OLD AND NEW ARO OFFENDERS

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Disclosures

- None
Objectives

- To review key IPAC control interventions for CPE, MRSA, CDI using typical case studies.
- To discuss the evolving knowledge of epidemiology of these pathogens.

I WILL NOT be trying to comprehensively review ALL of the best practices for each ARO!
PIDAC Best Practice Documents

Infection Prevention and Control for Clinical Office Practice

Provincial Infectious Diseases Advisory Committee (PIDAC)

Published: June 2013
Case Study #1: Infection Control Resource Team Request

- St. Elsewhere Hospital has contacted their local PHU as well as PHO ICRT team for input on elevated nosocomial CDI rates.
  - Average of 0.55/1000 pt-days for the 3 months.
  - Cases continue despite best efforts, including:
    - Focus on HH
    - Review of environmental cleaning practices
    - Raising awareness
PATHOGENESIS OF CLOSTRIDIUM DIFFICILE DIARRHEA

Antibiotic therapy
↓
Disruption of colonic microflora
↓
C. difficile exposure and colonization
↓
Release of Toxin A (enterotoxin) and Toxin B (cytotoxin)
↓
Mucosal injury and inflammation
Annex C: Testing, Surveillance and Management of *Clostridium difficile*

In All Health Care Settings

Provincial Infectious Diseases Advisory Committee (PIDAC)
Main IPAC Interventions

- Antibiotic Stewardship
- Environmental Cleaning
  - Sporocide twice daily in room and w/r and discharge cleans
- Accommodation
  - Early implementation isolation (Droplet)
  - Single room with dedicated washroom
- Hand Hygiene- Controversy on ABHR vs soap and water
- Contact precautions
- Laboratory testing
- Early treatment
- Other
  - Bedpan, commode, and human waste handling
  - Minimize transfers
Main IPAC Interventions

- **Antibiotic Stewardship**
- **Environmental Cleaning**
  - Sporocide twice daily in room and washroom and discharge cleans
- **Accommodation**
  - Early implementation isolation (Droplet)
  - Single room with dedicated washroom
- **Hand Hygiene- Controversy on ABHR vs soap and water**
- **Laboratory testing**
- **Early treatment**
- **Other**
  - Bedpan, commode, and human waste handling
  - Minimizing transfers
Antimicrobial Stewardship

- This is hard (!) and requires engagement of both the physicians and nurses/allied staff.
- Requires an understanding of the local culture.
- Areas of focus vary by site/unit/program:
  - LTCH
    - Urinary cultures
    - Empiric treatment of ‘UTI’ (to a lesser extent pneumonia)
    - Review usage and target high use broad spectrum agents (‘culture of antibiotic use’)
  - Hospitals
    - Urinary cultures
    - Empiric therapy (often started in ED)
    - Spectrum of Rx
    - Duration of Rx
Environmental Cleaning

Assess:

- Quality of cleaning
- Products used
  - Adequacy of sporocidal agent usage? Combination?
- How is frequency of cleaning implemented for CDI cases, and how is it assessed?
- Clarity of roles
  - Who cleans mobile equipment? In the hall? At the bedside? At discharge?

**NEW HOSPITAL - ACQUIRED C. DIFFICILE RATE PER 1,000 PATIENT DAYS**

JANUARY 2014 - AUGUST 2016

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<tr>
<td>Dec</td>
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Source: MOH, ETC
Molecular and Epidemiological Characterization of Healthcare-Associated *Clostridium difficile* Infections (HA-CDI) Among Adults in Canada, 2009-2015

CNISP Investigators
Results

HA-CDI cases reported from adult and mixed hospitals, 2009-2015
n=20,721 (aggregate number of cases)

EPI form received (adult cases)
n=17,202

C. diff strain typing result available
n=2,690
Results: HA-CDI rates and NAP1 (%) in adults, 2009 to 2015

CNISP Data
Results: Predominant *C. difficile* strains

![Graph showing the prevalence of NAP1 and NAP4 strains in the West, Central, and East regions from 2009 to 2015. The graph is labeled with years and regions, and the x-axis is labeled with 'CNISP Data'.]
Case Study #2

