

# Carbapenem-resistant Enterobacteriaceae (CRE) in North Carolina Hospitals: Results from Surveys of Hospital Infection Preventionists and Microbiology Laboratories

## Background

Carbapenem-resistant Enterobacteriaceae (CRE) are a growing public health concern. These organisms are associated with high mortality rates and have the potential to spread widely. In the United States, the most common mechanism of carbapenem resistance is the *Klebsiella pneumoniae* carbapenemase (KPC). Although KPC-producing strains of CRE have been identified in our state, the less common metallo- $\beta$ -lactamase strains (such as New Delhi metallo- $\beta$ -lactamase [NDM], Verona integrin-encoded metallo- $\beta$ -lactamase [VIM], and the imipenemase [IMP] metallo- $\beta$ -lactamase ) have not been reported.

In order to assess the scope of this problem in our state, the North Carolina Division of Public Health (NC DPH) and the North Carolina Statewide Program for Infection Control and Epidemiology (NC SPICE) requested that hospital infection preventionists (IPs) and hospital laboratories complete surveys regarding identification and reporting of CRE. These surveys were specifically developed to determine 1) the prevalence of CRE colonization and infection in NC, 2) current practices for detecting CRE and 3) current practices used to prevent transmission. These data will help public health officials and healthcare facilities determine which prevention strategies to adopt.

## Survey Methods

Surveys were sent by NC DPH and NC SPICE to IPs in all acute care hospitals in North Carolina during July, 2012. A separate survey was sent to all hospital-based microbiology laboratories in the state. Data from critical access, long-term acute care and specialty hospitals were excluded, leaving 87 hospitals eligible for analysis (Appendix A). Respondents were asked to report CRE-related information for the period of January 1, 2011–June 30, 2012. Responses were analyzed on the state and regional levels using 6 geographic regions defined by the North Carolina Hospital Association (Appendix A).

The interim CDC definition for CRE was provided to IPs and microbiology laboratories. For the purposes of this survey, CRE were defined as Enterobacteriaceae that are nonsusceptible to one of the carbapenems and resistant to all of the third-generation cephalosporins that were tested.

## Summary

Survey responses were received from IPs at 68/87 eligible hospitals and from 46 microbiology laboratories serving 57/87 eligible hospitals. CRE were identified in all regions within North Carolina during the study period. At least one patient with CRE infection or colonization was identified by 36 of 68 hospitals completing the IP survey and 37 of 46 laboratories completing the laboratory survey. CRE were identified less than once per month in most facilities. Given these findings, all regions in North Carolina can be classified as "regions with few CRE identified" using criteria established by CDC and outlined in the [2012 CRE Toolkit](#).

## I. Infection Preventionist Survey Results

### A. CRE Prevalence and Frequency of Identification

- 1. Statewide summary.** Completed surveys were received for 68 of the eligible 87 licensed, acute care hospitals in North Carolina (response rate = 78%). Thirty-six hospital infection preventionists (IPs) reported having at least one CRE -infected or -colonized patient present in their facility during January 1, 2011 through June 30, 2012. These 36 facilities represent 53% of all responding hospitals and 41% of all eligible hospitals, as described in Table 1.1.

Table 1.1 Number of hospitals reporting CRE during January 1, 2011–June 30, 2012

CRE Report Status	No. Facilities	No. Facilities Responding	CRE Status among Reporting Facilities
CRE Identified	36 (41%)	68 (78%)	36 (53%)
No CRE identified	32 (37%)		32 (47%)
No Response (CRE Unknown)	19 (22%)	19 (22%)	--
<i>Total</i>	<i>87</i>	<i>87</i>	<i>68</i>

