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Analysis of strategies for successful identification, reporting, and prevention of carbapenem-resistant enterobacteriaceae (CRE) in acute health care facilities in New York State

Christen Leigh Mayer

University at Albany, State University of New York, mayer.christen@gmail.com

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Analysis of Strategies for Successful Identification, Reporting, and Prevention of Carbapenem-Resistant Enterobacteriaceae (CRE) in Acute Health Care Facilities in New York State

by

Christen Leigh Mayer

A Dissertation
Submitted to the University at Albany, State of New York
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ACKNOWLEDGEMENTS

Dissertation Committee Members

Committee Chair: Valerie Haley, PhD
Research Assistant Professor, Epidemiology and Biostatistics University at Albany School of Public Health
Director, Healthcare Associated Infections Reporting Program Bureau of Healthcare Associated Infections Division of Epidemiology New York State Department of Health

Subject Matter Expert: Emily Lutterloh, MD, MPH
Assistant Professor, Epidemiology and Biostatistics University at Albany School of Public Health
Director, Bureau of Healthcare Associated Infections Division of Epidemiology New York State Department of Health

Committee Member: Kimberlee Musser, Ph.D.
Bacteriology Laboratory Director, Wadsworth Center
Assistant Professor, Biomedical Sciences University at Albany School of Public Health

Healthcare Associated Infections Bureau Staff Members

Rosalie Giardina MT(ASCP)                      Boldtsetseg Tserenpuntsag
Marie Tsivitis MT(ASCP)                        Robin Knab CLT, M(ASCP)
Peggy A. Hazamy RN, BSN, CIC                    Cindi Dubner
Kara Burke                                        Michael Dineen
Allison Braden

St. Peter’s Health Partners Clinical Laboratory
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ABSTRACT

Background

In healthcare in the United States antimicrobial resistant bacteria are an immediate concern. Carbapenem-resistant Enterobacteriaceae (CRE) are a unique problem because of high attributable mortality and ability to spread quickly in healthcare facilities. CRE has been selected for surveillance and intervention programs in New York State (NYS) hospitals.

Methods

Several data collection and intervention strategies were developed as part of this project. Surveys included information on laboratory methodologies for meeting the CRE case definition in hospital microbiology laboratories and the prevention practices in the environment of care. Informational presentations were given to hospital representatives and a Technical Advisory Workgroup (TAW). Surveillance data reported to the National Healthcare Safety Network (NHSN) was analyzed. Site visits were conducted to observe CRE prevention at the facility level. Comparisons were made between reported data and data audited by Infection Preventionists from the New York State Department of Health (NYSDOH).

Results

New York State hosts a variety of laboratory methodologies for microbiology testing including both manual and automated methods. The hospitals reported challenges with maintaining the infection prevention practices recommended by the Centers for Disease Control and Prevention (CDC), including hand hygiene. A large burden of CRE was reported, approximately 3200 cases in 2013; the majority of these cases are from hospitals in the New York City area. Site visits identified challenges with interdepartmental communication and meeting practice recommendations. Eleven hundred and fifty-one (1,151) CRE laboratory reports were audited
with 156 records (13.6%) determined to be unreported to NHSN and 53 records (4.6%) determined to be reported in error.

Discussion
Quantitative and qualitative results are used to identify educational needs for CRE reporting and the difficulty in accurate data reporting due to the variation in CRE definitions and challenges with communication. Errors in reporting were caused by a variety of reasons including lapses in surveillance and misinterpretation of the surveillance definition.

Conclusions
Educational initiatives to include microbiology laboratory staff, improvements in the use of laboratory information systems (LIS) to communicate with Infection Prevention (IP), and updated NHSN definitions should improve the accuracy and consistency of CRE reporting and prevention in NYS.
STATEMENT OF PROBLEM

Carbapenem-resistant Enterobacteriaceae (CRE) is an increasing problem in the United States and internationally. These pathogens result in infections in patients that cannot be treated with “last line” antimicrobial agents. CRE has been identified as an area of major concern by the Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO) CDC and WHO, and has become an increasingly common discussion topic in popular mass media outlets. This escalation in attention is rooted in the high rates of morbidity and mortality attributable to these pathogens, as well as the consideration that they are frequently transmitted within healthcare facilities.

In order to combat this growing threat the State of New York instituted a reporting mandate for the presence of these pathogens in acute care facilities. This mandate is designed to set a baseline prevalence rate for CRE and to identify acute care facilities or geographic areas that will require targeted intervention. These baseline rates will be used in the future to determine facilities that are successfully or unsuccessfully breaking the chain of transmission for CRE. Those that are unsuccessful will be selected for specifically designed infection prevention interventions.

There are several challenges that will arise as this reporting mandate is implemented across the state. These challenges include variation in laboratory testing methods, facility level ability to accurately meet and report CRE data, and knowledge and understanding of the problem by facility level stakeholders. These challenges will be met by developing surveys to identify individual facility practices, data audits to ensure compliance, CRE rate analysis, and educational initiatives. As more data is collected and more is understood about the CRE problem in New York State, targeted and effective prevention strategies can be developed and evolved.
OBJECTIVES

This project will have several main objectives. These objectives include:

1) Describe the incidence and prevalence of CRE in NYS.

2) Describe the laboratory testing methods used by facilities, and how they impact the reported infection rates.

3) Describe the accuracy of the reported data as measured by audits of laboratory records.

4) Compare CDC’s recommended surveillance and control practices with those implemented by the facilities and the reported barriers to implementation.

5) Recommend an intervention for NYSDOH to work with facilities to slow down the spread of CRE.
BACKGROUND

Enterobacteriaceae

The Enterobacteriaceae are a large family of non-spore forming bacteria. They are part of the phylum Proteobacteria and are given their own order of Enterobacteriales. The organisms of the family *Enterobacteriaceae* are Gram-negative bacilli and facultative anaerobes. Most of the organisms have flagella for mobility, but a few genera are non-motile. Many of the genera in this family are found as commensal organisms in the human gastrointestinal tract, although some live mainly as environmental organisms in soil and water.

Several of the Enterobacteriaceae are known to cause serious infections in humans. *Escherichia coli* and *Klebsiella* spp. are two examples of enteric organisms that are frequently cultured from human infections (Guh 2014). It is important to note that *E. coli* is an important research model organism, and its genetics and biochemistry have been closely studied. Infections from the bacteria in the family Enterobacteriaceae can occur in nearly any organ system of the human body. However, infections are most commonly identified in the urinary tract, the blood, soft tissue wounds, and the lungs (Bharagava 2013). Urinary tract infections are the most common due to the organism’s natural home in the gastro-intestinal tract.

Carbapenems

The carbapenems are part of the β lactam antimicrobial group. Beta lactams also include penicillins and cephalosporins. These antibiotics function by stopping bacterial growth through the inhibition of cell wall synthesis (Hawkey 2012). There are four commonly used carbapenems: ertapenem, doripenem, meropenem, and imipenem. These antibiotics are considered a last line of defense against resistant pathogens. However, the use of carbapenems
has been increasing due to the increasing resistance to cephalosporin antibiotics among Enterobacteriaceae. Most cephalosporin resistance is due to the development and spread of extended spectrum β-lactamases (ESBLs) (Queenan 2012).

Carbapenem-resistant Enterobacteriaceae (CRE)

Multi-drug resistant bacteria have become a serious problem in healthcare facilities. There are a variety of these pathogens, and they can lead to very serious health conditions. Among the most serious of these pathogens are carbapenem-resistant Enterobacteriaceae (CRE).

Carbapenem-resistant Enterobacteriaceae occur when organisms of this family cannot be effectively treated with carbapenem antibiotics. People with normally functioning immune systems do not typically get infections with CRE. These organisms are most commonly identified in hospitalized patients. Risk factors for developing CRE infections include: diagnosis with several co-morbid conditions, treatment with long course antibiotics, use of indwelling medical devices, and recurring inpatient medical care (Swaminathan 2013). People are at the highest risk of infection when they develop chronic conditions that require extended periods of invasive medical treatment. These risk factors illustrate why acute care hospitals and long term care facilities are important settings for surveillance and monitoring of CRE cases.

CRE was first identified in North Carolina in 1996 as part of a special antimicrobial surveillance project conducted by the CDC (Guh 2014). The unusual resistance pattern was originally determined to be an isolated case. Unfortunately, the surveillance project was only testing isolates from a handful of hospitals and analysis of specimens occurred with long delays after collection. As such, the spread of CRE in the United States was not uncovered until it had already caused several outbreaks in New York City. These organisms can be transmitted through
person to person contact as well as, although less commonly, through environmental contamination. Therefore, once CRE had found its way into the hospitals of New York City it has been very difficult to eradicate from the patient care environment.

Colonization rates with *K. pneumoniae* as high as 80% have been observed in hospitalized patients. High colonization rates have also been observed in the nasopharynges and on the hands of hospital inpatients (Tzouvelekis 2012). These high colonization rates facilitate the spread and persistence of the organism in health care settings.

Recently CRE has become a familiar topic in popular news media outlets. The public’s interest in CRE has increased as more facilities experience outbreaks and more mortalities are attributed to the pathogen. It has also become a talking point among politicians when discussing communicable disease prevention and control. The need for strong surveillance and prevention specifically for CRE is being requested by the public. It is important that the NYSDOH is able to offer evidence based solutions on the continuing CRE problem.

Organism Transmission and Epidemiology

Carbapenem-resistant Enterobacteriaceae are increasingly causing healthcare associated infections in many parts of the world. Cases have been identified in 40 US states and 25 countries representing 5 continents (Swaminathan 2013). The number of cases is increasing in frequency in many areas with some areas declaring the pathogen as endemic. Outbreaks of CRE have been identified in many states in the United States. Both highly populated and more rural states have experienced outbreaks of CRE in their hospitals. These states with documented outbreaks include New York, California, North Carolina, North Dakota, Illinois, Maryland, Massachusetts, and Virginia (Rasheed 2013, Kiedrowski 2014). CRE has been found in all US
states except for Idaho (CDC 2014). CRE has also been identified as a growing problem globally. Outbreaks have been confirmed in Israel, India, France, Italy, Greece and Taiwan (Chen 2013, Ikonomidis 2007, Nordmann 2013, Schwaber 2011).

There is high level of morbidity and mortality associated with CRE infections. These infections can lead to increased hospital length of stay and increased recovery times. Overall attributable mortality is between 3.7 to 6.5 times greater for carbepenem resistant *Klebsiella pneumoniae* (CRKP) infections than for infections with susceptible *K. pneumoniae* (Guh 2014). For bloodstream infections the mortality for CRE has been reported as high as 50% (MMWR 2012).

There are several important methods of CRE infection spread. One of these methods is person to person contact in an acute or long term health care setting. This type of spread includes both direct and indirect contact. The pathogens can be transferred from a patient to a surface to another patient, or in some cases to several other patients. Another transmission route is from colonization to infection. If a patient has CRE as a colonizing organism in the gastrointestinal tract the organism will live in the person’s body without causing any harm. However, if that person develops a chronic medical condition requiring invasive medical treatment it is possible that the colonizing organism will be able to move to a different body site and become an infection. A third method is the spontaneous development of a resistance mechanism due to antibiotic pressure. When the enteric organisms of the human gastrointestinal tract are exposed to long term antibiotic courses those that are able to survive are selected out of the bacterial population and are able to thrive. This survival is often due to the development of a resistance mechanism. An additional method of spread is through the ability of the bacteria to share the
genetic coding for resistance (plasmids) with one another. This plasmid sharing has even been demonstrated to take place among organisms of different genera.

There are several resistance mechanisms that are expressed by CRE. The most common types in the US are known as KPC (Klebsiella pneumoniae carbapenemase) and NDM (New Delhi metallo-beta-lactamase) (Rasheed 2013). KPC and NDM are enzymes that break down carbapenem and make them ineffective. Other carbapenem resistance enzymes that are less common in the US are VIM (Verona integron-mediated metallo-β-lactamase), OXA (oxacillinases), and IMP (active on imipenem) (Guh 2014). These resistance mechanisms consist of plasmids encoded for enzymes that can hydrolyze carbapenem antibiotics. It is important to note that to be considered a CRE an enteric organism does not have to produce a hydrolyzing enzyme. Showing phenotypic resistance in susceptibility testing is sufficient to be considered a CRE even in the absence of one of the resistance enzymes.

Existing Surveillance Structure

There are several possible approaches that can be used to collect data on CRE and other pathogens. Options include data entry through an online surveillance network and communicable disease reporting regulations. New York State chose to use online surveillance through the CDC’s National Healthcare Safety Network (NHSN). NHSN is the nation’s most widely used healthcare-associated infection tracking system. NHSN provides facilities, states, regions, and federal agencies with data needed to identify problem areas and measure the progress of prevention efforts. NHSN has more than 14,500 participating healthcare facilities, making it the largest healthcare associated infection (HAI) reporting system in the United States. NHSN publishes standard methods and definitions, online training modules, user support, and facility
comparison tools (CDC 2014). Nearly all U.S. hospitals and dialysis facilities are able to successfully report to NHSN, making it an important tool for national HAI tracking and elimination.

Research shows that when healthcare facilities and individual practitioners are aware of infection problems and take specific steps to prevent them, rates of certain HAIs can be decreased significantly. Infection data can give healthcare facilities and public health agencies the information they need to design, implement, and evaluate prevention strategies (CDC 2014). This information sharing must be an active process in order to be successful.

NHSN is designed to securely collect a variety of types of HAI information. The hospitals build a reporting plan that is specific to each individual facility. The reporting plan includes a name for each ward and unit in the hospital. The reporting plan also includes all of the types of data that is expected to be entered. Data includes surgical events and infection, device associated infections and laboratory identified events (Lab-ID). Building an individualized reporting plan allows data to be stratified by unit. It also allows for quality checks because NHSN will request data that was built into the reporting plan but not entered within the given time allowance.

CRE data is entered in the Multidrug-Resistant Organism & Clostridium difficile Infection (MDRO/CDI) Module through the secure online NHSN website. Demographic, hospital visit, and culture data are all entered into the module. Data entry is not successful unless all required fields are entered.
New York State Public Heath Law (PHL) Section 2819

NYSDOH recently mandated that all acute care hospitals report Lab-ID CRE- 
*E-coli* and CRE-*Klebsiella* beginning in July 2013. This mandate is enforced through Public Health Law 2819. PHL 2819 was enacted in 2005 mandating that New York hospitals report selected healthcare associated infections (HAIs) to NYSDOH. Ongoing use of health indicators included in the PHL 2819 mandate will be reviewed at least annually with an appointed Technical Advisory Workgroup (TAW). The TAW is a panel of professionals representing experts in the prevention, identification, and control of HAIs.

The PHL is divided into nine sections:

Section 1. Clearly defines hospital acquired infection.

Section 2. Describes what each facility’s surveillance program must be capable of providing. Sets the foundation for the Technical Advisory Workgroup (TAW).

Section 3. Outlines requirements and frequency of reporting data to the state.

Section 4. Establishes the creation of a statewide database that is publically accessible.

Section 5. Declares that a public report will be published each year.

Section 6. States that the annual report will be easy to understand and offers comparative hospital performance.

Section 7. Outlines the creation and development of the audit process.

Section 8. Assures funding through grants.

Section 9. Ensure protection of private individual medical information.

PHL Identified Stakeholders
A variety of relevant stakeholders are identified in the PHL:

- Hospitals
- Department of Health
- CDC
- General public
- Technical advisors – TAW
- Commissioner of Health
- Consumers
- Healthcare professionals
- Purchasers
- Payers
- Patients
- Auditors

Laboratory Testing and Case Definition

Laboratory identification of CRE can be achieved through several methods. All of the methods have benefits and drawbacks. There is no standardization for what method should be used in individual health care facility laboratories.

A common method is automated identification and susceptibility testing. Automation is performed on one of several commercially available instruments. The three automated instruments that are used in New York State are Vitek II, Microscan, and Phoenix. All of these instruments operate by using a dilution of live culture growth to determine biochemical reactions for identification (speciation) and growth or survival in the presence of antibiotics (standardized concentration) for susceptibility testing.

Manual susceptibility testing methods can also be used to identify CRE cases. These methods are used exclusively by a small number of facilities for detection of CRE, and they are used by many of the facilities using automated methods for purposes of confirmation. Manual
testing methods include disk diffusion and E-tests. These methods utilize live incubated culture growth and are able to more accurately predict carbapenem treatment failure in vivo.

Breakpoints for determining susceptibility or non-susceptibility (intermediate or resistant results) are published periodically by the Clinical Laboratory Standards Institute (CLSI). CLSI is a not-for-profit membership organization that defines its mission as bringing together the global laboratory in order to foster excellence in laboratory medicine by facilitating a unique process of developing clinical laboratory testing standards based on input from and consensus industry, government, and health care professionals. These breakpoints apply to both automated and manual testing methods. Fortunately, these breakpoint standards are used by all microbiology laboratories to ensure similarity of results regardless of testing location.

However, the breakpoints are often updated more frequently than they can be adopted at the facility level. As such there are some facilities in the state operating with previous breakpoints, some with current breakpoints, and some with a combination of sets of breakpoints. The lack of uniformity in the application of the standards creates a major challenge to accurate surveillance. The previous and current breakpoints (as of 2012) from the CLSI for all four carbapenems are given in Table 1.

**Table 1. CLSI Breakpoint categories**

<table>
<thead>
<tr>
<th>Agent</th>
<th>Previous Breakpoints (M100-S19) MIC (µg/mL)</th>
<th>Current Breakpoints (M100-S22) MIC (µg/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Susceptible</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Doripenem</td>
<td>≤4</td>
<td>8</td>
</tr>
<tr>
<td>Ertapenem</td>
<td>≤2</td>
<td>4</td>
</tr>
<tr>
<td>Imipenem</td>
<td>≤4</td>
<td>8</td>
</tr>
<tr>
<td>Meropenem</td>
<td>≤4</td>
<td>8</td>
</tr>
</tbody>
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Testing can also be performed to confirm the presence of one of the carbapenem hydrolyzing enzymes (carbapenemases) described above. Enzyme confirmation can be done using the Modified Hodge Test, molecular assays, metallo-beta lactamase test, or Carba NP. All of the methods described here can be used to appropriately meet the case definition for CRE. This case definition is published by the CDC (CDC 2014) and was adopted by NYSDOH for the purposes of its CRE reporting mandate.

**NHSN 2013-2014 MDRO Module CRE Definition:**

- **CRE-*E coli*: Any *E. coli* testing non-susceptible (i.e., resistant or intermediate) to imipenem, meropenem, or doripenem, by standard susceptibility testing methods or by a positive result for any method FDA-approved for carbapenemase detection from specific specimen sources.

- **CRE-*Klebsiella*: Any *Klebsiella* spp. testing non-susceptible (i.e., resistant or intermediate) to imipenem, meropenem, or doripenem, by standard susceptibility testing methods or by a positive result for any method FDA-approved for carbapenemase detection from specific specimen sources.

Only *E. coli* and *Klebsiella* species isolates meet the 2013-2014 reporting requirement. However, there are many other species and genera that can express carbapenem resistance. Please note that for both organism types the case definition can be successfully met either through testing non-susceptible or through the identification of a hydrolyzing enzyme.

An updated CRE surveillance definition was adopted by the CDC beginning January 1, 2015. This 2015 definition is as follows:

Any *Escherichia coli, Klebsiella oxytoca, Klebsiella pneumoniae, or Enterobacter* spp. testing resistant to imipenem, meropenem, doripenem, or ertapenem by standard susceptibility
testing methods (i.e., minimum inhibitory concentrations of ≥4 mcg/mL for doripenem, imipenem and meropenem or ≥2 mcg/mL for ertapenem) OR by production of a carbapenemase (i.e., KPC, NDM, VIM, IMP, OXA-48) demonstrated using a recognized test (e.g., polymerase chain reaction, metallo-β-lactamase test, modified-Hodge test, Carba-NP). Note: For in-plan CRE surveillance, facilities must conduct surveillance for all three organisms CRE-\textit{E. coli}, CRE-\textit{Enterobacter}, and CRE-\textit{Klebsiella} (\textit{Klebsiella oxytoca} and \textit{Klebsiella pneumoniae}).

New York State Response

As a result of the CDC Vital Signs CRE report of March 2013, the corresponding National press conference where CDC pointed out that CRE rates are very high in the New York City area, the subsequent NY media coverage, and the small percentage of hospitals voluntarily reporting, NYSDOH mandated that all acute care hospitals report Lab-ID CRE-\textit{E. coli} and CRE-\textit{Klebsiella} beginning in July 2013, enforced through Public Health Law 2819.

Data for mandated HAIs are obtained through the CDC’s National Healthcare Safety Network (NHSN). Individual patient or laboratory data is entered through the NHSN secure online server at the facility level. Data use agreements between each facility and the NYSDOH allow retrieval and audit of the data for the purposes of surveillance. Strict measures are taken to ensure the privacy and confidentiality of all patients and facilities.

The first six months of data was considered a pilot period. This pilot period allowed both the facilities and NYSDOH time to assess the baseline rates, the validity of the reporting, and the impact of laboratory testing methods and hospital patient mix on the variability in hospital-specific rates. The data collected during this pilot period is the foundation of the CRE project.
described here. De-identified pilot data was published in the annual public report in September 2014. Hospitals continued reporting this indicator in 2014 and the HAI Bureau will publish hospital-specific CRE rates in the 2014 annual public report.

Population of Interest

An important distinction in HAI prevention is delineating between infections that are community acquired and those that are acquired in a healthcare facility. Because the exact moment of onset of the infection cannot usually be determined a uniform proxy measure is used. The proxy measure is temporal; based on the number of days between admission to the hospital and collection of a positive culture. Identification of an infection within three days (less than or equal to) of admission to a healthcare facility is considered community acquired and any infection identified after three days is considered healthcare associated. The prevention directed and educational focus of this project will be on patients and providers associated with infections determined to be healthcare onset. This focus is due to the ability of healthcare facility prevention practices to intervene on these infections.

For this project our community of study will be the acute health care facilities in the State of New York. There are several important populations within this hospital community. These populations include patients, visitors, healthcare workers, and facility staff members. Contracted employees and vendors should also be considered part of the study community. However, the wider New York State population could also be impacted by the NYSDOH CRE reporting and surveillance initiative. Other resistant organisms have demonstrated how pathogens can spread from health care facilities into the community and become endemic there. MRSA and VRE are
excellent examples of pathogens moving from the patient environment into the community at large.

Another important population is the healthcare workers and residents of long term care and rehabilitation facilities. The patients who necessitate this type of continuous care are likely to have the risk factors associated with developing a CRE infection (long course antibiotics, multiple exposures to health care facilitates, use of indwelling medical devices) (Swaminathan, 2013). Although the NYS reporting mandate is only extended to acute care facilities these long term care and rehabilitation facilities are important reservoirs of antimicrobial resistant bacteria.

Evidence-based Transmission Prevention

A variety of transmission prevention strategies have been used both domestically and internationally to stop CRE outbreaks and slow the spread of the organism. The CDC has outlined eight core infection prevention strategies that should be followed by all facilities (CDC, 2012). These strategies include: hand hygiene, use of Contact Precautions, healthcare personnel education, proper use of indwelling medical devices, patient and staff cohorting, laboratory notification policies, antimicrobial stewardship, and targeted patient screening. In addition, facilities that have high rates of CRE or are in geographic areas that have shown high rates of CRE should also implement the following supplemental strategies: active surveillance testing, chlorhexidine bathing, improved inter-facility communication, and surveillance for unusual resistance mechanisms. These strategies will be used as the intervention part of this project to support acute care facilities in reducing their rates of CRE.
Behavioral Theories

The problems associated with bacterial pathogen spread in a healthcare facility are heavily behavioral. As described above, CRE are intrinsically suited to spread in the patient environment of care. The characteristics that allow CRE to be effective at causing healthcare associated infections are reasonably well understood; however, the scientific understanding of the bacteria’s transmission properties is not sufficient for their control. The behaviors of the humans involved in the care of patients are a major contributing factor to the spread of the pathogen.

Therefore, it is necessary to explore the constructs of these human behaviors and to understand how they can be changed to produce improved outcomes. Behavioral activities that are significant to infection prevention include hand hygiene, antimicrobial stewardship, following transmission based precautions protocols, and attention to reporting accuracy. Individual, inter-personal, and community levels of health behaviors should all be considerations.

Important behavioral theories that are applicable to infection prevention include the theory of ecological perspective and the theory of planned behavior. In the theory of ecological perspective the effect of knowledge and education can change behaviors. The theory offers six types of social powers: coercive, reward, legitimate, expert, referent and informational. The social powers that impact infection prevention behaviors are informational and expert powers (Pittet 2004). These powers can be translated into behavior change through ongoing education initiatives for caregivers and by identifying expert champions at the hospital as part of the infection prevention team. Having Infection Preventionists (IPs) identified by staff as disease
transmission experts is vital and can be achieved through relationship building and information sharing.

In the theory of planned behavior the most significant cognitive determinant is social pressure. Major elements include attitude, perceived social norm and perceived behavioral control (Borg 2013). These constructs speak to the institutional culture of the hospital. It is important for newly hired providers to observe correct behaviors performed by their more established colleagues. Educational and training initiatives need to empower caregivers to identify and correct inappropriate behaviors in themselves and their team members (Fuller 2014).

Cultural change can be very slow. However, once a set of correct behaviors is considered the social norm, incorrect behaviors will be less tolerated in general. Also, education through observation is better than through presentation alone (Palmore 2014). It is important for infection preventionists to have a visual presence in the environment of care and to always maintain proper behaviors that should be duplicated by caregivers.
METHODS

Several strategies and analytic methods have been used to address the objectives outlined for this project. The purpose of a mixed methods research approach, as it has come to be popularly known, is both to take a novel approach to the MDRO problem and to be as comprehensive with data collection as possible. The methods described here include both qualitative and quantitative data collection. The majority of the data presented is primary. Some is collected by the researcher herself and some by the professionals at the HAI Bureau. All of the data was collected for the purpose of reducing CRE in NYS, although not all was collected specially for the purposes of this dissertation. Each of the strategies employed will be individually described here.

