Battling Superbugs: Infection Control and Multi-drug Resistant Organisms (MDROs) in Long-term Care

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for the
Drug-Resistant Organism Prevention and Coordinated Regional Epidemiology (DROP-CRE) Network
Learning Objectives

• Be familiar with the basic concepts of antibiotic resistance and infection control

• Be aware of the emerging problem of carbapenem-resistant Enterobacteriaceae (CRE) and how it relates to long-term care

• Be aware of the new DROP-CRE Network to support MDRO response in Oregon
General Principles of Antibiotic Resistance
Antibiotic resistance

• Genetic mutation

• Decreased susceptibility to antibiotics

• Inherent or acquired
Why do we care about antibiotic resistance?

• Patients with resistant infections tend to have worse outcomes than patients with susceptible or no infections
  – Morbidity
  – Mortality
  – Costs
Why the increased risk?

• Treatment failure

• Resistant bacteria are more virulent

• Fewer treatment options
  – Inappropriate antibiotic therapy

• Confounding by severity illness
Spread of Antibiotic Resistance

• Patient-to-Patient Transmission

• Antibiotic Pressure
Patient-to-Patient Transmission

• Direct (rare)

• Indirect
  – Healthcare workers hands or clothing
  – Fomites (e.g. environmental surfaces)
Antibiotic selective pressure

- People are colonized with both susceptible and resistant bacteria
- Antibiotics kill antibiotic-susceptible bacteria
- Antibiotic-resistant bacteria are not killed
- Fill the void left by killed susceptible bacteria
Infections and Antibiotic Resistance in Older People
Older people at increased risk of acquisition and development of infections

- Decreased immunity
- Increased exposure to healthcare settings
- Increased usage of broad spectrum empiric antibiotic therapy
Other issues

• Decreased immune response and cognitive ability often mask symptoms

• Positive cultures in older people may not represent infection (e.g. urine cx)

• Certain drugs are favored because of better bioavailability (e.g. quinolones)
General Principles of Infection Control
Colonization and Infection

Infected patients

Colonized patients
Types of Infection Control Interventions

- Education
- Active surveillance
- Passive surveillance
- Standard and/or Contact Precautions
- Decolonization
- Environmental Decontamination
- Antimicrobial Stewardship
Active vs. Passive Surveillance

• Active surveillance relies on culturing patients to assess colonization and not infection

• Depending on patient population, ratio of colonized to infected will vary

• Colonized patients placed on contact isolation precautions
8 key elements of Standard Precautions

1. Hand hygiene
2. Personal Protective Equipment (PPE)
3. Respiratory Hygiene/Cough Etiquette
4. Safe injection practices
5. Environmental controls
6. Safe laundry practices
7. Resident placement (private/cohort)
8. Waste management

Standard Precautions: When should hand hygiene be performed?

- Before and after physical contact with a resident
- Before donning gloves and after removing gloves
- After handling soiled or contaminated items and equipment, including linens
- Before performing an invasive procedures
- Before handling sterile or clean supplies
- When hands are visibly dirty or soiled with blood and/or bodily fluids*
- After care of a resident with known or suspected infectious diarrhea*
- Before and after eating or handling food*

*Personal use of bathroom*

*Situations where soap and water preferred over alcohol-based hand rub
Standard Precautions: When should PPE be used?

Gloves:
• Before *any possible* contact with blood or body fluids, mucous membranes (eyes, nose, mouth) or potentially infectious materials such as contaminated medical equipment or waste

Face masks or shields
• To protect eyes during situations where blood or body fluids may spray or splatter

Gowns
• To protect skin and clothing during situations where blood or body fluids may spray or splatter or care of resident could result in contamination of skin/clothing
Contact Precautions

• Hand Hygiene
  – Before/after PPE use
  – During resident care as appropriate (e.g. if gloves changed)

• Use of gown and gloves for direct resident care
  – i.e. not just for potential contact with body fluids
  – Don prior to room entry
  – Remove prior to room exit

• Dedicating non-essential items for resident care
  – May help decrease transmission due to contamination
  – Blood pressure cuffs; Stethoscopes; IV poles and pumps

• Private rooms or cohorting residents if possible
Challenges with Contact Precautions in LTC

• Lack of private rooms / limited ability to move residents
  – Moving people is disrupting to residents and staff
  – Ability to identify carriers to cohort is limited (no active surveillance in most facilities)