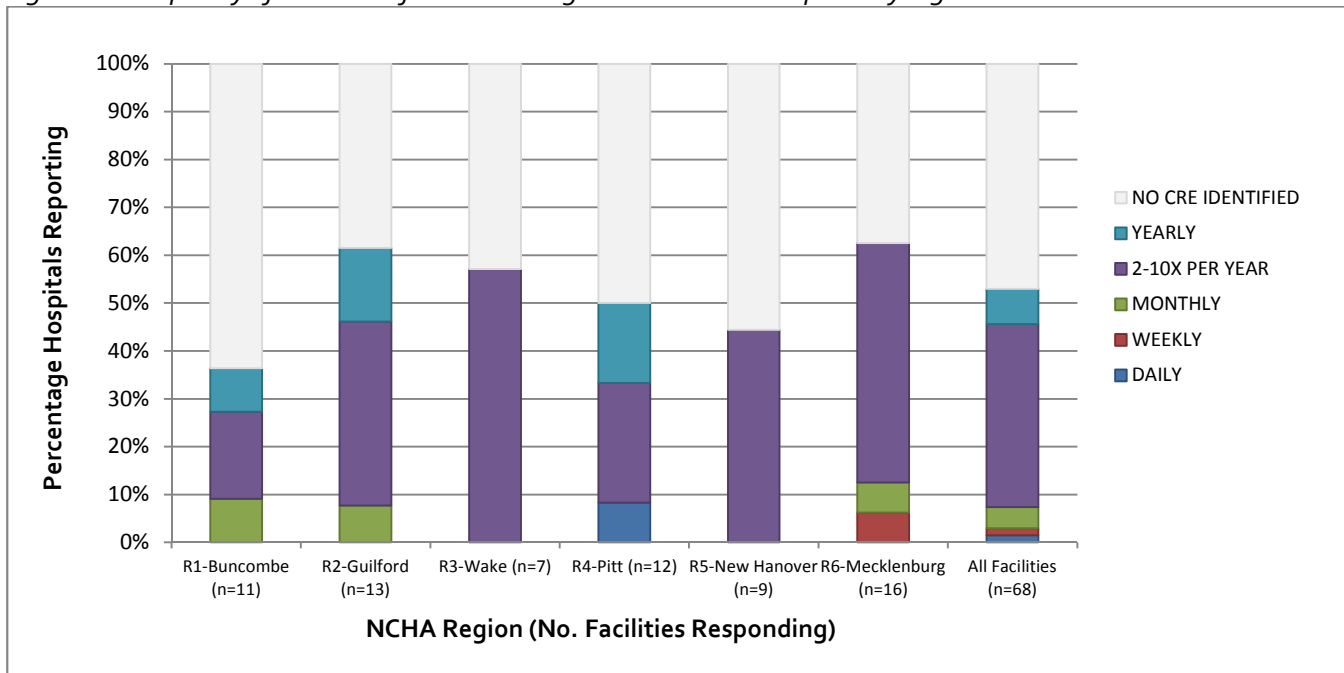
- 2. Regional summary.** CRE were reported by multiple facilities in all six regions of the state. The number of acute care hospitals and number reporting CRE are provided in Table 1.2 below.

Table 1.2 Number of hospitals reporting CRE during January 1, 2011–June 30, 2012 by region

NCHA Region	No. Facilities	No. Facilities Responding	Hospital Response (Survey Completed)	
			CRE Identified at Facility	No CRE Identified at Facility
1 (Buncombe)	14	11 (79%)	4 (36%)	7 (64%)
2 (Guilford)	15	13 (87%)	8 (62%)	5 (39%)
3 (Wake)	12	7 (58%)	4 (57%)	3 (43%)
4 (Pitt)	15	12 (80%)	6 (50%)	6 (50%)
5 (New Hanover)	13	9 (69%)	4 (44%)	5 (56%)
6 (Mecklenburg)	18	16 (89%)	10 (63%)	6 (38%)
<i>North Carolina</i>	<i>87</i>	<i>68 (78%)</i>	<i>36 (53%)</i>	<i>32 (47%)</i>

- 3. Reported frequency of CRE identification.** CRE were identified once per month or less frequently in more than 97% of responding hospitals. Regional variation in frequency of CRE identification among hospitals is illustrated in Figure 1.1 below.