Program Introduction

A Doctorate in Public Health candidate should take the knowledge she has from years of practical experience and marry it with the implementation strategies learned through the doctoral course of study. In the case of this project the background practice is based in clinical microbiology at various hospitals and infection prevention in acute and long term care settings. Due to the collaborative relationship between the University at Albany and the New York Department of Health (NYSDOH), it seemed sensible that doctoral work should take place as part of the NYDOH’s efforts to reduce HAIs in the state. These efforts are concentrated at the Bureau of Healthcare-Associated Infections.

After reaching out to the HAI Bureau a need within the Bureau for CRE related work was identified as a result of the new reporting mandate and a CDC Epidemiology and Laboratory Capacity Grant. At the time the Bureau did not have dedicated staff in place to work on the CRE
projects. This need and the background of the DrPH student lend themselves well to a practical collaboration.

Laboratory Methodology Survey

The first step in the CRE project was to understand how CRE data was being collected. Part of the challenge of performing consistent CRE surveillance is that there is not uniformity of methodologies in the laboratories that produce the culture results. CRE that appropriately meets the case definition can be identified through a variety of methods. All of these methods have advantages and drawbacks. Each individual laboratory makes the decision on which method, or combination of methods, it will use. However, testing practices can affect HAI rates and having many different methods can make comparisons among hospitals difficult.

A 32 question survey was developed in collaboration with HAI Bureau staff to determine individual facility practices related to CRE. The questions on the survey were designed to identify which testing methods, or combination of methods, each laboratory used to identify CRE in clinical cultures. The survey also included questions regarding the capabilities of the laboratory identification systems to generate CRE specific reports that are necessary for efficient auditing. The questions included laboratory detection methods for CRE and *Clostridium difficile* (C-diff), which CLSI breakpoints are applied, how the laboratory data is communicated to Infection Prevention, and quality control issues related to CRE reporting. (See Appendix A) The survey was sent through email with a link to Survey Monkey to the identified Infection Preventionist at each facility. Follow up with individual facilities was continued until 100% participation was achieved.
The data was downloaded from the Survey Monkey responses into an Excel spreadsheet for data cleaning. Any incomplete items had follow up with the facility IP for clarification. Any duplicate attempts to complete the survey were deleted to ensure that each facility only gave one answer to each survey question. The CLSI breakpoint data was used to group facilities into categories denoting likely accuracy of CRE case identification. Facilities using current breakpoints will be considered “sensitive” and facilities using previous breakpoints will be considered “non-sensitive” in terms of identifying true CRE cases. Qualitative comments were also analyzed and compared to identify themes and trends in challenges across facilities.

The laboratory survey identified a few areas for potential improvement in the surveillance of CRE. Any facilities that are shown to not be appropriately meeting CDC case definition based on survey results were educated about the identified problem. Education was provided through informational presentations (discussed later) as well as conversations with individual hospital representatives.

CRE Surveillance Data

The surveillance data for CRE in all hospitals in New York is the foundation of this project. As described previously, CRE recently became prominent in the popular media as an eminent public health threat. However, the exact scope of the CRE problem was not known at the time of this media attention. In order to target interventions and control programs, a baseline incidence and prevalence needed to be established. This surveillance data is collected through the NHSN as described previously.

Collecting LabID Event data through NHSN is not unprecedented in New York. A reporting structure for laboratory results of *C. difficile* testing was implemented in July 2009.
The existence of this reporting requirements is significant because reporting laboratory identified CRE should follow the model of these existing indicators. Training and education for reporting at the hospital level should therefore be limited to the nuances of meeting the case definition. All instruction on how to obtain the necessary culture data and enter it into NHSN has been previously established.

A comprehensive and updated list of at least one IP contact for every facility is kept by the HAI Bureau. Individual patient and laboratory data is entered in the NHSN online secure database by these facility IP contacts and their colleagues. The data is viewable and downloadable by HAI Bureau staff due to data sharing agreements between the NYSDOH and each facility. The facilities are not able to view one another’s reporting data, although named facility data is published in the annual reported (discussed subsequently). Data entered in NHSN by the facility is never altered by NYSDOH. The first six months of data were considered a pilot period, allowing time for both the facilities and NYSDOH to assess the baseline rates, the validity of the reporting, and the impact of laboratory testing methods and hospital patient mix on the variability in hospital-specific rates. The NHSN data was also used for several other analyses, including geographic trends in incidence and prevalence rates and accuracy or reporting based on audited culture reports.

The data from NHSN was downloaded into SAS® version 9.3 to be analyzed. Analysis included checks for accuracy. Accuracy checks, for example, will ensure that the same data has not been entered twice or that there are not facilities that have failed to report. Additional analysis will investigate the data for statistical anomalies and outliers. Any facilities with low rates that are in geographic areas with high rates will be investigated further. Any facilities that report high CRE rates will be considered for on-site visits.
Technical Advisory Workgroup Presentation

The Technical Advisory Workgroup (TAW) is an integral part of New York State’s Reporting Program. This group offers expertise in Infection Prevention, Infectious Disease Medicine, and Hospital Epidemiology. Any major changes that are proposed to the Reporting Program are discussed and evaluated with this group. Recommendations from the TAW are used to inform addition or removal of mandatory reporting indicators. The TAW was created as part of the state oversight plan developed through the NYS Public Health Law 2819. Described in PHL 2819 as: “technical advisors who are regionally or nationally-recognized experts in the prevention, identification and control of hospital acquired infection and the public reporting of performance data.”

In order to keep the TAW current on the successes and challenges being faced by the Reporting Program, presentations are given to the group at least once a year. These presentations also are an excellent opportunity of all of the TAW members to be physically present in the same space in order to foster in person discussions of Reporting Program related issues. The in person setting allows each member of the TAW to voice his or her opinion regarding the practices of and any proposed changes to the reporting program. It also creates an environment that encourages discussion among the members, and with the HAI Bureau members.

The TAW meeting that took place during this project occurred over two days in October 2013. Presentations were made by representatives from the Reporting Program, including an hour long presentation specific to CRE followed by questions and comments (Appendix B). This presentation offered background in the definition challenges faced, laboratory methods used throughout the state, surveillance data from the pilot period, and the CDC’s recommended facility level CRE prevention practices.
The results and recommendations presented allowed the foundation for an informative discussion among the TAW members specific to CRE reporting in the state. It was agreed by the members present that CRE is a useful indicator and should continue to be on the mandatory reporting list. The criteria used to select reporting indicators are displayed in Table 2.

**Table 2. Criteria for useful reporting indicators**

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Important</td>
<td>Affects large number of people, has a substantial impact for a smaller population, or recommended by CDC.</td>
</tr>
<tr>
<td>Performance gap</td>
<td>Considerable variation or overall less-than-optimal performance across facilities, demonstrates opportunity for improvement.</td>
</tr>
<tr>
<td>Evidence-based</td>
<td>Studies or expert opinion support the relationship between healthcare practices and infection rates.</td>
</tr>
<tr>
<td>Valid</td>
<td>The indicator measures what it is intended to measure. Outcomes can be adjusted as needed for differences in patient HAI risk factors between facilities.</td>
</tr>
<tr>
<td>Reliable</td>
<td>Indicator is well-defined so it can be reported consistently across facilities.</td>
</tr>
<tr>
<td>Usable</td>
<td>Audience can understand the results and find them useful for decision making.</td>
</tr>
<tr>
<td>Feasible</td>
<td>Required data can be reported without undue burden.</td>
</tr>
<tr>
<td>Comparison to related measures</td>
<td>Does not conflict with other measures/reporting requirements.</td>
</tr>
</tbody>
</table>

**Regional Conference Calls**

For the health care worker audience, annual regional conference calls were prepared and delivered to representatives from all facilities. These calls focused on the protocol for reporting the new CRE reporting indicator and recommended prevention practices. In 2013, New York State 171 acute care facilities with a wide variety of patient populations, laboratory capacities, and infection prevention support reported HAIs. As such it is difficult to deliver information and have meaningful discussion with all of the facilities at once. In order to mitigate this challenge the state is divided up in regions for the purposes of information dissemination and spreading
workload for other responsibilities of staff. Presentations, given as live interactive conference calls, allow for more directed communication and effective discussion.

These regional conference calls are roughly an hour in delivery time followed by a question and answer session. They are presented live using PowerPoint slides and conference call software. The audience includes an IP or appointed representative from every acute care hospital in NYS. The IPs are expected to attend and are aware that these talks will be coming each year. These conference calls are a good platform for questions and discussions, especially for new indicators.

The CRE regional conference calls were delivered January and February of 2014. The CRE presentation included preliminary surveillance data results (including a map showing the geographic distribution of CRE in NYS), clarification on the definition used for reporting, and recommended facility-level prevention measures. A presentation was also given mid-year 2013 before the mandated start date of the CRE indicator in order to inform IPs of the appropriate CRE case definition.

The prevention measures included in the 2012 CRE Toolkit include eight core strategies for all facilities and two supplemental strategies for facilities with high CRE prevalence or in areas of high CRE prevalence. The core measures are: (1) **Hand Hygiene** - Facilities should ensure that healthcare personnel are familiar with proper hand hygiene technique as well as its rationale. (2) **Contact Precautions** - Patients in acute care settings who are colonized or infected with CRE should be placed on Contact Precautions. Systems should be in place to identify patients with a history of CRE colonization or infection at admission so that they can be placed on Contact Precautions if not known to be free of colonization. (3) **Healthcare Personnel Education** - HCP in all settings who care for patients with MDROs, including CRE, should be
educated about preventing transmission of these organisms. At a minimum this should include information on the proper use of Contact Precautions and hand hygiene. (4) **Use of Devices** - Use of devices (e.g., central venous catheters, endotracheal tubes, urinary catheters) puts patients at risk for device–associated infections and minimizing device use is an important part of the effort to decrease the incidence of these infections. Additionally, device use has been associated with carbapenem resistance among Enterobacteriaceae. Therefore, minimizing device use in all healthcare settings should be part of the effort to decrease the prevalence of all MDROs including CRE. (5) **Patient and Staff Cohorting** - When available, patients colonized or infected with CRE should be housed in single patient rooms and if not available these patients should be cohorted together. In addition, consideration should be given to cohorting patients with CRE in specific areas (e.g., units or wards), even if in single patient rooms, and to using dedicated staff to care for them. (6) **Laboratory Notification** - Laboratories should have protocols in place that facilitate the rapid notification of appropriate clinical and infection prevention staff whenever CRE are identified from clinical specimens to ensure timely implementation of control measures. (7) **Antimicrobial Stewardship** - As part of an antimicrobial stewardship program designed to minimize transmission of MDROs, facilities should work to ensure that 1) antimicrobials are used for appropriate indications and duration and 2) that the narrowest spectrum antimicrobial that is appropriate for the specific clinical scenario is used. (8) **Screening Epidemiologically Linked Contacts** - Screening is used to identify unrecognized CRE colonization among epidemiologically linked contacts of known CRE colonized or infected patients as clinical cultures will usually identify only a fraction of all patients with CRE.
The two supplemental strategies are: (1) **Active Surveillance** - This process involves culturing patients who might not be epidemiologically linked to known CRE patients but who meet certain pre-specified criteria. This could include everyone admitted to the facility, pre-specified high-risk patients (e.g., those admitted from long-term care facilities), and/or patients admitted to high-risk settings (e.g., intensive care units [ICUs]). (2) **Chlorhexidine Bathing** - Chlorhexidine bathing has been used successfully to prevent certain types of healthcare-associated infections (e.g., bloodstream infections) and to decrease colonization with specific MDROs, primarily in ICUs. For CRE, it has been used as part of a multifaceted intervention to reduce the prevalence of CRE during an outbreak in a long-term acute care facility. During chlorhexidine bathing, diluted liquid chlorhexidine (2%) or 2% chlorhexidine-impregnated wipes are used to bathe patients (usually daily) while in high-risk settings (e.g., ICUs). (Guide for Control of Carbapenem-resistant *Enterobacteriaceae* (CRE) 2012 CRE Toolkit).

**Annual Report**

For healthcare consumers, hospital IPs and government audience hospital-specific CRE rates are published in the 2013 annual report. For the 2013 annual report the data from July to December 2013 for carbapenem-resistant Enterobacteriaceae (CRE) infections were published. CRE data are summarized in this report; hospital specific data will be provided for infections occurring in 2014. The report summarized HAI rates in NYS hospitals in 2013 (Appendix E).

**Site Visits (and Toolkit)**

Investigations included telephone or site visits with IPs and laboratory managers to ensure that the highest possible quality case identification and reporting is being performed. A
list or script of relevant questions was developed to aid in these investigations. The results from the data analysis also informed the audit process.

Site visits were scheduled and performed in geographic areas with the highest CRE burden (New York City area). Site visits are conducted in the Fall and Winter of 2014 and included four facilities. The facilities were chosen based on their location and on an on-site audit being concurrently scheduled. The goals the site visits visit were to make observations of infection prevention practices, to interview clinical staff members, and to offer education on CRE transmission reduction strategies.

Prior to scheduling site visits for the CRE initiative a ‘CRE Site Visit Toolkit’ was developed (Appendix F). This toolkit was created to standardize the visits and the qualitative data they produced as much as possible. The toolkit included background information on CRE, the goals and objectives of the visits, a tentative visit schedule/timeline, a checklist of relevant observations, and topics for clinical staff interviews. The toolkit is a combination of existing recommendations for best practices regarding CRE prevention.

Site visits included interviews with IPs and the IP Director, Microbiology Laboratory Director, Intensive Care Unit (ICU) nursing staff, and Central Sterile Processing (CSP) staff. Activities that took place on the day of the visit include the following:

- Introduction and explanation for visit to IPs
- Introduction and problem identification from physician leader and quality representative
- Observations on ICU
- Brief educational presentation to ICU staff with Q&A
- Interviews with ICU nurse leader and nurse educator
Observations in Central Sterile Processing (CSP)

On-site audit of CRE surveillance data

Observations in Laboratory

Interview with Laboratory Director and Microbiology Manager

Audit Comparison

The audit process developed and carried out by the NYSDOH HAI Reporting Program (RP) has several goals including: (1) to validate accuracy of infection rates and risk adjustment variables, (2) to evaluate current surveillance methods used to detect infections, (3) to determine the reliability and consistency of surveillance definitions, (4) to evaluate intervention strategies designed to reduce or eliminate specific infections, and (5) to provide education on definitions, surveillance mechanisms, and use of the NHSN (cite HAI Bureau audit document).

Hospitals are audited approximately every two years. High priority hospitals are more likely to be audited in a given year. These are hospitals that have a significantly high HAI rate in any indicator in the previous two or more annual reports. Medium priority hospitals includes facilities not audited in the previous two years, those with significantly high or low HAI rates in the previous annual report, those that performed poorly during a previous audit, and those demonstrating problems adhering to reporting requirements.

Prior to scheduling the audits, four NYSDOH HAI RP Regional Representative (RRs) certified in infection control download the CRE data from NHSN into a spreadsheet formatted to uniformly record agreement and disagreement comments for each NSHN variable. The RR then schedules the audit with the hospital Infection Preventionist (IP) as the primary contact person. An on- or off-site audit begins with an initial call to the IP to explain the audit process.
The IPs are asked to provide a chronological lab or data mined line list of up to twenty positive CRE lab reports for the time period being audited, of specimens from all body sources and from all inpatient locations, outpatient locations and emergency departments. Each report includes the following data: medical record number, specimen date, organism species, specimen source, collection location, facility admission date, location admission date, date of last discharge if within three months, and carbapenems tested with sensitivity results.

The RR evaluated the culture reports to see if they met the 2013/2014 NHSN CRE surveillance definition: a *Klebsiella* spp. or an *E coli* that tested resistant or intermediate to imipenem, meropenem, or doripenem by standard susceptibility testing methods (or by production of a carbapenemase) (CDC, 2013). Each data element (patient ID, specimen date, specimen source, facility admit date, location admit date, last discharge date, and organism species) was reviewed by the RR. If she agreed with the data, she entered ‘Yes;’ if she disagreed she entered ‘No’ and the appropriate response. The RR then determined whether or not the case was reportable and selected one of the following outcomes: “In NHSN-OK,” “In NHSN-Remove,” and “Not NHSN-Add.” If “Not NHSN-Add” was selected an explanation was entered in the “Comment” field (e.g. specimen was surveillance swab). Data entry into audit result spreadsheets performed by RRs is done using programmed drop-down boxes in order to avoid clerical errors.

Immediately following the audit the RR discussed the audit results with the IP and other relevant stakeholders within the organization. The RR also emailed a closing letter (Appendix G) to the facility CEO and IP detailing the findings from the audit and offering recommendations for improving reporting as needed. The IPs were asked to correct any disagreements in NHSN within three weeks.
Continuing Education (and evaluation)

A continuing education course was developed specifically for the microbiology laboratory personnel audience (Appendix H). This presentation is intended to be an hour long and is developed in two forms: one to be given in-person by a presenter and one to be delivered online as a self-guided learning module. It includes information specific to the laboratory’s role in preventing and accurately reporting CRE. Specific attention was given to explaining the difference between clinical and surveillance definitions for CRE. The course is designed to be challenging and to present new information to the audience. It includes information slides, learning questions, and case studies with associated questions.

An evaluation form was also developed to determine any weakness in the program design (Appendix I). The course was presented to a pilot audience of microbiology technologists from the microbiology laboratory at St. Peter’s Health Partners. Immediately following the presentation the technologists were asked to complete the evaluation form. Their responses were used to improve the course before publication or mass distribution.
RESULTS

Laboratory Survey

Two of the most relevant questions asked on the laboratory survey centered on which antibiotics were routinely used by hospital laboratories and which breakpoints were being used to determine susceptibility interpretations. The antibiotics used question allowed the HAI Bureau to identify facilities that may not have been meeting the case definition appropriately. The breakpoints question allowed facilities to be classified into their sensitive or non-sensitive groups in terms of successfully identifying CRE cases. These results were published as part of the 2013 annual report.

Additional results from the laboratory survey show that about half (51%) of hospital laboratories screen all potential enteric organisms to identify *E. coli* or *Klebsiella* spp. Most laboratories (63%) also screen all identified enteric organisms for resistance to carbapenems. It is possible for cases of CRE to be missed by those facilities that do not screen all cultures either for identification as an enteric or for resistance to carbapenems. However, those facilities that do not screen all enteric organisms reported that they do screen all pure isolates and sterile sites for resistance to carbapenems. This methodology means that those carbapenem-resistant infections with the highest likelihood of morbidity and mortality (e.g. bloodstream infections) are likely to be identified in all facilities across the state. A change in testing protocol for routine clinical specimens is not recommended based on these survey results.

The laboratory survey asked hospitals which of the four commonly used carbapenem antimicrobials they routinely use for antimicrobial susceptibility testing against Gram negative bacilli. The results of antibiotics question are given in Table 3.
Table 3. Carbapenems utilized

<table>
<thead>
<tr>
<th>Antibiotics Used</th>
<th>Percentage of Hospital Laboratories</th>
<th>Number of Hospital Laboratories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ertapenem, meropenem, and imipenem</td>
<td>39.8%</td>
<td>68</td>
</tr>
<tr>
<td>Ertapenem and imipenem</td>
<td>22.8%</td>
<td>39</td>
</tr>
<tr>
<td>Ertapenem and meropenem</td>
<td>11.7%</td>
<td>20</td>
</tr>
<tr>
<td>Ertapenem, meropenem, doripenem, and imipenem</td>
<td>10.0%</td>
<td>17</td>
</tr>
<tr>
<td>Meropenem and imipenem</td>
<td>7.0%</td>
<td>12</td>
</tr>
<tr>
<td>Ertapenem, doripenem, and imipenem</td>
<td>2.9%</td>
<td>5</td>
</tr>
<tr>
<td>Imipenem</td>
<td>2.9%</td>
<td>5</td>
</tr>
<tr>
<td>Meropenem</td>
<td>2.9%</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total: 171</td>
</tr>
</tbody>
</table>

The survey also asked which CLSI breakpoints the hospital laboratories were applying for both their automated (if applicable) and manual testing methods. The results of breakpoints question are given in Table 4.
### Table 4. CLSI breakpoints utilized

<table>
<thead>
<tr>
<th></th>
<th>CLSI Breakpoints Used</th>
<th>Percentage of Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>More sensitive test (i.e. will identify more CRE cases)</td>
<td>Automated and manual testing – both current breakpoints</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td>Automated testing only - current breakpoints</td>
<td>7%</td>
</tr>
<tr>
<td></td>
<td>Manual testing only – current breakpoints</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>Automated testing - current breakpoints; manual testing - older breakpoints</td>
<td>2%</td>
</tr>
<tr>
<td>Less sensitive test (i.e. will identify fewer CRE cases)</td>
<td>Automated testing - older breakpoints; manual testing - current breakpoints</td>
<td>12%</td>
</tr>
<tr>
<td></td>
<td>Automated and manual testing – both older breakpoints</td>
<td>11%</td>
</tr>
<tr>
<td></td>
<td>Automated testing only - older breakpoints</td>
<td>6%</td>
</tr>
</tbody>
</table>

Survey data on which CLSI breakpoints were used was applied to categorize the hospitals into sensitive and non-sensitive groups in terms of each hospital’s ability to correctly identify a CRE in culture. The updated breakpoints are lower and therefore more sensitive. Applying these breakpoints increases the likelihood that a CRE will be found when grown in the laboratory. The table below displays the information for blood specimen cultures by test category and region. Regions are defined as New York City (NYC) and New York State not including New York City (Upstate).

Data stratified by region for CRE-*Klebsiella* blood cultures is given in Table 5.
Table 5. CRE-*Klebsiella* blood culture prevalence rate by test category and region

<table>
<thead>
<tr>
<th>Region</th>
<th>CRE-<em>Klebsiella</em> blood culture prevalence rate by test category and region</th>
<th>Number of blood cultures</th>
<th>Number of Admissions</th>
<th>Blood incidence rate (per 100 admissions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NYC</td>
<td>Non-sensitive</td>
<td>72</td>
<td>369,280</td>
<td>0.019</td>
</tr>
<tr>
<td></td>
<td>Sensitive</td>
<td>344</td>
<td>1,380,372</td>
<td>0.025</td>
</tr>
<tr>
<td>Upstate</td>
<td>Non-sensitive</td>
<td>4</td>
<td>186,648</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>Sensitive</td>
<td>10</td>
<td>457,918</td>
<td>0.002</td>
</tr>
</tbody>
</table>

New York State data reported as of July 10, 2014. All data have been annualized to represent a full year. Prevalence rates are based on 2,394,218 admissions. Only one blood test can be entered per 14 days, including across calendar months. Data for two hospitals was excluded due to unknown testing methodology.

In the NYC region the CRE-*Klebsiella* positive blood prevalence rate is higher in the sensitive test category. In the Upstate region the prevalence rate is very similar between the two test categories. The very low numbers of CRE positive blood specimens outside of NYC may have an effect on the lack of an observed difference in the Upstate region.

CRE Surveillance Data

The pilot period data was analyzed for the 2013 HAI Annual Report. The data was entered into NHSN at the hospital by the infection preventionist. The data for selected hospitals was then audited by the HAI Regional Representatives and corrected were made by the IP. Basic epidemiological data gleaned from the reported cases is displayed in Table 6.

From the 2013 annual report:
Table 6. CRE Surveillance Data

<table>
<thead>
<tr>
<th></th>
<th>CRE-Klebsiella spp</th>
<th>CRE-E. coli</th>
<th>CRE combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of cases</td>
<td>2,988</td>
<td>268</td>
<td>3,256</td>
</tr>
<tr>
<td>Total rate (per 100 admissions)</td>
<td>0.124</td>
<td>0.011</td>
<td>0.136</td>
</tr>
<tr>
<td>Number of admission prevalent cases</td>
<td>1,480</td>
<td>140</td>
<td>1,620</td>
</tr>
<tr>
<td>Admission prevalence rate (per 100 admissions)</td>
<td>0.062</td>
<td>0.006</td>
<td>0.068</td>
</tr>
<tr>
<td>Number of admission prevalent bloodstream infection cases</td>
<td>164</td>
<td>18</td>
<td>182</td>
</tr>
<tr>
<td>Admission prevalence bloodstream infection rate (per 100 admissions)</td>
<td>0.007</td>
<td>0.001</td>
<td>0.008</td>
</tr>
<tr>
<td>Number of hospital onset (HO) cases</td>
<td>1,508</td>
<td>128</td>
<td>1,636</td>
</tr>
<tr>
<td>HO rate (per 10,000 patient days)</td>
<td>1.17</td>
<td>0.10</td>
<td>1.27</td>
</tr>
<tr>
<td>Number of HO bloodstream infection cases</td>
<td>264</td>
<td>14</td>
<td>278</td>
</tr>
<tr>
<td>HO bloodstream infection rate (per 10,000 patient days)</td>
<td>0.20</td>
<td>0.01</td>
<td>0.22</td>
</tr>
</tbody>
</table>

New York State data reported as of July 10, 2014. All data have been annualized to represent a full year. Incidence rates are based on 12,914,730 patient days, and prevalence rates are based on 2,394,218 admissions. The number of cases only includes one test per patient per hospital per month. In addition, only one blood test can be entered per 14 days, even across calendar months.

The statewide data is stratified below based on dividing the state in two regions: New York City (NYC) and Upstate. Only *Klebsiella* spp. bloodstream infections are shown. There is considerably less variation in processing and culturing blood specimen cultures across the state. Therefore, limiting the regional analysis gives information on the differences between the two regions with fewer confounding variables.

