Future of Infection Prevention: Predictions, Warnings and Challenges

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HEALTHCARE-ASSOCIATED INFECTIONS: IMPACT

1.7 million infections per year
98,987 deaths due to HAI
- Pneumonia 35,967
- Bloodstream 30,665
- Urinary tract 13,088
- SSI 8,205
- Other 11,062

6th leading cause of death (after heart disease, cancer, stroke, chronic lower respiratory diseases, and accidents)¹

¹ National Center for Health Statistics, 2004

COST ESTIMATES FOR HEALTHCARE-ASSOCIATED INFECTIONS (HAIs)

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

Costs based on literature review 1985-2005, adjusted to US 1995 dollars

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

Changing population of hospital patients
- Increased severity of illness
- Increased numbers of immunocompromised patients
- Increased numbers of older patients
- Shorter duration of hospitalization
- More and larger intensive care units

Growing frequency of antimicrobial-resistant and emerging pathogens

Lack of compliance with hand hygiene and other infection preventive measures (e.g., endoscope)
RISK FACTORS FOR HEALTHCARE-ASSOCIATED INFECTIONS


MRSA
VRE
C. difficile

RISK FACTORS FOR ICU-ACQUIRED INFECTIONS

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pit Catheterization</td>
<td>(1.01-1.43)</td>
</tr>
<tr>
<td>CVP Line</td>
<td>(1.16-1.57)</td>
</tr>
<tr>
<td>Stress Ulcer Prophylaxis</td>
<td>(1.20-1.60)</td>
</tr>
<tr>
<td>Urinary Catheterization</td>
<td>(1.19-1.69)</td>
</tr>
<tr>
<td>Mechanical Ventilation</td>
<td>(1.51-2.03)</td>
</tr>
<tr>
<td>Trauma on Admission</td>
<td>(1.75-2.44)</td>
</tr>
</tbody>
</table>

More HCPs and more invasive devices = higher HAI rates

AGING POPULATION, US

Figure 2. Infection incidence rates for all categories of nosocomial infection per decade of life.
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Changing population of hospital patients
- Increased severity of illness
- Increased numbers of immunocompromised patients
- Shorter duration of hospitalization
- More and larger intensive care units
- Larger step-down units

Growing frequency of antimicrobial-resistant pathogens and emerging pathogen

Lack of compliance with hand hygiene and other infection preventive measures (e.g., endoscope)

EMERGING RESISTANT PATHOGENS: HEALTH CARE FACILITIES

Staphylococcus aureus: Oxacillin (occ. vancomycin, linezolid)
Enterococcus: Penicillin, aminoglycosides, vancomycin, linezolid, daptomycin-quinupristin
Enterobacteriaceae: ESBL producers, carbapenems
Pseudomonas aeruginosa, Acinetobacter sp: Multidrug
Mycobacterium tuberculosis: MDR (INH, rifampin), XDR (multiple)

EMERGING INFECTIOUS DISEASES RELEVANT TO THE HOSPITAL

1977 (US) – Legionnaire’s disease
1978 (US) – Staphylococcal toxic shock syndrome
1996 (England → US) – Variant Creutzfeldt-Jakob disease (vCJD)
2001 (US) – Anthrax (attack via letters)*
2002 (US) – Vancomycin-resistant S. aureus*
2002 (Canada → US) – Hypervirulent C. difficile*
2003 (China → worldwide) – SARS*
2003 (US) – Monkeypox*
2004 (Asia) – Avian influenza (H5N1)*
2006 (Worldwide) – XDR-TB*  * HCWs at risk for infection
2009 Novel H1N1 influenza

RATIONALE FOR HAND HYGIENE

Many infectious agents are acquired via hand contact with contaminated surfaces
- Contact transmission: healthcare (MRSA, VRE), day care (MRSA), home (MRSA, “cold viruses”, herpes simplex)
- Fecal-oral transmission: day care (Shigella, E. coli O157:H7), home (Salmonella, E. coli O157:H7, Cryptosporidium)

Hand hygiene effective in reducing or eliminating transient flora
Hand hygiene demonstrated to be effective in preventing illness (especially fecal-oral diarrheal illnesses) in healthcare facilities, child care centers/homes, and households

~40% of healthcare-associated infections due to cross-transmission
ASSOCIATION BETWEEN HAND HYGIENE COMPLIANCE AND HAI RATES

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

HAI, healthcare-associated infections  *Other infection control measures also instituted

WHAT IS OUR TRACK RECORD ON HANDWASHING IN HEALTHCARE FACILITIES?

