Healthcare-Associated Infections

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Arkansas Department of Health

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Objectives

• Review the history of healthcare-associated infections (HAI)
• Summarize National and ADH HAI Programs
• Present and interpret current national and statewide data for various HAI measures
• *Mycobacterium chimaera* is a slow-growing acid-fast bacilli part of the *Mycobacterium avium* complex

• Transmission issue between these devices and this pathogen originally identified in spring of 2015 (6 invasive cases in Switzerland and subsequent cluster in Pennsylvania)

• Recent data show that LivaNova PLC (formerly Sorin Group Deutschland GmbH) units were likely contaminated at time of manufacture

• Patient notification?
Figure 1. Schematic representation of heater–cooler circuits tested for transmission of *Mycobacterium chimaera* during cardiac surgery despite an ultraclean air ventilation system. Blue arrows indicate cold water flow, and red arrows indicate hot water flow and patient blood flow.

Previous HAI Investigations in Arkansas

- Potential drug diversion/Unsafe injection practices at a dental clinic
- Cryptococcus neoformans bloodstream infections from non-immunocompromised patients
- Contaminated methylprednisone from a compounding pharmacy
- Bipolaris wound infections following cardiovascular surgery
- Clostridium difficile
- And many more…
Results of Ebola Preparedness

• Coordination of efforts regarding high consequence pathogens
  – Identification of assessment and treatment facilities

• Training and competency assessments for core infection control principles and use of PPE

• Development of communication network for rapidly evolving situation to distribute updates, guidance, and provide assistance

• Infections anywhere are infections everywhere!
Nosocomial vs HAI

- Nosocomial (hospital-acquired) designation has transitioned to using the acronym HAI
- HAI = Healthcare-Associated Infection
- New term accounts for
  - Additional healthcare facility types
  - Additional infections such as *C Difficile* that are highly associated with antibiotic use, infections from drug diversion and unsafe injection practices, and infections acquired by healthcare workers
A brief history…

• HAIs have co-existed with medicine throughout its development

• Ignaz Semmelweis
  – Vienna 1800s
  – Puerpural Fever
The Intervention: Hand scrub with chlorinated lime solution

Hand hygiene basin at the Lying-In Women's Hospital in Vienna, 1847.
Hand Hygiene: Not a New Concept

Maternal Mortality due to Postpartum Infection
General Hospital, Vienna, Austria, 1841-1850

Semmelweis’ Hand Hygiene Intervention

~ Hand antisepsis reduces the frequency of patient infections ~

Adapted from: Hosp Epidemiol Infect Control, 2nd Edition, 1999
A brief history…

• 1940s - Development of antibiotics and pre-surgery prophylaxis

• 1980s - Dedicated staff to perform infection control work

International Infection Prevention
Week October 16-22, 2016
Public Health and HAI

- Institute for Healthcare Quality Improvement founded in 1991 by Dr. Don Berwick

- 1999 Institute of Medicine’s *To Err is Human* detailed the prevalence of medical errors in US hospitals which included HAIs as a leading cause of mortality
Public Health and HAI

- 2000s – Paradigm shift from believing HAIs to be non-preventable but to preventable
- 2000s – Public health issue
- 2011 – CMS requires central-line associated bloodstream infections be reported as part of the inpatient quality performance program
- 2013 - Hospital specific HAI data is publicly reported on CMS’ Hospital Compare
Prevalence In Hospitals

• ~750,000 HAI infections a year
  – 1 in 25 hospitalized patients a day
• ~75,000 people with an HAI will die during that hospital admission
  – 1 in 9 patients with an HAI
• More than 50% occur outside the ICU
• Device-associated infections account for ~ 25%

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<table>
<thead>
<tr>
<th>Major Site of Infection</th>
<th>Estimated No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonia</td>
<td>157,500</td>
</tr>
<tr>
<td>Gastrointestinal Illness</td>
<td>123,100</td>
</tr>
<tr>
<td>Urinary Tract Infections</td>
<td>93,300</td>
</tr>
<tr>
<td>Primary Bloodstream Infections</td>
<td>71,900</td>
</tr>
<tr>
<td>Surgical site infections from any inpatient surgery</td>
<td>157,500</td>
</tr>
<tr>
<td>Other types of infections</td>
<td>118,500</td>
</tr>
<tr>
<td><strong>Estimated total number of infections in hospitals</strong></td>
<td><strong>721,800</strong></td>
</tr>
</tbody>
</table>

To read the full report, please visit: CDC HAI Prevalence Survey
Prevalence In Nursing Homes