CRE-*Klebsiella* statewide surveillance data is given by region in Table 7.
Table 7. CRE-*Klebsiella* surveillance data by region

<table>
<thead>
<tr>
<th></th>
<th>CRE-<em>Klebsiella</em> spp NYC</th>
<th>CRE-<em>Klebsiella</em> spp Upstate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of cases</td>
<td>2,844</td>
<td>144</td>
</tr>
<tr>
<td>Total rate (per 100 admissions)</td>
<td>0.119</td>
<td>0.006</td>
</tr>
<tr>
<td>Number of admission prevalent cases</td>
<td>1,398</td>
<td>82</td>
</tr>
<tr>
<td>Admission prevalence rate</td>
<td>0.058</td>
<td>0.003</td>
</tr>
<tr>
<td>Number of admission prevalent bloodstream infection cases</td>
<td>152</td>
<td>12</td>
</tr>
<tr>
<td>Admission prevalence bloodstream infection rate (per 100 admissions)</td>
<td>0.006</td>
<td>0.001</td>
</tr>
<tr>
<td>Number of hospital onset (HO) cases</td>
<td>1,446</td>
<td>62</td>
</tr>
<tr>
<td>HO rate (per 10,000 patient days)</td>
<td>1.12</td>
<td>0.04</td>
</tr>
<tr>
<td>Number of HO bloodstream infection cases</td>
<td>262</td>
<td>2</td>
</tr>
<tr>
<td>HO bloodstream infection rate (per 10,000 patient days)</td>
<td>0.203</td>
<td>0.002</td>
</tr>
</tbody>
</table>

New York State data reported as of July 10, 2014. All data have been annualized to represent a full year. Incidence rates are based on 12,914,730 patient days, and prevalence rates are based on 2,394,218 admissions. The number of cases only includes one test per patient per hospital per month. In addition, only one blood test can be entered per 14 days, even across calendar months.

The geographic distribution of incident (occurred in hospitalized patients more than three days after admission) CRE-*Klebsiella* spp. bloodstream infections in the state shows that the highest concentration of cases can be found in Brooklyn and Queens. The farther from New York City geographically, the lower the concentration of cases. The organism is spreading out from its area of highest incidence and thus demonstrates the urgent need for action to stop this spread. Bloodstream infection are discussed specifically due to the consistency of methods used to screen blood specimens for CRE among laboratories across the state.

The HAI Bureau conducts an Infection Prevention Practices Survey once a year for all reporting hospitals. In 2014 the survey included a question specific to the CRE and Supplemental Measures recommended in the CDC CRE Toolkit (CDC 2012). The question was worded: “If you have difficulty consistently implementing the following MDRO core or supplemental measures, please describe the challenges and barriers to implementation.” Any measure that was reported as a challenge for more than 10% of responding hospitals is displayed in Table 8.

Table 8. Assessment of Routine Practices

<table>
<thead>
<tr>
<th>Prevention Measure/Description</th>
<th>Common Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hand Hygiene</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Healthcare workers must be familiar with proper hand hygiene technique and rationale. Policies that require hand hygiene are not sufficient. Compliance should be monitored and adherence rates should be communicated directly back to staff. Immediate feedback should be provided to staff who miss opportunities for hand hygiene. Ensuring adequate access to stocked and supplied hand hygiene stations (i.e., clean sinks and/or alcohol-based hand rubs) is also necessary. | • Missed hand hygiene opportunities (80.1%)  
• Appropriate monitoring system (54.1%) |
| **Contact Precautions**        |                   |
| Patients in acute care settings who are colonized or infected with CRE should be placed on Contact Precautions. Systems should be in place to identify patients with a history of CRE colonization or infection at admission so that they can be placed on Contact Precautions if not known to be free of colonization | • Knowing when to discontinue precautions (45.9%)  
• Staff education/understanding (42.5%)  
• Appropriate monitoring system (32.0%) |
| **HCW Education**             |                   |
| HCP in all settings who care for patients with MDROs, including CRE, should be educated about preventing transmission of these organisms. At a minimum this should include information on the proper use of Contact Precautions and hand hygiene. | • Attendance at educational events (53.6%)  
• Consistent messaging (39.8%)  
• Staff understanding (35.9%) |
| **Use of Devices** | • Devices not discontinued appropriately (64.1%)  
| Use of devices (e.g., central venous catheters, endotracheal tubes, urinary catheters) puts patients at risk for device-associated infections and minimizing device use is an important part of the effort to decrease the incidence of these infections. Minimizing device use in all healthcare settings should be part of the effort to decrease the prevalence of all MDROs including CRE. In acute and long-term care settings, device use should be reviewed regularly to ensure they are still required and devices should be discontinued promptly when no longer needed. | • Devices not reviewed frequently to ensure need (33.2%)  
| • Devices place when not necessary (33.2%)  
| **Patient and Staff Cohorting** | • Private room availability (52.0%)  
| When available, patients colonized or infected with CRE should be housed in single patient rooms and if not available these patients should be cohorted together. In addition, consideration should be given to cohorting patients with CRE in specific areas (e.g., units or wards), even if in single patient rooms, and to using dedicated staff to care for them. | **Laboratory Notification** | • Information being communicated among clinicians (29.8%)  
| Laboratories should have protocols in place that facilitate the rapid notification of appropriate clinical and infection prevention staff whenever CRE are identified from clinical specimens to ensure timely implementation of control measures. | **Screening Epidemiologically Linked Contacts** | • Not done (52.0%)  
| Screening is used to identify unrecognized CRE colonization among epidemiologically linked contacts of known CRE colonized or infected patients as clinical cultures will usually identify only a fraction of all patients with CRE. Generally, this screening has involved stool, rectal, or peri-rectal cultures and sometimes cultures of wounds or urine (if a urinary catheter is present). | **Active Surveillance** | • Not done (25.9%)  
| Active Surveillance testing could be focused on patients admitted to certain high-risk settings (e.g., ICUs, long-term acute care) or could target specific patients (i.e., patients with risk factors, patients admitted from high-risk settings like long-term acute care or transferred from areas with high CRE prevalence). This testing is generally done at admission but can also be done periodically during admission (e.g., weekly). Patients identified as positive by this surveillance testing should be treated as colonized (i.e., placed on Contact Precautions, etc.). In some situations (e.g., patients admitted from high-risk settings) patients might be placed | • Initiating preemptive precautions (11.8%)  
| **Not done (25.9%)**  
| **Initiating preemptive precautions (11.8%)** |
in preemptive Contact Precautions until surveillance testing is found to be negative.

**Chlorhexidine Bathing**
During chlorhexidine bathing, diluted liquid chlorhexidine (2%) or 2% chlorhexidine-impregnated wipes are used to bathe patients (usually daily) while in high-risk settings (e.g., ICUs). The chlorhexidine is usually not used above the jaw line or on open wounds. When chlorhexidine bathing is used for a particular patient population or in a particular setting, it is usually applied to all patients regardless of CRE colonization status. The purpose of the bathing is to remove colonizing organisms.

- Not done (22.4%)

**Inter-facility Communication**
Inform admitting facility when CRE colonization or infection is identified on admission. Ensure CRE is noted on inter-facility transfer form.

- Lack of uniformity in transfer forms (39.4%)
- Missing/incomplete records from transferring facility (35.9%)
- Lack of CRE history on transfer forms (34.7%)

**Surveillance for Unusual Resistance Patterns**
When CRE is identified in a patient with a history of an overnight stay in a healthcare facility outside the United States (within the last 6 months), lab should determine the carbapenem resistance mechanism.

- Not done (20.0%)

Hospital Site Visits

Four facility site visits were scheduled and carried out as part of this project. Each site visit was combined with a previously scheduled audit and a uniform observation checklist was used. The major observations from each of the four visits are described below.

**Site Visit #1**

This facility is a large hospital located in the geographic area with the highest CRE burden. The visit interviews and observations highlighted that CRE is well understood at this facility and the need for improvement has been recognized, including attributable mortalities.
Recent changes have been implemented in an effort to decrease CRE transmission that include creation of a multi-disciplinary HAI Team, daily review of urinary catheter orders, and use of chlorhexidine (CHG) cloths to bathe all ICU patients.

Based on the toolkit and CDC recommended prevention practices, this facility is performing most of the recommendations. General infection prevention training is offered, but no CRE specific programming exists. Surveillance and data reporting is in place using appropriate case definition. Hand hygiene, PPE, and transmission based precaution procedures are in place, including education and necessary supplies. Environmental cleaning and reusable instrument reprocessing procedures are performed correctly.

Opportunities for improvement were observed in the patient care environment that included improper cohorting of a CRE patient with a non-CRE patient. The facility offered no CRE specific information as part of general MDRO staff education. The laboratory did not have a CRE specific notification protocol and there was some confusion about applying the CDC case definition. CRE screening and active surveillance were not performed.

Site Visit #2

This facility is a moderately sized hospital that has recently become part of a large metropolitan healthcare system. It is located within an area of medium-high CRE burden. This facility does not have high HO CRE rates. This facility has identified CRE as a local problem and enjoys an adequate level of administrative support in prevention initiatives. The facility is meeting the majority of CRE related recommended practices. Policies for appropriate hand hygiene, PPE use, environmental cleaning, instrument reprocessing, and transmission based precautions are present.
Challenges were identified in the laboratory reporting, where no CRE notification policy was present and lab sensitivity results were being incorrectly interpreted and reported. Also, the surveillance data submitted to NHSN is not entered at the facility level. The laboratory and demographic information is sent to a central data analysis center directed by the larger healthcare system and then reports are returned to the hospital IP, with no expedient way to verify the quality of the reports.

Site Visit #3

It is located within an area of medium-high CRE burden. This facility does not have high HO CRE rates. The facility has not identified CRE as a specific problem. However, the administration and staff demonstrate a cultural commitment to infection prevention, evidence-based best practices, and antimicrobial stewardship.

The facility has information technology support to identify patients with a history or a positive culture of CRE. The readily available information allows patients to be housed appropriately and precautions to be initiated. This facility has a strong antimicrobial stewardship champion in its Director of Pharmacy who keeps a restricted formulary. It was discovered that no policy was in place to notify clinical units of resistant Gram negative rods. The Microbiology Supervisor revised the online policy for laboratory notifications during the interview once the oversight was identified.

Other areas for improvement include confusion by clinical staff about the differences between clinical and surveillance case definitions. There was a clear knowledge gap related to CRE; a nurse leader in the ICU asked for the meaning of the acronym during the interview. During observations in CSP it was identified that endoscopy scopes were cleaned by endoscopy
staff, not sterile processing staff, and the policies for cleaning these scopes could not be readily produced.

Site Visit #4

This facility is a large hospital in the area of the highest CRE burden. The facility has identified CRE as a problem and it is well understood by the staff. However, other prevention barriers were identified.

The interviews and observations in the ICU and CSP went very well. All questions were answered appropriately and confidently, and all requested policies were produced without delay. Opportunities for improvement were identified in the lack of communication among the departments and the notification of CRE culture positive results to the clinical staff. The laboratory had difficulty producing case results necessary for the audit. The audit identified an error in the surveillance program where community onset cases were not being reported.

Infection Prevention is not housed in the hospital itself. The office, including that of IP Director, is located across the street. This physical separation of the IP department from the clinical setting lends itself to detachment from process measures by both the hospital staff and the IP department staff. IP staff members do complete patient care area rounds daily (observed on visit). Nonetheless, the physical separation of the department from the hospital does not offer the ability to foster relationships among clinical staff members and Infection Preventionists, does not allow for timely assessment of emergent IC situations, and does not encourage staff member to reach out to IC for guidance with questions or concerns. Having the department across the street is a detriment to cultivating a culture of compliance.
Overall Site Visit Data

Although not enough facilities have been visited to date for a formal qualitative analysis to be performed, several informative trends have been identified. These trends will be important for steering further initiatives and resource allocation. The identification of these trends highlights the importance of employing mixed methods in data collection. Information from site visits that include interviews and observations augments the information that is collected from audits and facility surveys. Site visitors are able to identify successes and areas of improvement that could be missed by less intimately collected information.

The clearest trends highlighted by the visits are problems with the ability to identify cases and communication of CRE results among clinical departments. The failure of several facilities to implement all of the recommended prevention practices is also an important finding of the interviews and observations.

Another identified problem is that the CDC recommended prevention practices (HAI Toolkit 2012) including antimicrobial stewardship, CRE screening, and testing for unusual resistance mechanisms have not been universally adopted. These practices are not clinically or diagnostically driven and therefore tend to be more difficult for facilities to implement and maintain. However, these are important parts of the prevention model and facilities must be encouraged to include them in their infection prevention policies.

The observed results from the site visits vary somewhat from the self-reported results of the Infection Prevention Practices Survey.
Audit Comparison Data

Auditors reviewed 1,151 CRE laboratory test results from 69 hospitals. An additional 19 hospitals had no CRE cases for the audit. The CRE surveillance data is given in Table 9. Overall, the auditors agreed with hospital reports 81.8% of the time. Auditors identified a total of 1098 cases, and increase of 10.3% over the 995 that were originally reported. There was variation in agreement rates among facilities: 35% of facilities had perfect agreement, while 29% had less than 50% agreement.

Problems with reporting are systematic within facilities. For example, one facility did not include community acquired cases, and so it had several records that needed to be added. Another example is of a facility that reported ESBLs as CREs and so it had several records that needed to be removed. An additional source of systematic reporting errors arises when IPs do not have access to all of the medical record and are unable to complete thorough investigations of every case.

Audited records were evaluated for individual data element agreement. Agreement rates by data element were: specimen date (97.3%), specimen source (98.9%), facility admit date (97.0%), location admit date (97.4%), collection location (97.9%), and last discharge date (96.4%).

Table 9. Carbapenem-resistant Enterobacteriaceae audit results

<table>
<thead>
<tr>
<th>Hospital Surveillance</th>
<th>Determination of Auditor</th>
<th>Reportable</th>
<th>Not reportable</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported</td>
<td></td>
<td>942</td>
<td>53</td>
<td>995</td>
</tr>
<tr>
<td>Not reported</td>
<td></td>
<td>156</td>
<td>0</td>
<td>156</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>1,098</strong></td>
<td><strong>53</strong></td>
<td><strong>1,151</strong></td>
</tr>
</tbody>
</table>
Reported CRE cases included the specific site from which the culture was collected. These specific specimen sources were grouped in five source categories based on similar body sites. The results of the specimen source by audit result are displayed in Table 10.

**Table 10. Audit results for specimen source categories**

<table>
<thead>
<tr>
<th>Specimen Source</th>
<th>In NHSN-Correct</th>
<th>In NHSN-Remove</th>
<th>Not in NHSN-Add</th>
<th>Total</th>
<th>#reported/#true= %complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood</td>
<td>126</td>
<td>4</td>
<td>23</td>
<td>153</td>
<td>130/145=90%</td>
</tr>
<tr>
<td>Respiratory</td>
<td>189</td>
<td>8</td>
<td>35</td>
<td>232</td>
<td>197/216=91%</td>
</tr>
<tr>
<td>Urine</td>
<td>489</td>
<td>30</td>
<td>73</td>
<td>592</td>
<td>519/532=98%</td>
</tr>
<tr>
<td>Sterile fluid/Organ</td>
<td>24</td>
<td>2</td>
<td>0</td>
<td>26</td>
<td>26/22=118%</td>
</tr>
<tr>
<td>Wound/Abscess/Other</td>
<td>114</td>
<td>9</td>
<td>25</td>
<td>148</td>
<td>123/130=95%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>942</td>
<td>53</td>
<td>156</td>
<td>1151</td>
<td>995/1045=95%</td>
</tr>
</tbody>
</table>

Urine were least likely to be underreported of all the specimen source categories. Sterile fluids/organ specimens were equally as likely to be over-reported as urine cultures were to be underreported. However, considerably more urine cultures resulted in CRE cases than sterile body site cultures. Of the 156 reportable but not reported (missing) records, 23 (14.7%) were specimen source blood. A total of 149 CRE cases were specimen source blood.

Data for onset category by audit result is given in Table 11.

**Table 11. Onset category and audit result**

<table>
<thead>
<tr>
<th>Onset Category</th>
<th>In NHSN-Correct</th>
<th>In NHSN-Remove</th>
<th>Not in NHSN-Add</th>
<th>Total</th>
<th>#reported/#true= %complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community onset</td>
<td>436</td>
<td>23</td>
<td>89</td>
<td>548</td>
<td>459/502=91%</td>
</tr>
<tr>
<td>Hospital onset</td>
<td>506</td>
<td>30</td>
<td>65</td>
<td>601</td>
<td>536/541=99%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>942</td>
<td>53</td>
<td>154</td>
<td>1149</td>
<td>995/1043=95%</td>
</tr>
</tbody>
</table>
Hospital onset cases were less likely to be under-reported. There are 2 records excluded from the ‘Not in NHSN-Add’ category. These records were missing the admission date and therefore the onset category could not be determined.

Data for onset category true versus reported is given in Table 12.

**Table 12. Category onset true and category onset reported**

<table>
<thead>
<tr>
<th>True Onset Category</th>
<th>Community onset</th>
<th>Hospital onset</th>
<th>Missing</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community onset</td>
<td>451</td>
<td>8</td>
<td>89</td>
<td>548</td>
</tr>
<tr>
<td>Hospital onset</td>
<td>7</td>
<td>529</td>
<td>65</td>
<td>601</td>
</tr>
<tr>
<td>Missing</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>458</td>
<td>537</td>
<td>156</td>
<td>1151</td>
</tr>
</tbody>
</table>

A higher percentage of hospital onset cases are correctly identified by onset than that of community onset cases.

Data for specimen source category and onset determination is given in Table 13.

**Table 13. Specimen source categories and onset determination**

<table>
<thead>
<tr>
<th>Specimen Source</th>
<th>Onset Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Community onset</td>
</tr>
<tr>
<td>Blood</td>
<td>57</td>
</tr>
<tr>
<td>Respiratory</td>
<td>67</td>
</tr>
<tr>
<td>Urine</td>
<td>356</td>
</tr>
<tr>
<td>Sterile fluid/Organ</td>
<td>7</td>
</tr>
<tr>
<td>Wound/Abscess/Other</td>
<td>61</td>
</tr>
<tr>
<td>Total</td>
<td>548</td>
</tr>
</tbody>
</table>

Of the 1149 cases where onset category could be determined, 601 (52.3%) are hospital onset and 548 (47.7%) are community onset.
For community onset CRE cases the largest percentage of cases were urine specimens (65.0%), followed by respiratory specimens (12.2%), wound specimens (11.1%), blood specimens (10.4%) and sterile specimens (1.3%). For hospital onset CRE cases the largest percentage of cases were urine specimens (39.1%), followed by respiratory specimens (27.4%), blood specimens (16.0%), wound specimens (14.3%) and sterile specimens (3.2%).

A comparison of the reported specimen source category and the actual specimen source category is given in Table 14.

**Table 14. Specimen source actual and specimen source reported**

<table>
<thead>
<tr>
<th>Specimen Source True</th>
<th>Blood</th>
<th>Respiratory</th>
<th>Sterile fluid/ Organ</th>
<th>Urine</th>
<th>Other</th>
<th>Missing</th>
<th>Total</th>
<th>#reported/#true= %complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood</td>
<td>128</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>23</td>
<td>153</td>
<td>130/151=86%</td>
</tr>
<tr>
<td>Respiratory</td>
<td>0</td>
<td>196</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>33</td>
<td>230</td>
<td>197/229=86%</td>
</tr>
<tr>
<td>Urine</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>518</td>
<td>0</td>
<td>58</td>
<td>577</td>
<td>519/576=90%</td>
</tr>
<tr>
<td>Sterile fluid/ Organ</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>26/26=100%</td>
</tr>
<tr>
<td>Wound/ Abscess/ Other</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>119</td>
<td>25</td>
<td>148</td>
<td>123/144=85%</td>
</tr>
<tr>
<td>Missing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>17</td>
<td>17</td>
<td>995/1126=88%</td>
</tr>
<tr>
<td>Total</td>
<td>130</td>
<td>199</td>
<td>26</td>
<td>520</td>
<td>120</td>
<td>156</td>
<td>1151</td>
<td></td>
</tr>
</tbody>
</table>

Specimen source category misclassifications occur rarely in the majority of the categories, and not at all in the sterile fluid/organ category. The most often misclassified specimen category is wound/abscess/other.

Data for onset category and audit result is given in Table 15.
Table 15. Onset category and audit result for specimen source blood

<table>
<thead>
<tr>
<th>Onset Category</th>
<th>In NHSN-Correct</th>
<th>Audit Result</th>
<th>Not in NHSN-Add</th>
<th>Total</th>
<th>#reported/#true= %complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community onset</td>
<td>43</td>
<td>2</td>
<td>12</td>
<td>57</td>
<td>45/53=85%</td>
</tr>
<tr>
<td>Hospital onset</td>
<td>83</td>
<td>2</td>
<td>11</td>
<td>96</td>
<td>85/92=92%</td>
</tr>
<tr>
<td>Total</td>
<td>126</td>
<td>4</td>
<td>23</td>
<td>153</td>
<td>130/145=90%</td>
</tr>
</tbody>
</table>

Facilities are less likely to under-report hospital onset bloodstream CRE infections.

Data from the audit was also used to compare the New York City area to the Capital, Central and Western regions of the state, which are represented here as ‘Upstate.’ Data for each region by audit result is displayed in Table 16.

Table 16. New York State region by audit result

<table>
<thead>
<tr>
<th>Region</th>
<th>In NHSN-Correct</th>
<th>Audit Result</th>
<th>Not in NHSN-Add</th>
<th>Total</th>
<th>#reported/#true= %complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>NYC</td>
<td>887</td>
<td>39</td>
<td>128</td>
<td>1054</td>
<td>926/976=95%</td>
</tr>
<tr>
<td>Upstate</td>
<td>55</td>
<td>14</td>
<td>28</td>
<td>97</td>
<td>69/69=100%</td>
</tr>
<tr>
<td>Total</td>
<td>942</td>
<td>53</td>
<td>156</td>
<td>1151</td>
<td>995/1045=95%</td>
</tr>
</tbody>
</table>

The results from the audit data and the laboratory survey were merged in order to offer insight into the correctness of reported data given laboratory methods. The results from the merged data are given in the tables below.

The survey included a question specific to the laboratory’s ability to specifically flag CRE culture results. Including a flag on the culture result makes the CRE result more obvious to clinicians and facilitates generating CRE specific line lists. The results of the flag CRE question are given in Table 17.
Table 17. Ability to flag CRE culture results by audit result

<table>
<thead>
<tr>
<th>Ability to flag culture results</th>
<th>Audit Result</th>
<th>In NHSN-Correct</th>
<th>In NHSN-Remove</th>
<th>Not in NHSN-Add</th>
<th>Total</th>
<th>#reported/#true=</th>
<th>%complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Correct</td>
<td>446</td>
<td>9</td>
<td>37</td>
<td>492</td>
<td>455/474=96%</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Remove</td>
<td>494</td>
<td>44</td>
<td>119</td>
<td>657</td>
<td>538/569=95%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>940</td>
<td>53</td>
<td>156</td>
<td>1149</td>
<td>993/1043=95%</td>
<td></td>
</tr>
</tbody>
</table>

Hospitals that were able to flag culture results for CRE are less likely to under-report cases than those that were not.

The survey included a question about whether or not laboratories perform speciation on all Gram negative rods (GNRs) grown in clinical cultures. The results from the speciation question are given in Table 18.

Table 18. Speciation of all GNRs by audit result

<table>
<thead>
<tr>
<th>Speciation</th>
<th>Audit Result</th>
<th>In NHSN-Correct</th>
<th>In NHSN-Remove</th>
<th>Not in NHSN-Add</th>
<th>Total</th>
<th>#reported/#true=</th>
<th>%complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Correct</td>
<td>419</td>
<td>44</td>
<td>59</td>
<td>522</td>
<td>463/434=107%</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Remove</td>
<td>523</td>
<td>9</td>
<td>97</td>
<td>629</td>
<td>532/611=87%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>942</td>
<td>53</td>
<td>156</td>
<td>1151</td>
<td>995/1045=95%</td>
<td></td>
</tr>
</tbody>
</table>

Laboratories that performed organism speciation testing on all Gram negative bacilli were likely to under-report CRE cases and laboratories that did not were likely to over-report.

The survey included a question about whether or not laboratories perform susceptibility testing on all Gram negative rods (GNRs) grown in clinical cultures. The results from the susceptibility question are given in Table 19.
Laboratories that performed susceptibility testing on all Gram negative bacilli are less likely to under-report CRE cases than laboratories that did not.

The survey included a question regarding the primary sensitivity methods used by each laboratory. Of the 1151 reported culture results, all were performed using automated methods except for two; these two were both correctly entered into NHSN.

A survey question was asked specific to which automated instruments were used. The results of the automated method question are given in Table 20.

Table 20. Automated method by audit result

<table>
<thead>
<tr>
<th>Automated testing method</th>
<th>In NHSN-Correct</th>
<th>Audit Result</th>
<th>Not in NHSN</th>
<th>Total</th>
<th>#reported/#true= %complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microscan</td>
<td>354</td>
<td>10</td>
<td>57</td>
<td>421</td>
<td>364/401=91%</td>
</tr>
<tr>
<td>Phoenix</td>
<td>49</td>
<td>23</td>
<td>15</td>
<td>87</td>
<td>72/41=175%</td>
</tr>
<tr>
<td>Vitek</td>
<td>476</td>
<td>20</td>
<td>78</td>
<td>574</td>
<td>496/534=93%</td>
</tr>
<tr>
<td>Vitek and Microscan</td>
<td>61</td>
<td>0</td>
<td>6</td>
<td>67</td>
<td>61/67=91%</td>
</tr>
<tr>
<td>Total</td>
<td>940</td>
<td>53</td>
<td>156</td>
<td>1149</td>
<td>993/1043=95%</td>
</tr>
</tbody>
</table>

Use of the Vitek instruments showed the least likelihood to under-report CRE cases as compared to the other automated testing methods. The use of the Phoenix resulted in over-reporting of presumed CRE cases.
A question on the survey asked whether or not laboratories that use automated methods as their primary sensitivity method also confirm CRE results using manual methods. The results of the confirmation question are given in Table 21.