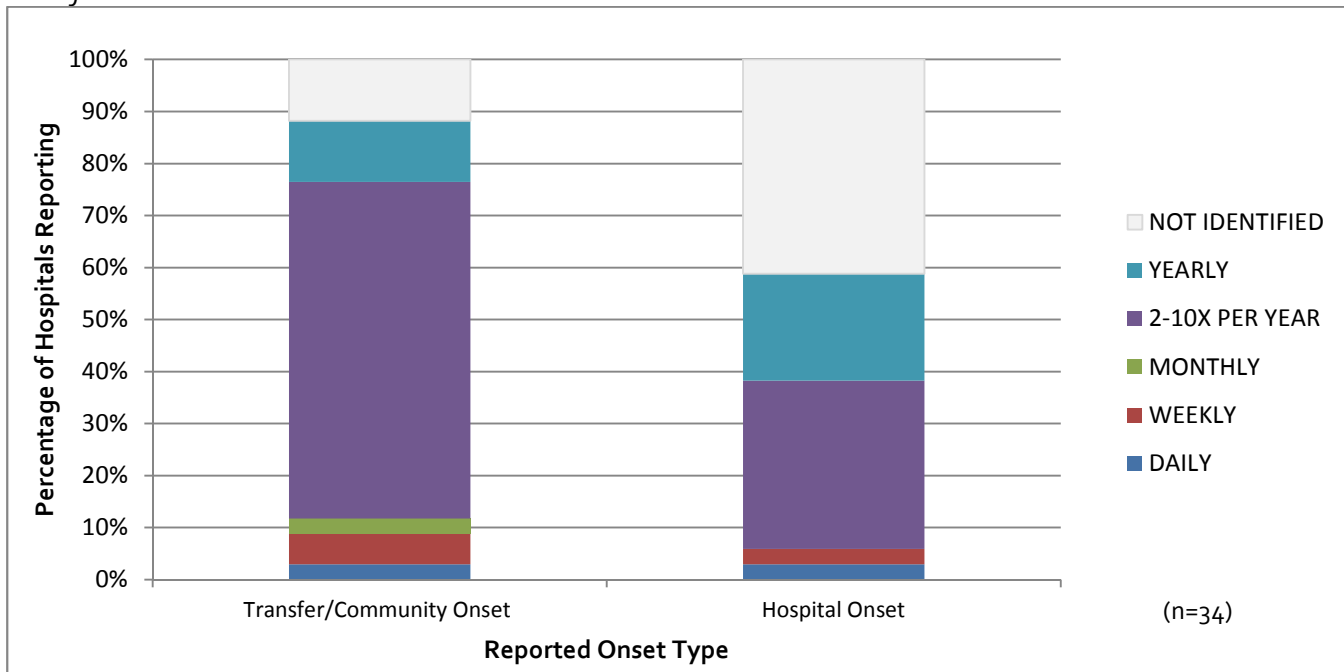
Figure 1.1 Frequency of CRE identification among North Carolina hospitals by region



**4. Hospital and transfer/community-onset CRE.** For the purposes of this survey, IPs were asked to report whether CRE infections or colonizations were hospital-onset (culture collected after 48 hours after admission) or transfer/community-onset (culture collected before or within 48 hours after admission).

Of the 34 facilities reporting CRE identification and responding to the question, 59% (n=20) identified at least one hospital-onset CRE. Of those same facilities, 88% (n=30) of hospitals reported at least one transfer/community-onset CRE identification. Statewide frequencies of hospital- and transfer/community-onset CRE are presented in Figure 1.2.

Figure 1.2 Frequency of hospital and transfer/community onset CRE among NC hospitals in which CRE were identified



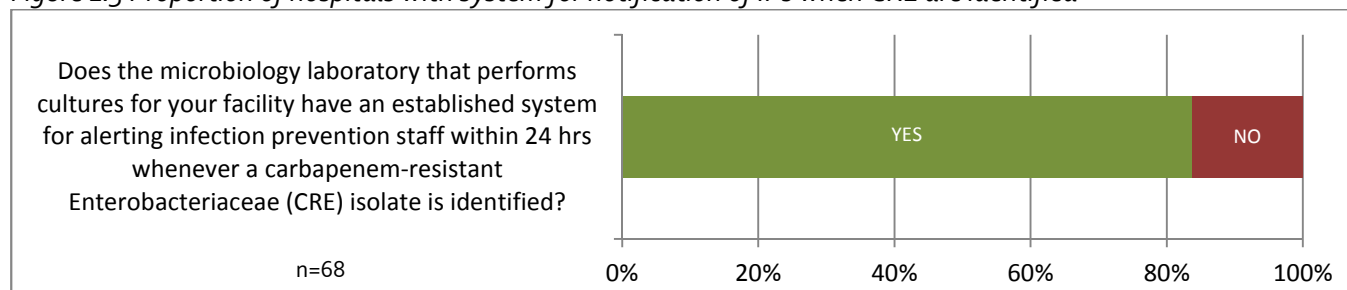
## B. Surveillance and Screening

Infection preventionists were asked to report implementation of CDC recommendations for detection of CRE-infected or -colonized patients ([2012 CRE Toolkit](#)).

