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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



Public Health Image Library



Carbapenems

- Characteristics of the carbapenem family of antibiotics
 - β -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

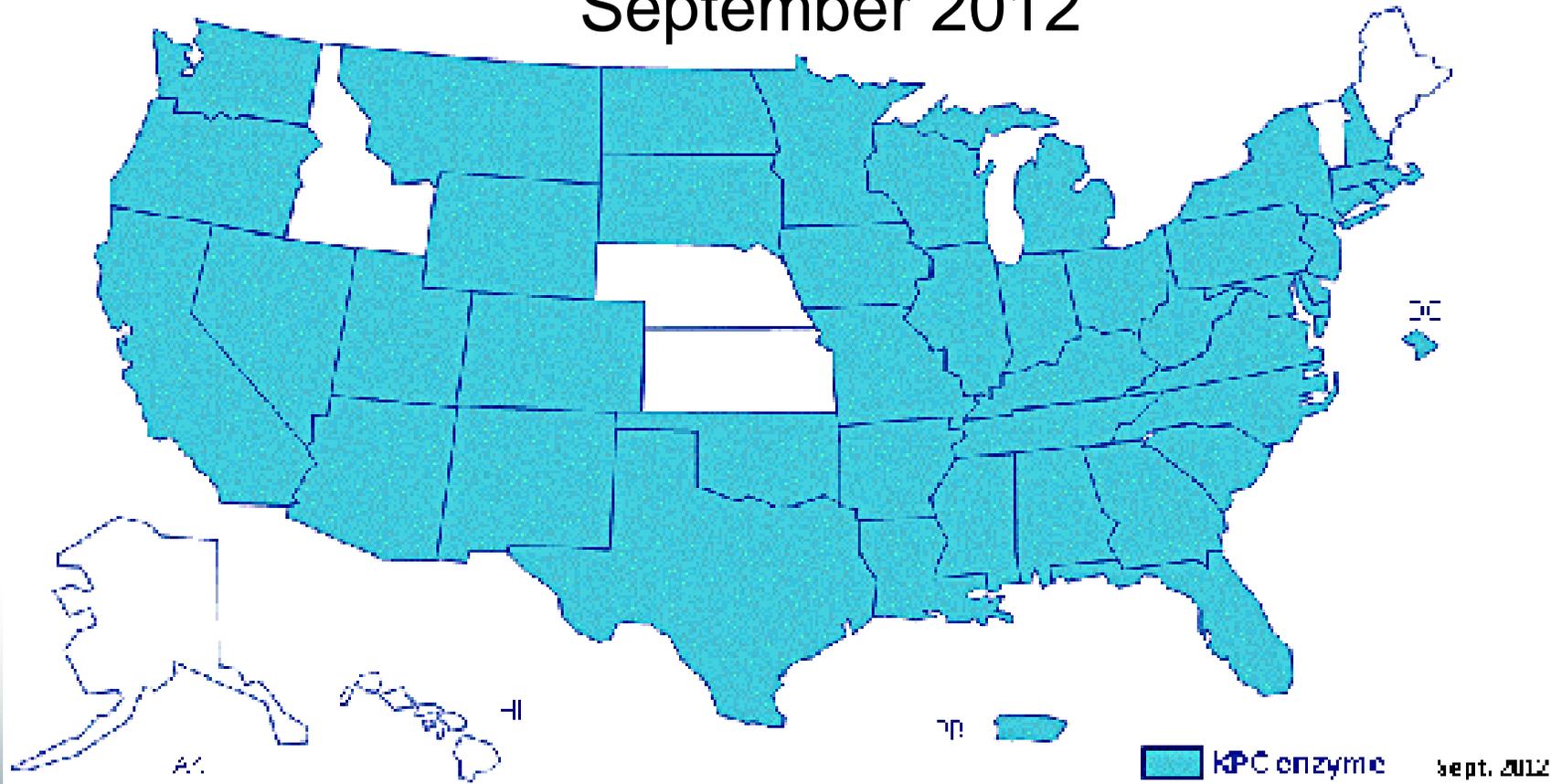
- 2001: CRE first identified in the United States in North Carolina, in a case of *Klebsiella pneumoniae*
- As of September 2012, now identified in 43 states in various *Enterobacteriaceae* species
- In 2012, 4.6% of acute care hospitals reported at least one CRE infection*
 - 3.9% in short-stay hospitals, 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