**Table 21. Manual confirmation by audit result**

<table>
<thead>
<tr>
<th>Manual Confirmation</th>
<th>Audit Result In NHSN</th>
<th>Audit Result Remove</th>
<th>Audit Result Not in NHSN-Add</th>
<th>Total</th>
<th>#reported/#true= %complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>457</td>
<td>24</td>
<td>82</td>
<td>563</td>
<td>481/515=93%</td>
</tr>
<tr>
<td>No</td>
<td>483</td>
<td>29</td>
<td>74</td>
<td>586</td>
<td>512/528=97%</td>
</tr>
<tr>
<td>Total</td>
<td>940</td>
<td>53</td>
<td>156</td>
<td>1149</td>
<td>993/1043=95%</td>
</tr>
</tbody>
</table>

Not including manual confirmation of CRE as part of a testing procedure resulted in less likelihood to under-report CRE than confirming cases.

As previously discussed, the survey asked which breakpoints were used, either the current CLSI breakpoints M100-S22 or the previous CLSI breakpoints M100-S19. The results of the breakpoints question by audit result for automated methods are given in Table 22.

**Table 22. Breakpoints used by audit result**

<table>
<thead>
<tr>
<th>Breakpoints Utilized</th>
<th>Audit Result In NHSN-Correct</th>
<th>Audit Result Remove</th>
<th>Audit Result Not in NHSN-Add</th>
<th>Total</th>
<th>#reported/#true= %complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current M100-S22</td>
<td>698</td>
<td>39</td>
<td>107</td>
<td>844</td>
<td>737/766=96%</td>
</tr>
<tr>
<td>Previous M100-S19</td>
<td>242</td>
<td>14</td>
<td>49</td>
<td>305</td>
<td>256/277=92%</td>
</tr>
<tr>
<td>Total</td>
<td>940</td>
<td>53</td>
<td>156</td>
<td>1149</td>
<td>993/1043=95%</td>
</tr>
</tbody>
</table>

Use of the current M100-S22 breakpoints resulted in less likelihood to under-report CRE cases than using the previous M100=S19 breakpoints.
The survey asked hospital laboratories whether or not they had a method in place to confirm the production of a carbapenemase. The results of the carbapenemase verification question are given in Table 23.

**Table 23. Verification of carbapenemase production by audit result**

<table>
<thead>
<tr>
<th>Verify carbapenemase</th>
<th>In NHSN-Correct</th>
<th>Audit Result</th>
<th>Not in NHSN-Add</th>
<th>Total</th>
<th>#reported/#true= %complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>375</td>
<td>13</td>
<td>63</td>
<td>451</td>
<td>388/425=91%</td>
</tr>
<tr>
<td>No</td>
<td>565</td>
<td>40</td>
<td>93</td>
<td>698</td>
<td>605/618=98%</td>
</tr>
<tr>
<td>Total</td>
<td>940</td>
<td>53</td>
<td>156</td>
<td>1149</td>
<td>993/1042=95%</td>
</tr>
</tbody>
</table>

Not verifying the presence of a carbapenase resulted in less likelihood to under-report CRE cases as compared to verifying the enzyme.

The survey asked which laboratory information system (LIS) is employed by each laboratory for the purposes of culture processing and clinical reporting. Results for LISs other than the five most commonly used platforms are not included. The results of the LIS question are given in Table 24.

**Table 24. Laboratory information system by audit result**

<table>
<thead>
<tr>
<th>Laboratory Information System</th>
<th>In NHSN-Correct</th>
<th>In NHSN-Remove</th>
<th>Not in NHSN-Add</th>
<th>Total</th>
<th>#reported/#true= %complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cerner</td>
<td>171</td>
<td>5</td>
<td>40</td>
<td>216</td>
<td>176/206=85%</td>
</tr>
<tr>
<td>Meditech</td>
<td>173</td>
<td>27</td>
<td>24</td>
<td>224</td>
<td>200/170=118%</td>
</tr>
<tr>
<td>Mysis</td>
<td>10</td>
<td>3</td>
<td>12</td>
<td>25</td>
<td>13/19=68%</td>
</tr>
<tr>
<td>SOFT</td>
<td>165</td>
<td>3</td>
<td>21</td>
<td>189</td>
<td>168/183=92%</td>
</tr>
<tr>
<td>Sunquest</td>
<td>316</td>
<td>10</td>
<td>33</td>
<td>359</td>
<td>326/339=96%</td>
</tr>
<tr>
<td>Total</td>
<td>835</td>
<td>48</td>
<td>130</td>
<td>1013</td>
<td>883/917=96%</td>
</tr>
</tbody>
</table>
Use of the Meditech resulted in over-reporting of CRE presumed cases. Use of Sunquest resulted in the least likelihood to under-report CRE cases. The Mysis system performed most poorly of the evaluated laboratory information systems.

Continuing Education

The continuing education model was approved by HAI Bureau leadership and presented to an audience of microbiology technologists to test its effectiveness in delivering the information. The ten question evaluation form was completed by all fifteen technologists in attendance. Feedback was almost entirely positive. Several of the open-ended comments mentioned that the slides are too wordy and distract from the presentation. This problem will be corrected for future in-person presentations. However, the intention of this continuing education module is that it will be delivered online in a self-directed learning format. Therefore it will be necessary to retain the text for the intended format. All of the audience members responded that the information would be either be “good” or “very good” as a self-guided online course.
DISCUSSION

The exact incidence and prevalence for CRE is not known in most of the United States because many states have not instituted mandatory reporting of CRE from their acute and long term care facilities. Without these reporting requirements in place prevalence and incidence measures are limited to voluntary reporting and published outbreaks, which only offer a limited picture of the overall CRE burden.

Conversations with other agencies receiving the CRE Epidemiology and Laboratory Capacity Grant revealed that some states have few enough cases that each case can be individually investigated and addressed. The incidence and prevalence data generated by New York State through the CRE mandated reporting indicator has shown a significantly larger burden than in some other states. The annualized number of cases from 2013 projected approximately 3200 CRE cases. This large number of cases makes individualized investigations impossible in New York. Therefore, a more comprehensive approach to preventing CRE is necessary. This approach included survey and audit data as well as facility visits and a targeted educational initiative.

The laboratory methodology survey outlined the high level of variability of testing options used in microbiology laboratories throughout New York State. There is no set requirement nor recommendation for microbiology laboratories about which testing methods they should use. And when a methodology or methodologies are chosen the laboratory leadership has to take into account the full available testing battery offered through their laboratory. CRE or other state mandated indicators cannot be considered in isolation. Despite the fact that these culture results are reported to and audited by the state, their identification is contingent on the
testing methods established by the laboratory in its entirety. Limited resources and budgetary restrictions by the laboratory could impede its ability to successfully identify CRE cases.

For example, there are commercially available testing methods that can confirm the presence of CRE in a clinical isolate. The Carba NP by bioMerieux is a rapid phenotypic method that tests for the presence of a carbapenemase in a pure bacterial isolate. An NIH funded evaluation of the test showed it to carry 100% specificity and positive predictive value when performed correctly (Tijet 2013). However, this test is not commonly used in laboratories because of the extra cost associated with validating and using it. Microbiology laboratories are able to identify CRE using broader testing methods that can be used to identify many pathogens in clinical cultures. Therefore, despite the impressive performance of the Carba NP test, it is not consistently used in laboratories due to its associated additional costs.

Molecular based methods are also a good example of the limitations placed on the clinical laboratory. Although PCR is known in the industry to be highly effective in the detection of specific pathogens it is expensive and requires specialized training for technologists. Small laboratories or laboratories not associated with a university based research center may not have the resources necessary to develop and maintain a PCR laboratory. Isolates can be sent to state operated public health laboratories. However, these laboratories also have resource restrictions and heavy workloads. Therefore, only high priority isolates, like those implicated in an outbreak, should be sent for confirmation by the PHL.

Differences in the completeness of the data from the audit by testing method can be seen. For example, Vitek showed the least likeliness to under-report CRE cases. The breakpoints employed also show how a decision in the laboratories affect surveillance data. Laboratories using current breakpoints missed 13% of the CRE cases. Laboratories using previous breakpoint
missed 16% of cases. The laboratory as the source of the surveillance data is a major stakeholder is its quality.

Changing or updating the testing methodology of a clinical microbiology laboratory is a laborious undertaking. There is a large cost associated with such a change. The cost is made of the instrumentation, reagents, supplemental materials, and training. Space restrictions are problematic in many laboratories, and simply being unable to find room for new instrumentation can be a concern. Support from hospital leadership and finance is necessary for successful implementation of a new, and potentially more expensive, testing method. Support from infectious disease physicians, hospital epidemiologists, and state regulatory agencies are very valuable.

Not all laboratory information systems allow CRE data to be flagged or to generate CRE specific line lists and not all hospitals had infection prevention data mining software. These IT issues place restrictions on the quality and timeliness of data both for infection prevention practices and for state auditing. Changes to a hospital IT structure can also be difficult due to costs and training. However, having access to accurate data is necessary for quality patient care and disease surveillance.

Oversight from regulatory agencies also offered challenges for successful CRE surveillance. Two notable examples are the FDA and the CDC. Problems with meeting the case definition arose after the Clinical Laboratory Standards Institute (CLSI) changed the breakpoints for the carbapenem antimicrobial group. Laboratories should use the most recent guidelines published by the CLSI when making clinical interpretations for the use of an antimicrobial against an isolate. However, as previously described there are several widely used commercial antimicrobial susceptibility test systems in New York. The use of the instruments and their Gram
negative susceptibility panels are regulated and approved by the FDA, including the breakpoints for antibiotics. When the CLSI updated the breakpoints for the cabapenems in early 2012, the FDA did not immediately approve the changes. This situation created problems for laboratories that needed to update their breakpoints to be current and to meet surveillance case definitions but did not want to be noncompliant with FDA recommended usage. This discrepancy highlights problems that can be created when oversight and regulatory groups do not collaborate. Having two different breakpoints from two agencies can negatively affect both laboratory practice and surveillance efforts.

The CDC example is one where problems were created by issues related to too many recommendations. Development of a surveillance laboratory identified event definition is a collaborative process that requires time and discussion. Unfortunately, more than one definition was published for CRE during this process. The two different and conflicting CRE surveillance definitions published by the CDC (NHSN MDRO Module and 2012 CRE Toolkit) created confusion about reporting requirements (CDC 2012, CDC 2013). The 2015 NHSN module definition was changed to read: Any *Escherichia coli*, *Klebsiella oxytoca*, *Klebsiella pneumoniae*, or *Enterobacter* spp. testing resistant to imipenem, meropenem, doripenem, or ertapenem by standard susceptibility testing methods (i.e., minimum inhibitory concentrations of ≥4 mcg/mL for doripenem, imipenem and meropenem or ≥2 mcg/mL for ertapenem) OR by production of a carbapenemase (i.e., KPC, NDM, VIM, IMP, OXA-48) demonstrated using a recognized test (e.g., polymerase chain reaction, metallo-β-lactamase test, modified-Hodge test, Carba-NP) (CDC,2015). This new definition is closer to, but still conflicts with, CDC’s toolkit definition. The Council for State and Territorial Epidemiologist (CSTE) also drafted a working CRE definition that includes additional species and focuses on carbapenemase production. The
CSTE working definition created three categories for the likelihood of carbapenemase production in order to expand on the information made available by the initial two category based definitions (CSTE 2014).

The NHSN MDRO Module definition initially adopted by NYS Reporting Program also had problems. For example, the exclusion of ertapenem and the use of intermediate interpretations in the case definition created additional confusion for reporting purposes. A few laboratories changed the interpretations of all carbapenems based on the ertapenem result. Inclusion of ertapenem in the 2015 case definition will alleviate this problem. Removal of intermediates from the 2015 definition will also alleviate a source of confusion and improve the consistency between surveillance and clinical interpretations.

The difference between surveillance definitions and clinical interpretations is another important concept in laboratory identified event surveillance. The laboratory’s most immediate responsibility is to provide clinical information to providers actively involved in patient care. Proper surveillance and prevention measures are not secondary to patient care, but they do have practical differences. When NYS collects surveillance information on CRE it is necessary that all of the hospitals report their data the same way. All of the hospital data must follow the same set of requirements. Using a uniform case definition for CRE surveillance allows for comparisons among different hospitals. If different definitions are being used by each hospital the overall picture of the CRE burden in the state will not be meaningful. For example, it is possible for *Proteus* spp. to produce a carbapenemase and it is a member of the Enterobacteriaceae family of bacteria. Nonetheless, a carbapenemase producing *Proteus* spp. is not reportable as a CRE to NYS. That does not mean that the *Proteus* spp. is not a CRE clinically, it just is not a reportable CRE for the purposes of surveillance.
It is important to keep these differences in mind when a carbapenemase producer is identified in the laboratory. Any carbapenemase producer can result in a negative patient outcome and requires transmission based precautions, regardless of whether or not it meets the surveillance case definition. Therefore, the identification of such organisms should be communicated to infection prevention and to the patient’s clinician. All laboratory personnel must be familiar with their hospital’s laboratory result notification policies. When such an identification is made it is also important for the laboratory to assess whether or not it needs to be reported. The clinical laboratory is an integral part of CRE surveillance in NYS. Knowing when an organism meets the surveillance case definition will allow the laboratorians to ensure their hospital has timely and accurate CRE reporting.

Despite the challenges faced by the microbiology laboratory at successfully identifying CRE in clinical isolates, inferences can be made based on the outcomes seen. The collected CRE surveillance data confirmed the assumptions of the HAI Bureau. For instance, the CRE burden in the state is very high, exceeding three thousand cases per year. The considerably larger portion of reporting CRE being *Klebsiella* spp as opposed to *E. coli* confirms expected results based on the available literature. Also, the majority of the CRE in NYS can be found in the hospitals of the New York City area. Having these baseline figures allows the HAI Bureau to develop interventions using evidence based decision making.

The observations made through the site visits are useful in slowing the spread of CRE in New York State. Facilities were open to having a site visit because they recognize CRE as a problem and are willing to accept help in fighting it from the state Department of Health. Having a person visit on site reinforces the idea that the state is available and shares the goal of preventing disease transmission with the facilities. The visits also allow for candid discussion
and conversations regarding challenges. The observer is exposed to the perspective of multiple departments and is able to encourage conversation among these departments. Any method that develops interdepartmental cooperation will help achieve successful infection prevention.

The site visits are also useful due to the impact they are capable of having on the risks and benefits of CRE prevention as perceived by hospital staff. Establishing the site visitor as an ‘expert’ can positively affect the behavior of the hospital staff and help them take ownership of the problem. If CRE was not a perceived threat before the visit it is more likely that it will be after. The implication is that if the state deems CRE important enough to send a person for an on-site visit, then it must truly be an important issue and worthy of behavior change. The visits also empower the hospital staff to ask questions directly to the ‘expert’ and to thus have a personal connection to the transmission prevention process.

The use of the checklist was important for keeping the site visits uniform and as comparable to one another as possible. Different hospitals have a variety of policies and procedures, available treatment methods, and infection prevention practices in place. They also differ by clinical culture. The practice of infection prevention is multifaceted and complicated. Therefore, the checklist allowed the observer to ask the same questions and observe the same practice elements at each location. Having the checklist in place would be particularly useful if multiple observers were perform site visits to ensure uniformity of the information collected.

Although not enough facilities have been visited to date for a formal qualitative analysis to be performed, several informative trends have been identified. These trends will be important for steering further initiatives and resource allocation. The identification of these trends highlights the importance of employing mixed methods in data collection. Information from site visits that include interviews and observations augments the information that is collected from
audits and facility surveys. Site visitors are able to identify successes and potential areas of improvement that could be missed by less intimately collected information.

The clearest trends highlighted by the visits are problems with the ability to identify cases and communication of CRE results among clinical departments. The failure of several facilities to implement all of the recommended prevention practices is also an important finding of the interviews and observations, and in some cases conflicts with data from the infection prevention practices survey.

A common problem found during the site visits and the audits was that the reported CRE data does not consistently meet case definition. CRE is arguably difficult to identify because the case definition is complicated, including minimum inhibitory concentration breakpoints, and only three of the four commonly used carbapenems. Multiple conflicting surveillance definitions have been published, and facilities have had difficulty applying the correct definition at the correct time (CDC 2012; CDC 2014). The recommended definition can also be confused with other categories of antimicrobial resistance, most commonly extended spectrum beta-lactamases (ESBLs). This laboratory jargon would be understood by a microbiologist. IPs are frequently less familiar with the terminology and therefore must rely on the laboratory to correctly identify CRE cases for NHSN reporting. However, the education on how to meet the definition is prepared for and delivered to the IPs and not to the laboratory staff, and it may not be comprehensive enough for an IP without a laboratory background to be successful at identifying cases. This educational barrier does not prepare the laboratory to identify cases and does not prepare the IPs to validate the microbiology reports. Additional laboratory focused education is needed to fill this knowledge gap and improve the quality of surveillance reporting.
According to the challenges highlighted by the Infection Prevention Practices Survey the CDC recommended prevention practices (HAI Toolkit 2012) including antimicrobial stewardship, CRE screening, and testing for unusual resistance mechanisms have not been universally adopted. These practices are not clinically or diagnostically driven and therefore tend to be more difficult for facilities to implement and maintain. However, these are important parts of the prevention model and facilities must be encouraged to include them in their infection prevention policies.

Applying the behavioral theory research discussed previously could offer an avenue for the necessary behavioral and cultural changes identified in both the practices survey and the observational site visits. Knowledge and education are very powerful tools for effective behavioral changes. It is important for infection preventionists to be identified as disease transmission experts by the staff. This perception can be achieved by ongoing interactions on the floors and units of the hospital as well as infection prevention specific educational initiatives given by the IPs. Social pressures are also very important in behavioral and culture change. Clinical staff members will learn from and replicate the behaviors of their colleagues. As such, hospital leadership should support staff members who routinely execute correct hygiene behaviors and should have a structure of accountability in place for those who chose not to correctly perform.

The 2013 audit data comparison did not show the expected high level of agreement between the audit results and the facility reports. Facilities demonstrated more of a problem with underreporting CRE data, although there were some challenges associated with over-reporting, including reporting ESBLs as CREs. Improvements can be made, but the level of agreement for the pilot period of CRE reporting is encouraging.
The percent agreements for the individual data showed some variation across data elements, but all of the categories showed between 96 and 99% agreement. Reporting errors could be clerical or investigational. Based on a frequency analysis of the auditor comments, problem with information systems did play a role in data disagreement. Lapses in available data through the electronic medical records could partially explain the demonstrated disagreements. Problems relating to the information interfaces at the facility level also had a small effect on the data available for analysis. In some instances not all of the required data was available. Producing accurate CRE line lists from the laboratory information systems was another common problem. Some records had to be excluded from analysis because they were not found on laboratory generated line lists and therefore could not be verified as meeting the case definition.

The frequency analysis of the comments revealed challenges with properly interpreting and applying the CRE 2014 definition. Repeated problems included misinterpretation of MIC breakpoints for carbapenems and reporting ESBLs as CREs.

Missing cases can have seriously negative effects on patients as well as resource allocation for hospitals will high rates or outbreaks. Forty-two and a half percent of the cases that were not reported were hospital onset. Missing transmission that is occurring within a facility is an important barrier to prevention and rate reduction.

Blood specimen results are particularly significant because bloodstream infections with CRE carry a considerably increased attributable mortality rate as compared to other specimen sources. Blood specimens are also an important metric because they always indicate infection; it is not possible to have CRE colonization in the bloodstream. The presence of colonization in the reported CRE cases for the other specimen sites can make determining the effect of these cases
on the patients more complicated. Describing CRE in blood illustrates a clearer picture of the threat posed by this pathogen.

The audit analysis showed that CRE rates were under-reported by approximately 9%. The observed underreporting rate may be an underestimate, as it was difficult to confirm that the hospitals provided the required list of reports, especially in low prevalence areas. This percent disagreement is higher than expected for an indicator based solely on laboratory-identification of cases in conjunction with easily retrievable admission data. However, as discussed previously, CRE for surveillance purposes can be difficult to correctly identify.

There are several methods IPs can use to obtain data from the microbiology laboratory. These include having microbiology culture reports printed immediately to infection prevention, generated daily, generated as needed from a laboratory information system, or generated as needed from a data mining program. The majority of hospitals in NYS generate daily reports from microbiology to infection prevention. Some hospitals were unable to produce CRE-specific line lists that are necessary to efficiently audit the LabID data. These hospitals must work with their IT departments to generate laboratory line lists based on both the organism species name and the MIC results of specific antibiotics. The ability to generate pathogen-specific chronological line lists is important for hospital infection prevention programs as well as statewide surveillance. Hospitals are encouraged to consider including infection prevention data mining software as part of their information system. Physical locations can also create challenges; communication between the laboratory and infection prevention is more difficult when microbiology testing is performed at an off-site laboratory or the IP office is not housed within the hospital. Interestingly, larger percentages of missed cases were identified by hospital that could generate
CRE flagged culture results and used on-site laboratory facilities. This unexpected result may be due to the ability of these hospitals to generate more accurate line lists for state auditors.

A larger percent of the missed CRE cases occurred in the lower prevalence area. Missing cases can have seriously negative effects on patients as well as statewide initiatives designed for hospitals with high rates or outbreaks. The differences observed between the two regions may be explained by the hospitals in the higher prevalence areas being more familiar with CRE and having more experience implementing the definition. To increase efficiency in identifying surveillance errors, the audit protocol was improved in April 2015. Hospitals that cannot generate the required line list must now provide a list of cultures positive for the species included in the case definition. The minimum inhibitory concentrations (MICs) are reviewed in order to ensure that CRE cases are not being missed. The audit tool was also improved to consistently collect data on reasons for under- and over-reported cases using drop-down choices.

The traditional NYS and NHSN approaches have been web-based presentations and periodically published newsletters. These methods of information dissemination are useful and efficient; however, they may not be sufficient. For Procedure-Associated Infections education it is sensible to target the IPs who are interpreting a variety of clinical record information to make determination about meeting definitions. However, with LabID cases a significant burden falls on the laboratorians to ensure cases are reported that accurately meet the published case definition. Presenting information through webinars and newsletters is not conducive to effective information dissemination to laboratory staff. Technologists may not have access to webinars or time allotted to read/watch educational materials. Although they use computers consistently at the laboratory bench, the programs are usually specialized clinical software and may not have access to the internet and necessary webinar or presentation software.
The need for a novel approach to education is highlighted here. Informational materials should be designed that are targeted specifically to the microbiology laboratory staff and management, although it should also be available to IPs and clinical staff as needed. Hospital laboratories in New York require technologists to maintain twelve hours of continuing education as part of the state’s regulatory oversight. Offering a CRE specific continuing education requirement could be a successful way to ensure that the HAI Reporting Program initiatives are inclusive of the laboratory and recognize laboratory personnel as significant stakeholders regarding the surveillance case definitions for LabID HAIs.

NYS educational conference calls regarding the CRE case definition and reporting requirements were delivered to IPs before mandated reporting began and after analyzing preliminary results. Training and newsletters were also disseminated by NHSN. However, the audit data suggests that IPs did not consistently understand the NHSN definition or communicate with laboratory personnel to ensure that the appropriate cases were identified for reporting. Potential sources of misunderstanding are knowledge and informational barriers. Infection prevention and infectious disease surveillance are interdisciplinary fields that rely on communication and cooperation across several medical and public health specialties. Despite the cross cultural nature of these fields, the NHSN and NYS educational initiatives focused almost exclusively on IPs. The exclusion of the laboratory is detrimental to reporting accurate data. The NYS HAI RP could have improved the CRE training by including laboratorians at the onset, as Oregon has done (Pfieffer 2011). It is important to include the laboratory in the educational process and the wider infection prevention narrative in order to ensure a strong understanding of the surveillance definition being used.
NYSDOH plans to target future informational materials specifically to the microbiology laboratory staff and management, although it should also be available to IPs and clinical staff as needed. Offering a CRE specific continuing education requirement could be a successful way to ensure that the HAI Reporting Program initiatives are inclusive of the laboratory and recognize laboratory personnel as significant stakeholders regarding the surveillance case definitions for LabID HAIs.
LIMITATIONS

There are several notable limitations to the work described here that should be mentioned and explained. Some of these are not able to be manipulated by the researcher and some were but were missed in the design of the project. These missed opportunities will be lessons for improved practice in future endeavors.

The development of the laboratory survey created limitations to the use of data from two of the 32 questions. Two questions were not included in analysis due to problems building the survey. These two questions included:

- ‘If ertapenem is resistant, do you interpret all carbapenem drugs as resistant?’
- ‘Does the LIS have the capability to pull a line list of only CRE positive cultures for a given time period?’

The person taking the survey online had to check ‘Yes’ to move to the next question. Therefore the data from the questions cannot be trusted to be accurate. In an attempt to be sure data for these questions was received from all facilities the quality of the data was compromised. All future surveys will be tested thoroughly before being disseminated.

Another important limitation relates to the way information is distributed from the HAI Bureau to the acute care facilities. It is not practical or feasible to deliver educational material to every staff member at a hospital. As such one representative from infection prevention is identified to receive training and to respond to practice and methodology surveys. Having one hospital representative creates limitations in information dissemination. If that person does not ensure that the information is shared with all stakeholders a knowledge barrier can be created. Also having one hospital representative answer surveys only offers that person’s point of view.
that may not be shared by all stakeholders at the facility. These limitations cannot be corrected by project team, but it is important to keep in mind how information moves between the hospitals and the HAI Bureau.

The execution of the observation checklist on the site visits highlighted challenges as well. Although having a uniform tool to guide all the visits and make them as comparable as possible given the differences in setting, the tool itself was a problem. On the first visit the staff members were very concerned about what was being written on the checklist during the interviews. More open and frank discussion was fostered by conversation without the checklist in hand. After the first interview at the first site the checklist was not used during the interviews or unit visits. Information from the conversations and observations were transferred to the checklist immediately following completion of visits to each unit or department. Therefore, the checklist is the origin of two limitations; it made staff members nervous and less willing to converse about potential problems on their units and it could introduce a recall bias on the part of the observer.

