carling, Janet L. Briggs, Jeanette Perkins, and Deborah Highlander

Department of Hospital Epidemiology, Carney Hospital, and Boston University School of Medicine, Boston, Department of Hospital Epidemiology, Rehabilitation Hospital of the Cape and Islands, Sandwich, and Department of Hospital Epidemiology, Quincy Medical Center, Quincy, Massachusetts

Clinical Infectious Diseases 2006;42:385–8

Used fluorescent dyes as part of quality improvement process for environmental cleaning

Figure 2. The percentage of high-touch objects cleaned prior to (A) and after (B) educational interventions in 3 hospitals (A, B, and C)
Supplements to Routine Environmental Cleaning

- Disinfection units that decontaminate environmental surfaces

- Must remove debris and dirt in order for these units to be effective

- Two most common methods
  - UV light
  - Hydrogen peroxide (HP)
Room Decontamination Systems: Pros and Cons

• Advantages
  – Effective in eliminating vegetative bacteria
  – Sporicidal (HP > UV light)

• Disadvantages
  – Capital cost
  – Room turnover
  – Does not obviate cleaning

Device-related Infections: Age of the Bundle

• Central-line associated bloodstream infection (CLABSI)

• Ventilator-associated pneumonia (VAP)

• Catheter-associated urinary tract infection (CAUTI)

• Major impact of bundles are realized only when all components are followed
  – Checklist
CLABSI Bundle (IHI)

- Hand Hygiene
- Maximal Barrier Precautions Upon Insertion
- Chlorhexidine (CHG) Skin Antisepsis
- Optimal Catheter Site Selection, with Avoidance of the Femoral Vein for Central Venous Access in Adult Patients
- Daily Review of Line Necessity with Prompt Removal of Unnecessary Lines

www.IHI.org

An Intervention to Decrease Catheter-Related Bloodstream Infections in the ICU

Peter Pronovost, M.D., Ph.D., Dale Needham, M.D., Ph.D., Sean Berenholtz, M.D., David Simopoloi, M.P.H., M.B.A., Haitao Chu, M.D., Ph.D., Sara Congrove, M.D., Bryan Sexton, Ph.D., Robert Hyzy, M.D., Robert Walsh, M.D., Gary Roth, M.D., Joseph Bander, M.D., John Kepros, M.D., and Christine Goeschel, R.N., M.P.A.


<table>
<thead>
<tr>
<th>Study Period</th>
<th>No. of ICUs</th>
<th>Overall</th>
<th>Teaching Hospital</th>
<th>Nonteaching Hospital</th>
<th>&lt;200 Beds</th>
<th>&gt;200 Beds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>55</td>
<td>2.7 (0.6-4.8)</td>
<td>2.7 (1.3-4.7)</td>
<td>2.6 (0.4-9)</td>
<td>2.1 (0-3.0)</td>
<td>2.7 (1.3-4.8)</td>
</tr>
<tr>
<td>During implementation</td>
<td>96</td>
<td>1.6 (0.4-4)</td>
<td>1.7 (0-4.5)</td>
<td>0 (0-3.5)</td>
<td>0 (0-5.8)</td>
<td>1.7 (0-4.3)</td>
</tr>
<tr>
<td>After implementation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0- 3 mo</td>
<td>96</td>
<td>0 (0-3.0)</td>
<td>1.3 (0-3.1)</td>
<td>0 (0-1.6)</td>
<td>0 (0-2.7)</td>
<td>1.1 (0-3.1)</td>
</tr>
<tr>
<td>4-6 mo</td>
<td>96</td>
<td>0 (0-2.7)</td>
<td>1.1 (0-3.6)</td>
<td>0 (0-0)</td>
<td>0 (0-0)</td>
<td>0 (0-3.2)</td>
</tr>
<tr>
<td>7-9 mo</td>
<td>95</td>
<td>0 (0-2.1)</td>
<td>0.8 (0-2.4)</td>
<td>0 (0-0)</td>
<td>0 (0-0)</td>
<td>0 (0-2.2)</td>
</tr>
<tr>
<td>10-12 mo</td>
<td>90</td>
<td>0 (0-1.9)</td>
<td>0 (0-2.3)</td>
<td>0 (0-1.5)</td>
<td>0 (0-0)</td>
<td>0.2 (0-2.3)</td>
</tr>
<tr>
<td>13-15 mo</td>
<td>85</td>
<td>0 (0-1.6)</td>
<td>0 (0-2.2)</td>
<td>0 (0-0)</td>
<td>0 (0-0)</td>
<td>0 (0-2.0)</td>
</tr>
<tr>
<td>16-18 mo</td>
<td>70</td>
<td>0 (0-2.4)</td>
<td>0 (0-2.7)</td>
<td>0 (0-1.2)</td>
<td>0 (0-0)</td>
<td>0 (0-2.6)</td>
</tr>
</tbody>
</table>
CLABSI Prevention: Other Considerations

• Education and training
• Chlorhexidine-impregnated sponge dressings
• Antispetic or antimicrobial-impregnated catheters
• Optimal catheter care
• Antibiotic/alcohol Line Locks