• 1.5 million people live in 16,000 nursing homes
• 2 million infections a year
• Common infections:
  – Urinary tract infections
  – Pneumonia
    • Leading cause of mortality for NH residents
  – Gastrointestinal Infections
    • C Difficile
    • Norovirus
  – Skin & soft tissue infections (Pressure ulcers)

Complex Transmission Dynamics are Possible
Bad Bugs

- Any pathogen can be a HAI
- However, these have a reputation:
  - Enterococcus spp.
  - Staphylococcus aureus
  - C Difficile
  - Acinetobacter spp.
  - Klebsiella spp.
  - Pseudomonas aeruginosa
  - Stenotrophomonas maltophilia
  - E coli
  - Enterobacter spp.
ADH HAI Background

• Before 2007 – No state-sponsored HAI program
• 1st HAI law passed in 2007 – volunteer reporting
• Received ARRA funding in late 2009
  – Provided dedicated staff at ADH to perform HAI work
• 2nd HAI law passed in 2011
  – Mandatory reporting from acute care hospitals
  – Use of the National Healthcare Safety Network
  – Aligned required reporting requirements with those of CMS
HAI Advisory Board

• Formed in 2007
• Membership made up of recognized leaders in infectious disease and infection control from around the state
  – Includes membership from a critical access hospital infection preventionist
• Co-chaired by Dr. Gary Wheeler and Dr. Terry Yamauchi
• Reviewed and submit annual reports to the state legislature
• Key to getting input from outside the department, as well as getting buy-in from Arkansas hospitals
HAI Program Activities

• Provide NHSN data analysis/quality assistance to hospitals
• Collaborate with healthcare facilities and other organizations to prevent HAIs, such as AFMC and AHA
• Provide statewide HAI data to multiple stakeholders including the public
• Coordinate HAI outbreak responses
• Beginning to include promotion of antibiotic stewardship and monitoring of antibiotic resistant pathogens
What is NHSN?

- The National Healthcare Safety Network
- Developed and maintained by CDC
- Secure web-based surveillance system to monitor healthcare-associated conditions from a variety of settings
- As of September 2016, more than 18,950 healthcare facilities are enrolled and providing data
- Used by CMS and states to fulfill reporting requirements

Public Reporting

- Recognition as a public health issue
- Allows for non-biased interpretation of data and assessment of interventions
- Measure progress for prevention by state and nationally
- Promotes a culture of safety
- Data is used for incentives and penalties through CMS Value Based Purchasing and Healthcare Acquired Conditions programs
- Enables the public to make choices
# Current Acute Care Reporting Requirements

<table>
<thead>
<tr>
<th>HAI Event</th>
<th>Reporting Specifications</th>
<th>Reporting Start Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central line-associated bloodstream infections</td>
<td>Adult, Pediatric, and Neonatal ICUs <strong>And other locations</strong></td>
<td>January 2011/15</td>
</tr>
<tr>
<td>Catheter-associated urinary tract infections</td>
<td>Adult and Pediatric ICUs</td>
<td>January 2012</td>
</tr>
<tr>
<td>Surgical Site Infections</td>
<td>Invasive Colon Surgeries Abdominal Hysterectomies</td>
<td>January 2012</td>
</tr>
<tr>
<td>MRSA Bacteremias</td>
<td>Facility-wide</td>
<td>January 2013</td>
</tr>
<tr>
<td>C. Difficile Infections</td>
<td>Facility-wide</td>
<td>January 2013</td>
</tr>
<tr>
<td>Healthcare Worker Influenza Vaccination</td>
<td>Facility-wide</td>
<td>January 2013</td>
</tr>
</tbody>
</table>

Calculating a Standardized Infection Ratio (SIR)

\[
SIR = \frac{\text{Observed (O) HAIs}}{\text{Predicted (P) HAIs}}
\]

- To calculate O, sum the number of HAIs among a reporting entity.
- To calculate P, requires the use of the appropriate aggregate data from a standard population.

<table>
<thead>
<tr>
<th>If the SIR:</th>
<th>It means that:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equals 1</td>
<td>The state had infections at the same rate as would be predicted from national rates</td>
</tr>
<tr>
<td>Is higher than 1</td>
<td>The state had more infections than predicted from national rates</td>
</tr>
<tr>
<td>Is less than 1</td>
<td>The state had fewer infections than predicted from national rates</td>
</tr>
</tbody>
</table>

Risk Adjustment

- Predicted number of infections is risk-adjusted to account for the size, type, and acuity of patients cared for at a healthcare facility.