Additional limitations are highlighted through the expansion of the reporting program. Although there is evidence to support the correlation between mandated healthcare associated infections reporting and reduced rates there is no way to establish causality. Too many behavioral, cultural, and technical factors interact to result in improvements in healthcare associated infections to attribute reduction in rates to reporting mandates. Following the HAI trends over time can give some insight into whether or not the reporting program is contributing to positive outcomes, but the relationships must only be viewed as correlative.

Temporal relationships are important in quality oversight work. However, when CDC changed the CRE case definition beginning in January 2015, these temporal comparisons are no longer so straightforward. Data from 2013-2014 cannot be directly compared to 2015 and future
data because they will not be comparing results based on the same criteria. The definition change
creates a serious limitation to CRE surveillance.
CONCLUSIONS/RECOMMENDATIONS

CRE has been called the “nightmare bacteria” in popular news media outlets. Although this attention grabber is dramatic and fear inspiring, it is not far from the reality of the situation we face. In order to combat such a threat it is necessary to think and operate outside traditional practices and efforts.

Ongoing auditing of CRE LabID cases from the acute care hospitals in New York State is a necessary practice in order to ensure consistent and accurate reporting and understanding of the scope of the CRE problem in the state. Although the case identification and reporting at the hospitals is going reasonably well, the audits have shown room for improvement in the accuracy of meeting the surveillance definition. The CRE reporting program will benefit from informational initiatives targeted to microbiology laboratory personnel and by improvements in the information technologies available at the hospital level.

Traditional education models have demonstrated themselves to be insufficient to tackle the problem of very antibiotic resistant organisms. It is necessary to look at hospitals as integrated communities, where each member is an important part of breaking transmission chains of infectious pathogens, including CRE. It is also likely given current antibiotic usage practices that drug resistance will spread to new organisms, and any current successes can be applied to future interventions against drug resistant pathogens that are yet unknown.

Also, for purposes of appropriate isolation and infection prevention it is important to educate the laboratory technologists about the dangers presented by these organisms and the necessity of immediate notification. Notification that is funneled from the laboratory to infection prevention and then to the patient care provider creates an unnecessary delay in initiating transmission based precautions and possibly changing the patient’s accommodations.
Effective laboratory information systems are also an important part of the overall surveillance structure. The ability to generate pathogen-specific line lists is important for hospital infection prevention programs as well as statewide surveillance. Perhaps line list programs for CRE could be modelled after existing ones for other LabID events such as C-diff and MRSA. Access to quality data is essential for successful transmission prevention.

Recommendations

The laboratory methodology and infection prevention practice surveys should be continued with changes and updates as identified by the HAI Bureau staff and leadership. The information gleaned from these surveys is an important part of the state’s comprehensive CRE prevention initiative. The yearly presentations to the hospital infection preventionists and the conference for the TAW are also vital for information sharing and concept discussion. Additional site visits should also be considered because of their intimacy with hospital staff and potential to improve prevention behaviors.

Education should be targeted specifically to the microbiology laboratory staff and management, although it should also be available to IPs and clinical staff as needed. Including a CRE specific continuing education recommendation could be a successful way to ensure that there is not a knowledge barrier to the laboratory.

The results of the audit data and site visits have also outlined the need for improved communication among facility departments. A move toward a cultural change can be very difficult, but inclusion of interdisciplinary committees and administrative support are essential to foster trust and communication across disciplines and departments.
Dear Infection Preventionist:

The New York State Department of Health Hospital-Acquired Infection Reporting Program is conducting an annual survey of laboratory testing practices for CRE and CDI because testing methods may impact reported HAI rates. Please discuss the questions in the attached PDF with your Microbiology Laboratory Manager and enter the responses in the following survey monkey link:

http://www.surveymonkey.com/s/NYS_HAI_LabSurvey2013

Your responses should reflect your practices as of October 15, 2013. Please be prepared with all the survey answers before opening Survey Monkey. You cannot return to a partially completed survey online.

Please complete this survey by November 5, 2013. If you have any questions, please don’t hesitate to contact your HAI Regional Representative or the Central office program staff (518-474-3343).

Regards,
HAI Reporting Program Staff
1) Hospital NSHN ID:
2) Hospital Name:
3) Survey Date:
4) Name of person completing survey:

**N=179**

**CRE Laboratory Testing and Reporting Questions**

5) Are all Enteric Gram Negative Rods (GNRs) isolated for identification in both diagnostic and screening cultures (excluding stool cultures)?
   - 92 Yes.
   - 87 No.

6) If no, please indicate specimen sources from which enteric GNRs are not identified (Choose all that apply):
   - 67 Non-sterile wound (mixed culture)
   - 79 Urine (mixed culture)
   - 68 Respiratory (less or equal to quantity of oropharyngeal flora)
   - 16 Other. Please name:
     ________________________________________________________________

7) Which of the following best describes your laboratory services?
   - 7 Commercial laboratory that serves multiple facilities
   - 121 On-site laboratory serving single facility
   - 42 An off-site core laboratory serving more than one facility in a healthcare system
   - 9 An off-site core laboratory serving more than one facility in different healthcare systems

8) If using an off-site facility, please name: ________________________________________________

9) Is antimicrobial sensitivity testing (AST) performed on all identified enteric GNRs (diagnostic and screening cultures)?
10) If no, please indicate specimen sources on which AST is not performed (Choose all that apply):

- [___ 36 ___] Non-sterile wound (mixed culture)
- [___ 41 ___] Urine (mixed culture)
- [___ 38 ___] Respiratory (less or equal to quantity of oropharyngeal flora)
- [___ 26 ___] Other. Please name: ____________________________________________________________

11) What is the primary method of enteric GNR sensitivity testing performed in your facility?

- [___ 176 ___] Automated
- [___ 3 ___] Manual

12) If automated, please indicate which automated system:

- [___ 104 ___] Vitek
- [___ 64 ___] Microscan
- [___ 1 ___] Trek
- [___ 5 ___] Phoenix
- [___ 1 ___] Other. Please name: ____________________________________________________________

13) If manual, please indicate which manual method (Choose all that apply):

- [___ ] Disk diffusion
- [___ ] Broth dilution
- [___ 3 ___] E-test
- [___ ] Other. Please name: ____________________________________________________________
14) Antibiotic sensitivity testing for which carbapenem antibiotics is routinely performed on enteric GNRs? Please include all carbapenem antibiotics tested regardless of whether or not they are clinically reported. Choose all that apply.

- Doripenem
- Imipenem
- Meropenem
- Ertapenem

<table>
<thead>
<tr>
<th>Antibiotics Used</th>
<th>Percentage of Hospital Laboratories</th>
<th>Number of Hospital Laboratories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ertapenem, meropenem, and imipenem</td>
<td>39.8%</td>
<td>68</td>
</tr>
<tr>
<td>Ertapenem and imipenem</td>
<td>22.8%</td>
<td>39</td>
</tr>
<tr>
<td>Ertapenem and meropenem</td>
<td>11.7%</td>
<td>20</td>
</tr>
<tr>
<td>Ertapenem, meropenem, doripenem, and imipenem</td>
<td>10.0%</td>
<td>17</td>
</tr>
<tr>
<td>Meropenem and imipenem</td>
<td>7.0%</td>
<td>12</td>
</tr>
<tr>
<td>Ertapenem, doripenem, and imipenem</td>
<td>2.9%</td>
<td>5</td>
</tr>
<tr>
<td>Imipenem</td>
<td>2.9%</td>
<td>5</td>
</tr>
<tr>
<td>Meropenem</td>
<td>2.9%</td>
<td>5</td>
</tr>
<tr>
<td>Total: 171</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

15) If Ertapenem is resistant, do you interpret all Carbapenem drugs as resistant?

- 92 Yes
- 77 No

*This question was not included in analysis due to problems building the survey (had to check ‘Yes’ to move to the next question)*

16) Are suspected CRE isolates confirmed using a manual method?

- 93 Yes
- 82 No

17) Please indicate which manual method (Choose all that apply):

- 28 Disk diffusion
- 1 Broth dilution
- 20 E-test
- 62 Modified Hodge Test
18) Which CLSI breakpoints are routinely used for your automated sensitivity testing?

_____ Previous Breakpoints (M100-S19)

_____ Current Breakpoints (M100-S22)

_____ Neither.

If neither, please explain your alternative method:

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

<table>
<thead>
<tr>
<th>CLSI Breakpoints Used</th>
<th>Percentage of Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>More sensitive test (i.e. will identify more CRE cases)</td>
<td></td>
</tr>
<tr>
<td>Automated and manual testing – both current breakpoints</td>
<td>60%</td>
</tr>
<tr>
<td>Automated testing only - current breakpoints</td>
<td>7%</td>
</tr>
<tr>
<td>Manual testing only – current breakpoints</td>
<td>2%</td>
</tr>
<tr>
<td>Automated testing - current breakpoints; manual testing -</td>
<td>2%</td>
</tr>
<tr>
<td>older breakpoints</td>
<td></td>
</tr>
<tr>
<td>Less sensitive test (i.e. will identify fewer CRE cases)</td>
<td></td>
</tr>
<tr>
<td>Automated testing - older breakpoints; manual testing -</td>
<td>12%</td>
</tr>
<tr>
<td>current breakpoints</td>
<td></td>
</tr>
<tr>
<td>Automated and manual testing – both older breakpoints</td>
<td>11%</td>
</tr>
<tr>
<td>Automated testing only - older breakpoints</td>
<td>6%</td>
</tr>
</tbody>
</table>

19) Which CLSI breakpoints are routinely used for your manual sensitivity testing?

_____ Previous Breakpoints (M100-S19)

_____ Current Breakpoints (M100-S22)

_____ Neither.

If neither, please explain your alternative method:

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

- 77 -
20) Is testing done to verify the production of a carbapenemase?
   ___88__ Yes
   ___88__ No

21) If yes, please indicate method used (Choose all that apply):
   ___68__ Modified Hodge Test
   ___13__ PCR test
   ___12__ Other, please name:____________________________________________________

22) What laboratory information system (LIS) is used at your facility?
   ___8__ Mysis
   ___27__ SOFT
   ___32__ Cerner
   ___49__ Meditech
   ___31__ Sunquest
   ___30__ Other. Please name:____________________________________________________

23) Are you able to flag CRE reports in your LIS?
   ___127__ Yes
   ___49__ No

24) How long is data retrievable from the LIS?
   Please indicate length of time:____________________________________________________

25) Does the LIS have the capability to pull a line list of only CRE positive cultures for a given time period?
   ___102__ Yes.
   ___73__ No, please explain________________________________________________________
26) Which of the following parameters are included when CRE data is retrieved from the LIS? Choose all that apply.

- 94 __ Admit date
- 156 __ Collection date
- 143 __ Hospital unit/location of specimen collection
- 150 __ Specimen source

27) How does the Infection Preventionist obtain CRE case information to enter into NHSN? Choose all that apply.

- 72 ___ Immediate lab generated alert
- 91 ___ Daily laboratory generated report/email/phone call and save copies in folder
- 60 ___ Daily laboratory generated report/email/phone call and enter data in spreadsheet.
- 35 ___ As needed, generated from infection control data mining program (i.e., Medmined/Theradoc ™)
- 51 ___ As needed, generated from a laboratory based program (i.e., Meditech/Cerner ™)
- 21 ___ Other
(describe) ___________________________________________________________

28) How do you plan to verify the completeness of your CRE reporting?

- 143 ___ Periodically (monthly, quarterly, yearly) check that all CRE cases have been reviewed and entered.
- 27 ___ No verification will be performed.

29) In addition to NHSN LabID CRE surveillance definitions, are CRE cases tracked using another case definition?

- 137 ___ No
- 28 ___ Yes, CDC 2012 CRE Toolkit interim surveillance definition.
6. Yes, alternative definition. Please describe:

30. If you have any additional comments about CRE surveillance, please include them here:

---

Clostridium difficile lab testing and reporting questions

31. What is the usual test method your laboratory currently uses to detect *C. difficile*?

- 86% Nucleic Acid Amplification test (NAAT, e.g. PCR, LAMP)
- 2% Toxin A antibody only (ELISA or EIA)
- 33% Toxin A and B antibody only (ELISA or EIA)
- 23% GDH and Toxin A/B
- 3% GDH and NAAT
- 32% GDH and Toxin A/B, confirm discrepancy with NAAT
- 5% Other, describe

32. Was the above test newly implemented within the last year?

- 29% Yes. Identify the start date. Date: _________________
- 152% No

33. Does the laboratory perform *C. difficile* tests on formed stool specimens?

- 162% No
- 8% Yes, and this is documented on the lab report so I do not enter these cases into NHSN.
- 7% Yes, and this is not documented on the lab report so I enter these cases into NHSN. (These cases should not be entered into NHSN. I will work with my lab to have these specimens flagged).
- Other, please describe ____________________________________________
34) How to you enter LabID events into NHSN?
   __165__ Manually entered into NHSN
   __1__ Manually entered into a spreadsheet, then imported into NHSN
   __2__ File developed by hospital system is imported into NHSN
   __9__ CDA import (Clinical Document Architecture through vendor software)

35) How do you verify the completeness of your C. difficile reporting?
   __154__ Periodically (monthly, quarterly, yearly) check that all cases have been reviewed and entered.
   __19__ No verification is performed.

36) If you have any additional comments about C. difficile surveillance, please include them here:

   ________________________________________________________________
Carbapenem-Resistant Enterobacteriaceae (CRE): Preliminary Pilot Data

Christen Mayer and Valerie Haley
TAW Meeting
November 20, 2013

LabID CRE Event Definition

• CRE-E.coli: Any E. coli testing non-susceptible (i.e., resistant or intermediate) to imipenem, meropenem, or doripenem, by standard susceptibility testing methods or by a positive result for any method FDA-approved for carbapenemase detection from specific specimen sources.

• CRE-Klebsiella: Any Klebsiella spp. testing non-susceptible (i.e., resistant or intermediate) to imipenem, meropenem, or doripenem, by standard susceptibility testing methods or by a positive result for any method FDA-approved for carbapenemase detection from specific specimen sources.

Same definition for both organisms

Two ways to meet definition: 1) standard testing methods 2) carbapenemase detection

Important to note that both resistant and intermediate MIC results meet the definition (non-susceptible)
Sent out a 36-question survey to all reporting facilities. Goal of the survey is to learn about how facilities are reporting and identify strategies for auditing CRE data. Included questions about laboratory testing and CRE reporting capabilities (responses by IPs and laboratory managers).

This data shows how widespread the capture is — ie how many cultures are actually being screened. Are we missing possible CRE cases?

Homogeneity in testing is encouraging for reliability of data.

Possible implications for audit — data retrieved from automated systems.

Imipenem degrades easily. Studies suggest meropenem may be more stable than imipenem. However, for either antimicrobial agent, storage conditions of susceptibility panels, cards, and disks must be monitored carefully and quality control results checked frequently (http://www.cdc.gov/HAI/settings/lab/lab_imipenem.html)

Ertapenem is not included in the CDC definition for CRE. Other carbapenem sensitivity results should NOT be changed based on the ertapenem
result.

In case they ask – in MARO 79% use current breakpoints

CLSI M100-S22 breakpoints meet current definition. Issues with instrumentation.

Is it possible to tag CRE isolates in order to generate a line list?

Some facilities have capability of line list but need to build a report for it. Pulling data for audit by organism name will be labor intensive. Pulling a CRE specific report will be very beneficial.

Offer education to lab staff/IPs? Encourage IT support?
Preliminary NHSN data for CRE Klebsiella and E. coli
• Reporting began in July 2013
• 2 months of data – July and August 2013
• 93% of hospitals that should be reporting

Most hospitals have reported at least two months of data. Many hospitals are current through October.

Max 22 cases entered in a month

Excluding non-blood sources would miss many cases.

Interestingly not clustered in ICUs.
Slide 11

**CRE-Klebsiella classification (out of 483 cases)**

![Diagram showing prevalence rates of different sources and locations of CRE infections.]

Slide 12

**Overall Prevalence**

**CRE-E. Coli**

![Map showing prevalence in New York State.]

Note the small number of cases.

Slide 13

**CRE-E.coli Descriptive Statistics**

- **Location:**
  - 27% Medical-surgical wards
  - 18% Medical wards
  - 5% Surgical wards
  - 3% Medical ICUs
  - 11% Surgical ICUs
  - 8% Step-down units

- **Average age:** 63 (range 0-101)

- **Gender:** 59% Male

- **Specimen source:**
  - 54% Urine
  - 16% Blood
  - 8% Wound
  - 8% Sputum
  - 5% Trans-tracheal

Excluding non-blood sources would miss many cases.
Slide 14

**CRE-E. coli classification (out of 38 cases)**

- Hospital onset incidence rate: 0.008/1,000 patient days
- Admission prevalence rate: 0.001 cases/100 admissions

**Bloodstream infection admission prevalence rate:**

- 0.006 cases/100 admissions

**Bloodstream infection incidence rate:**

- 0.001 per 1,000 patient days

**Hospital onset incidence rate:**

- 0.008/1,000 patient days

**Admission prevalence rate:**

- 0.001 cases/100 admissions

**Is CRE a Good indicator For Public Reporting?**

<table>
<thead>
<tr>
<th>Disease</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Klebsiella</td>
<td>Affects large number of people, has substantial impact for a smaller population</td>
</tr>
<tr>
<td>E. coli</td>
<td>Affects a larger number of people, has substantial impact for a smaller population, or recommended by the CDC.</td>
</tr>
</tbody>
</table>

**Important**

- Infection rates have been growing since first identified in the US
- Recommended by CDC (Vital Signs and Toolkit, 2012)
- Identified as a regional problem
  - Based on first 2 months of reporting, expecting annual counts of:
    - Klebsiella: ~ 3000 cases
    - E. coli: ~ 300 cases
- Infection data can give healthcare facilities and public health agencies the knowledge needed to design, implement, and evaluate prevention strategies that protect patients and save lives
Performance Gap

- Variation in incidence rates among hospitals
- Infection prevention strategies have been shown successful in decreasing rates in healthcare facilities
- Clear opportunity for improvement

Considerable variation or overall less-than-optimal performance across facilities, demonstrates opportunity for improvement.

Evidence-based

- Peer reviewed literature showing
- Risk factors
- Clonal expansion
- Successful prevention strategies

Studies or expert opinion support the relationship between healthcare practices and infection rates.

Successful control of KPC-producing Enterobacteriaceae will require a coordinated, regional effort among acute and long-term health care facilities and public health departments (Won SY Clin Infect Dis. 2011)

Carbapenem resistance among common Enterobacteriaceae has increased over the past decade; most CRE are associated with health-care exposures. IMPLICATIONS FOR PUBLIC HEALTH: Interventions exist that could slow the dissemination of CRE. Health departments are well positioned to play a leading role in prevention efforts by assisting with surveillance, situational awareness, and coordinating prevention efforts. (MMWR Morb Mortal Wkly Rep. 2013 Mar)
Slide 19

Valid
• Bacteremias - highly likely to represent infection
• Difficult to distinguish colonization and infection for non-bloodstream infections
• Risk adjustment not available

The indicator measures what it is intended to measure. Outcomes can be adjusted as needed for differences in patient HAI risk factors between facilities.

Slide 20

Reliable
• LabID definition is clear
• Rates will vary among hospitals based on identification and susceptibility methods
• Similar to CDI, we won’t be able to compare hospitals

Indicator is well-defined so it can be reported consistently across facilities.

Slide 21

Implications for Audit
• Important to be able to pull a CRE specific line list
• If not, will need to pull lists by organism and review all
• May be able to retrieve data from automated instrumentation

Cases could be missed if rely only on what is reported to/by IPs.
**Slide 22**

**Usable**
- Similar to CDI, influenced by test methods so more difficult to use than other data

*Audience can understand the results and find them useful for decision making.*

**Slide 23**

**Feasible**
- LabID infections are easy to identify
- Does not place undue burden on facility or IP because these are important to track

*Required data can be reported without undue burden*

**Slide 24**

**Comparison to Related Measures**
- No conflicts
- Similar to LabID CDI

*Does not conflict with other measures/reporting requirements.*
So, Is CRE a Good Indicator?

Do you agree?

Discussion

• Moving forward with CRE reporting (end of pilot/beginning of formal reporting Jan 1, 2014)
• We will share pilot rates with hospitals on regional conference calls, with discussion of prevention strategies
• Follow up with hospitals to ensure accurate application of CRE definition
• We will continue to assess reasons for variations in rates between hospitals
• Plan for hospitals with high CRE rates

For hospitals with high rates do we plan to be as aggressive as CDC recommends?

Possible Follow-Up for High Rate Hospitals:

• Currently receive annual survey
• Ask about current prevention practices
• Is that enough?
• Site visits
• Request detailed information of practices
• Initiate active surveillance testing
• Identify a geographic region with high rates
• Follow up with specific hospitals or region-wide
• Some states have so few events each positive LabID receives follow-up
CDC Recommendations for High-Rate Hospitals

- Dedicated Personnel
- Advisory panel
- Engagement of Healthcare Facilities
- Discussions with facility directors and/or administrators in addition to the infection prevention personnel
- Reinforcement of Core Prevention Measures
- Review current infection control policies and practices
- Reinforce best practices, targeted education and in-service training
- Implementation of Supplemental Measures
- Performing active surveillance testing and/or chlorhexidine bathing

Assessing Facility Compliance to Prevention Measures

- Monthly assessments
- Reporting by facility Infection Preventionists or assessed through site visits
- Additional educational outreach, such as in-service trainings and webinars
- Performance feedback should be shared with facility directors and/or administrators
- Inter-facility Communication
- Transfer forms
- Regional Surveillance and Feedback of Results
- Making CRE cases reportable

Thank you! Questions??
APPENDIX C. Regional Conference Call Presentation – January & February 2014

Slide 1

Carbapenem-Resistant Enterobacteriaceae (CRE): Preliminary Pilot Data
NYSDOH Hospital Acquired Infection Reporting Program
January/February Regional Conference Calls 2014

PRELIMINARY UNAUDITED DATA – DO NOT DISTRIBUTE OUTSIDE YOUR FACILITY

Slide 2

Survey Results and Pilot Data

Slide 3

Important Note on Using Correct CRE Definition
• CDC has disseminated two CRE definitions:
  • NHSN MDRO module
  • 2012 CRE Toolkit
• These definitions are slightly different (described on the next two slides)
• Please use the definition in the NHSN protocol for NHSN reporting
**Slide 4**

NHSN 2014 MDRO Module CRE Definition (Use this definition)

- **CRE-E coli**: Any *E. coli* testing non-susceptible (i.e., resistant or intermediate) to imipenem, meropenem, or doripenem, by standard susceptibility testing methods or by a positive result for any method FDA-approved for carbapenemase detection from specific specimen sources.

- **CRE-Klebsiella**: Any Klebsiella spp. testing non-susceptible (i.e., resistant or intermediate) to imipenem, meropenem, or doripenem, by standard susceptibility testing methods or by a positive result for any method FDA-approved for carbapenemase detection from specific specimen sources.

---

**Slide 5**

2012 CRE Toolkit Definition

(Do not select cases for NHSN using this definition)

Enterobacteriaceae that are:

- **Nonsusceptible** to one of the following carbapenems: doripenem, meropenem, or imipenem AND
- **Resistant** to all of the following third-generation cephalosporins that were tested: ceftriaxone, cefotaxime, and ceftazidime.

---

**Slide 6**

Preliminary Lab Survey Results

October 22, 2013 survey: 86% of hospitals so far

- Are all Gram Negative Rods (GNRs) isolated for identification?
  - Yes: 56%
  - No: 44%
  - Exclude non-sterile wound (mixed culture): 79%
  - Exclude urine (mixed culture): 92%
  - Exclude respiratory (< oropharyngeal flora): 87%

- Is antimicrobial susceptibility testing performed on all identified GNRs?
  - Yes: 65%
  - No: 35%
  - Exclude non-sterile wound (mixed culture): 60%
  - Exclude urine (mixed culture): 50%
  - Exclude respiratory (< oropharyngeal flora): 50%

Sent out a 36-question survey to all reporting facilities. Goal of the survey is to learn about how facilities are reporting and identify strategies for auditing CRE data. Included questions about laboratory testing and CRE reporting capabilities (responses by IPs and laboratory managers).

This data shows how wide the capture is—i.e., how many cultures are actually being screened. Are we missing possible CRE cases?
Homogeneity in testing is encouraging for reliability of data.

Possible implications for audit – data retrieved from automated systems.

Imipenem degrades easily. Studies suggest meropenem may be more stable than imipenem. However, for either antimicrobial agent, storage conditions of susceptibility panels, cards, and disks must be monitored carefully and quality control results checked frequently (http://www.cdc.gov/HAI/settings/lab/lab_imipenem.html)

Ertapenem is not included in the CDC definition for CRE. Other carbapenem sensitivity results should NOT be changed based on the ertapenem result. Will need to follow up with these hospitals.
Which CLSI breakpoints are routinely used for your automated testing?

<table>
<thead>
<tr>
<th>Breakpoints</th>
<th>59%</th>
<th>32%</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLSI M100-S22</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Is testing done to verify the production of a carbapenemase? Yes 51%

Note: If resistance pattern meets CDC criteria but carbapenemase test is negative, event should be reported to NHSN

In case they ask – in MARO 79% use current breakpoints

CLSI M100-S22 breakpoints meet current definition. Issues with instrumentation.

Are line lists available?

<table>
<thead>
<tr>
<th>Method</th>
<th>% of Hospitals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review line list of CRE cases for a given period, as generated by LIS</td>
<td>58%</td>
</tr>
<tr>
<td>Review line list of organisms and sensitivities for a given time period, as generated by ICT or Lab program</td>
<td>21%</td>
</tr>
<tr>
<td>Review daily lab reports that IP previously saved in a folder or spreadsheet</td>
<td>13%</td>
</tr>
<tr>
<td>Unknown</td>
<td>8%</td>
</tr>
</tbody>
</table>

Is it possible to tag CRE isolates in order to generate a line list?

Some facilities have capability of line list but need to build a report for it. Pulling data for audit by organism name will be labor intensive. Pulling a CRE specific report will be very beneficial.