- 1. Notification by laboratory staff of CRE identification.** It is recommended that laboratories develop communication protocols when CRE are identified to ensure timely implementation of control measures.

Findings: Over 80% of reporting facilities (57/68) reported that their laboratories had an established system for alerting IPs within 24 hours whenever a CRE isolate was identified.

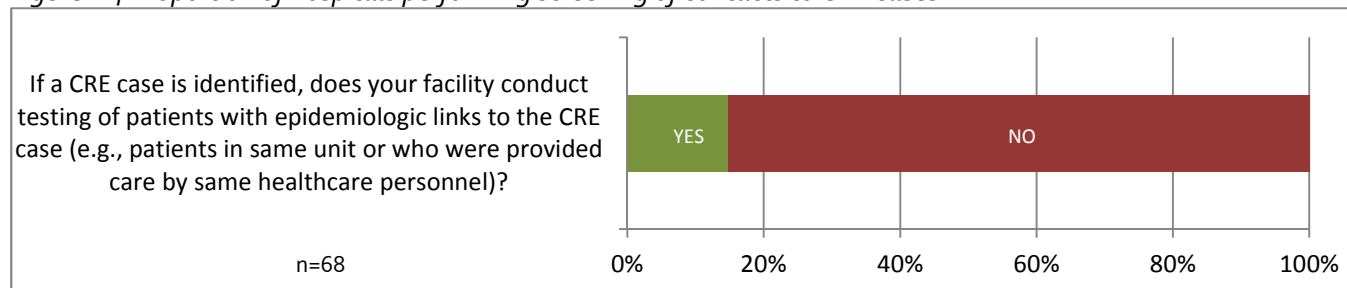
Figure 1.3 Proportion of hospitals with system for notification of IPs when CRE are identified



- 2. CRE screening of epidemiologically linked patients.** When previously unrecognized CRE carriers are identified, screening of patient contacts can be conducted to identify transmission within the facility. Screening is a primary prevention strategy in this instance.

Findings: Approximately 15% of facilities (10/68) reported that they would conduct screening of patient contacts to a CRE case.

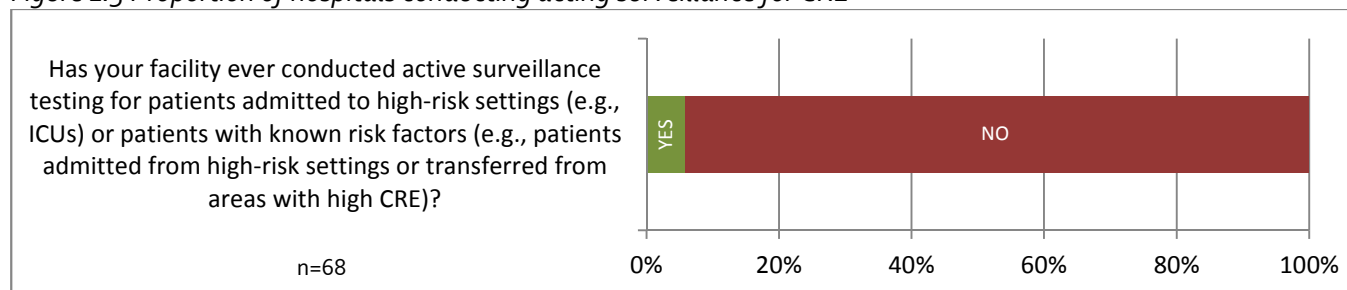
Figure 1.4 Proportion of hospitals performing screening of contacts to CRE cases



- 3. Active surveillance.** An active surveillance initiative may be considered as a supplemental measure for facilities with CRE transmission. Initiatives may include such as screening patients who meet specific criteria such as pre-specified high-risk patients or those patients admitted to high-risk settings.