• Determining duration of contact precautions
  – Unable to restrict resident mobility and participation in social events/therapy for prolonged periods
  – Unlikely to document clearance of carriage

• Large population of residents with unrecognized MDRO carriage
  – Underestimating the sources of potential transmission
Strategic placement of residents based on risk factors

• New roommate assignments on resident characteristics and history of MDRO carriage
  – Try to avoid placing two high risk residents together
  – May be safer to cohort low-risk and high-risk residents

• Don’t necessarily change stable room assignments just because of a new culture result unless it now poses new risk
  – Roommates who’ve been together for a long time have already had opportunity to share organisms in the past (even if you only learned about it recently)
Resident Characteristics to Consider: “5 C’s”

- **Cognitive function** (understands directions)
- **Cooperative** (willing and able to follow directions)
- ** Continent** (of urine or stool)
- **Contained** (secretions, excretions or wounds)
- **Cleanliness** (capacity for personal hygiene)
Consider contact precautions during direct care

• High risk exposures for MDRO transmission if known carrier (also high risk for acquisition if non-carrier)
  – Presence of wounds (fresh/new, multiple, increased stage/size, active drainage)
  – Indwelling devices (IV lines, urinary catheters, tracheostomy, PEG tubes)
  – Incontinence
  – Current antibiotic use
Consider contact precautions and restricted movement within NH

- Active symptoms of a contagious infection
  - Nausea/vomiting
  - New or worsening diarrhea
  - New or worsening respiratory symptoms
  - New, undiagnosed fever

- Precautions and restrictions can be time-limited
  - Only until diagnosis made (e.g. infection excluded) and/or symptoms resolve
Discontinuing Contact Precautions

• There is no single ‘best’ strategy for discontinuation of contact precautions for MDRO carriers (in any setting)

• Typically, would resume standard precautions once high-risk exposures or active symptoms have discontinued

• Communication to care-givers and clear documentation of rationale is key
Practical Tips

• Maintain an ongoing database of residents with a history of prior MDRO carriage
• Incorporate assessment of risk factors for MDRO carriage or acquisition into resident care planning
• Outline protocols for implementation and discontinuation of contact precautions
• Regularly assess staff knowledge of MDRO transmission and steps for prevention
• Hand hygiene, hand hygiene, hand hygiene...
Carbapenem-resistant Enterobacteriaceae (CRE)
Enterobacteriaceae

• Normal human gut flora & environmental organisms

• More than 70 species
  • *E. coli*
  • *Klebsiella*

• Range of human infections: UTI, wound infections, pneumonia, bacteremia
Carbapenem-resistant Enterobacteriaceae

• Carbapenems
  – Doripenem
  – Meropenem
  – Imipenem
  – Ertapenem

• Major Genetic Mutations
  • KPC (*Klebsiella pneumoniae* carbapenamase)
  • NDM (New Delhi metallo-beta-lactamase)

CDC, unpublished data
KPC-producing CRE in the United States (2012)

CDC, unpublished data
CDC: 'Nightmare bacteria' spreading

By William Hudson, CNN
updated 11:02 AM EST, Thu March 7, 2013

CDC warns about drug-resistant bug CRE

STORY HIGHLIGHTS
- Deadly bacteria are called carbapenem-resistant Enterobacteriaceae
- 59% of patients with CRE bloodstream infections die
- CDC has issued a “detect and protect” plan for doctors, hospitals

(CNN) -- Hospitals need to take action against the spread of a deadly, antibiotic-resistant strain of bacteria, says the Centers for Disease Control and Prevention. The bacteria kill up to half of patients who are infected.

The bacteria, called carbapenem-resistant Enterobacteriaceae or CRE, have increased over the past decade and grown resistant to even the most powerful antibiotics, according to the CDC. In the first
KPC Point Prevalence Survey - Chicago

- Hospitals with >10 ICUs and 7 LTACHs
- Two point prevalence surveys (2010 and 2011)

- Results
  - All LTACHs and 15/24 hospitals had at least one patient with KPC
  - In acute care, 3.3% of patients colonized (30/909)
  - In LTACH, 30.4% of patients colonized (119/391)
KPC Point Prevalence Survey - Chicago

Distribution of KPC+ patients across length of stay, at LTACHs

Number of patients

Length of stay (days)

- KPC-pos
- KPC-neg
- % KPC+
- Linear (% KPC+)

y = 0.031x + 0.1394
Prevalence of CRE Colonization following transfer from LTCFs to Acute Care