Offer education to lab staff/IPs? Encourage IT support? Meaningful use grant applications here?
Overall Prevalence = Number of 1st LabID events per patient per month per 100 admissions = 0.13
Overall Prevalence of CRE-Klebsiella
1,012 cases reported July - October 2013,
50% of cases in Queens, Brooklyn, and Bronx
PRELIMINARY UNAUDITED DATA – DO NOT DISTRIBUTE OUTSIDE YOUR FACILITY

Slide 13

**CRE-Klebsiella Descriptive Statistics**
- **Location:**
  - 31% Medical-surgical wards
  - 22% Medical wards
  - 9% Medical ICUs
  - 9% Medical-surgical ICUs
  - 4% Step-down units
- **Average age:** 70 (range 0-101)
- **Gender:** 51% Female
- **Specimen source:**
  - 51% Urine
  - 12% Blood
  - 11% Wound
  - 9% Sputum
  - 5% Tracheal

Excluding non-blood sources would miss many cases.
Interestingly not clustered in ICUs.

Slide 14

**CRE-Klebsiella classification (out of 1,012 cases)**
- Hospital-onset bloodstream infection incidence rate = 0.115 /1,000 patient days
- Hospital-onset infection admission prevalence rate = 0.007 cases/100 admissions
- Healthcare-onset bloodstream infection incidence rate = 0.018 per 1,000 patient days
- Healthcare-onset infection admission prevalence rate = 0.06 cases/100 admissions

- 97 -
Slide 15

Overall Prevalence
CRE - E. Coli

86 cases reported July-October 2013
most in Brooklyn and Queens
Overall Prevalence = Number of 1st LabID events per patient per month per 100 admissions = 0.011

PRELIMINARY UNAUDITED DATA – DO NOT DISTRIBUTE OUTSIDE YOUR FACILITY

Slide 16

CRE - E. coli Descriptive Statistics
• Location:
  - 34% Medical-surgical wards
  - 15% Medical wards
  - 6% Surgical ICUs
  - 6% Step-down units
  - 5% Surgical wards
  - 2% Medical-surgical ICUs
• Average age: 62 (range 0-101)
• Gender: 55% Male
• Specimen source
  - 58% Urine
  - 11% Blood
  - 6% Wound
  - 6% Sputum
  - 4% Trans-tracheal

Excluding non-blood sources would miss many cases.

Slide 17

CRE - E. coli classification (out of 86 cases)

Hospital onset admission prevalence rate:
0.006 cases/100 admissions
Bloodstream infection incidence rate:
0.0005 per 1,000 patient days
Hospital onset incidence rate:
0.001 cases/100 admissions

EXHIBIT 1: Hospital Onset Incidence Rate
Annual Projections

- Based on first 4 months of reporting, expecting annual counts of:
  - Klebsiella: ~ 3000 cases
  - E. coli: ~ 250 cases

Affects a large number of people, has a substantial impact for a smaller population, or recommended by the CDC.

Prevention Strategies

- All facilities: 8 core prevention strategies
- Facilities with high rates or in communities with high rates: 8 core prevention strategies plus supplemental strategies

CDC Core Measures (All Acute Care and LTC Facilities)

- There are 8 core measures facilities should follow
  - Hand Hygiene
  - Contact Precautions
  - Healthcare Personnel Education
  - Use of Devices
  - Patient and Staff Cohorting
  - Laboratory/Notification
  - Antimicrobial Stewardship
  - CRE Screening
Hand Hygiene

• Personnel must be familiar with technique and rationale
• Ensure access to adequate hand hygiene stations
• Promote staff ownership of hand hygiene
• Adherence should be monitored and adherence rates should be reported directly back to staff
• Immediate feedback should be provided to staff who miss opportunities for hand hygiene

Contact Precautions

• Patients in acute care settings who are colonized or infected with CRE should be placed on Contact Precautions.
• Systems should be in place to identify patients with a history of CRE colonization or infection at admission
• Clinical laboratories should have an established protocol for notifying clinical and/or infection prevention personnel when CRE are identified from clinical or surveillance cultures
• No firm recommendation about when to discontinue Contact Precautions among infected patients
• Process to monitor and improve HCP adherence to Contact Precautions
• Preemptive Contact Precautions, often in conjunction with surveillance cultures or transfer from high risk location

Healthcare Personnel Education

• HCP in all settings who care for patients with MDROs, including CRE, should be educated about preventing transmission of these organisms.
• At a minimum this should include information on the proper use of Contact Precautions and hand hygiene.
**Slide 24**

**Use of Devices**

- Device use has been associated with carbapenem resistance among Enterobacteriaceae.
- Minimizing device use in all healthcare settings should be part of the effort to decrease the prevalence of all MDROs including CRE.
- Device use should be reviewed regularly to ensure they are still required.
- Devices should be discontinued promptly when no longer needed.

**Slide 25**

**Patient and Staff Cohorting**

- When available, patients colonized or infected with CRE should be housed in single patient rooms.
- If not possible, then these patients should be cohorted together.
- Consideration should be given to cohorting patients with CRE in specific areas, even if in single patient rooms, and to using dedicated staff to care for them.
- Preference for single rooms should be given to patients at highest risk for transmission such as patients with incontinence, medical devices, or wounds with uncontrolled drainage.

**Slide 26**

**Laboratory Notification**

- Laboratories should have protocols in place that facilitate the rapid notification of appropriate clinical and infection prevention staff whenever CRE are identified from clinical specimens to ensure timely implementation of control measures.
Antimicrobial Stewardship

- Multiple antimicrobial classes have been shown to be a risk for CRE colonization and/or infection
- As part of an antimicrobial stewardship program designed to minimize transmission of MDROs facilities should work to ensure
  1. Antimicrobials are used for appropriate indications and duration
  2. That the narrowest spectrum antimicrobial that is appropriate for the specific clinical scenario is used

PRELIMINARY UNAUDITED DATA – DO NOT DISTRIBUTE OUTSIDE YOUR FACILITY

CRE Screening

- Screening is used to identify unrecognized CRE colonization
- Involves stool, rectal, or peri-rectal cultures and sometimes cultures of wounds or urine (if a urinary catheter is present)
- Laboratory protocol for evaluating rectal or peri-rectal swabs
- CRE screening of epidemiologically linked patients is a primary prevention strategy for all healthcare facilities
- Particularly important for healthcare facilities with CRE outbreaks or facilities that do not or only rarely admit patients with CRE infection or colonization

Note that screening on admission is not included in this recommendation.

Supplemental Strategies

- Active surveillance testing
- Chlorhexidine bathing
- Inter-facility communication
- Surveillance for unusual resistance mechanisms

Need more info on what makes a good AS program – hospital size/resource specific
Active surveillance testing

- Select location/type of at risk patients
- If there is evidence of intra-facility transmission, which wards/units are most affected?
- If cases are community onset, what is source of admission (e.g., long-term care facility)?
- Patients hospitalized within the last 6-months in countries outside the U.S.
- Place patients on contact precautions while awaiting results of these cultures.

PRELIMINARY UNAUDITED DATA – DO NOT DISTRIBUTE OUTSIDE YOUR FACILITY

Chlorhexidine bathing

- If there is evidence of intra-facility transmission
- Consider bathing high risk patients with 2% chlorhexidine

PRELIMINARY UNAUDITED DATA – DO NOT DISTRIBUTE OUTSIDE YOUR FACILITY

Inter-facility communication

- Inform admitting facility when CRE colonization or infection is identified on admission
- Ensure CRE is noted on inter-facility transfer form

PRELIMINARY UNAUDITED DATA – DO NOT DISTRIBUTE OUTSIDE YOUR FACILITY
Surveillance for unusual resistance mechanisms

- When CRE is identified in a patient with a history of an overnight stay in a healthcare facility outside the United States (within the last 6 months), lab should determine the carbapenem resistance mechanism
APPENDIX D. Infection Prevention Practices Survey – CRE Section Spring 2014

Assessment of Routine Practices – Carbapenem-resistant Enterobacteriaceae:

35) Standard and supplemental precautions: If you have difficulty consistently implementing the following MDRO core or supplemental measures, please describe the challenges and barriers to implementation.

A) Hand Hygiene Challenges

☐ Staff education/understanding
☐ Improper technique
☐ Missed hand hygiene opportunities
☐ Monitoring system
☐ Reporting compliance to staff
☐ Access to adequate hand hygiene stations
☐ No challenges

Comments: ______________________________________________________________

B) Contact Precautions Challenges

☐ Identifying patients who need precautions
☐ Notification of results from laboratory
☐ Staff education/understanding
☐ Knowing when to discontinue precautions
☐ Monitoring system
☐ Reporting compliance to staff
☐ Use of preemptive precautions
☐ No challenges

Comments: ______________________________________________________________
C) Healthcare Personnel Education Challenges

- Staff understanding
- Attendance at educational events
- Consistent messaging
- No challenges

Comments: ______________________________________________________________

D) Use of Devices Challenges

- Devices not reviewed frequently to ensure need
- Devices placed when not necessary
- Devices not discontinued appropriately
- No challenges

Comments: ______________________________________________________________

E) Patient and Staff Cohorting Challenges

- Private room availability
- Cooperation from bed placement/admitting
- Timely cohorting of patients
- Timely cohorting of staff
- Preference for single rooms given to high risk patients
- Willingness of staff to cohort
- No challenges

Comments: ______________________________________________________________

F) Laboratory Notification Challenges

- Protocols for rapid notification
□ Appropriate clinician being contacted
□ Information being communicated among clinicians
□ Proper documentation of notifications (date/time/person spoke with)
□ Use of patient identifiers
□ Delay due to faxing reports
□ No challenges
Comments: ______________________________________________________________

G) Antimicrobial Stewardship Challenges (Questions will be asked later in the survey)

H) CRE Screening of Epidemiologically Linked Contacts Challenges
□ Identifying epidemiologically linked contacts
□ Maintaining records of known CRE colonized or infected patients
□ Timely collection of screening swabs
□ Established screening protocol
□ Reimbursement for screening cultures
□ Patient willingness to be screened
□ No challenges
□ Not done
Comments: ______________________________________________________________

Supplemental Precautions:
□ These do not apply because MDROs are not a problem at my facility or in my community.

I) Challenges to MDRO Active Surveillance
□ Identifying high risk patients
□ Screening patients in high risk units/wards
□ Use of preemptive precautions
□ Timely/periodic collection of screening cultures

□ Screening protocol

□ Action plan for positive screens

□ No challenges

□ Not done

Comments: ______________________________________________________________

J) Chlorhexidine Bathing Challenges

□ Availability of CHG wash and cloths

□ Patient education/understanding on use of CHG

□ Identification of high risk patients

□ Use on high risk units/wards

□ Application protocol

□ Inadequate evidence to use

□ Cost

□ No challenges

□ Not done

Comments: ______________________________________________________________

K) Inter-facility Communication Challenges

□ Missing/Incomplete records from transferring facility

□ Lack of uniformity in transfer forms

□ Delay in receipt of transfer information

□ Lack of CRE history on transfer form

□ Ability to complete form for discharged/transferred patients (to different facility)

□ No challenges
I) Surveillance for Unusual Resistance Mechanisms

☐ Ability of facility to test for unusual resistant mechanisms

☐ Availability of reference lab

☐ Reimbursement for testing

☐ Identification of patients with exposure to international healthcare facility (>6 months)

☐ Prompt reporting

☐ No challenges

☐ Not done

Comments: ______________________________________________________________
Multidrug-Resistant Organisms (MDROs)

Multidrug resistant organisms (MDROs) are bacteria that cannot be treated with commonly used antibiotics. Examples of MDROs that may affect hospitalized patients include:

- carbapenem-resistant Enterobacteriaceae (CRE)
- methicillin-resistant *Staphylococcus aureus* (MRSA)
- vancomycin-resistant Enterococci (VRE)
- cephalosporin-resistant *Klebsiella* spp. (CEPHRK)
- multi-drug resistant *Acinetobacter* spp. (MDR-AB)

MDROs are important to monitor because they can spread among patients in hospital settings and there are fewer treatment options, which result in increased morbidity and mortality. These MDROs can be tracked using the National Healthcare Safety Network’s (NHSN) inpatient Laboratory-Identified event (LabID) protocol.

LabID cases are separated into reporting categories depending upon whether the onset of illness is presumed to have occurred in the community or in a hospital. Cases termed “community-onset (CO)” are cases in which the positive specimen was obtained during the first three days of the patient’s hospital admission. Hospital-onset (HO) cases are cases in which the positive specimen was obtained on day four or later during the hospital stay (Figure X).

Figure X: Definition of community and hospital onset

<table>
<thead>
<tr>
<th>Community onset</th>
<th>Hospital onset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1 (Admission)</td>
<td>Day 4</td>
</tr>
<tr>
<td>Day 2</td>
<td>Day 5</td>
</tr>
<tr>
<td>Day 3</td>
<td>Day 6</td>
</tr>
<tr>
<td>Day 7+</td>
<td>Day 7+</td>
</tr>
</tbody>
</table>
Carbapenem-Resistant Enterobacteriaceae Infections (CRE)

The Enterobacteriaceae are a large family of bacteria. Some of these organisms are normally found in the human gastrointestinal tract; others live mainly in soil and water. When these organisms are living in the gastrointestinal tract they do not cause harm and can help with necessary digestive functions. They are able to cause infections if they are spread to other locations in the body (e.g. through surgery or trauma) or are introduced into other body sites by contact with an infected person or contaminated surface.

Carbapenem-resistant Enterobacteriaceae (CRE) cannot be effectively treated with antibiotics called carbapenems, which are a type of antibiotic of last resort. Healthy people do not typically get infections with CRE. These organisms are most commonly identified in hospitalized patients. Risk factors for developing CRE infections include diagnosis with multiple medical conditions, treatment with a long course of antibiotics, use of indwelling medical devices, and repeated inpatient medical care. CRE are increasingly causing healthcare associated infections in many parts of the world. As of 2013 cases have been identified in forty US states and twenty-five countries on five continents (Swaminatham, 2013).

The specific types of CRE that are tracked by the NYSDOH are *E. coli* and *Klebsiella* spp. CRE is monitored because it is a relatively newly emerged pathogen, it has been increasing ever since it was first identified, and it can be responsible for high mortality rates. It is important for medical and public health professionals to know how common CRE is in the state so efforts can be taken to prevent its continued spread.

Carbapenems are considered last resort antibiotics by medical professionals. They are among the most powerful antibiotics currently available. These antibiotics are only used when other antibiotics cannot be used. As antimicrobial resistance becomes a larger problem, last resort antibiotics like carbapenems have to be used more often. When carbapenems cannot be used to treat an infection, the alternative therapies can be dangerous for the patient. In some cases no alternative treatment is available. Bloodstream infections with CRE have been reported to have mortality rates of 38% (Borer 2009; Mouloudi 2010). These infections can also lead to increased hospital length of stay and increased recovery times (Swaminathan, 2013).

CRE has emerged as a serious public health threat in New York State. While some areas of the state have never reported a case, downstate hospitals, especially in New York City, carry a very high burden of CRE. Although the problem of CRE in New York is very serious, it is important to note that infections with these pathogens can be prevented, and their spread in health care facilities can be stopped. Successful campaigns to stop the spread of CRE have been undertaken both in the US and internationally.
Israel offers an excellent example of a CRE prevention success story. In 2006 Israel faced an ongoing CRE outbreak in its hospitals. Control measures at individual hospitals did little to reduce the rates of CRE. In order to stop the spread of the pathogen a government sponsored task force was created to oversee the containment of CRE. This task force evaluated infection control and laboratory policies for individual hospitals and performed site visits to observe prevention practices and staff behaviors. Feedback on these evaluations and visits was offered to the administration of each hospital, and necessary changes or improvements were initiated. A direct connection was observed between compliance with isolation guidelines and reducing the spread of CRE (Schwaber, 2011). The main lesson from the experiences in Israel is the need for a coordinated effort to reduce CRE. Studies from the US have also shown how application of the CDC recommendations in the 2012 CRE Toolkit - Guidance for Control of Carbapenem-resistant Enterobacteriaceae (CRE) are successful in reducing the burden of CRE and other MDROs in hospitals (Enfield, 2014).

The first step to stopping CRE in NYS is to understand the true scope of the problem in the state. In order to obtain these baseline rates NYS required that all hospitals report LabID CRE-\textit{E.coli} and CRE-\textit{Klebsiella} spp. beginning in July 2013. July 2013 through December 2013 was considered a pilot reporting period. This time period provided NYSDOH the opportunity to ensure the accuracy and completeness of reporting, assess variation in CRE rates, and explore the relationship between differences in laboratory testing methods and CRE rates. Preliminary regional rates and infection surveillance and prevention recommendations were shared with all hospitals via regional conference calls in January and February 2014. CRE became a fully-reportable required indicator in January 2014, and NYSDOH plans to provide individual hospital rates in the next annual report. The goals of the reporting requirement and surveillance efforts are to stop the spread of CRE in affected areas and to prevent the spread of CRE to areas that have not yet seen any cases.

Table X summarizes the statewide prevalence and incidence rates for CRE, annualized to represent all of 2013. The majority of reported CRE cases in NYS are CRE-\textit{Klebsiella} spp. (92%). Having a majority of CRE cases be CRE-\textit{Klebsiella} spp. is consistent with previously reported data. Emergence of carbapenemase-producing strains is especially likely among \textit{Klebsiella} spp. (MMWR 2013). Also, of the CRE cases in New York, 14% are bloodstream infections. This percentage is important because of the high mortality rate for CRE associated with this specimen site.
Table X: Carbapenem-Resistant Enterobacteriaceae (CRE) Infections, New York State 2013

<table>
<thead>
<tr>
<th></th>
<th>CRE-Klebsiella spp</th>
<th>CRE-E. coli</th>
<th>CRE combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of cases</td>
<td>2,988</td>
<td>268</td>
<td>3,256</td>
</tr>
<tr>
<td>Total rate (per 100 admissions)</td>
<td>0.124</td>
<td>0.011</td>
<td>0.136</td>
</tr>
<tr>
<td>Number of admission prevalent cases</td>
<td>1,480</td>
<td>140</td>
<td>1,620</td>
</tr>
<tr>
<td>Admission prevalence rate (per 100 admissions)</td>
<td>0.062</td>
<td>0.006</td>
<td>0.068</td>
</tr>
<tr>
<td>Number of admission prevalent bloodstream infection cases</td>
<td>164</td>
<td>18</td>
<td>182</td>
</tr>
<tr>
<td>Admission bloodstream infection rate (per 100 admissions)</td>
<td>0.007</td>
<td>0.001</td>
<td>0.008</td>
</tr>
<tr>
<td>Number of hospital onset (HO) cases</td>
<td>1,508</td>
<td>128</td>
<td>1,636</td>
</tr>
<tr>
<td>HO rate (per 10,000 patient days)</td>
<td>1.17</td>
<td>0.10</td>
<td>1.27</td>
</tr>
<tr>
<td>Number of HO bloodstream infection cases</td>
<td>264</td>
<td>14</td>
<td>278</td>
</tr>
<tr>
<td>HO bloodstream infection rate (per 10,000 patient days)</td>
<td>0.20</td>
<td>0.01</td>
<td>0.22</td>
</tr>
</tbody>
</table>

New York State data reported as of July 10, 2014. All data have been annualized to represent a full year. Incidence rates are based on 12,914,730 patient days, and prevalence rates are based on 2,394,218 admissions. The number of cases only includes one test per patient per hospital per month. In addition, only one blood test can be entered per 14 days, even across calendar months.

Figure X shows the geographic distribution of incident CRE-Klebsiella spp. bloodstream infections in the state. Bloodstream infection specially are shown due to the consistency of methods used to screen blood specimens for CRE among laboratories across the state. These infections occurred in hospitalized patients more than three days after admission. The highest concentration of cases can be found in Brooklyn and Queens. The farther from New York City the lower the concentration of cases. The map shows how the organism is spreading out from its area of highest incidence and thus demonstrates the urgent need for action to stop this spread.
Figure X. Carbapenem-Resistant *Klebsiella* spp. Bloodstream Infection Incidence, New York State 2013
Laboratory Survey

Along with collecting the surveillance data presented above, DOH also surveyed hospitals to determine how each facility identifies CRE cases. The purpose of this survey was to verify that surveillance data is as accurate as possible.

When conducting surveillance it is important for all reporting facilities to follow the same guidelines to be sure that the data is comparable across various locations. The laboratory survey identified a few areas for potential improvement in the surveillance of CRE.

Questions were asked on the laboratory survey to identify whether or not it is likely that cases of CRE could be missed by routine laboratory practice. Many hospital laboratories (51%) screen all potential enteric organisms to identify *E. coli* or *Klebsiella* spp. Most laboratories (63%) also screen all identified enteric organisms for resistance to carbapenems. It is possible for cases of CRE to be missed by those facilities that do not screen all cultures either for identification as an enteric or for resistance to carbapenems. However, those facilities that do not screen all enteric organisms reported that they do screen all pure isolates and sterile sites for resistance to carbapenems. This methodology means that those carbapenem-resistant infections with the highest likelihood of morbidity and mortality (e.g. bloodstream infections) are likely to be identified in all facilities across the state. A change in testing protocol for routine clinical specimens is not recommended based on these survey results.

How each laboratory identifies cases of CRE is also important for accurate and reliable surveillance. There are a variety of approved methods for testing enteric organisms for resistance to carbapenems or production of a resistance enzyme (production of an enzyme is not required to be a case of CRE).

There are four carbapenem antibiotics: ertapenem, meropenem, doripenem, and imipenem. For technical reasons only three of these (meropenem, doripenem, and imipenem) are included in the CDC and NYSDOH CRE case definition. Laboratories were asked to report which carbapenem antibiotics they routinely use for antibiotic sensitivity testing on enteric organisms regardless of whether or not the results are reported to clinicians. The combinations of antibiotics used by hospital laboratories in NYS for susceptibility testing are given in Table X.
Table X. Combinations of Carbapenems Used by Hospital Laboratories in NYS for Susceptibility Testing

<table>
<thead>
<tr>
<th>Antibiotics Used</th>
<th>Percentage of Hospital Laboratories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ertapenem, meropenem, and imipenem</td>
<td>39.8%</td>
</tr>
<tr>
<td>Ertapenem and imipenem</td>
<td>22.8%</td>
</tr>
<tr>
<td>Ertapenem and meropenem</td>
<td>11.7%</td>
</tr>
<tr>
<td>Ertapenem, meropenem, doripenem, and imipenem</td>
<td>10.0%</td>
</tr>
<tr>
<td>Meropenem and imipenem</td>
<td>7.0%</td>
</tr>
<tr>
<td>Ertapenem, doripenem, and imipenem</td>
<td>2.9%</td>
</tr>
<tr>
<td>Imipenem</td>
<td>2.9%</td>
</tr>
<tr>
<td>Meropenem</td>
<td>2.9%</td>
</tr>
</tbody>
</table>

Breakpoints for determining whether an organism is susceptible, intermediate, or resistant to an antibiotic are published by the Clinical Laboratory Standards Institute (CLSI). These breakpoint standards are used by all microbiology laboratories to ensure similarity of results regardless of testing location. However, the CLSI breakpoints are often updated more frequently than they can be adopted at the facility level. Therefore, there are some facilities in the state using older breakpoints, some with current breakpoints, and some with a combination of breakpoint sets. The lack of uniformity in the use of breakpoints creates a challenge to accurate surveillance because the use of older breakpoints will not identify as many isolates as CRE.

Laboratory identification of CRE can be achieved through several methods, all of which have benefits and drawbacks. There is no standardization for which method should be used in individual health care facility laboratories. As such, surveillance for CRE is complicated by variation in testing methodology.

A common method is automated identification and susceptibility testing. Automation is performed on one of several commercially available instruments. The majority (98%) of facilities in the state use automated instruments for primary detection of CRE. The four automated instruments that are used in NYS are Vitek II (58% of hospitals that use automated instruments), Microscan (36%), Phoenix (3%), and Trek (1%). Two percent of hospitals use both Vitek and Microscan.

Manual susceptibility testing methods (e.g. disk diffusion, E-tests) can also be used to identify CRE cases. These methods are used as the sole method of detecting CRE by a small number of facilities (2%), and they are used by many facilities for purposes of confirmation (53%) after use of automated methods.
Table X summarizes the percent of hospitals using different methods.

**Table X: Application of CLSI Breakpoints in NYS**

<table>
<thead>
<tr>
<th>CLSI Breakpoints Used</th>
<th>Percentage of Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>More sensitive test (i.e. will identify more CRE cases)</td>
<td></td>
</tr>
<tr>
<td>Automated and manual testing – both current breakpoints</td>
<td>60%</td>
</tr>
<tr>
<td>Automated testing only - current breakpoints</td>
<td>7%</td>
</tr>
<tr>
<td>Manual testing only – current breakpoints</td>
<td>2%</td>
</tr>
<tr>
<td>Automated testing - current breakpoints; manual testing - older breakpoints</td>
<td>2%</td>
</tr>
<tr>
<td>Less sensitive test (i.e. will identify fewer CRE cases)</td>
<td></td>
</tr>
<tr>
<td>Automated testing - older breakpoints; manual testing - current breakpoints</td>
<td>12%</td>
</tr>
<tr>
<td>Automated and manual testing – both older breakpoints</td>
<td>11%</td>
</tr>
<tr>
<td>Automated testing only - older breakpoints</td>
<td>6%</td>
</tr>
</tbody>
</table>

Seventy-one percent of New York hospitals are classified as having sensitive testing methods (Table X), meaning they use current CLSI breakpoints (M22 or M23) for their primary testing method. Eighty-eight percent of hospitals in the 5 county NYC area use a sensitive method, while 64% of other hospitals use the sensitive method. CRE bloodstream infection prevalence rates are three times higher in hospitals that use the more sensitive (current M22 or M23 breakpoints) testing method in the New York City area.