- Rehab Facility Alpha Beta has noted that 3 patients have required treatment at local hospitals for UTI due to a very resistant *K. pneumoniae*.
- One of the patients had a long stay in hospital prior to admission to rehab, while the others were admitted on day 2 post total hip replacements and developed their infections 7-10 days after admission.
- They call for assistance with management.
- As you are on the phone, they receive a call from the CPHL that the organisms have been confirmed to be carrying the ‘KPC gene’.
## Susceptibility Profile of KPC-Producing *K. pneumoniae*

<table>
<thead>
<tr>
<th>Antimicrobial</th>
<th>Interpretation</th>
<th>Antimicrobial</th>
<th>Interpretation</th>
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<tr>
<td>Amikacin</td>
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<td>R</td>
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<td>R</td>
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<tr>
<td>Cefazolin</td>
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<td>Imipenem</td>
<td>R</td>
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<td>Meropenem</td>
<td>R</td>
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<td>Cefotaxime</td>
<td>R</td>
<td>Pipercillin/Tazo</td>
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<tr>
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<td>R</td>
<td>Tobramycin</td>
<td>R</td>
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<tr>
<td>Cefoxitin</td>
<td>R</td>
<td>Trimeth/Sulfa</td>
<td>R</td>
</tr>
<tr>
<td>Ceftazidime</td>
<td>R</td>
<td>Polymyxin B</td>
<td>MIC &gt;4µg/ml</td>
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<tr>
<td>Ceftriaxone</td>
<td>R</td>
<td>Colistin</td>
<td>MIC &gt;4µg/ml</td>
</tr>
<tr>
<td>Cefepime</td>
<td>R</td>
<td>Tigecycline</td>
<td>S</td>
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Nomenclature (sorry...we couldn't make up our minds!)

- **Carbapenem resistant enterobacteriaceae (CRE)**
  - Includes COLIFORMs resistant to carbapenems due to various mechanisms (e.g.) porin loss, as well as carbapenemases

- **Carbapenem resistant organism (CRO)**
  - Includes ALL organisms resistant to carbapenems due to various mechanisms (e.g.) porin loss, as well as carbapenemases

- **Carbapenemase-producing enterobacteriaceae (CPE)**
  - Includes COLIFORMs that produce carbapenemase

- **Carbapenemase-producing organism (CPO)**
  - Includes ALL organisms that produce carbapenemase
3 ‘Bugs’ listed as Critical:
-CPE
-CR Pseudomonas
-CR Acinetobacter
The issue

- CPE are resistant to many classes of antibiotics
  - Carbapenems, all penicillins and cephalosporins, and usually aminoglycosides and fluoroquinolones
- Treatment of CPE infections is difficult and involves the use of antibiotics with significant adverse events
  - e.g. colistin
- The case fatality rate for serious infections (bacteremia) may be as high as 50%
- CPE have been transmitted within Ontario hospitals
Carbapenemase Producing Enterobacteriaceae

- To date, carbapenemases have been found most commonly in *E. coli* and *Klebsiella* spp.
  - Also been found in other Gram-negative species
- The genetic information to produce carbapenemases is often located on a mobile genetic element
  - Can transfer this resistance to other strains and species
  - Usually also confers resistance to other antimicrobials
Classes of carbapenemase

- Several different classes exist
- Each class has a three-letter acronym
  - **KPC** = *Klebsiella pneumoniae* carbapenemase
  - **NDM** = New Delhi metallo-β-lactamase
  - **VIM** = Verona integron-encoded metallo-β-lactamase
  - etc
- Enzymes other than NDM have almost exclusively been found in hospitals
- NDM has been found in both hospitals and the community
Acquisition of CPE

- To date, the major risk factor appears to be receipt of health care in settings that have CPE
  - Hospitals along the eastern US seaboard - particularly New York City (KPC)
  - Greece (KPC)
  - Israel (KPC) and
  - The Indian subcontinent (NDM-1) – people coming from the Indian subcontinent with or without exposure to healthcare are also at risk
Transmission of CPE