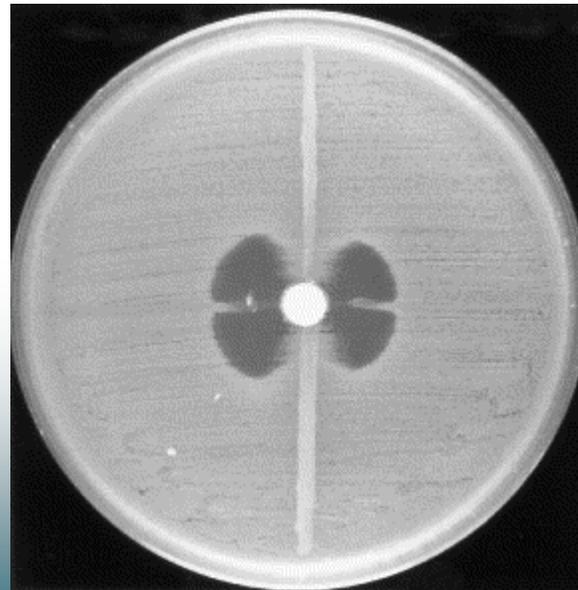
Risk Factors:

- 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

	<u>Target</u>	<u>Route</u>	<u>Dose</u>	<u>RX</u>	<u>AB</u>	<u>Cost</u>	<u>M.I.C.</u>
* AMP/SULB				R			>16/8
* CEFEPIME				R			>16
* CEFTRIAZONE				R			>32
* CIPROFLOXACIN				R			>2
* LEVOFLOXACIN				R			>4
* MEROPENEM				R			>8
* GENTAMICIN				S			<=4
* PIP/TAZO				R			>64
TIGECYCLINE				S			<=2
* TRIMETH/SULFA				R			>2/38

