Outbreak of Carbapenem-Resistant *Klebsiella pneumoniae* Infection in an Acute Care Hospital – Charlotte County

Bureau of Epidemiology
Grand Rounds Presentation
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Investigation Team

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Objectives

• Understand Carbapenem-resistant *Enterobacteriaceae* (CRE) infection
• Describe the characteristics of the Charlotte County outbreak
• Examine key risk factors identified during the investigation
• Describe the infection control steps taken to stop the outbreak
• Explain recommendations to be used for future outbreaks
What are *Enterobacteriaceae*?

- Rod-shaped, Gram negative bacterium in the *Enterobacteriaceae* family that includes:
  - *E. coli*, *Klebsiella*, *Proteus* and *Citrobacter* species.
- Commensal bacteria commonly found in the human gut
Carbapenems

• Characteristics of the carbapenem family of antibiotics
  – ß-lactam structure similar to penicillin
  – Considered “drug of last resort”
  – Ertapenem, imipenem, meropenem, doripenem
Carbapenem Resistance

- Most common method of resistance is production of an enzyme that can destroy the β-lactam ring
  - *Klebsiella pneumoniae* carbapenemase (KPC)
  - New Delhi Metallo-beta-lactamase (NDM)
- *Enterobacteriaceae* that are carbapenem-resistant often carry genes that cause resistance to other antibiotics as well
Background on CRE infections

• 2001: CRE first identified in the United States in North Carolina, in a case of *Klebsiella pneumoniae*

• As of September 2012, now identified in 43 states in various *Enterobacteriaceae* species

• In 2012, 4.6% of acute care hospitals reported at least one CRE infection*
  – 3.9% in short-stay hospitals, 17.8% in long-stay hospitals
Background on CRE infections

• Since March 2008, several CRE outbreaks have been reported to the FDOH
  – Most of these outbreaks were reported at long term acute care hospitals (LTACH)
Epidemiology

States where KPC enzyme has been isolated, September 2012

http://www.cdc.gov/hai/organisms/cre/TrackingCRE.html
CRE infections

• Primarily a health care-associated infection
• Common sites of infection:
  – Respiratory tract
  – Urinary tract
  – Wounds
  – Blood stream infections (BSI)

• Mortality rates of 30-50%
CRE Colonization

• Bacteria found on or in the body but not causing any symptoms or disease

• CRE typically colonize the intestinal tract

• Colonization can go on to cause infection if the bacteria gain access to a normally sterile site, such as the urinary tract, lungs, or bloodstream
CRE infections

Risk factors:

– Failure to adhere to standard infection prevention and control practices
  
  • Hand-hygiene
  • Standard sterile techniques
  • Proper sterilization and storage of equipment used in invasive procedures
CRE infections

Risk Factors:

– Long-term health care stays
– Use of invasive devices
– Long courses of antibiotics
– Recent organ or stem cell transplant
– ICU admission
Laboratory Methods

Diagnosis

– Routine culture
– Automated resistance testing methods
  • Confirmation requires Modified Hodge test and PCR

Antibiotic Treatment

Treatment (options limited)

– Based on antibiotic sensitivity assays for individual infections and published case series
  
  • Gentamicin
  • Tigecycline
  • Colistin
## Antibiotic Treatment

### 1. KLEBSIELLA PNEUMONIAE

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Charlotte County Outbreak

- FDOH – Charlotte notified in October 2012 by a local acute care hospital of 8 Carbapenem-resistant *Klebsiella pneumoniae* (CRKP) infections during the month of September
  - 238-bed hospital
  - No previous CRKP infections detected
- Reviewed medical records of CRKP-infected patients and requested the hospital perform a retrospective review of all *Enterobacteriaceae* results
Initial Information

Initial cases were:

- 3 Males, 5 Females
- Ages 53-82
- 5 pneumonia cases, 3 UTIs
- All 8 cases stayed in the same unit
  - Not all at the same time
- All 8 cases had an endoscopy procedure
  - 5 bronchoscopies
  - 3 Esophagogastroduodenoscopies (EGD)
Methods

• Case definition
  – A patient of Hospital A with a positive culture for any CRE
    • From either a clinical or surveillance specimen
• Active case finding
  – Conducted through reviewing microbiology records starting from September 2011 any carbapenem-resistant *Enterobacteriaceae*
Active Surveillance Cultures

• Active surveillance culture of rectal swabs was initiated in November 2012 in order to:
  – Identify new cases
  – Monitor existing cases
  – Determine prevalence in the facility and the cohort unit where CRKP-infected patients stayed
  – Monitor effectiveness of infection control measures
Active Surveillance Cultures

• First performed among all inpatients to:
  – Assess prevalence
  – Initiate recommendations
  – Implement cohorting

• Biweekly surveillance conducted through February 2013 on cohort unit
Investigation – Methods

- FDOH staff performed walk-through of facility
  - Observe infection prevention and control practices
  - Unit where CRKP patients were cohorted
  - Endoscopy procedure rooms

- Meetings with hospital ICP, nursing staff, and environmental staff, and medical executive committee
  - Initial conference call between FDOH – Charlotte, hospital staff, hospital administration, and FDOH staff
Investigation - Methods

• Retrospective review of CRKP patients’ medical records

• Community coordination and collaboration
  – Retrospective and prospective lab surveillance at other local hospitals
    • Charlotte County Medical Administrator requested records review in writing
  – Meetings with the medical society
  – Providing education to linked facilities
    • Long-term care facilities
    • Rehabilitation centers
Molecular Laboratory Methods