Prevention – Ventilator Bundle

1. Elevation of the Head of the Bed
2. Daily "Sedation Vacations" and Assessment of Readiness to Extubate
3. Daily Oral Care with Chlorhexidine
4. Peptic Ulcer Disease Prophylaxis
5. Deep Venous Thrombosis Prophylaxis

www.ihi.org
VAP: Additional Preventive Methods

- Changing ventilator circuit only when malfunctioning or visibly contaminated
- Use of non-invasive ventilation to reduce need and duration of intubation and mechanical ventilation
- Maintain endotracheal tube cuff pressure 20 cm H₂O or greater

Coffin et al, Infect Cont Hosp Epi, 2008, s31-s40
**VAP Prevention: Other Modalities**

- Continuous intermittent subglottic suctioning
- Silver endotracheal tube
- High Volume Low Pressure ETT with Ultrathin Polyurethane Cuff
- Selective oropharyngeal decontamination and/or selective digestive tract decontamination


**Catheter-Associated Urinary Tract Infection (CA-UTI)**

1. Avoid unnecessary urinary catheters
2. Insert using aseptic technique
3. Maintain catheters based on recommended guidelines (daily care)
4. Review catheter necessity daily and remove promptly

www.ihi.org
CA-UTI: Other Preventive Modalities

• Appropriate insertion methods

• Appropriate management of indwelling catheters

• +/-Silver impregnated catheters

Lo, ICHE, 2008

Surgical Site Infection Prevention: Surgical Care Improvement Project (SCIP)

• SCIP INF 1:
  – Prophylactic antibiotic within one hour prior to surg incision

• SCIP INF 2:
  – Prophylactic antibiotic selection for surgical patients

• SCIP INF 3:
  – Prophylactic antibiotics discontinued within 24 hours after surgery end time (48 hours for cardiac patients)

• SCIP INF 4:
  – Cardiac surgery patients with controlled 6 a.m. postoperative serum glucose

• SCIP INF 6:
  – Surgery patients with appropriate hair removal (no shaving)

• SCIP INF 7:
  – Colorectal surgery patients with immediate postoperative normothermia

www.qualitynet.org
SSI Prevention: Other Modalities

- Conducting SSI surveillance, routine feedback of data to surgeons
- Optimizing surgeon and patient prep
- Adequate sterilization/disinfection of surgical equipment (limiting flash sterilization)
- Traffic control in OR
- Pre-operative bathing with chlorhexidine
- Pre-operative intra-nasal, ooropharyngeal chlorhexidine (CT surgery)
- Supplemental oxygen (colorectal surgery)
- Preoperative screening/decolonization for *Staphylococcus aureus*, methicillin-resistant *S. aureus* (MRSA)

Anderson, ICHE, 2008

- Predominantly surgical cohort (cardiothoracic, orthopedic, general surgery)
- PCR-determined *Staphylococcus aureus* colonization
- 5-day treatment regimen of mupirocin intranasally and chlorhexidine soap applied to entire body for colonized patients
• ~ 60% reduction in all hospital-acquired S. aureus infections
• Infection reduction driven by ~ 80% reduction in SSI (CT, Orthopedics)

Figure 3. Kaplan–Meier Curves Showing Cumulative Hazard of Hospital-Acquired Staphylococcus aureus Infection in the Study Groups.
Data were censored at the end of the follow-up period or at the time of death.

Bad Bugs, No Drugs: No ESKAPE! An Update from the Infectious Diseases Society of America

Helen W. Bausher,1,2 George H. Talbot,3 John S. Bradley4,5 John E. Edwards, Jr.6,7 David Gilbert,4,6,7 Louis B. Rice,1,8 Michael Scheld,1,2 Brad Spellberg,6,9 and John Bartlett10

• Bad Bugs, No Drugs: No ESKAPE
  – Enterococcus faecium (E), Staphylococcus aureus (S), Klebsiella pneumoniae (K), Acinetobacter baumannii (A), Pseudomonas aeruginosa (P), and Enterobacter spp. (E)

• The late-stage clinical development pipeline remains unacceptably lean
  – Some important molecules for problematic pathogens such as MRSA
  – Few novel molecules for other ESKAPE pathogens
  – No new drugs for infection due to multidrug-resistant Gram-negative bacilli (eg, A. baumannii and P. aeruginosa)
  – None represent more than an incremental advance over currently available therapies

Clinical Infectious Diseases 2009; 48:1–12
Barrier Precautions: Do They Work to Limit the Spread of Multi-Drug Resistant Organisms?