Findings: Four facilities (6%) reported conducting active surveillance testing for CRE.

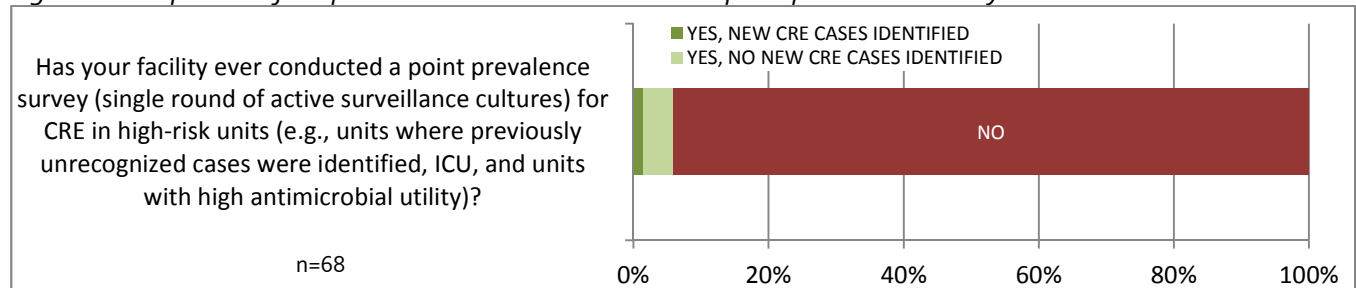
Figure 1.5 Proportion of hospitals conducting active surveillance for CRE



4. **Point prevalence survey.** Point prevalence surveys can be used to rapidly evaluate the prevalence of CRE in particular units.

Findings: Four hospitals (6%) indicated that a point prevalence survey had been conducted. Of those 4, one facility (2%) identified a previously unidentified CRE case as a result.

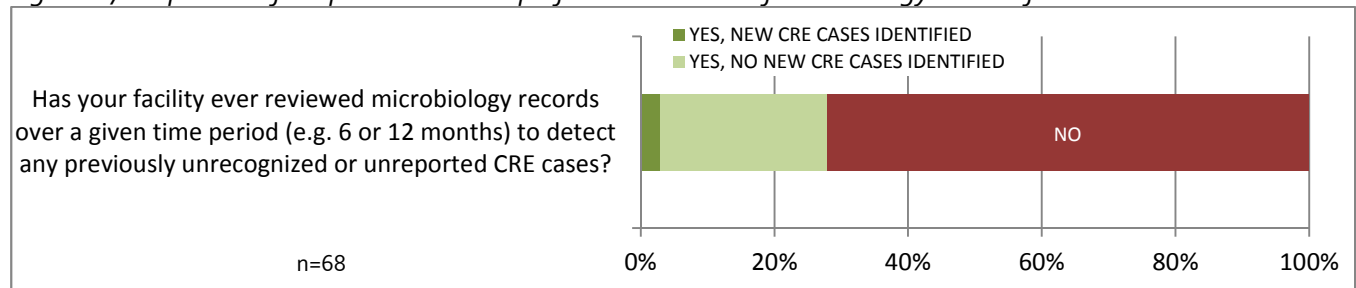
Figure 1.6 Proportion of hospitals that have ever conducted a point prevalence survey



5. **Review microbiology records.** The review of microbiology records may also be an effective method to detect previously unrecognized or unreported CRE cases.

Findings: 19 facilities (28%) reported that they had performed a review of microbiology records. Of those 19 hospitals, 2 facilities (3%) identified previously undetected cases.