- Patients transferred to 4 acute-care hospitals
  - 180 patients transferred from LTCFs
  - 180 patients admitted from the community (matched age, clinical service, date)

- Rectal swabs (<3 days) to assess KPC prevalence

- No community patients colonized
- 8.3% of LTCF patients were colonized

Prabaker K et al. ICHE 2012; 33:1193-1199
CRE Prevalence in LTCF: By Type

Prevalence of CRE Carriage at admission to 4 acute-care hospitals

- SNF: 1.5%
- VSNF: 27.3%
- LTACH: 33.3%
- LTCF overall: 8.3%

0% from those admitted to the community

Prabaker K et al. ICHE 2012; 33:1193-1199
Why are CRE Clinically and Epidemiologically Important?

- Infections are associated with high mortality rates
- Resistance is highly transmissible
  - Between organisms (plasmids)
  - Between patients
- Treatment options are limited
  - Pan-resistant strains have been identified
  - Few new agents in the antibiotic pipeline
- Potential for spread into the community
  - *E. coli* common cause of community infection
Prevention

http://www.cdc.gov/hai/organisms/cre/cre-toolkit/
Types of Infection Control Interventions

- Education
- Active surveillance
- Passive surveillance
- Standard and/or Contact Precautions
- Decolonization
- Environmental Decontamination
- Antimicrobial Stewardship
Surveillance and Definitions

• Facilities/Regions should have an awareness of the prevalence of CRE in their facility/region

• Should concentrate on *Klebsiella* and *E. coli*

• Definition* (based on 2012 CLSI definitions):
  • Non-susceptible to one of the carbapenems (doripenem, meropenem, imipenem)
  • Resistant to ANY 3rd generation cephalosporins tested
  • PCR-positive or phenotypic (Modified Hodge Test) for carbapenemase

*The Oregon definition is broader; the goal is to detect all cases of carbapenemase-positive CRE
Active Surveillance for CRE

• Used to identify unrecognized CRE colonization among contacts of CRE patients

• Stool, rectal, peri-rectal

• Link to laboratory protocol
  http://www.cdc.gov/ncidod/dhqp/pdf/ar/Klebsiella_or_E.coli.pdf

• Applicable to both acute and long-term care settings

• Description of types
  • Point prevalence survey
    • Rapid assessment of CRE Prevalence on particular wards/units
    • Might be useful if lab review identifies one or more previously unrecognized CRE patient on a particular unit
  • Screening of epidemiologically linked patients
    • Roommates
    • Patients who shared primary HCP
Surveillance Sites

• Rectal appears to be most sensitive (68% to 97%)

• Skin (axillae/inguinal) can also be colonized with CRE and can add to sensitivity if sampled

Thurlow C et al. ICHE 2013;34:56-61
## Sensitivity of Sites for Surveillance Culturing

**Table 2. Sensitivity of Culture of Different Anatomic Sites for *Klebsiella pneumoniae* Carbapenemase–Producing Enterobacteriaceae**

<table>
<thead>
<tr>
<th>Site</th>
<th>No. of positive cultures (N = 24)</th>
<th>Sensitivity, % (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin sites</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I nguinal</td>
<td>19</td>
<td>79 (58–93)</td>
</tr>
<tr>
<td>Axillary</td>
<td>18</td>
<td>75 (53–90)</td>
</tr>
<tr>
<td>Upper back</td>
<td>6</td>
<td>25 (10–47)</td>
</tr>
<tr>
<td>Antecubital fossae</td>
<td>6</td>
<td>25 (10–47)</td>
</tr>
<tr>
<td>Nonskin sites</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rectal¹</td>
<td>21</td>
<td>88 (68–97)</td>
</tr>
<tr>
<td>Urine (N = 19)²</td>
<td>10</td>
<td>53 (29–76)</td>
</tr>
<tr>
<td>Oropharyngeal/tracheal secretions</td>
<td>10</td>
<td>42 (22–63)</td>
</tr>
<tr>
<td>Combined sites</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rectal and inguinal</td>
<td>24</td>
<td>100 (86–100)</td>
</tr>
<tr>
<td>Rectal and axillary</td>
<td>23</td>
<td>96 (79–100)</td>
</tr>
<tr>
<td>Axillary and inguinal</td>
<td>22</td>
<td>92 (73–99)</td>
</tr>
</tbody>
</table>

**Note.** CI, confidence interval.

¹ Three patients had negative rectal swab cultures but positive cultures of inguinal skin.