A review of 34 published studies of handwashing adherence among healthcare workers found that adherence rates varied from 5% to 81%

The average adherence rate was only 40%

Hand Hygiene Adherence an Institutional Priority

Multidisciplinary Program
- Administrative support (IOC, Executive Staff, Dept Heads)
- Monitor HCWs adherence to policy and provide staff with information about performance
- Provide HCWs with accessible hand hygiene (HH) products to include alcohol based hand rubs
- Education regarding types of activities that result in hand contamination and indications for hand hygiene
- Reminders in the workplace (e.g., posters)
- Considering ways to include HH in management standards (loss of hospital privileges, tickets for non-compliance, coffee coupons)

UNC Hospitals Intensive Care Units: Hand Hygiene Compliance (%), 2003-2009

GI ENDOSCOPIES

Widely used diagnostic and therapeutic procedure
Endoscope contamination during use \((10^9 \text{in}/10^5 \text{out})\)
Semicritical items require high-level disinfection minimally
Inappropriate cleaning and disinfection has lead to cross-transmission
In the inanimate environment, although the incidence remains very low (35 cases of transmission from 1993-2002), endoscopes represent a risk of disease transmission
Endoscope Reprocessing: Current Status of Cleaning and Disinfection

Guidelines
- Society of Gastroenterology Nurses and Associates
- European Society of Gastrointestinal Endoscopy
- British Society of Gastroenterology Endoscopy
- Gastroenterological Society of Australia
- Gastroenterological Nurses Society of Australia
- American Society for Gastrointestinal Endoscopy
- Association for Professional in Infection Control and Epidemiology
- Multi-society Guideline for Reprocessing Flexible GI Endoscopes, 2011
- Centers for Disease Control and Prevention, 2008

TRANSMISSION OF INFECTION

Gastrointestinal endoscopy
- >300 infections transmitted
- 70% agents Salmonella sp. and P. aeruginosa
- Clinical spectrum ranged from colonization to death (~4%)
- Number of reported infections is small, suggesting a very low incidence
- Endemic transmission may go unrecognized

Bronchoscopy
- 90 infections transmitted
- M. tuberculosis, atypical Mycobacteria, P. aeruginosa

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

Limited infection prevention resources
Implementation of guidelines/standards, bundles and new technology demonstrated to reduce HAIs
Public reporting of HAIs
CMS non-reimbursement for HAIs
State and federal laws legislating care issues
- Influenza immunization for staff
- MRSA screening of patients and staff
Greater emphasis on infection prevention by The Joint Commission

INCREASING DEMANDS ON IPs WITH ACCOUNTABILITY

Public expectation of 0 rate of healthcare-associated infections?
Buy in by legislatures and CMS
IP accountability and attention rich but resource poor

IP ACTIVITIES

1975 to 1990
- Surveillance
- Outbreak investigations
- Exposure evaluations
- Education
- JCAHO
- Policy development and review
- Sterilizer monitoring
- Dialysis water

1991 to 2003 (new)
- Targeted surveillance
- OSHA TB
- OSHA Bloodborne
- Molecular epidemiology
- MRSA, VRE
- BT preparedness
- Construction rounds

2004 to 2008 (new)
- IHI bundles
- CMS core measures
- NSQUIP (VAs, others)
- NDNQI (ANA)
- Other CQI initiatives
- MRSA active surveillance
- Unannounced TJC visits
- Avian influenza preparedness
- Endoscope sampling