Figure 1.7 Proportion of hospitals that have performed a review of microbiology records for CRE

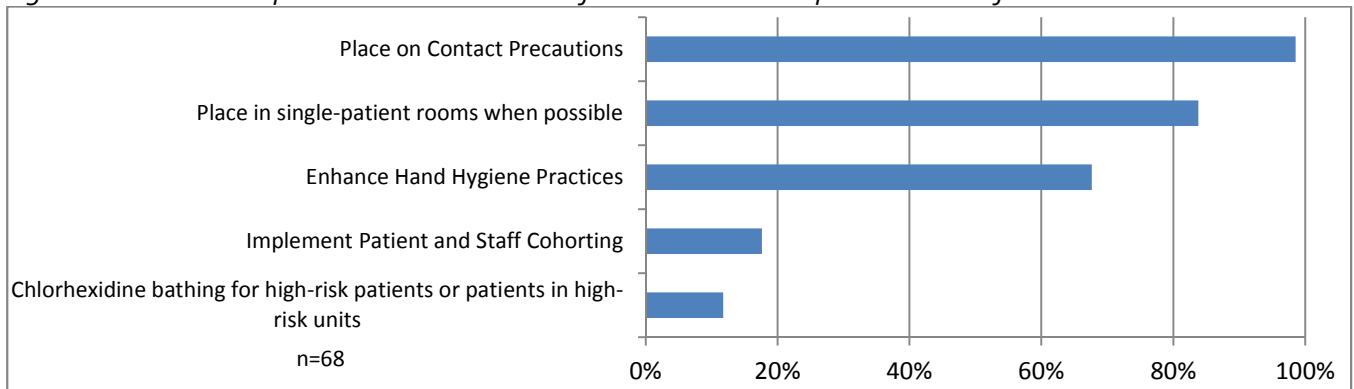


### C. Infection Control & Prevention: In-hospital

The CDC recommended approach to preventing CRE transmission in healthcare setting includes 8 core measures detailed in the [2012 CRE Toolkit](#): 1) hand hygiene, 2) contact precautions, 3) healthcare personnel education, 4) minimizing use of invasive devices, 5) patient and staff cohorting, 6) laboratory notification, 7) promoting antimicrobial stewardship and 8) CRE screening. A primary objective of the survey was to identify which of these practices were being implemented.

1. **Measures implemented.** Prevention strategies that facilities performed, or would perform, when a CRE -infected or -colonized patient is identified are shown in Figure 1.8. The most frequently reported strategies include: 1) placing the patient on contact precautions (99%), 2) placing the patient in a single-patient room when possible (84%) and 3) enhancing hand hygiene practices (68%). 87% of facilities reported implementing more than one measure.

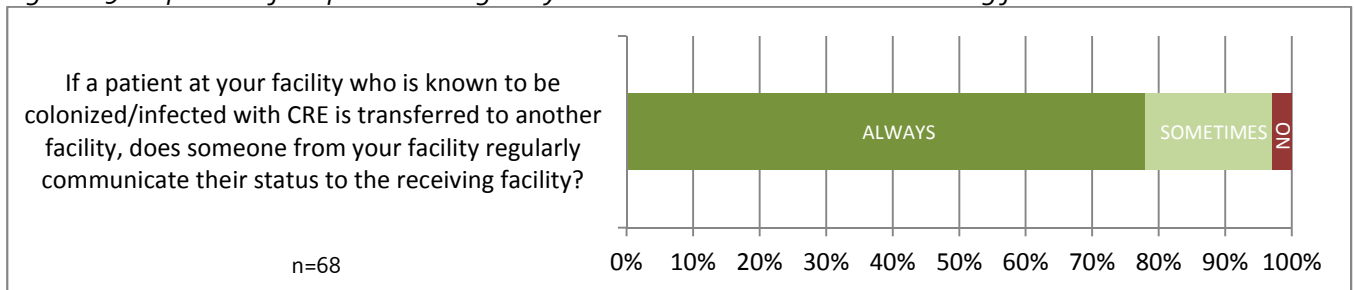
Figure 1.8 Measures implemented when a CRE- infected or -colonized patient is identified



2. **Transferring OUT of hospital.** Patients may seek medical care at more than one facility and be transferred between facilities. This inter-facility sharing of patients has the potential to facilitate transmission of CRE.