² Five patients were anuric, so urine was not collected for culture.

Thurlow C et al. ICHE 2013;34:56-61
Duration of Contact Precautions

- 33 LTCF patients colonized with MDR GNB followed for 1 year with serial (q 3 to 4 week rectal swabs)
  - Clearance of MDR GNB in 3/33 (9%)
  - Median duration of colonization 144 days

Chlorhexidine Bathing

• Limited evidence for CRE
  • Used effectively in outbreak in LTAC as part of a package of interventions

• Applied to all patients regardless of CRE colonization status

• Has shown decrease transmission of MRSA and VRE

Munoz-Price et al. ICHE 2010;31:341-7
Environment as Source for CRE Transmission

- Anecdotal associations in outbreaks
  - Equipment from physical therapy room

- One study in 6 LTACHs included 371 environmental samples
  - 2 (0.5%) positive for CRE
  - Bed rail and call button
  - Of note, 57 grew other CR Gram-negative bacilli (primarily *Acinetobacter baumannii*)

Thurlow C et al. ICHE 2013;34:56-61
Environment as Source for CRE Transmission

- Cultures of environmental samples from rooms of CRE carriers
- Sampled pillow, groin, legs, bedside table and infusion pump on 2 wards
  - 18% to 29% positive for CRE
- Proximity to patient and prior to cleaning predictive of

CRE Environmental Contamination

- Acute care hospital in Israel
- Cultures of environmental sites in rooms of CRE colonized patients

- 14 sites were cultured 6 times
  - bed linen around the head (pillow), crotch, and legs
  - personal bedside table;
  - infusion pump; personal chair
  - dedicated stethoscope
  - electrical outlet line
  - suction machine; respirator
  - cardiovascular monitor screen
  - pulse oximeter
  - manual respirator bag
  - enteral feeding pump

Lerner et al. J Clin Micro 2013
CRE Environmental Contamination

- 5/14 sites were contaminated
- Contamination decreased with distance from the patient

![Bar chart showing recovery rates of positive samples/total samples collected at each of the sampling site.](chart.png)

Recovery rates of positive samples/total samples collected at each of the sampling site (% positive sample):
- Pillow: 33%
- Crotch: 31%
- Legs: 23%
- Infusion pump: 16%
- Personal bed table: 14%

\[\chi^2, p<0.0001\]
Inter-Facility Transmission of MDROs (Including CRE)

Figure 3. Patient flow among regional health care facilities. Outbreaks of infection with multidrug-resistant organisms have been found to follow the flow of colonized patients across institutions.
Regional Approach to MDRO Prevention is Essential

- Successful regional coordination by public health
  - VRE control in Siouxland region
  - CRE containment in Israel

- Public health well placed to facilitate/support regional prevention efforts
  - Situational awareness
  - Technical and laboratory support

Israel Experience in CRE Containment

- KPCs likely originally from U.S. were identified in Israel beginning in late 2005

- By early 2006, an increase in cases was observed

- Initiated National effort to control CRE
  - Mandatory reporting of patients with CRE
  - Mandatory isolation (CP) of CRE patients
    - Staff and patient cohorting
  - Task Force developed with authority to collect data and intervene

Israel Experience

Pre-Intervention Monthly incidence: 55.5 cases/100,000 pt days

Post-Intervention Monthly incidence: 11.7 cases/100,000 pt days

Drug-Resistant Organism Prevention and Coordinated Regional Epidemiology (DROP-CRE) Network
DROP-CRE Network

- Initiated Sept, 2012
- **Primary Objective:** establish a statewide network to detect, control, and prevent multidrug-resistant organisms (MDROs) with an initial focus on carbapenem-resistant *Enterobacteriaceae* (CRE).
- **Spearheaded by OHA**
  - Collaboration with PVAMC/OHSU/OSU/CDC
DROP-CRE Advisory Committee

• Primary Functions
  – Help guide Oregon’s strategy for CRE
  – Promote the DROP-CRE Network

• Our recruitment strategy: broad membership from groups potentially impacted
  – ID physicians/Hospital Epidemiologists
  – Infection Preventionists
  – Microbiologists
  – Include representatives from Long Term Care Facilities (LTCFs), OPSC, Acumentra Health, and CDC
DROP-CRE Network Personnel