- Transmission is via direct and indirect contact
- Site of colonization is the lower gastrointestinal tract
  - Urinary tract is a common secondary site of colonization/infection
- Although the environment less commonly implicated in outbreaks, sinks, drains and other environmental surfaces have been implicated in transmission.
- Duodenoscopes also appear to carry significant risk given the difficulty of disinfecting/sterilizing the elevator mechanism.
- Acquisition of resistance may also occur by transmission of the mobile genetic element carrying the carbapenemase between different bacterial strains and species
We’re heading for big trouble

Antimicrobial resistance is rising quickly

Our antibiotic armamentarium is not
CPE in Canada: CPHLN Data

Number of Isolates

<table>
<thead>
<tr>
<th>Year</th>
<th>KPC (n)</th>
<th>NDM (n)</th>
<th>OXA-48-like (n)</th>
<th>SME (n)</th>
<th>OXA-48/NDM (n)</th>
<th>Other (n)</th>
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Public Health Agency of Canada
CPE by Region: CPHLN Data

Number of Isolates

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<td>Central: ON, QB</td>
<td>(n=1442)</td>
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<tr>
<td>East: NS, NB, NF, PEI</td>
<td>(n=17)</td>
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Public Health Agency of Canada
Carbapenemases by Region

West: BC, AB, SK, MB
Central: ON, QB
East: NS, NB, NF, PEI

Number of Isolates

Carbapenemase

Public Health Agency of Canada
CPE by Species: CPHLN Data

- E. coli
- K. pneumoniae
- K. oxytoca
- Enterobacter spp.
- Serratia spp.
- Other

<table>
<thead>
<tr>
<th>Carbapenemase</th>
<th>Number of Isolates</th>
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<tr>
<td>KPC</td>
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<tr>
<td>NDM</td>
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<tr>
<td>OXA-48-like</td>
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<tr>
<td>SME</td>
<td>100</td>
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<tr>
<td>VIM</td>
<td>50</td>
</tr>
<tr>
<td>Other</td>
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</tbody>
</table>

Public Health Agency of Canada
CRE Positive Isolates by LHIN

NOTE: 19 CRE positive isolates obtained from outpatient clinics have been excluded.
Current States with CP-CRE

http://www.cdc.gov/hai/organisms/cre/TrackingCRE.html
Global Dissemination of CRE


http://cid.oxfordjournals.org/content/56/9/1310.full?sid=b2bcabcc-cb4d-41ab-ba19-b91734089663
Screening Patients/Residents for CPE

- An effective, consistent approach to surveillance is important in preventing the spread of CPE.
- All facilities should institute a screening program and targeted surveillance for CPE.
  - At a minimum for those receiving healthcare out of country and those know to be exposed.
- Admission screening and pre-emptive Contact Precautions are indicated for individuals with risk factors for CPE.
- Screening for those undergoing ERCP?
- Patients with known CPE carriage should have their records flagged, be placed on Contact Precautions, and re-screened on re-admission.
Screening Specimens for CPE

- All infection prevention programs should review with their microbiology laboratory whether they have had any cases of CPE in the past 6-12 months and determine if their laboratory is able to detect and report all patients colonized/infected with CPE.
- Primary screening specimens are stool or rectal swabs.
- Urine specimens and swabs from open wounds may also be indicated.
- In critical care areas, sputum or ETT specimens and swabs from exit sites may be indicated.
CPE Decolonization and Duration of Precautions

- There are insufficient data to support CPE decolonization and it is not currently recommended.
- Duration of bowel colonization with CPE is unknown but is likely of long duration.
- Most colonized patients/residents are asymptomatic.
Management of patients/residents with CPE

- Contact Precautions – for duration of care, if possible
- CPE colonized patients who are re-admitted should be placed on Contact Precautions and re-screened
- If a single patient/resident with CPE is identified, consider conducting a full prevalence screen of the unit/ward; at a minimum, all roommates should be screened
  - Minimum 3 sets of specimens, with one set taken at least 21 days after last exposure
- If there is evidence of transmission, expert advice should be sought
- Environmental services
  - routine cleaning
- In a CPE outbreak, protocols should be in place to screen patients in close proximity to the CPE positive patient or who have risk factors for CPE acquisition (foleys, open wounds, etc).
Schematic drawing of a cross section of a flexible endoscope