Future (2009-)
- Public health reporting
- Mandated influenza vaccine
- Mandated MRSA surveillance
- Cost analyses
- Comprehensive surveillance
- Transparency
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SOURCE OF INFECTION PREVENTION STRATEGIES

Centers for Disease Control and Prevention
The Joint Commission
CMS
Institute for Healthcare Improvement (IHI)
Professional Organizations: APIC, SHEA, AAMI, AORN, SGNA, AIA, SGNA, ASGE

INFECTION PREVENTION STRATEGIES

Centers for Disease Control and Prevention
- Prevention of Intravascular Device-Related Infections, 2010
- Prevention of Catheter-Associated UTI, 2009
- Guideline for Isolation Precautions, 2007
- Management of MDR Organisms, 2006
- Preventing HA Pneumonia, 2003
- Environmental Infection Control in HCF, 2003
- Hand Hygiene in Healthcare Settings, 2002
- Prevention of Surgical Site Infections, 1999
- Management of Occupational Exposure to HBV, HCV, HIV, 2002
- Infection Control in Healthcare Personnel, 1998

Society of Healthcare Epidemiology of America (SHEA)
- Management of HCWs Infected with HBV, HCV, HIV, March 2010
- Disinfection and Sterilization of Prion-Contaminated Medical Instruments, February 2010
- Compendium of Strategies to Prevent HAIs, October 2008
  - Surgical Site Infection
  - CLA-Bloodstream Infection
  - Catheter-Associated UTI
  - Ventilator-Associated Pneumonia
  - Clostridium difficile
  - Methicillin-resistant S. aureus

INFECTION PREVENTION STRATEGIES

Institute for Healthcare Improvement

VAP AND CA-BSI BUNDLES

VAP Bundle
Elevation of the head of the bed to between 30 and 45 degrees
Daily “sedation vacation” and daily assessment of readiness to extubate
Pepptic ulcer disease (PUD) prophylaxis
Deep venous thrombosis (DVT) prophylaxis (unless contraindicated)

CA-BSI
Hand hygiene
Maximal barrier precautions
Chlorhexidine skin antisepsis
Optimal catheter site selection, with subclavian vein as the preferred site for non-tunneled catheters
Daily review of line necessity, with prompt removal of unnecessary lines

INFECTION CONTROL INTERVENTIONS

2000: Addition of 2% chlorhexidine/70% isopropyl alcohol (ChoraPrep®) to the central line dressing kit.
2001: Mandatory training for nurses on IV line site care and maintenance.
2003: Full body drape added to central line kit. MD could choose kit containing a catheter impregnated with antiseptic or antibiotic.
2005: 2nd generation impregnated catheter included in all central line kits (except for Neonatal ICU).
2006: Pilot in MICU of IHI bundle to prevent CLA-BSI.
2007: Implementation of the IHI bundle in all ICUs.
2008: Implementation of Infection Control Liaison Program
### UNC HOSPITALS INTENSIVE CARE UNITS, 1999-09

Central Catheter-Associated Bloodstream Infections

- **Infections/1000 Catheter Days**
  - Medical Staff education
  - Evening shift with Chloraprep
  - Nursing education
  - Custom insertion kits with antiseptic catheters

### IMPACT OF UNC REDUCTION IN CLA-BSI, 1999-2008

- **Infections prevented**
  - 887
- **Deaths prevented (based on attributable mortality)**
  - 222 to 266 death preventing (attributable mortality 25% to 30%)
- **Savings (2005 dollars)**
  - $20,615,654

### POTENTIAL ROUTES OF INFECTION

- Skin organisms
  - Endogenous flora
  - Exogenous sources (e.g., health care worker, contaminated device, or patient)
- Contamination of catheter hub
  - Exogenous sources (e.g., health care worker)
  - Resident flora (e.g., from the skin)
- Contaminated fluid
  - Fluid or medication
  - Exogenous sources
  - Manufacturer
- Infection prevention
  - Hematogenous: From distant infection
  - Focal wound, thrombus