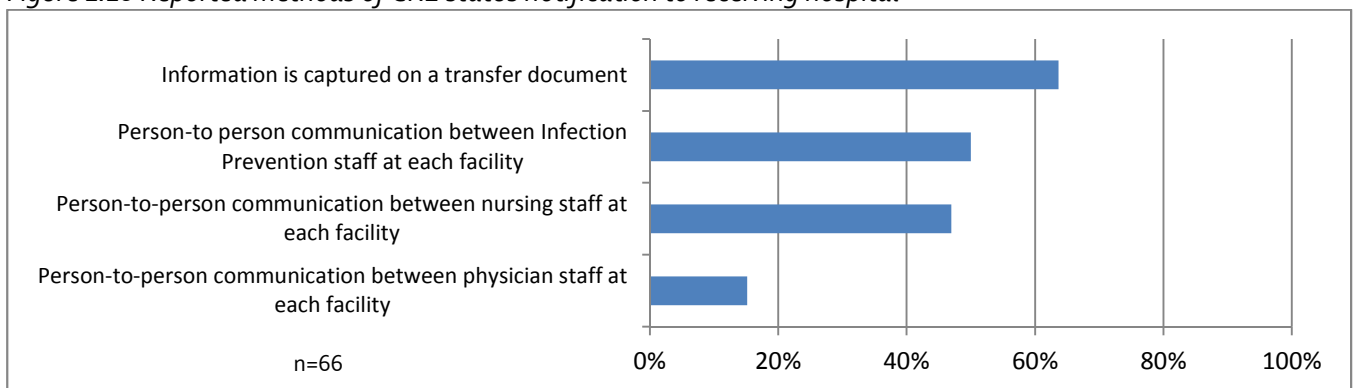
When CRE-identified patients are transferred out of the hospital, the majority of facilities (66/68) reported always or sometimes communicating the status to the receiving facility.

Figure 1.9 Proportion of hospitals that regularly communicate CRE status to receiving facilities



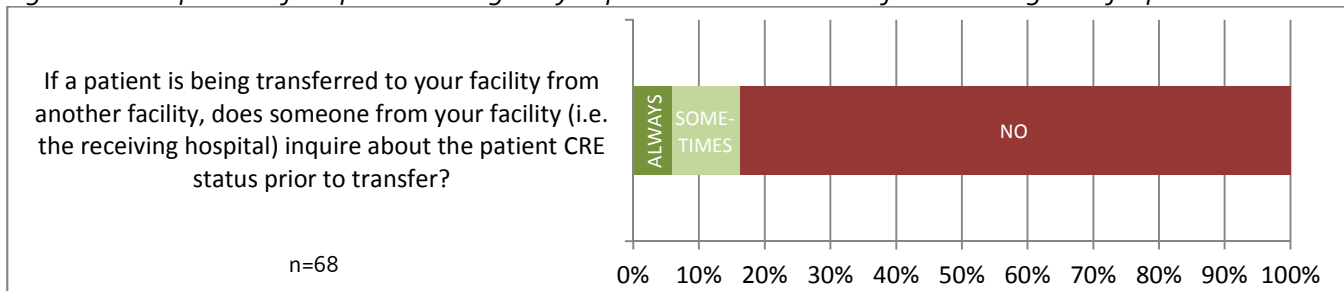
Of these 66 facilities communicating CRE status, communication generally occurs via transfer document (64%), between the infection prevention staff (50%), or the nursing staff (47%). Communication between physicians was reported by 15% of facilities; 64% of facilities reported multiple channels through which CRE status was conveyed. Other means of notification described included case managers and electronic medical records.