Identification of enzymes that bacteria produce that destroy carbapenems, called carbapenemases, can also meet the LabID definition for CRE. Forty-six percent of New York hospitals identify CRE cases by detecting the presence of a carbapenemase. Of the hospitals that test for a carbapenemase, 83% use the culture-based Modified Hodge Test (MHT), 14% use a molecular method called polymerase chain reaction (PCR), and 3% send isolates for confirmation by a reference laboratory. An enzyme must be identified in order to call an organism a carbapenemase producer; however, an organism may show resistance to the carbapenems, and therefore be considered CRE, without producing an enzyme. The methods described above are used by laboratories to differentiate between enzyme-producing CRE and non-enzyme producing CRE.
Referenced Papers:


NYS HAI Reporting Program Personnel – Group Authorship of Annual Report

Director, Bureau of Healthcare-Associated Infections – Emily Lutterloh, MD, MPH
HAI Reporting Program Director/Data Manager/Capital Area Representative – Valerie Haley, PhD
Western Region Program Representative – Peggy Hazamy, RN, BSN, CIC
Metropolitan Area (LI, Queens, Manhattan) Program Representative – Marie Tsivitis, MPH, CIC
Metropolitan Area (SI, Brooklyn, Bronx to mid-Hudson Valley) Program Rep – Rosalie Giardina, MT(ASCP), CIC
Central Region Program Representative – Robin Knab, CLT, MT(ASCP), CIC
Data Analyst – Boldtsetseg Tserenpuntsag, DrPH
State HAI Plan Coordinator (Feb 2014-current) – Kara Burke, MPH
State HAI Plan Coordinator (through Dec 2013) – Cindi Dubner, BS
Student Data Analyst – Christen Mayer, DrPHc, CLS(ASCP), CIC
Student Data Analyst – Yifeng Wu, PhD
APPENDIX F. Site Visit Toolkit – November 2014

CRE Site Visit Toolkit

New York State Department of Health
Bureau of Healthcare-Associated Infections
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<td>Observation Checklist</td>
<td>11</td>
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</tbody>
</table>
Overview

Successes in reducing CRE rates in acute care facilities have been demonstrated both domestically and internationally. These successes have focused on increased infection prevention measures at individual facilities and centralized oversight of practices. In order to reduce the burden of CRE in New York State the Healthcare Associated Infections Bureau of the New York State Health Department is conducting site visits of hospitals with a large number of hospital onset CRE bacteremia cases. The purpose of the site visits is to observe current practices and offer recommendations targeted at reducing CRE transmission within the facility. This toolkit is for use by the site visitor and facility stakeholders.
What is CRE?

Carbapenem-resistant Enterobacteriaceae (CRE)

Carbapenem-resistant *Enterobacteriaceae* occur when organisms of this family cannot be effectively treated with carbapenem antibiotics. People with normally functioning immune systems do not typically get infections with CRE. These organisms are most commonly identified in hospitalized patients. Risk factors for developing CRE infections include: diagnosis with several co-morbid conditions, treatment with long course antibiotics, use of indwelling medical devices, and recurring inpatient medical care. These risk factors illustrate why acute care hospitals and long term care facilities are important settings for surveillance and monitoring of CRE cases.

CRE was first identified in North Carolina in 1996 as part of a special antimicrobial surveillance project conducted by the CDC. The unusual resistance pattern was originally determined to be an isolated case. Unfortunately, the surveillance project was only testing isolates from a handful of hospitals and analysis of specimens occurred with long delays after collection. As such, the spread of CRE in the United States was not uncovered until it had already caused several outbreaks in New York City. These organisms can be transmitted through person to person contact as well as, although less commonly, through environmental contamination. Therefore, once CRE had found its way into the hospitals of New York City it has been very difficult to eradicate from the patient care environment. Currently, CRE is endemic in some area of the New York Metropolitan Area Region. The CDC recently alerted clinicians about the need for additional prevention steps regarding CRE due increased reports of CRE and reports of unusual forms of CRE (such as the New Delhi Metallo-beta-lactamase).
2013-2014 National Healthcare Safety Network (NHSN) CRE Definitions*:

CRE-Ecoli: Any E. coli testing non-susceptible (i.e., resistant or intermediate) to imipenem, meropenem, or doripenem, by standard susceptibility testing methods or by a positive result for any method FDA-approved for carbapenemase detection from specific specimen sources.

CRE-Klebsiella: Any Klebsiella spp. testing non-susceptible (i.e., resistant or intermediate) to imipenem, meropenem, or doripenem, by standard susceptibility testing methods or by a positive result for any method FDA-approved for carbapenemase detection from specific specimen sources.

*These definitions are scheduled to be modified beginning January 2015.
List of Visit Goals

Goals for site visits:

1. Decreasing risk and stopping spread of CRE infection and colonization
2. Provide recommendations for improving infection prevention practices
3. Offer insights for future facility level trainings and action plans
4. Learn about successful initiatives that have already been tried or implemented

Specific activities

1. Hygiene and practice observations
2. Opportunities for education
3. Sit-down meeting with stakeholders
4. Discuss hospital rates within context of NYS average
5. Discuss hospital responses to CRE section of 2014 Prevention Practices Survey
6. Develop future goals based on visit

Tangible measurements:

1. Number of units visited
2. Number of staff/administrators reached
Tentative Schedule

9:00 – 10:00 am  Introductory meeting with Stakeholders

✓ Examples: IPs, ID physicians, Laboratory manager, Hospital Administrators, Pharmacists, Nurse Managers
✓ Explain reason for visit, reason for site selection, describe process

10:30 -12:30 pm  Practice Observations

✓ Selected units (ICU, med surg, PACU, endoscopy, sterile processing, laboratory)
✓ Accompanied by IP/Regional Representative
✓ Use CRE specific checklist

1:00 pm – 1:30 pm  Question and Answer Session

✓ Any facility community member welcome
✓ Opportunity to address any CRE questions or concerns
Recommended Infection Prevention Strategies

Core Practices:

Hand Hygiene
- Personnel must be familiar with technique and rationale
- Ensure access to adequate hand hygiene stations
- Promote staff ownership of hand hygiene
- Adherence should be monitored on all shifts and adherence rates should be reported directly back to staff
- Immediate feedback should be provided to staff who miss opportunities for hand hygiene

Contact Precautions
- Patients in acute care settings who are colonized or infected with CRE should be placed on Contact Precautions.
- Systems should be in place to identify patients with a history of CRE colonization or infection at admission
- Clinical laboratories should have an established protocol for notifying clinical and/or infection prevention personnel when CRE are identified from clinical or surveillance cultures
- No firm recommendation about when to discontinue Contact Precautions among infected patients
- Ensure HCP and visitors are educated about the proper use and rationale for Contact Precautions
- Process to monitor and improve HCP adherence to Contact Precautions
- Preemptive Contact Precautions, often in conjunction with surveillance cultures or transfer from high risk location

HCW Education
- HCP in all settings who care for patients with MDROs, including CRE, should be educated about preventing transmission of these organisms
- At a minimum education should include information on the proper use of Contact Precautions and hand hygiene.

Use of Medical Devices
- Device use has been associated with carbapenem resistance among Enterobacteriaceae
- Minimizing device use in all healthcare settings should be part of the effort to decrease the prevalence of all MDROs, including CRE
- Device use should be reviewed regularly to ensure they are still required
- Devices should be discontinued promptly when no longer needed
Patient and Staff Cohorting
• When available, patients colonized or infected with CRE should be housed in single patient rooms
• If not possible, then these patients should be cohorted together.
• Consideration should be given to cohorting patients with CRE in specific areas, even if in single patient rooms, and to using dedicated staff to care for them
• Preference for single rooms should be given to patients at highest risk for transmission such as patients with incontinence, medical devices, or wounds with uncontrolled drainage

Laboratory Notification
• Laboratories should have protocols in place that facilitate the rapid notification of appropriate clinical and infection prevention staff whenever CRE are identified from clinical specimens to ensure timely implementation of control measures.

Antimicrobial Stewardship
• Multiple antimicrobial classes have been shown to be a risk for CRE colonization and/or infection
• As part of an antimicrobial stewardship program designed to minimize transmission of MDROs facilities should work to ensure
  • (1) antimicrobials are used for appropriate indications and duration
  • (2) that the narrowest spectrum antimicrobial that is appropriate for the specific clinical scenario is used

Screening
• Screening is used to identify unrecognized CRE colonization
• Involves stool, rectal, or peri-rectal cultures and sometimes cultures of wounds or urine (if a urinary catheter is present)
• Laboratory protocol for evaluating rectal or peri-rectal swabs
• CRE screening of epidemiologically linked patients is a primary prevention strategy for all healthcare facilities
  • Particularly important for healthcare facilities with CRE outbreaks or facilities that do not or only rarely admit patients with CRE infection or colonization

Supplemental Strategies

Active Surveillance
• Select location/type of at risk patients
  • If there is evidence of intra-facility transmission, target wards/units are most affected
  • If cases are community onset, identify the source location
• Patients hospitalized within the last 6 months in countries outside the U.S.
• Place patients on contact precautions while awaiting results of these cultures.

Chlorhexidine bathing
• If there is evidence of intra-facility transmission
  • Consider bathing high risk patients with 2% chlorhexidine

Inter-facility Communication
• Inform admitting facility when CRE colonization or infection is identified on admission
• Ensure CRE is noted on inter-facility transfer form

Surveillance for Unusual Resistance Mechanisms
• When CRE is identified in a patient with a history of an overnight stay in a healthcare facility outside the United States (within the last 6 months), lab should determine the carbapenem resistance mechanism
Observation Checklist

Infection Prevention Checklist for facilities with high CRE rates

Facility Name __________________________ Date __________________
Facility Representative Name(s)______________________________
NYSDOH Representative Name(s)______________________________
Facility CRE data:______________________ Regional HO data: __________

<table>
<thead>
<tr>
<th>General Infection Prevention Education and Training.</th>
<th>Practice Performed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthcare Personnel (HCP) receive job-specific training on CRE infection prevention policies and procedures upon hire and at least annually or according to state or federal requirements</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>Competency and compliance with job-specific CRE infection prevention policies and procedures are documented both upon hire and through annual evaluations/assessments</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>Visitors of CRE patients are educated about CRE</td>
<td>Yes No N/A</td>
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<td>Comments:</td>
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<thead>
<tr>
<th>Surveillance and Disease Reporting</th>
<th>Practice Performed</th>
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<tbody>
<tr>
<td>A plan and action list is in place for reporting a CRE case once identified. This plan should include the healthcare provider, the laboratory, NHSN, and any relevant transferring/receiving facility.</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>CRE case definition is met appropriately in laboratory practice.</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>Facility identified units with high rates/transmission</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>CRE events and rates are shared monthly with units and directors</td>
<td>Yes No N/A</td>
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<td>Comments:</td>
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### Hand Hygiene

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<tr>
<th>Practice Performed</th>
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<tbody>
<tr>
<td>Written procedures are consistent with CDC guidelines for hand hygiene</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>The facility provides supplies necessary for adherence to hand hygiene (e.g., soap, water, paper towels, alcohol-based hand rub) and ensures they are readily accessible to HCP in patient care areas</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>HCP are educated regarding appropriate indications for hand washing with soap and water versus hand rubbing with alcohol-based hand rub</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>The facility periodically monitors and records adherence to hand hygiene and provides feedback to personnel regarding their performance</td>
<td>Yes No N/A</td>
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<td>Comments:</td>
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### Personal Protective Equipment (PPE)

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<tr>
<th>Practice Performed</th>
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<tbody>
<tr>
<td>The facility has sufficient and appropriate PPE available and readily accessible to HCP</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>HCP receive training on proper selection and use of PPE for CRE prevention</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>HCP are observed appropriately donning, wearing, and removing PPE</td>
<td>Yes No</td>
</tr>
<tr>
<td>Comments</td>
<td>N/A</td>
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### Environmental Cleaning (for use on Units)

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<thead>
<tr>
<th>Practice Performed</th>
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<tbody>
<tr>
<td>Facility has written policies and procedures for routine cleaning and disinfection of environmental services, including identification of responsible personnel (both with patient in room and at discharge) and use of EPA-approved disinfectant</td>
</tr>
<tr>
<td>Environmental services staff receive job-specific training and competency validation at hire and when procedures/policies change</td>
</tr>
<tr>
<td>Cleaning procedures are periodically monitored and assessed to ensure that they are consistently and correctly performed</td>
</tr>
<tr>
<td>The facility has a policy/procedure for decontamination of spills of blood or other body fluids</td>
</tr>
<tr>
<td>Proper disinfection of CRE patient room observed.</td>
</tr>
<tr>
<td>Comments:</td>
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</table>

### Reprocessing of Reusable Instruments and Devices (use in Endoscopy and Central Sterile Processing)

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<thead>
<tr>
<th>Practice Performed</th>
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<tbody>
<tr>
<td>Facility has policies and procedures to ensure that reusable medical devices are cleaned and reprocessed appropriately prior to use on another patient (Note: This includes clear delineation of responsibility among HCP.)</td>
</tr>
<tr>
<td>Policies, procedures, and manufacturer reprocessing instructions for reusable medical devices used in the facility are available in the</td>
</tr>
<tr>
<td>reprocessing area(s)</td>
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<tr>
<td>HCP responsible for reprocessing reusable medical devices are appropriately trained and competencies are regularly documented (at least annually and when new equipment is introduced)</td>
</tr>
<tr>
<td>Training and equipment are available to ensure that HCP wear appropriate PPE to prevent exposure to infectious agents or chemicals (PPE can include gloves, gowns, masks, and eye protection). (Note: The exact type of PPE depends on infectious or chemical agent and anticipated type of exposure.)</td>
</tr>
<tr>
<td>Proper disinfection of equipment from CRE patients observed.</td>
</tr>
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<td>Comments:</td>
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<thead>
<tr>
<th><strong>Contact Precautions</strong></th>
<th><strong>Practice Performed</strong></th>
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<tbody>
<tr>
<td>Patients in acute care settings who are colonized or infected with CRE are placed on Contact Precautions</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>Systems in place to identify patients with a history of CRE colonization or infection at admission</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>HCP are educated about the proper use and rationale for Contact Precautions</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>Process is in place to monitor and improve HCP adherence to Contact Precautions</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>Preemptive Contact Precautions are used, often in conjunction with surveillance cultures or transfer from high risk location</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>Comments:</td>
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<tr>
<td>Healthcare Worker Education</td>
<td>Practice Performed</td>
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<td>-----------------------------------------------------------------</td>
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</tr>
<tr>
<td>HCP in all settings who care for patients with MDROs, including CRE, are educated about preventing transmission of these organisms (at a minimum education should include information on the proper use of Contact Precautions and hand hygiene)</td>
<td>Yes No N/A</td>
</tr>
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<table>
<thead>
<tr>
<th>Proper Use of Devices (use in Units and ICU)</th>
<th>Practice Performed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policies in place for device use to be reviewed regularly to ensure they are still required</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>Devices discontinued promptly when no longer needed</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>Observation of all devices used on CRE patients are still medically necessary.</td>
<td>Yes No N/A</td>
</tr>
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<td>Comments:</td>
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<table>
<thead>
<tr>
<th>Patient and Staff Cohorting</th>
<th>Practice Performed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policies in place for patients colonized or infected with CRE to be housed in single patient rooms or cohorted together.</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>Preference for single rooms given to patients at highest risk for transmission such as patients with incontinence, medical devices, or wounds with uncontrolled drainage</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>CRE in specific areas and dedicated staff available in facility.</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>Observation of patient and staff cohorting for CRE patient care.</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>Comments:</td>
<td>N/A</td>
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### Laboratory Policies and Notification

<table>
<thead>
<tr>
<th>Practice Performed</th>
<th>Yes No N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratories have protocols in place that facilitate the rapid notification of appropriate clinical and infection prevention staff whenever CRE are identified from clinical specimens</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>Observation of laboratory notification (or evidence of notification) of a newly identified CRE case.</td>
<td>Yes No N/A</td>
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<td>Comments:</td>
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### Antimicrobial Stewardship

<table>
<thead>
<tr>
<th>Practice Performed</th>
<th>Yes No N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimicrobial Stewardship ship committee is present and meets regularly</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>Policies and procedures specific to Antimicrobial Stewardship are available.</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>Antimicrobials are only used for appropriate indications and duration</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>The narrowest spectrum antimicrobial that is appropriate for the specific clinical scenario is used</td>
<td>Yes No N/A</td>
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<td>Comments:</td>
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<table>
<thead>
<tr>
<th>CRE Screening</th>
<th>Practice Performed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screening and preemptive contact precautions are used to identify unrecognized CRE colonization among epidemiologically linked contacts of known CRE colonized or infected patients</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>Active surveillance testing and preemptive contact precautions are used in areas identified with transmission or high CRE prevalence</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>Screening is done using stool, rectal, or peri-rectal cultures.</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>Observation of screening protocol.</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>Comments:</td>
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<table>
<thead>
<tr>
<th>Active Surveillance</th>
<th>Practice Performed</th>
</tr>
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<tbody>
<tr>
<td>Active surveillance is initiated when high risk patients are identified (transfer from an affected unit or facility, hospitalization outside the US in the last six months)</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td>Patients are placed on transmission based precautions while awaiting results of screening cultures</td>
<td>Yes No N/A</td>
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<thead>
<tr>
<th>Chlorhexidine (CHG) Bathing</th>
<th>Practice Performed</th>
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<tbody>
<tr>
<td>At risk patients are instructed to bath using CHG before procedures.</td>
<td>Yes No N/A</td>
</tr>
<tr>
<td><strong>Bathing with CHG</strong> is initiated if there is evidence of intra-facility transmission of CRE</td>
<td>Yes No</td>
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<td><strong>Comments:</strong></td>
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<tr>
<th><strong>Interfacility Communication</strong></th>
<th>Practice Performed</th>
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<tbody>
<tr>
<td>Communication forms indicating CRE status are used when patients are transferred within the facility.</td>
<td>Yes No</td>
</tr>
<tr>
<td>Communication forms indicating CRE status used when patients are transferred to another facility.</td>
<td>Yes No</td>
</tr>
<tr>
<td>Communication forms indicating CRE status used when patients are transferred from another facility.</td>
<td>Yes No</td>
</tr>
<tr>
<td><strong>Comments:</strong></td>
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<table>
<thead>
<tr>
<th><strong>Surveillance for Unusual Resistance Mechanisms</strong></th>
<th>Practice Performed</th>
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<tbody>
<tr>
<td>When CRE is identified in a patient with a history of an overnight stay in a healthcare facility outside the United States (within the last 6 months), lab determines the carbapenem resistance mechanism</td>
<td>Yes No</td>
</tr>
<tr>
<td><strong>Comments:</strong></td>
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| **Additional Comments** | | |
APPENDIX G. Sample Closing Letter – March 2015

March 5, 2015

Richard Becker
President/Chief Executive Officer
Brooklyn Hospital - Downtown
121 DeKalb Avenue
New York NY 11001

Dear Mr. Becker,

The NYSDOH Hospital Acquired Infection (HAI) Reporting Program has completed its 2014 on-site validation audit of your facility. I wish to thank you and your staff, particularly the Infection Prevention, Information Technology and Medical Records Department for their cooperation and the effort they contributed during our review and audit process.

The purposes of this audit were initially presented to you in the letter of notification. Based upon my review of the medical records, no compliance issues were detected. Also reviewed was the timeliness of reporting, as well as compliance with the requirement to notify hospitals of surgical site infections in patients admitted to your hospital during the post-operative recovery period. These communications must be recorded and retrievable for a minimum of six (6) years. These elements were found to be consistent with current legislation.

Overall, the audit demonstrated satisfactorily reported HAI data for central line-associated bloodstream infections (CLABSIs) in the ICUs, surgical procedures and surgical site infection (SSI) events for targeted surveillance performed on colon, abdominal hysterectomy and hip procedures, and C. difficile LabID events. However, two (2) additional, unreported surgical site infections were identified in colon procedures (2-SSI-IAB), which must be entered into the NHSN database.

NYS mandated reporting of carbapenem-resistant Enterobacteriaceae (CRE), a highly resistant pathogen recently highlighted in the news, began in July 2013 as a means to establish baseline incidence and prevalence rates for CRE statewide. Initial data indicates your facility as having one of the highest hospital-onset CRE rates (HO-CRE) in the state and observations on site showed opportunities to improve pathogen transmission prevention behaviors. Observations that highlight the need to apply the most current recommendations include small and difficult to notice transmission based precautions signage, housing CRE and non-CRE patients in the same room, moving a rolling workstation from one room to another without disinfection, and a lack of a CRE-specific notification procedure in the laboratory. Your hospital protocols and
practices should be carefully examined to ensure that they are in line with the most currently recommended CRE-prevention strategies. Review of CRE LabID events, included in this year’s audit to assess adherence to NHSN reporting protocols revealed an additional twelve (12) CRE-LabID events that should be entered into the NHSN database, as well as two (2) CRE-lab events to be removed (as these events did not meet reporting criteria). It is recommended that your infection preventionists and laboratory leadership review the NHSN protocols for the reporting of CRE LabID events and ensure that this information is used to improve reporting, as the identified inaccuracies could be linked to either knowledge deficit or (specific) process flaws between the laboratory and infection prevention department.

At the present time, your facility is manually retrieving most of the required data elements from multiple sources and is then manually (re-)entering this data into the NHSN database in order to accurately report HAI information according to NHSN protocols. Preferably, data should be made available to the Infection Prevention department through some electronic means. Additional IT support could provide for the electronic transfer of OR information, and/or a computerized IC program could assist in readily identifying infections. As additional data submission requirements (i.e., CMS HAI reporting requirements, participation in state-wide HAI-reduction collaboratives) have placed an increased burden on the expanding role of the IP, these electronic resources would benefit the facility-wide efforts of the Infection Prevention and Quality Management Departments in identifying and preventing infections on a more proactive basis.

During the exit conference, we discussed the (CDC) surveillance definition vs. the clinical definition of HAIs, the reporting of such surveillance-defined infections and their impact on the public report. Additional data entry issues or concerns were addressed with the IP in an effort to offer continued support with NYS mandatory reporting. Some minor data discrepancies were identified. A list of each record requiring data edits to be made in NHSN was provided and reviewed with Ms. Lanuza before the conclusion of the audit. All data corrections should be entered into NHSN within 30 days of the completion of the audit.

If you need any additional information or have any further questions regarding this site visit please contact me directly, either by phone - 914-654-4362, or email, rosalie.giardina@health.state.ny.us.

Sincerely,

Rosalie Giardina, MT (ASCP)
NYSDOH Bureau of Healthcare-Associated Infections
Hospital Acquired Infection Reporting Program
Regional Representative - MARO/New Rochelle
145 Huguenot Street, Suite 609
New Rochelle, NY 10801
Carbapenem-resistant Enterobacteriaceae (CRE) for the Laboratory

Objectives

At the completion of this course the learner should be able to:

- Describe the epidemiology of CRE and understand why CRE is a problem in healthcare facilities
- Identify the methods by which CRE spreads
- Highlight the differences between clinical and surveillance case definitions
- Identify whether or not an organism meets the case definition for CRE
- Understand the laboratory’s role in CRE prevention and antimicrobial stewardship
- Describe the importance of interdepartmental communication among the laboratory, Infection Prevention, and clinical practitioners.

Carbapenem-resistant Enterobacteriaceae (CRE)

Multi-drug resistant bacteria have become a serious problem in healthcare facilities. There are a variety of these pathogens, and they can lead to very serious health conditions. Among the most serious of these pathogens are Carbapenem-resistant Enterobacteriaceae (CRE).

CRE are Gram negative bacteria from the family Enterobacteriaceae that are resistant to any member of the carbapenem group of antimicrobials. Enterobacteriaceae is a large bacterial family that includes several common human pathogens including E. coli, Klebsiella spp, and Enterobacter spp. Carbapenems are an antibiotic group that use a beta lactam ring to stop bacterial growth.
This continuing education module will focus on the role the laboratory plays on CRE prevention within healthcare facilities in New York State (NYS).

**Learning question**

What other laboratory identification (LabID) cases are part of the NYS Public Health Law 2819 mandated reporting program?

a) MRSA

b) VRE

c) *C. difficile*

d) MDR *Acinetobacter*

Feedback: The correct answer is c: *C. difficile*. C-diff has been identified as a serious problem in NYS healthcare facilities. In 2013, NYS hospitals reported 20,273 cases of C-diff infection (CDI). Approximately half of the cases were community-onset and half were hospital-onset. The other MDROs listed are also important and the New York State Department of Health monitors changes in national and voluntarily reported rates in order to determine whether additional organisms should be added as reporting indicators.

**More on Carbapenems**

The carbapenems are part of the β lactam antimicrobial group. Beta lactams also include penicillins and cephalosporins. These antimicrobials function by stopping bacterial growth through the inhibition of cell wall synthesis. There are four commonly used carbapenems: ertapenem, doripenem, meropenem, and imipenem. These antimicrobials are considered a last
line of defense against resistant pathogens. However, the use of carbapenems has been increasing due to the increasing resistance to cephalosporin antimicrobials among Enterobacteriaceae. Most cephalosporin resistance is due to the development and spread of extended spectrum β lactamases (ESBLs). ESBLs are enzymes that mediate resistance to extended-spectrum (third generation) cephalosporins (e.g., ceftazidime, cefotaxime, and ceftriaxone) and monobactams (e.g., aztreonam) but do not affect cephamycins (e.g., cefoxitin and cefotetan) or carbapenems (e.g., meropenem or imipenem).

![Ertapenem](image1.png)

**Ertapenem**

![β-lactam ring](image2.png)

**β-lactam ring**
**Learning question**

In 2012 the Clinical Laboratory Standards Institute (CLSI) changed the breakpoints for how carbapenem antimicrobials are interpreted.

a) True

b) False

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<tr>
<th>Agent</th>
<th>Previous Breakpoints (M100-S19) MIC (µg/mL)</th>
<th></th>
<th>Current Breakpoints (M100-S22) MIC (µg/mL)</th>
<th></th>
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<tr>
<td></td>
<td>Susceptible</td>
<td>Intermediate</td>
<td>Resistant</td>
<td>Susceptible</td>
</tr>
<tr>
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<td>-</td>
<td>-</td>
<td>≤1</td>
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<tr>
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<td>≤4</td>
<td>8</td>
<td>≥16</td>
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<tr>
<td>Meropenem</td>
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<td>≤1</td>
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<tr>
<td>Ertaopenem</td>
<td>≤2</td>
<td>4</td>
<td>≥8</td>
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</table>


Feedback: The answer is true. The CLSI updated the breakpoints used to interpret carbapenems in 2012. The updated, lower breakpoints increase the likelihood that the laboratory will find a carbapenemase producer.