- In outbreak settings, gowns/gloves effective in preventing spread of multidrug-resistant organisms (MDROSs)
- In terms of prevention of endemic spread, data are mostly observational
- Success with many different types of MDROs
  - *Clostridium difficile*
  - Methicillin-resistant *S. aureus* (MRSA)
  - Vancomycin-resistant enterococcus (VRE)
  - MDR Gram-negatives (including carbapenem-resistant enterobacteriaceae (CRE), extended-spectrum B-lactamase-producers (ESBLs), *Acinetobacter baumannii*)


Active Surveillance

- Use of “screening” cultures to identify patients colonized with pathogens (usually MDR) of interest
- Goal is to prevent spread in the hospital by identifying patients who are colonized and intervening to prevent spread
- Universal vs targeted strategies
Universal Screening for Methicillin-Resistant *Staphylococcus aureus* at Hospital Admission and Nosocomial Infection in Surgical Patients

- Swiss study
- Prospective cohort, with crossover design
- 12 surgical wards
- Admission screening for MRSA
- Rapid PCR detection of MRSA with contact isolation, decontamination of patients if MRSA positive
- Outcomes: nosocomial invasive MRSA infections

Harbarth et al, JAMA, 2008

![Figure 2. Statistical Process Control Chart](chart.png)

No difference in MRSA acquisition in two groups
Limitations of Swiss MRSA Study

- Low prevalence of MRSA in Switzerland
- High hand hygiene compliance
- Not randomized, single institution

Observational study

- 3 hospitals
- Rapid PCR detection of MRSA upon hospital admission
- Decolonization with bactroban and CHG
- 3 phases: baseline, ICU screening, universal screening
69% reduction in MRSA disease prevalence from baseline

Limitations of Robicsek Study

- Observational: no control arm
- Changes in time to obtain study results during study period
- Single health system
Implementation of “MRSA bundle” nation-wide (universal screening, barrier precautions and culture change)
- New admissions, unit transfers, discharges
- Screening done with selective chromogenic agar or PCR

- 62% reduction in healthcare-associated MRSA in ICUs
- 45% reduction in healthcare-associated MRSA in non-ICUs
Limitations of VA MRSA Study

• Health-system intervention: no control hospital

• No monitoring of compliance with hand hygiene, barrier precautions

• No monitoring of decolonization (left up to treating physician)
• STAR®ICU Trial
• Cluster-randomized controlled trial in ICUs
• Active surveillance + contact precautions vs contact precautions alone (ie usual care)
• Active surveillance screening for MRSA and VRE in ICU upon admission, weekly and upon discharge from ICU
• Primary outcome: ICU-acquired MRSA, VRE colonization or infection

No impact of intervention on MRSA and VRE acquisition
Limitations of STAR*ICU Trial

• Poor compliance with hand hygiene, barrier precautions

• Delay of > 5 days from time surveillance cultures obtained until results returned

• Without and intervention/process to act upon results, active surveillance will have no impact on spread of pathogens

Active surveillance: take home

• Jury is still out
• Universal surveillance not clearly shown to be cost effective
• Targeted active surveillance likely useful in some instances
• Need well defined process behind screening protocol to have any effect
Chlorhexidine Gluconate (CHG)

- Broad-spectrum antimicrobial disinfectant
- Preferred agent for skin preparation prior to insertion of vascular catheter and prior to surgery
- Studied for “source control”, decrease in degree of contamination of patients by problem hospital pathogens

Effectiveness of Chlorhexidine Bathing to Reduce Catheter-Associated Bloodstream Infections in Medical Intensive Care Unit Patients

Susan C. Bleazard, MD; William E. Trick, MD; Ines M. Gonzalez, MD; Ruste D. Lyles, MD; Mary K. Hayden, MD; Robert A. Weinstein, MD

Cross-over study comparing CHG body washes vs soap and water in 2 MICUs

Primary outcome: primary bloodstream infection
Significant reduction in primary BSI in CHG group vs control (4.1 vs 10.4 infection/1000 patient days)

Effect of Chlorhexidine Whole-Body Bathing on Hospital-Acquired Infections Among Trauma Patients

Heather L. Evans, MD, MS; Timothy H. Dellit, MD; Jeannie Chan, PharmD, MS; Avery B. Nathens, MD, PhD; Ronald V. Maier, MD; Joseph Cuschieri, MD

Arch Surg. 2010;145(3):240-246

Observational study, pre/post implementation of CHG cloth bathing in trauma ICU

Main outcomes: VAP, CLABSI and colonization with MDROs
Significant reductions in MRSA (~ 3-fold)
Reductions in Acinetobacter not statistically significant
CLASBI rates significantly reduced

Conclusions

- HAI and MDROs have become more prominent in regulatory, reimbursement and legal arenas
- Hand hygiene and environmental hygiene needs to improved
- Device management has improved greatly
- Novel methods to control spread of MDROs are attractive but not clearly effective and cost-effective (particularly active surveillance)
- Technology and protocols alone will not prevent infections – need compliance with basic process components
Looking to the Future

• Regulation (and more regulation)
• More affordable technology for hand hygiene monitoring, environmental cleaning
• Rise in importance of antimicrobial stewardship
• Commitment to actual “translational” quality will become a necessity for survival of hospitals
  – Infection Prevention and Control needs to seize this opportunity

Thank You!

• Mike Bergiel
• Debbie Decamillo
• George Alangaden
• Emily Toth Martin
• Jack Sobel
• SolutionsX2