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

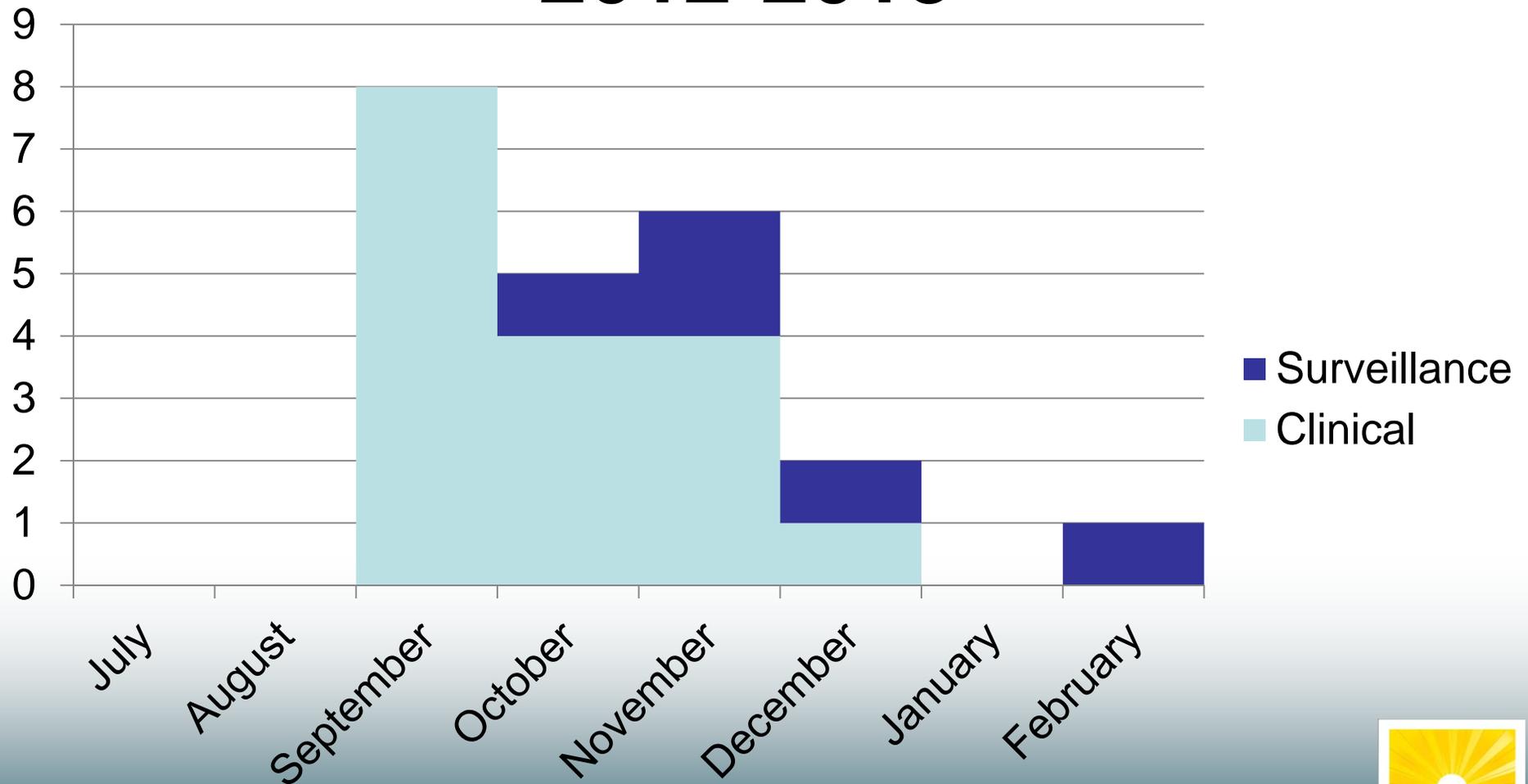
Results

- 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



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

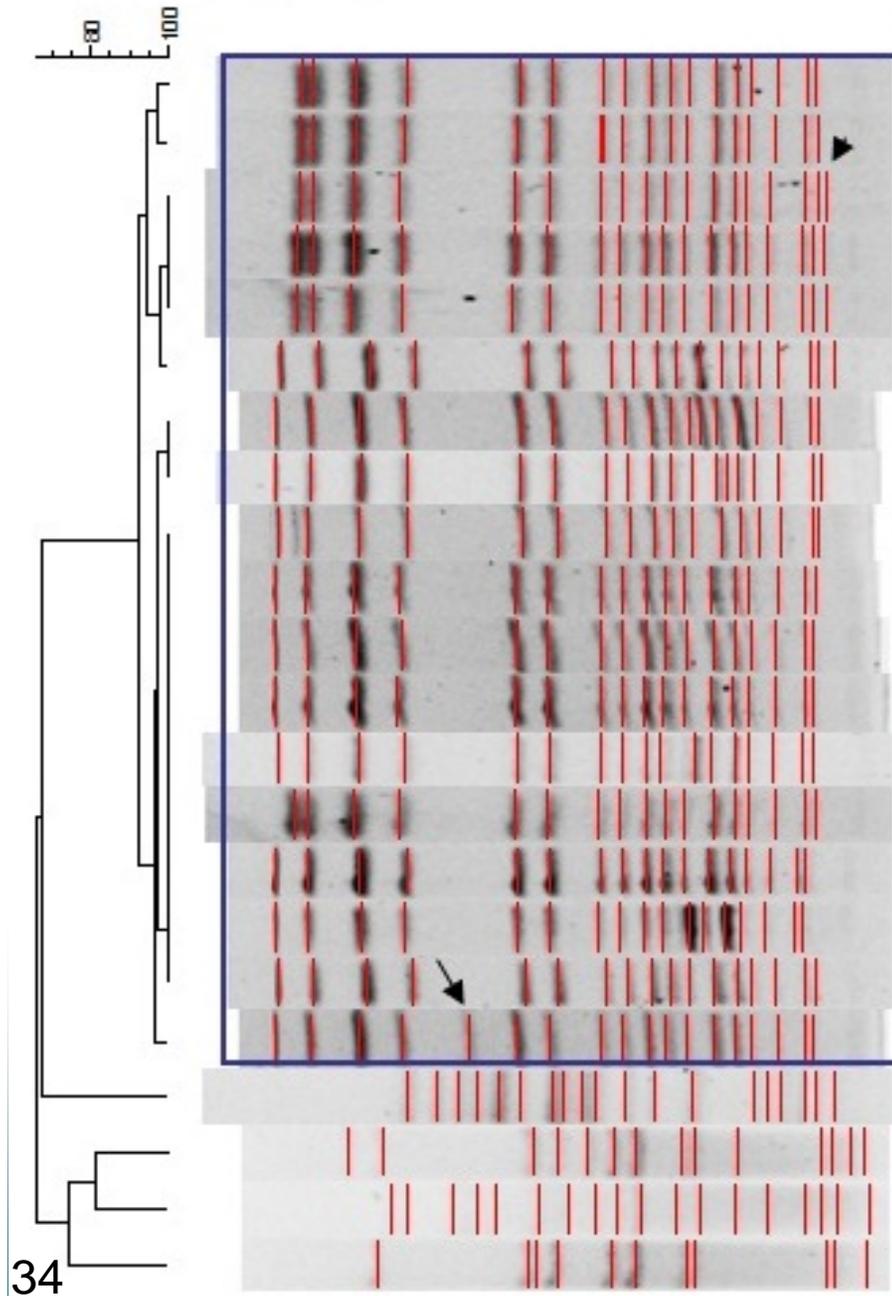
- 21/22 patients had complicated medical histories
 - Patients had a range of 1 to 5 admissions to the acute care hospital prior to first CRKP culture, with a median of 2 admissions
 - Prior treatment with many and various antibiotics
 - Multiple comorbidities
 - 21-year-old patient had a CRKP-positive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