- Pulsed-field gel electrophoresis (PFGE) performed on all clinical isolates at the Bureau of Public Health Laboratories in Jacksonville.
- PFGE creates a DNA “fingerprint” for bacteria and is unique for each strain.
  - PFGE patterns can be compared to determine if they are similar.
  - Patterns that are similar or indistinguishable between different isolates may indicate a common source, when supported by the epidemiology.
Infection Prevention and Control Interventions Implemented

• **Hand-hygiene and contact precautions**
  – Wash hands before entering and leaving a patient’s room
  – Put on gown and gloves before entering patient’s room
  – Use disposable devices in the room when possible
  – Discard gown and gloves before leaving patient’s room

• Monitor adherence and provide feedback

• Promote hand hygiene and contact precautions
Infection Prevention and Control Interventions Implemented

- Patient cohorting and dedicated staff
  - Cohort CRKP colonized or infected patients in a single unit and no sharing of rooms with non-infected patients
  - Dedicate nursing staff and equipment to CRKP patients
Infection Prevention and Control Interventions Implemented

- Health care staff education
  - Repeated meetings with ICP and senior nursing staff
  - Competency-based CRE education provided to all nursing staff
  - Observation of hand washing procedures and immediate feedback
  - Review of contact isolation
Results

• 22 cases were identified from September 2012 to February 2013
  – 17 cases detected through clinical culture
    • First positive clinical sites were urine (10), respiratory sites (6), and abscess (1)
    • 3 patients progressed to BSI
  – 5 colonized cases detected through active surveillance
Results

- 7/17 cases with positive clinical culture died
  - 41% clinical case fatality rate
  - All 3 cases with BSI expired
Epidemic Curve by First CRE Culture Date – Charlotte County, 2012-2013

July, August, September, October, November, December, January, February

Surveillance
Clinical
Results

• Ages ranged from 21-93 years
  – 20/22 patients over the age of 60 (90.9%)
  – Other ages: 21, 53
• 14/22 patients were female (63.6%)
• 18/22 patients had an endoscopy procedure (81.8%)
  – 9 bronchoscopies
  – 9 EGDs
• 18/22 (81.8%) received respiratory therapy
Results

- 21/22 patients had complicated medical histories
  - Patients had a range of 1 to 5 admissions to the acute care hospital prior to first CRKP culture, with a median of 2 admissions
  - Prior treatment with many and various antibiotics
  - Multiple comorbidities
    - 21-year-old patient had a CRKP-positive urine culture collected in the ER
Results

• Most common comorbidities included:
  – Coronary artery and heart disease
  – Chronic obstructive pulmonary disease (COPD)
  – Diabetes
  – Renal insufficiency
  – Cancer (lung, colon, skin, brain)
  – Liver cirrhosis
• 18/22 PFGE patterns were greater than 95% similar (81.8%)
• Combined with the epidemiology, these results are likely to be related
Biweekly Point Prevalence Survey in Cohort Unit, Charlotte County – November 2012 to June 2013

*Size of Unit = 28 beds

1st active surveillance - Prevalence 21% (n=5)
End of FDOH active investigation – Prevalence 9% (n=2)
End of hospital surveillance – Prevalence 0% (n=0)

Division of Disease Control and Health Protection
Discussion

• This outbreak mirrored the common clinical picture seen in other CRE outbreaks throughout the USA
  – Patients had prolonged hospital stays due to complicated medical histories
  – Patients were exposed to many invasive and indwelling devices
  – Patients were older and had many comorbidities
  – Patients were previously on multiple antibiotics
Discussion

• Implementing infection control measures and active surveillance successfully reduced hospital transmission
  – Decreased prevalence from 20% in November 2012 to 9% in February 2013.

• Continued vigilance from the hospital resulted in no cases identified in the June 2013 prevalent survey.

• Coordination among administration, lab and clinical staff is key to implementing, correcting, and sustaining proper adherence to infection control measures in a timely manner.
Limitations

• Unable to locate a common source of exposure
  – Descriptive observations only
  – Difficult to design case-control study

• Multiple hospitals and long-term care facilities in the area
  – Past medical history was not evaluated
Recommendations

- Laboratory should have protocols for alerting clinical and infection control staff of positive CRE cultures
- Active surveillance cultures are an important aspect to outbreak response
  - Point prevalence surveys useful for identifying previously undetected cases of CRE and to measure the efficacy of infection control measures
  - Screening should be based around unit and epidemiological contacts of positive CRE cases
Recommendations

• In conjunction with the infection control staff, evaluate performance of potentially high-risk procedures and perform a walk through of the facility
  – Identify and give immediate feedback of possible breaks in infection control
  – Identify areas where cohorting could be performed more efficiently
  – Reinforce the need for standard precautions
• Alert other hospitals and facilities in the area that enhanced CRE surveillance might be needed
Recommendations

- Health care facility staff infection prevention and control education and auditing with feedback are key
  - Ongoing education to update staff on existing and new developments and guidelines
  - Educate local medical community to be alert
  - Provide materials and education to other facilities to ensure regional awareness
  - Inter-facility communication detailing the types of infection the patient has is important
Additional CDC Recommendations

• Antimicrobial stewardship
  – Antimicrobials are used for appropriate indications and duration
  – The narrowest spectrum antimicrobial that is appropriate for the specific clinical case is used
**Additional CDC Recommendations**

- **Minimizing use of invasive devices**
  - Examples such as urinary catheters, central lines, endotracheal tubes
  - Device use should be observed/audited and reviewed regularly to ensure they are still required
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Questions?
References

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