- Tip bending control wire
- Water channel
- Air channel
- Outer layers
- Biopsy/suction channel
- Fiberoptic image bundle
- Fiberoptic light guides

complex design
multiple internal channels
(Inner diameter: 2.8 to 3.8 mm)

Source: Kovaleva et al. Transmission of infection by flexible gastrointestinal endoscopy and bronchoscopy. 2013
Duodanoscope elevator channel

- Elevator Pivot Arm
- Elevator Rod Sealing Block
- Elevator Wire
- Sus-Pipe Channel
- Elevator Cleaning Channel
- Elevator Control Knob
- Coil Pipe
- Elevator Riser
- Sus-pipe / Flex Coil Pipe Connection
Manual cleaning of flexible endoscope: brushing and irrigation of internal channels

Importance of brush diameter for effecting cleaning of endoscope channel
Biofilm

- Protective matrix makes penetration by cleaning agents very difficult

- Location of biofilm in drain makes manual cleaning very difficult

- Once a drain is contaminated, difficult to decontaminate without removal of plumbing
Biofilm

Source: http://textbookofbacteriology.net/normalflora_2.html
Case Study #3

- LTCF Beta Gamma notes that 4 residents on a single floor have developed purulent skin infections over the course of 2 weeks.
  - Laboratory testing has confirmed MRSA as the causative pathogen.

- The facility routinely screens patients for MRSA upon admission and re-admission.
  - Single room and contact precautions implemented to the best of their ability.

- What to do?
Epidemiology of MRSA

- The issue evolved in hospitals/healthcare settings
- Established healthcare risk factors include:
  - proximity to an MRSA-colonized patient
  - hospitalization, especially prolonged
  - ICU admission
  - surgery
  - chronic lung, liver, or renal disease and malignancy
  - indwelling percutaneous medical devices (IV, dialysis line, etc.)
  - older age, residence in a long-term care facility
  - presence of wounds and skin lesions
  - prior antibiotic therapy
CA-MRSA Outbreaks

- Often first detected as clusters of abscesses or “spider bites”
- Various settings
  - Sports participants: football, wrestlers, fencers
  - Correctional facilities
  - Military recruits
  - Daycare and other institutions
  - Newborn nurseries
  - Intravenous drug use (IVDU)
  - Men who have sex with men (MSM)
MRSA Evolution

- Initially HA- and CA-MRSA had distinct epidemiology and molecular phenotypes
- Over time, CA-strains have taken hold in healthcare facilities
Annex A:
Screening, Testing and Surveillance for Antibiotic-Resistant Organisms (AROs)
In All Health Care Settings

Provincial Infectious Diseases Advisory Committee (PIDAC)

Revised: February 2013
Figure 9: Chain of Transmission example: MRSA

Prevent entry:
- Hand hygiene for health care providers
- Aseptic technique

Interrupt transmission:
- Screening of high risk patients
- Placement of patients with positive cultures
MRSA control measures

- Early identification of colonized (asymptomatic!) residents
  - Nasal, rectal, open wound/exit sites
  - Repeated screen will be required through the outbreak
- Major focus on hand hygiene
  - BEFORE patient/environment contact, as well as AFTER patient/environment contact
  - Audit compliance with HH, as well as other aspects of the HH policy (no rings, no artificial nailes, appropriate duration of ABHR rub, etc)
- Equipment and the environment play a role in transmission to a lesser degree
- Cover open draining wounds
Less common control measures

- Decolonization
  - Topical (mupirocin, 2% CHG) combined with systemic antimicrobial generally not recommended in practice guidelines

- Healthcare worker screening
  - Extremely rarely required
  - If the outbreak is refractory, start by asking about recent purulent skin infections (specifically ask about paronychia), and eczema flares.
Questions?