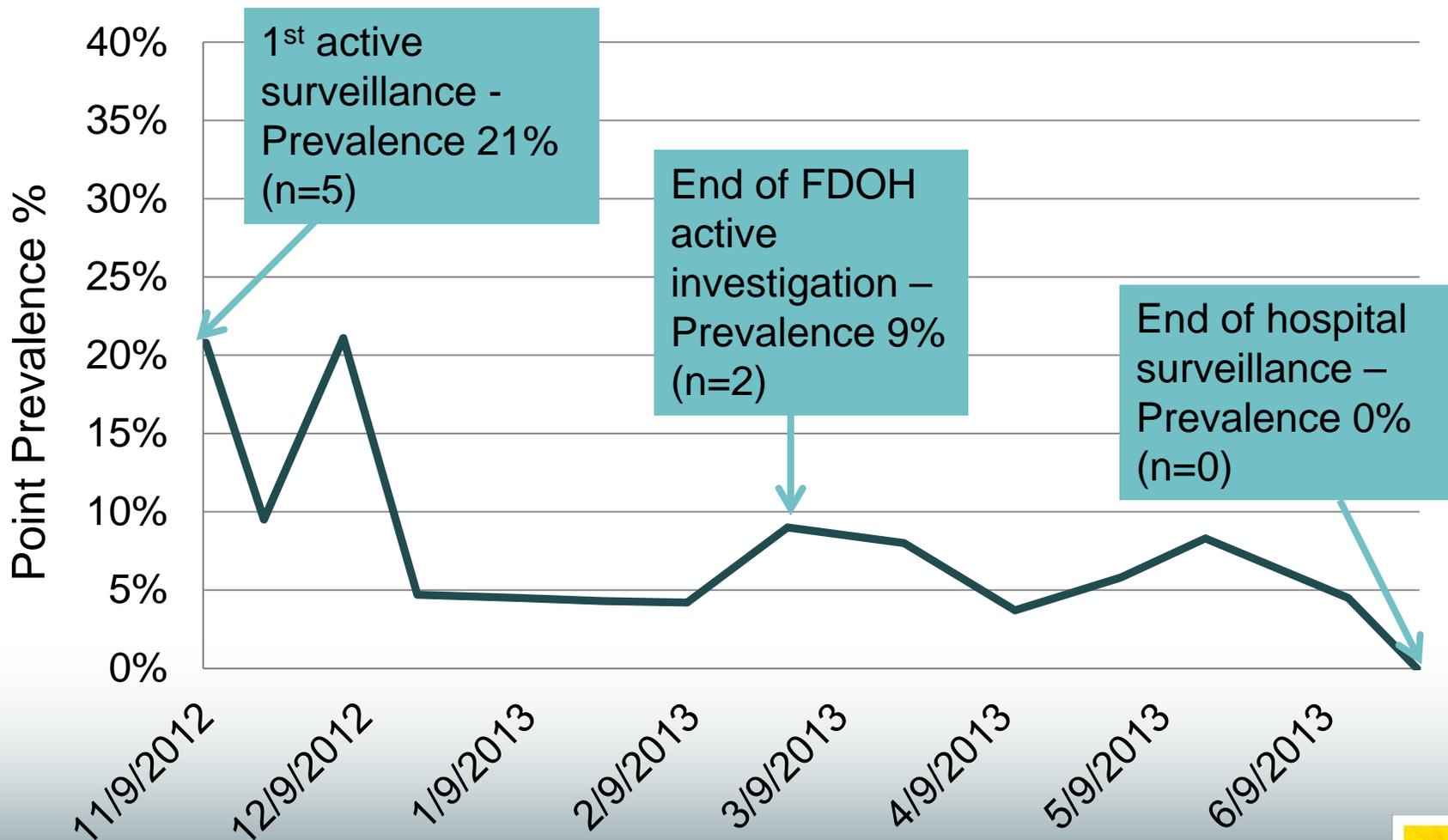
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PFGE-XbaI PFGE-XbaI



- 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

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 case

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

Acknowledgements

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Questions?

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