### CHG PATCH

- Protective Disk with CHG

#### Bacteria can recolonize the skin and CHG suppresses regrowth
- CHG patch provides contact around the insertion site and 7 day continuous release of CHG provides ongoing antimicrobial protection
- Randomized, controlled trials show CHG patch reduces risk of infection (JAMA 2009;301:1231 and Ann Hematol 2009;88:267)

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### Healthcare Facility HAI Reporting to CMS via NHSN – Current and Proposed Requirements (8/1/2011)

<table>
<thead>
<tr>
<th>HAI Event</th>
<th>Facility Type</th>
<th>Start Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLABSI</td>
<td>Acute Care Hospitals</td>
<td>January 2011</td>
</tr>
<tr>
<td>CAUTI</td>
<td>Acute Care Hospitals</td>
<td>January 2012</td>
</tr>
<tr>
<td>SSI</td>
<td>Acute Care Hospitals</td>
<td>January 2012</td>
</tr>
<tr>
<td>L.V. antimicrobial start (proposed)</td>
<td>Dialysis Facilities</td>
<td>January 2012</td>
</tr>
<tr>
<td>Positive blood culture (proposed)</td>
<td>Dialysis Facilities</td>
<td>January 2012</td>
</tr>
<tr>
<td>Signs of vascular access infection (proposed)</td>
<td>Dialysis Facilities</td>
<td>January 2012</td>
</tr>
<tr>
<td>CAUTI</td>
<td>Inpatient Rehabilitation Facilities</td>
<td>October 2012</td>
</tr>
<tr>
<td>CLABSI (proposed)</td>
<td>Long Term Care Hospitals</td>
<td>October 2012</td>
</tr>
<tr>
<td>MRSA Bacteremia</td>
<td>Acute Care Hospitals</td>
<td>January 2013</td>
</tr>
<tr>
<td>C. difficile LabID Event</td>
<td>Acute Care Hospitals</td>
<td>January 2013</td>
</tr>
<tr>
<td>HCO Influenza Vaccination</td>
<td>Acute Care Hospitals, OP Surgery, ASCs</td>
<td>January 2013</td>
</tr>
<tr>
<td>SSI (proposed)</td>
<td>Outpatient Surgery/ASCs</td>
<td>January 2014</td>
</tr>
</tbody>
</table>

### CMS – HAI DIAGNOSES FOR WHICH REIMBURSEMENT NOT ALLOWED, FY 2009

- Catheter-associated UTI
- Vascular catheter-associated infection
- Surgical Site Infection
  - Coronary artery bypass graft (CABG) - Mediastinitis
  - Bariatric surgery: Laparoscopic gastric bypass, gastroenterostomy, laparoscopic gastric restrictive surgery
  - Orthopedic procedures: Spine, neck, shoulder, elbow

Modified 2/19/2009 – 10 conditions listed – Effective 1 October 2008
http://www.cms.hhs.gov/HospitalAcqCond/06_Hospital-Acquired_Conditions.asp

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**CONCLUSIONS**

Healthcare-associated infections are associated with significant patient morbidity and mortality
- Compliance with infection prevention recommendations needed to prevent HAIs
- Many challenges will impact the incidence of HAIs
CONCLUSIONS

Current challenges
- Increased emphasis on preventing HAIs;
- Increased demands on IP time
- Lack of compliance with hand hygiene and guidelines/policies
- Institution of IHI bundles and other CQI activities
- Public reporting, mandated vaccines, mandated practices
- Multidrug pathogens: VRSA, MDR-GNRs, XDR-TB
- Emerging pathogens: C. difficile, norovirus
- Public desire for 0 rate of healthcare-associated infections
- CMS non-reimbursement for HAIs

CONCLUSIONS

Future
- Gene therapy-genes introduced into human cells
- Xenotransplantation-organs from nonhuman species to human recipients emerged due to shortage of human organs
- Emerging pathogens?
- Influenza pandemic?
- Bioterrorism?

DISCUSSION TOPICS

Impact of healthcare-associated infections
Challenges in infection control

Thank you