• Zintars Beldavs, MS (OHA)
• Genevieve Buser, MD (OHA)
• Margaret Cunningham, MPH (OHA)
• Tasha Poissant, MPH (OHA)
• Ann Thomas, MD, MPH (OHA)
• JJ Furuno, PhD (OSU College of Pharmacy)
• Chris Pfeiffer, MD, MHS (PVAMC, OHSU)
• John Townes, MD (OHSU)
Advisory Committee Members

- Dianna Appelgate, MS, MPH, CIC (Sacred Heart, Springfield)
- Avanthi Doppalapudi, MD (Providence, Medford)
- Ronald Dworkin, MD (Providence, Portland)
- Kendra Gohl, RN, BSN, CIC (Columbia, Astoria)
- Alex Kallen, MD, MPH (CDC)
- Margret Oethinger, MD, PhD (Providence, Portland)
- Robert Pelz, MD, PhD (PeaceHealth, Springfield)
- Kathy Phipps, RN, BSN, CPUR (Acumentra, Portland)
- Mary Post, RN, MS, CNS, CIC (OPSC, Portland)
- Pat Preston, MS (Geriatric Infection Control)
- Sheryl Ritz, RN, BSN (Vibra, Portland)
- Susan Sharpe, PhD, DABMM, FAAM (Kaiser, Portland)
- Sarah Slaughter, MD (Providence, Portland)
- Cathy Stone, MT, CIC (Good Samaritan, Corvallis)
DROP-CRE Network: 2012-13
Goals/Accomplishments

1. Assess statewide needs and capabilities for MDRO/CRE response in acute care hospitals, microbiology laboratories, and LTCFs. **(completed)**

2. Coordinate statewide CRE education.

3. Develop capacity for rapid CRE identification.

4. Offer real-time epidemiologic outbreak assistance to Oregon facilities with CRE.

5. Track CRE regionally between facilities.
LTCF Needs Assessment: Facility Characteristics

- We conducted a needs assessment of Oregon LTCFs
- 58/140 completed survey
LTCF Needs Assessment: Major Concerns

**Most difficult HAIs to prevent**

- C. diff
- Catheter assoc UTIs
- MRSA
- MDRO
- VRE
- Norovirus
- Influenza

**Most challenging aspect of infection control**

- Env. cleaning
- Hand hygiene
- Surveillance
- Isolation precautions
- Outbreaks
CRE Education

• Invited Speakers to Oregon
• Speaking engagements for DROP-CRE Network Personnel around Oregon
• Oregon CRE Toolkit (coming soon)
  – Patient education
  – Staff education
  – Specific long-term care section
• CD Summary (Spring 2013)
• Ideally: develop website with CRE slidesets for tailored education to groups impacted
Rapid CRE Identification

• Worked with Oregon State Public Health Laboratory (Dr. Robert Vega) to develop real-time capacity to perform:
  – Modified Hodge Test
  – PCR (coming soon)

• Considering other collaborations for more detailed molecular testing
Real-time Outbreak Assistance

• When CRE is reported, our objectives are:
  – Support the local facility as needed via phone or on-site consultation
  – Ensure a standardized statewide approach to infection prevention and control response

• Hence, we created the “Oregon CRE Toolkit”
Oregon CRE Toolkit (Available April 2013)

1. Overview of the Toolkit
2. Definition(s)
3. Prevention and Control in Acute Care
4. Prevention and Control in Long Term Care
5. Microbiology Laboratories: Detection/Reporting
6. References
7. Appendices (Lab Protocols, CRE FAQ, inter-facility transfer form)
Real-time Outbreak Assistance

• In December, we assisted with:
  – One CRE case (LTCF → acute care facility → LTCF)
  – One other MDRO cluster

• Additional point prevalence studies are planned
Regional tracking of CRE

• We developed a statewide database for improved central tracking of CRE

• We developed a relatively simple Inter-Facility Transfer Form for use in CRE cases

• We have discussed potential expansion to a larger regional collaboration (i.e. West Coast)
Regional tracking of CRE

- Statewide CRE database
- Inter-Facility Transfer form
- Collaboration with neighboring state health departments
Summary

- MDROs and infection control are/will continue to be a constant battle
- Carbapenem resistance among Enterobacteriaceae appears to be increasing
- A regional approach to MDRO prevention is required
  - Public health well-positioned to facilitate and support regional prevention efforts
- Resources and assistance are available in Oregon to assist with this prevention
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- Chris Pfeiffer, MD, MHS
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*people who let me use their slides