- Some factors used for the various measures include:
  - Bed size
  - Medical school affiliation (Medical and Graduate)
  - Community prevalence of disease
  - Sensitivity of test method for laboratory identified measures (i.e. rapid vs molecular)
<table>
<thead>
<tr>
<th>HAI Metric</th>
<th>Number of observed infections</th>
<th>SIR</th>
<th>SIR Interpretation as compared to national baseline</th>
<th>Number of Infections needed to be prevented to meet national goals*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central line-associated bloodstream infections (CLABSI)</td>
<td>260</td>
<td>0.66</td>
<td>↓ 34%</td>
<td>65</td>
</tr>
<tr>
<td>Catheter-associated urinary tract infections (CAUTI)</td>
<td>183</td>
<td>0.63</td>
<td>↓ 37%</td>
<td></td>
</tr>
<tr>
<td>Surgical Site Infections (SSI) after colon surgeries</td>
<td>87</td>
<td>0.93</td>
<td>↓ 7%</td>
<td>17</td>
</tr>
<tr>
<td>Surgical Site Infections (SSI) after abdominal hysterectomies</td>
<td>17</td>
<td>0.49</td>
<td>↓ 51%</td>
<td></td>
</tr>
<tr>
<td>MRSA bloodstream infections</td>
<td>94</td>
<td>1.09</td>
<td>↑ 9%</td>
<td>30</td>
</tr>
<tr>
<td><em>Clostridium difficile</em> infections (CDI)</td>
<td>628</td>
<td>0.67</td>
<td>↓ 33%</td>
<td></td>
</tr>
</tbody>
</table>

This data was collected and analyzed using the Center for Disease Control and Prevention’s National Healthcare Safety Network.

*National prevention goals have been set by the US Department of Health and Human Services in the 2013 National Action Plan to Prevent Healthcare-Associated Infections: Road Map to Elimination. These goals represent a decrease beyond the national baseline (SIR =1.0) The SIR goals are 0.5 for CLABSI, 0.75 for CAUTI, both SSI, MRSA bloodstream infections, and 0.70 for CDI.
• How can you find out your own facility’s data?
• ADH is not allowed to release facility-identifiable data
• Hospital Compare is run by CMS and includes required HAI reporting from NHSN
• https://www.medicare.gov/hospitalcompare/search.html
<table>
<thead>
<tr>
<th>Infection Type</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central line-associated bloodstream infections (CLABSI) in ICUs and select wards</td>
<td>Better than the National Benchmark</td>
</tr>
<tr>
<td>Central line-associated bloodstream infections (CLABSI) in ICUs only</td>
<td>Better than the National Benchmark</td>
</tr>
<tr>
<td>Catheter-associated urinary tract infections (CAUTI) in ICUs and select wards</td>
<td>Better than the National Benchmark</td>
</tr>
<tr>
<td>Catheter-associated urinary tract infections (CAUTI) in ICUs only</td>
<td>Better than the National Benchmark</td>
</tr>
<tr>
<td>Surgical site infections from colon surgery (SSI: Colon)</td>
<td>No Different than National Benchmark</td>
</tr>
<tr>
<td>Surgical site infections from abdominal hysterectomy (SSI: Hysterectomy)</td>
<td>No Different than National Benchmark</td>
</tr>
<tr>
<td>Methicillin-resistant <em>Staphylococcus Aureus</em> (MRSA) Blood Laboratory-identified Events (Bloodstream infections)</td>
<td>Worse than the National Benchmark</td>
</tr>
<tr>
<td><em>Clostridium difficile</em> (C.diff.) Laboratory-identified Events (Intestinal infections)</td>
<td>No Different than National Benchmark</td>
</tr>
</tbody>
</table>
## Table 7 of 8 Methicillin-resistant *Staphylococcus aureus* (MRSA) Blood Laboratory-identified Events (Bloodstream infections)

<table>
<thead>
<tr>
<th></th>
<th>No. of Infections Reported (A)</th>
<th>Number of Patient Days (B)</th>
<th>Predicted No. Infections (B)</th>
<th>Standardized Infection Ratio (SIR) (A/B)</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HOSPITALS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of Infections Reported (A)</td>
<td>47</td>
<td>352764</td>
<td>23.269</td>
<td>2.020</td>
<td>Worse than the National Benchmark</td>
</tr>
</tbody>
</table>

Standardized infection ratio (SIR) national benchmark = 1. Lower SIRs are better. A score of (0) – meaning no MRSA infections – is best.