**Learning question**

What is a major limitation of CLSI published breakpoints?

a) They are not properly researched and may be inaccurate.
b) The National Committee for Clinical Laboratory Standards (NCCLS) publishes conflicting breakpoints.

c) In vitro testing in the laboratory is limited because the entire host environment cannot be replicated.

Feedback: The answer is c. Interactions among pathogens and antimicrobials inside a human host are very complicated. This environment cannot be created in the laboratory to test how the pathogens and antimicrobial agents will behave in a patient. However, the controlled environment of the laboratory and the reproducibility of the results obtained there offer important insights. This information can be used by clinicians to select and dose proper treatment.

**Learning question**

What is the difference between an antibiotic and an antimicrobial?

a) There is no difference, the terms can be used interchangeably.

b) Antibiotics are used to kill microbes and antimicrobials are used to prevent further growth of microbes.

c) Antimicrobials are used to kill microbes and antibiotics are used to prevent further growth of microbes.

Feedback: The answer is B. Antibiotics kill bacteria. Literally anti-“life.” Antimicrobials, including the carbapenems and other beta lactams, inhibit growth. Once log phase growth is
stopped within the patient his or her immune system is able to kill the remaining pathogenic bacteria.

**CRE Epidemiology**

Infections caused by the bacteria in the family Enterobacteriaceae can occur in nearly any organ system of the human body. However, infections are most commonly identified in the urinary tract, blood, soft tissue wounds, and the lungs.

Carbapenem-resistant Enterobacteriaceae occur when organisms of this family cannot be effectively treated with carbapenem antimicrobials. These organisms are most commonly identified in people who have chronic medical conditions and need recurring invasive medical treatment. Risk factors for developing CRE infections include: diagnosis with several co-morbid conditions, treatment with antimicrobials for long periods of time, use of indwelling medical devices, and recurring inpatient medical care. These risk factors illustrate why acute care hospitals and long term care facilities are important settings for surveillance and monitoring of CRE cases.

Cases have been identified in 40 US states and 25 countries representing 5 continents. In NYS in 2013 there were approximately 3,200 CRE cases. The number of cases is increasing in frequency in many areas with some areas declaring the pathogen as endemic. There is a high level of morbidity and mortality associated with CRE infections. These infections can lead to increased hospital length of stay and increased recovery times. Overall attributable mortality is between 3.7 to 6.5 times greater for carbapenem resistant *Klebsiella pneumoniae* (CRKP) infections than for
infections with susceptible *K. pneumoniae*. For bloodstream infections the attributable mortality for CRE has been reported as high as 50%.

**How Does CRE Spread?**

There are several important methods that facilitate CRE spread:

1) Person to person contact. This type of spread includes both direct and indirect contact. The pathogens can be transferred from a patient to a surface to another patient, or in some cases to several other patients.

2) From colonization to infection. If a patient has CRE as a colonizing organism in the gastrointestinal tract the organism will live in the person’s body without causing any harm. However, if that person develops a chronic medical condition requiring invasive medical treatment it is possible that the colonizing organism be able to move to a different body site and become an infection.

3) Spontaneous development of resistance due to antibiotic pressure. When the organisms of the human gastrointestinal tract are exposed to antimicrobials those that are able to survive are selected out of the bacterial population. This survival is often due to the presence of or development of a resistance mechanism.

4) The ability of bacteria to share the genetic coding for resistance (plasmids) with one another. This plasmid sharing has even been demonstrated to take place among organisms of different genera.
Resistance Mechanisms

There are several mechanisms for carbapenem resistance that are expressed by CRE. The most common types in the US are known as KPC (*Klebsiella pneumoniae* carbapenemase) and NDM (New Delhi metallo-beta-lactamase). KPC and NDM are enzymes that break down carbapenems and make them ineffective. Other carbapenem resistance enzymes that are less common in the US are VIM (Verona integron-mediated metallo-β-lactamase), OXA (oxacillinases), and IMP (active on imipenem). These resistance mechanisms consist of plasmids encoded for enzymes that can hydrolyze carbapenem antibiotics and are called carbapenemases. It is important to note that to be considered a CRE an enteric organism does not have to produce a hydrolyzing enzyme. Showing phenotypic resistance in susceptibility testing is sufficient to be considered a CRE even in the absence of one of the resistance enzymes.

National Healthcare Safety Network

The Center for Disease Control and Prevention’s (CDC’s) National Healthcare Safety Network (NHSN) is used by many healthcare facilities throughout the United States to track healthcare-associated infections. NYS hospitals are required to enter certain types of HAI data into NHSN. For CRE, NYS uses laboratory-identified (LabID) event reporting, which means direct reporting of LabID cases without clinical evaluation of the patients. This provides proxy measures of the infection burden and transmission within healthcare facilities.

NHSN is an excellent resource for information related to healthcare associated infections and surveillance. NHSN is available here: [http://www.cdc.gov/nhsn/](http://www.cdc.gov/nhsn/)
CRE Surveillance Case Definition

New York hospitals are required to report CRE cases using the following NHSN definition:

Any *Escherichia coli*, *Klebsiella oxytoca*, *Klebsiella pneumoniae*, or *Enterobacter* spp. testing resistant to imipenem, meropenem, doripenem, or ertapenem by standard susceptibility testing methods (i.e., minimum inhibitory concentrations of ≥4 mcg/mL for doripenem, imipenem and meropenem or ≥2 mcg/mL for ertapenem) OR by production of a carbapenemase (i.e., KPC, NDM, VIM, IMP, OXA-48) demonstrated using a recognized test (e.g., polymerase chain reaction, metallo-β-lactamase test, modified-Hodge test, Carba-NP).

http://www.cdc.gov/nhsn/PDFs/pscManual/12pscMDRO_CDADcurrent.pdf

This definition was put into use on January 1, 2015.

Modified Hodge Test
A Modified Hodge Test (MHT) is an example of a confirmatory test for a carbapenemase. An ertapenem or meropenem disk is placed at the center of lawn of a non-carbapenemase producer. A positive control, negative control, and test organism are struck away from the disk in a straight line. The lawn organism will be inhibited by the disk unless a carbapenemase is present allowing it to grow closer to the center. This growth is visualized as indentations of the circle of inhibition near the carbapenemase producing organisms.

**Learning question**

What does an infection preventionist (IP) do when he or she receives notification of a positive CRE culture?

a) Makes sure the patient is on Contact Precautions

b) Makes sure the patient is in a single room if possible.

c) Determines how many days the patient has been in the hospital before the culture was collected

d) Identifies whether or not there are other patients in the hospital (or who have recently been in the hospital) who have the same organism.

Feedback: All of these actions are important for an IP following notification of a CRE culture. Having patients on Contact Precautions and in single occupancy rooms decreases the likelihood
the pathogen will spread to the environment of care or to other patients. Determining the number of days since admission allows the IP to classify the organism as community onset (less than or equal to three days since admission) or hospital onset (greater than three days since admission). Investigating other patients with the same organism allows the IP to identify possible spread of a pathogen and gives him or her the ability to stop outbreaks.

**Clinical versus Surveillance Case Definitions**

You may have noticed that the case definition just presented is different than how your clinicians typically define CRE. You are correct in this observation, and there is a good reason for the differences. It is possible that you may have to apply multiple definitions depending on how the data will be used (clinical vs. surveillance).

When NYS collects surveillance information on CRE it is necessary that all of the hospitals report their data the same way. All of the hospital data must follow the same set of requirements. Using a uniform case definition for CRE surveillance allows for comparisons among different hospitals. If different definitions are being used by each hospital the overall picture of the CRE burden in the state will not be meaningful.

For example, it is possible for *Proteus* spp. to produce a carbapenemase and it is a member of the Enterobacteriaceae family of bacteria. Nonetheless, a carbapenemase producing *Proteus* spp. is not reportable as a CRE to NYS. That does not mean that the *Proteus* spp. is not a CRE clinically, it just is not a reportable CRE for the purposes of surveillance.

It is important to keep these differences in mind when a carbapenemase producer is identified in the laboratory. Any carbapenemase producer can result in a negative patient outcome and
requires transmission based precautions, regardless of whether or not it meets the surveillance case definition. Therefore, the identification of such organisms should be communicated to infection prevention and to the patient’s clinician. Be sure you are familiar with your hospital’s laboratory result notification policies. When such an identification is made it is also important for the laboratory to assess whether or not it needs to be reported.

The clinical laboratory is an integral part of CRE surveillance in NYS. Knowing when an organism meets the surveillance case definition will allow you as a laboratorian to ensure your hospital has timely and accurate CRE reporting.

**Preventing the Spread of CRE in the Patient Care Environment**

It is important for all healthcare professionals to understand how to stop the spread of pathogens within their facility. The CDC has outlined strategies on how to prevent CRE within a healthcare facility. The core strategies outlined in the Guide for Control of Carbapenem-resistant *Enterobacteriaceae* (CRE) 2012 CRE Toolkit that should be part of every healthcare facility’s infection prevention plan are as follows:

1. **Hand Hygiene** - Facilities should ensure that healthcare personnel are familiar with proper hand hygiene technique as well as its rationale.

2. **Contact Precautions** - Patients in acute care settings who are colonized or infected with CRE should be placed on Contact Precautions.

3. **Healthcare Personnel Education** - HCP in all settings who care for patients with MDROs, including CRE, should be educated about preventing transmission of these organisms.
(4) **Use of Devices** - Use of devices (e.g., central venous catheters, endotracheal tubes, urinary catheters) puts patients at risk for device-associated infections and minimizing device use is an important part of the effort to decrease the incidence of these infections.

(5) **Patient and Staff Cohorting** - When available, patients colonized or infected with CRE should be housed in single patient rooms and if not available these patients and/or caregivers should be cohorted.

(6) **Laboratory Notification** - Laboratories should have protocols in place that facilitate the rapid notification of appropriate clinical and infection prevention staff whenever CRE are identified from clinical specimens to ensure timely implementation of control measures.

(7) **Antimicrobial Stewardship** - As part of an antimicrobial stewardship program designed to minimize transmission of MDROs, facilities should work to ensure that 1) antimicrobials are used for appropriate indications and duration and 2) that the narrowest spectrum antimicrobial that is appropriate for the specific clinical scenario is used.

(8) **Screening Epidemiologically Linked Contacts** - Screening is used to identify unrecognized CRE colonization among epidemiologically linked contacts of known CRE colonized or infected patients as clinical cultures will usually identify only a fraction of all patients with CRE.

**Preventing the Spread of CRE in the Patient Care Environment (continued)**

The two supplemental strategies are:

(1) **Active Surveillance** - This process involves culturing patients who might not be epidemiologically linked to known CRE patients but who meet certain pre-specified criteria. This could include everyone admitted to the facility, pre-specified high-risk patients (e.g., those
admitted from long-term care facilities), and/or patients admitted to high-risk settings (e.g., intensive care units [ICUs]).

(2) Chlorhexidine Bathing - Chlorhexidine bathing has been used successfully to prevent certain types of healthcare-associated infections (e.g., bloodstream infections) and to decrease colonization with specific MDROs, primarily in ICUs. For CRE, it has been used as part of a multifaceted intervention to reduce the prevalence of CRE during an outbreak in a long-term acute care facility. During chlorhexidine bathing 2% chlorhexidine is used to bathe patients (usually daily) while in high-risk settings (e.g., ICUs).

Illustration of an Indwelling Urinary Catheter

![Figure 1 – Female catheter](image1.jpg)  ![Figure 2 – Male catheter](image2.jpg)

Illustration of an Intravenous Catheter

Using indwelling medical devices, such as urinary and intravenous catheters, create an increased risk of developing a CRE. The catheter creates an entry way for the bacteria to enter the urinary track or the bloodstream and lead to an infection. These devices should be place only when medically necessary, and should be routinely evaluated for the possibility of removal. Allowing an indwelling medical device to stay in a patient longer than medically necessary greatly increases the patient’s risk of a preventable infection.

**Contact Precautions**

The use of Contact Precautions is an important strategy for preventing the spread of pathogens in the patient care environment. When a patient is on Contact Precautions anyone who enters his or her room must perform hand hygiene and don an impervious gown and gloves. This personal protective equipment (PPE) needs to be worn at all time while in the room, and removed directly before exiting. Hand hygiene must be performed again after removal of PPE. An example of a Contact Precautions sign is show here:
CONTACT PRECAUTIONS

(Contact Precautions are in addition to Standard Precautions. See Standard Precautions for questions)

ATTENTION!

VISITORS must report to the nurse station before entering.

Patient Placement
Private room, if possible. Ensure that patients are physically separated (i.e., >3 feet apart) from each other. Draw the privacy curtain between beds to minimize opportunities for direct contact.

Personal Protective Equipment (PPE)
Don gown upon entry into the room or cubicle. Remove gown and observe hand hygiene before leaving the patient-care environment.

Hand Hygiene (according to Standard Precautions)
Avoid unnecessary touching of surfaces in close proximity to the patient.
When hands are visibly dirty, contaminated with proteinaceous material, or visibly soiled with blood or body fluids, wash hands with soap and water.
If hands are not visibly soiled, or after removing visible material with soap and water, decontaminate hands with alcohol-based hand rub. Alternatively, hands may be washed with an antimicrobial soap and water.

Perform Hand Hygiene:
- Before having direct contact with patients
- After contact with blood, body fluids, or excretions, mucous membranes, non-intact skin, or wound dressings.
- After contact with a patient’s intact skin (e.g., when taking a pulse or blood pressure or lifting a patient)
- If hands will be moving from a contaminated body site to a clean body site during patient care
- After contact with inanimate objects (including medical equipment) in the immediate vicinity of the patient
- After removing gloves

Patient Transport
Limit transport and movement of patients outside of the room to medically-necessary purposes.
When transport or movement in any healthcare setting is necessary, ensure that infected or colonized areas of the patient’s body are contained and covered.
Remove and dispose of contaminated PPE and perform hand hygiene before and after transporting patients on Contact Precautions.

Patient-Care Equipment and Instruments/Devices
If common use of equipment for multiple patients is unavoidable, clean and disinfect such equipment before use on another patient.

Reference CDC stock image
Laboratory’s Role in Antimicrobial Stewardship

Antimicrobial susceptibility data from clinical isolates is an essential part of any antimicrobial stewardship program (ASP). This data originates in the laboratory, thus making the laboratory a very important part of its hospital’s ASP. One role of an ASP is to evaluate and update the hospital’s antibiogram. The hospital antibiogram is a summary of antimicrobial susceptibilities of bacterial isolates submitted to the hospital's clinical microbiology laboratory.

Sample antibiogram:

Antibiograms are used by clinicians in the selection of empiric antimicrobial therapies. However, the results can be misinterpreted when the number of isolates is small, duplicate isolates are present in the summary, or isolates from outside communities not excluded. The clinical microbiology laboratory is necessary for development, interpretation, and refinement of the antibiogram.
Antibiograms are also useful to the ASP in assessing local susceptibility rates and comparing rates across different institutions, monitoring resistance trends, performing epidemiologic investigations and infection control interventions, updating the drug formulary, and evaluating the effectiveness of interventions.

**Learning question**

According to the CDC, what are the core elements needs to build/maintain a successful antimicrobial stewardship program (ASP)?

a) Leadership Commitment: Dedicating necessary human, financial and information technology resources

b) Accountability: Appointing a single leader responsible for program outcomes. Experience with successful programs show that a physician leader is effective

c) Drug Expertise: Appointing a single pharmacist leader responsible for working to improve antibiotic use.

d) Action: Implementing at least one recommended action, such as systemic evaluation of ongoing treatment need after a set period of initial treatment (i.e. “antibiotic time out” after 48 hours)

e) Tracking: Monitoring antibiotic prescribing and resistance patterns

f) Reporting: Regular reporting information on antibiotic use and resistance to doctors, nurses and relevant staff

g) Education: Educating clinicians about resistance and optimal prescribing

Feedback: All of these elements are required for a successful ASP. Antimicrobial stewardship is interdisciplinary and requires excellent communication and cooperation among hospital
departments. The laboratory is most vital in the tracking and reporting elements. A member of the laboratory should sit on your hospital’s antimicrobial stewardship committee.

**Laboratory’s role in CRE prevention**

When a culture is positive for a CRE this result must be communicated to the clinician caring for the patient and infection prevention right away. This communication should be done following your hospital’s policy on the preferred means of communication (for example, over the phone with a read-back of the organism and patient information).

Clinicians will use the culture information to appropriately treat the patient. Infection prevention will use the information to be sure the patient is in appropriate transmission based precautions (isolation precautions). These actions will decrease the likelihood that the pathogen will spread to more patients or into the patient care environment.

Keep in mind that notification must be done regardless of the shift or day. Infection prevention departments are routinely open during business hours. Technologists working evening, overnight, and weekend shifts should report the CRE based on your hospital’s notification policy. Be sure you are familiar with this policy and are able to notify positive CRE culture results immediately regardless of whether or not it is an evening, night, weekend, or holiday shift.

Preliminary culture results should be communicated. Do not wait unit the culture result is final to notify the clinician and infection preventionist. Indicate during the notification that the result is preliminary. If the final result is different from the notified preliminary result then the change
will need to be communicated as well. Patients can always be taken off of transmission based precautions, but the pathogen may spread while waiting on finalized culture results.

**Laboratory Information System and Infection Prevention’s Role**

It is important for the purposes of surveillance and auditing that complete and chronological line lists of CRE cultures can be generated by the laboratory information system (LIS). It is important that the laboratory can access CRE cases both as a line list for data validation purposes and to respond in real time to individual cases. Coordination of these capabilities between the laboratory and the hospital’s information technology department should be ongoing.

The Infection Prevention Department uses the CRE data from the laboratory to enter culture results and patient demographics into the National Healthcare Safety Network (NHSN). Data entered into NHSN is also retrievable by the New York State Department of Health (NYSDOH).

CDC and NYSDOH use the CRE data to perform surveillance and know what the disease burden is for both the country and the state respectively. Surveillance data is used to develop initiatives to stop the spread of the pathogen and to allocate resources to areas or facilities with the most need.

The culture result data generated by the laboratory is an essential first step in the CRE surveillance process.

NYS CRE surveillance data are available in annual reports on the NYSDOH website.

Involvement with Public Health Laboratory

Some clinical laboratories may save isolates of CRE on slants or send them directly to their public health laboratory. The public health laboratory is able to confirm the organism, perform pulse field gel electrophoresis (PFGE) to determine if several isolates are genetically related, and test for unusual resistance mechanisms.

Be sure to be familiar with your public health laboratory’s testing and shipping guidelines.

Learning question

At the public health laboratory, what testing is performed on clinical isolates to determine if a single source outbreak is (or has) taking place in the hospital?

a) PCR

b) MALDI-TOF

c) PFGE

d) Modified Hodge Test

Feedback: the answer is c, pulse field gel electrophoresis (PFGE). This testing identifies the genetic make-up of the isolates from the hospital. These genetic pictures can be compared across isolates to determine similarity. Because bacteria go through asexual reproduction the daughter cells genetically match the parent cells. Therefore, if the outbreak began with one source patient, all of the other patient isolates from the outbreak should genetically match. PFGE helps IPs and
state epidemiologists make this determination. Computer software is used to determine the percent similarity in the genetic make-up of the isolates.


If your infection prevention department requests that you save isolates in your laboratory it is so that this testing can be performed if an outbreak is later identified.

**Case Study A**

A large university medical center is located in an area with a high incidence of CRE. This hospital laboratory regularly identifies CRE and notifies infection prevention and clinicians. The
laboratory routinely tests enteric organisms against ertapenem and meropenem, and has the capability to perform PCR for the KPC resistance plasmid.

Over a three month period ten *Klebsiella pneumoniae* isolates were identified using a Microscan. The isolates test resistant to both ertapenem and meropenem by E-test. These isolates represent a variety of specimen sources, locations, and patient demographics with no clear epidemiological link. The isolates test negative by PCR. However, ertapenem and meropenem resistant isolates have tested PCR positive during the same time period. All of the internal controls work correctly during the PCR testing.

Question A1

Should the ten PCR negative culture results be reported to NSHN and NYS?

a) No, because CRE does not need to be reported in areas with high incidence of the pathogen.

b) No, because confirmation of carbapenemase production is necessary for reporting.

c) Yes, because confirmation of carbapenemase production is not necessary for reporting.

Feedback: The answer is c. confirmation of enzyme production is not necessary for reporting. These isolates should be reported based on the E-test results.

Question A2

What is the most likely cause of the unexpected results?

a) The PCR testing is not being performed correctly.
b) The organisms were misidentified as *Klebsiella pneumonia*.

c) The organisms are producing a carbapenemase through a resistance mechanism other than KPC.

Feedback: The answer is c. The most likely cause of the results is that another resistance mechanism is present (i.e. OXA or NDM).

**Question A3**

What should the microbiology laboratory do with the information it has collected?

a) Nothing because it is infection prevention’s responsibility.

b) Contact the local public health laboratory to get advice about additional testing options.

c) Retest all of the isolates to be sure the results are correct.

Feedback: The answer is b. The clinical laboratory needs to be familiar with the protocols of the public health laboratory (PHL). In some instances the clinical isolates should be sent to the public health laboratory for additional testing. However, not all isolates are appropriate for additional testing.

**Case Study B**

A laboratory tests two carbapenem resistant *Serratia marcescens* isolates within a week of each other. The *S. marcescens* antimicrobial susceptible patterns were: susceptible to ceftriaxone, ceftazidime, and cefepime (MIC < or = 0.25 microg/ml), and resistance to the carbapenems
(imipenem and meropenem; MIC > 32 microg/ml) and aztreonam (MIC > = 16 microg/ml). Each 
*S. marcescens* isolate shared an identical epidemiologic type by PFGE from the state public 
health laboratory.

Question B1

Should these results be reported to the patient’s clinician and to infection prevention (IP)?

a) Yes, it is a multi-drug resistant pathogen that can have negative patient outcomes and requires 
Contact Precautions.

b) No, it does not meet the CDC and NYS case definition for a CRE.

Feedback: The answer is a. The results should be notified to the clinical and IP immediately. 
Treatment options and the need for transmission based precautions should be assessed as quickly 
as possible.

Question B2

Should these results be reported through NHSN to the NYS Reporting Program?

a) Yes, it is a multi-drug resistant pathogen that can have negative patient outcomes and requires 
Contact Precautions.

b) No, it does not meet the CDC and NYS case definition for a CRE.

Feedback: The answer is b. These results should not be reported because *Serratia marcescens* is 
not part of the NHSN CRE surveillance definition.
Case Study C

A medium sized community hospital identifies six carbapenem resistant *E. coli* isolates within one month of each other. The specimen sources include four urines, one wound and one blood. All of the patients were in the ICU during their stay, although not all of the specimens were collected while the patients were in the ICU.

Question C1

What does the infection preventionist need to do with the above information?

a) Be sure all of the patients are on Contact Precautions, in single occupancy rooms, and have dedicated equipment (i.e. thermometers, stethoscopes, blood pressure cuffs).

b) Create a line list of all of the patients that includes their admission date, all of the locations and dates of transfers within the hospital, microbiology specimen collection dates and results, and insertion dates of indwelling medical devices.

c) Interview clinical staff members and housekeeping to identify any lapses in infection prevention protocol.

Feedback: All of these actions should be taken. Ensuring the patients are properly isolated protects other patients from the spread of the CRE *E. coli*. Creating a line list and interviewing staff begins the investigation into the cause of the outbreak. Finding the cause can lead to changes in policy or additional education targeted at preventing future spread.
Question C2

Should the outbreak be reported to the Department of Health?

a) No, CRE is considered endemic in New York State hospitals and therefore outbreaks do not need to be reported.

b) Yes, according to the New York State Department of Health Communicable Disease Reporting Requirements a cluster or outbreak of cases of any communicable disease is a reportable event.

Feedback: The answer is b. The outbreak should be reported to the Department of Health.

Question C3

No additional cases of CRE *E. coli* are identified in the next six months. What additional action should the infection preventionist take?

a) No action needs to be taken, the outbreak is over.

b) The findings of the outbreak investigation should be shared with hospital staff and leadership.

Feedback: The answer is b. The findings should be shared. It is important that anything learned from the outbreak investigation (either at the DOH or by the IP) should be shared to all important stakeholders. Disseminating this information decreases the likelihood that such an outbreak will occur again.
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Continuing Education Presentation Evaluation Form – April 2015

Continuing Education Program Evaluation Form

Program Title: Carbapenem-resistant Enterobacteriaceae (CRE) for the Laboratory

Date Presented: April 14, 2015  Presenter: Christen Mayer
Location: St. Peter’s Health Partners Microbiology Laboratory

Response scale: 1=very poor  2=poor  3=neutral  4=good  5=very good

Please indicate your responses to the following questions:

1) How well did the presentation meet its identified objectives?

   1  2  3  4  5

2) How appropriate was the length of time used for the presentation?

   1  2  3  4  5

3) How appropriate was the difficulty of the presentation content?

   1  2  3  4  5

4) How well did the presentation hold your interest?

   1  2  3  4  5

5) How effective would the material be as a self-guided online course?

   1  2  3  4  5

6) How effective was the presentation at teaching the subject matter?

   1  2  3  4  5

7) How appropriate was the presentation in addressing a topic relevant to your position?

   1  2  3  4  5

8) How successful was the presentation at delivering information that was new to you?
9) How appropriate were the learning questions?

1 2 3 4 5

10) How appropriate were the case studies?

1 2 3 4 5

Please give any comments or suggestions on the presentation content and delivery.

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Thank you for your time and feedback!
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