## Table 8 of 8 *Clostridium difficile* (C.diff.) Laboratory-identified Events (Intestinal infections)

<table>
<thead>
<tr>
<th></th>
<th>No. of Infections Reported (A)</th>
<th>Number of Patient Days (B)</th>
<th>Predicted No. Infections (B)</th>
<th>Standardized Infection Ratio (SIR) (A/B)</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HOSPITALS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of Infections Reported (A)</td>
<td>284</td>
<td>313610</td>
<td>287.313</td>
<td>0.988</td>
<td>No Different than National Benchmark</td>
</tr>
</tbody>
</table>

Standardized infection ratio (SIR) national benchmark = 1. Lower SIRs are better. A score of (0) – meaning no C.diff. infections – is best.
Antibiotic Resistance Perspective

• Many state healthcare-associated infections (HAI) programs around the country have begun to:
  – incorporate antimicrobial resistance surveillance
  – promotion of antimicrobial stewardship into core functions

• HAI programs face barriers due to their increased efforts to identify and to prevent emerging HAIs

• **Public Health vs Clinical**
Four Core Actions to Prevent Resistance

- Preventing infections
- Tracking
- Improving antimicrobial prescribing/stewardship
- Developing new drugs and diagnostic tests

Preventing Infections

Keep Calm and Wash Your Hands

I do a lot of things to stay healthy, including getting vaccinated.

Who are infection preventionists?
Infection preventionists use their detective skills to find the bad germs and make sure everyone is doing the right things to keep you safe.

Calumers or other devices will be placed in your body after your skin receives proper cleaning.

Healthcare workers will clean their hands before and after they care for you.

Your healthcare workers will wear gowns, gloves, and masks at the right times.

You are in isolation, you and your visitors may need to do this too.

Every year, thousands of adults in America suffer serious health problems from diseases they could have been vaccinated against like measles, whooping cough, hepatitis A and B, flu, and pneumococcal disease. Some even die.

Talk with your doctor about which vaccines are right for you.

Learn more at cdc.gov/vaccines/adults or call 1-800-CDC-INFO (1-800-232-4636).
Identifying Resistance

E-test

https://www.biomerieux-diagnostics.com/etest

Kirby-Bauer test


PCR (Polymerase Chain Reaction)


*Dark blue category represents 966-1281 prescriptions per 1000 persons

Antibiotic prescribing per 1000 persons by state in 2011 for all ages (A)

CDC 2013 Threat Report

ANTIBIOTIC RESISTANCE THREATS in the United States, 2013

HAZARD LEVEL
- **URENT**
  - These are high-consequence antibiotic-resistant threats because of significant risks identified across several criteria. These threats may not be currently widespread but have the potential to become so and require urgent public health attention to identify infections and to limit transmission.
  - *Clostridium difficile* (*C. difficile*), Carbapenem-resistant Enterobacteriaceae (CRE), Drug-resistant *Neisseria gonorrhoeae* (*cephalosporin resistance*)

HAZARD LEVEL
- **SERIOUS**
  - These are significant antibiotic-resistant threats. For varying reasons (e.g., low or declining domestic incidence or reasonable availability of therapeutic agents), they are not considered urgent, but these threats will worsen and may become urgent without ongoing public health monitoring and prevention activities.

HAZARD LEVEL
- **NCERNING**
  - These are bacteria for which the threat of antibiotic resistance is low, and/or there are multiple therapeutic options for resistant infections. These bacterial pathogens cause severe illness. Threats in this category require monitoring and in some cases rapid incident or outbreak response.
  - Vancomycin-resistant *Staphylococcus aureus* (VRSA), *Erythromycin-resistant Streptococcus Group A*, Clindamycin-resistant *Streptococcus Group B*
### List of Antimicrobial Resistant Pathogens of Interest Based on Level of Concern

<table>
<thead>
<tr>
<th>Level</th>
<th>Pathogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urgent –</td>
<td><em>Clostridium difficile</em> *Carbapenem-resistant Enterobacteriaceae (CRE) *</td>
</tr>
<tr>
<td></td>
<td>Drug-resistant <em>Neisseria gonorrhoeae</em> (cephlasporin resistance)</td>
</tr>
<tr>
<td>Serious –</td>
<td>Multidrug-Resistant Acinetobacter *</td>
</tr>
<tr>
<td></td>
<td>Drug-Resistant Campylobacter</td>
</tr>
<tr>
<td></td>
<td>Fluconazole-Resistant Candida *</td>
</tr>
<tr>
<td></td>
<td>Extended Spectrum Enterobacteriaceae (ESBL) *</td>
</tr>
<tr>
<td></td>
<td>Vancomycin-Resistant Enterococcus (VRE) *</td>
</tr>
<tr>
<td></td>
<td>Multidrug-Resistant <em>Pseudomonas aeruginosa</em> *</td>
</tr>
<tr>
<td></td>
<td>Drug-Resistant Non-Typhoidal Salmonella</td>
</tr>
<tr>
<td></td>
<td>Drug-Resistant Salmonella Serotype Typhi</td>
</tr>
<tr>
<td></td>
<td>Drug-Resistant Shigella</td>
</tr>
<tr>
<td></td>
<td>Methicillin-Resistant <em>Staphylococcus aureus</em> (MRSA) *</td>
</tr>
<tr>
<td></td>
<td>Drug-Resistant <em>Streptococcus pneumoniae</em> *</td>
</tr>
<tr>
<td></td>
<td>Drug-Resistant <em>Tuberculosis</em></td>
</tr>
<tr>
<td>Concerning-</td>
<td>Vancomycin-Resistant <em>Staphylococcus aureus</em> (VRSA)</td>
</tr>
<tr>
<td></td>
<td>Erythromycin-Resistant Group A *Streptococcus</td>
</tr>
<tr>
<td></td>
<td>Clindamycin-Resistant Group B *Streptococcus</td>
</tr>
</tbody>
</table>

Pathogens listed with a * have been identified in Arkansas from HAI reports

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Laboratory Identified MRSA Bloodstream Infections from Arkansas Acute Care Hospitals reported to the National Healthcare Safety Network

<table>
<thead>
<tr>
<th>Year</th>
<th>Source</th>
<th>Pathogen</th>
<th>Community Onset</th>
<th>Healthcare Onset</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>Blood</td>
<td>MRSA</td>
<td>627 (84%)</td>
<td>117 (16%)</td>
<td>737</td>
</tr>
</tbody>
</table>

- **Community-onset**: 84%
- **Healthcare-onset**: 16%

- Community-onset
- Healthcare-onset
Laboratory Identified C Difficile Infections from Arkansas Acute Care Hospitals reported to the National Healthcare Safety Network

<table>
<thead>
<tr>
<th>Year</th>
<th>Source</th>
<th>Pathogen</th>
<th>Community Onset</th>
<th>Community Onset-Healthcare Facility Associated</th>
<th>Healthcare Onset</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>Stool</td>
<td>C Difficile</td>
<td>1210 (53%)</td>
<td>355 (16%)</td>
<td>720 (32%)</td>
<td>2285</td>
</tr>
</tbody>
</table>

Unpublished Arkansas aggregate data from CDC’s National Healthcare Safety Network.
Social Network

- Healthcare facilities are not islands but interconnected
- Knowledge and disease sharing
- Public health relies on healthcare facilities, laboratories, clinicians, healthcare workers, and communities to alert us of clusters or unusual infections to respond locally and statewide
- Not all social networks overlap and health departments can play a key role in facilitating communication
Emergence & Rapid Regional Spread of *K. pneumoniae* Carbapenemase-Producing Enterobacteriaceae

*Hospital and Long-term Care Interrelations*

**Social Network** depiction of LTACH, Nursing Home, & Hospital spread of KPC (Carbapenem-resistant *Klebsiella pneumoniae*)

### Legend
- LTACH
- Nursing Home
- Acute Hospital
- Patient

**LTACH, Long term acute care hospital; MDRO, Multidrug resistant organism**


Slide developed by the Centers for Disease Control and Prevention
Facilities work together to protect patients.

**Common Approach (Not enough)**

- Patients can be transferred back and forth from facilities for treatment without all the communication and necessary infection control actions in place.

**Independent Efforts (Still not enough)**

- Some facilities work independently to enhance infection control but are not often alerted to antibiotic-resistant or *C. difficile* germs coming from other facilities or outbreaks in the area.
- Lack of shared information from other facilities means that necessary infection control actions are not always taken and germs are spread to other patients.

**Coordinated Approach (Needed)**

- Public health departments track and alert health care facilities to antibiotic-resistant or *C. difficile* germs coming from other facilities and outbreaks in the area.
- Facilities and public health authorities share information and implement shared infection control actions to stop spread of germs from facility to facility.

An estimated 619,000 infections and 37,000 deaths over 5 years could be averted.

ICAR Visits

• New initiative funded by CDC
• On-site visits to assess infection control program and provide guidance and resources
• Data is being collected nationally to develop education and programs to mitigate common gaps
• Goal is to increase infection control capacity around the state, build collaboration and communication between ADH and facilities, and improve efforts to prevent HAIs and resistant infections
Conclusion

• HAI is an issue ($)$
• Tools exist to improve
• Collaboration/Leadership are needed to move forward
Questions?

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