Figure 1.10 Reported methods of CRE status notification to receiving hospital



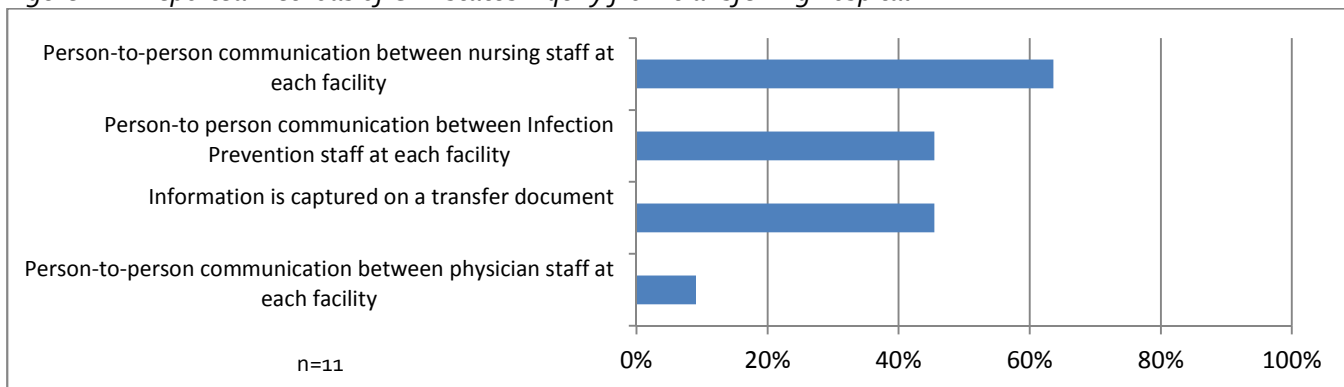
3. **Transferring INTO hospital.** Hospitals generally rely on the facility from which the CRE infected patient is being transferred from to notify the receiving facility. When CRE-identified patients are transferred into a hospital, 16% (n=11) of facilities sometimes or always inquired about the CRE status of a patient. Of those 11, 4 (6%) facilities always asked.

Figure 1.11 Proportion of hospitals that regularly inquire about CRE status of an incoming transfer patient



Of the 11 facilities that do inquire about CRE status, communication between the nursing staff is the primary means of inquiry (64%), followed by communication between infection prevention staff (45%) and capturing information on the transfer document (45%). Few facilities (9%) rely on the physician staff to obtain this information. Six facilities (55%) reported using more than one means of inquiry.

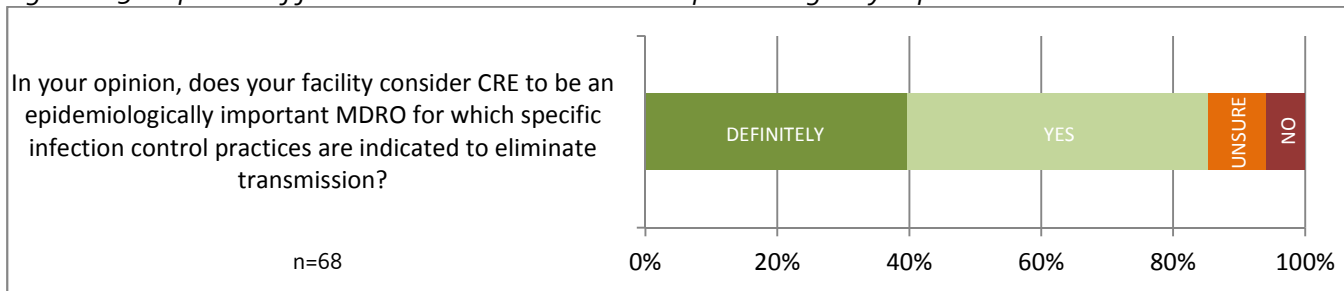
Figure 1.12 Reported methods of CRE status inquiry from transferring hospital



#### D. CRE as an Important Multi-Drug Resistant Organism (MDRO)

Controlling transmission of CRE in healthcare facilities is dependent upon healthcare facilities recognizing that these organisms are epidemiologically important. The majority of responding infection preventionists (n=58) responded that CRE were considered by their facilities to be an important multidrug resistant organism.

Figure 1.13 Proportion of facilities that consider CRE to be epidemiologically important



## II. Laboratory Survey Results

Microbiology laboratories were asked to indicate the number of patients from whom CRE was isolated during January 2011–June 2012. Laboratories were included in the analysis if they provided service to one of the 87 eligible acute care hospitals.

Forty-six eligible laboratories responded to the survey and were included in the analysis. These laboratories provided service to 57 licensed, acute care hospitals within North Carolina. These 57 facilities accounted for 66% of the 87 facilities eligible for inclusion in the survey.

**A. Statewide Survey and CRE Responses.** CRE were identified on at least one occasion in all regions of the state through the laboratory survey. Thirty-seven (80%) of the 46 reporting laboratories identified CRE during the 18-month survey period. Regional response rates and the proportion of reporting hospitals in which CRE were identified are presented in Table 2.1.

Among the 57 hospitals covered by reporting laboratories, the median number of CRE-infected or -colonized patients identified over the 18-month survey period was 3. The interquartile range was 1–7.

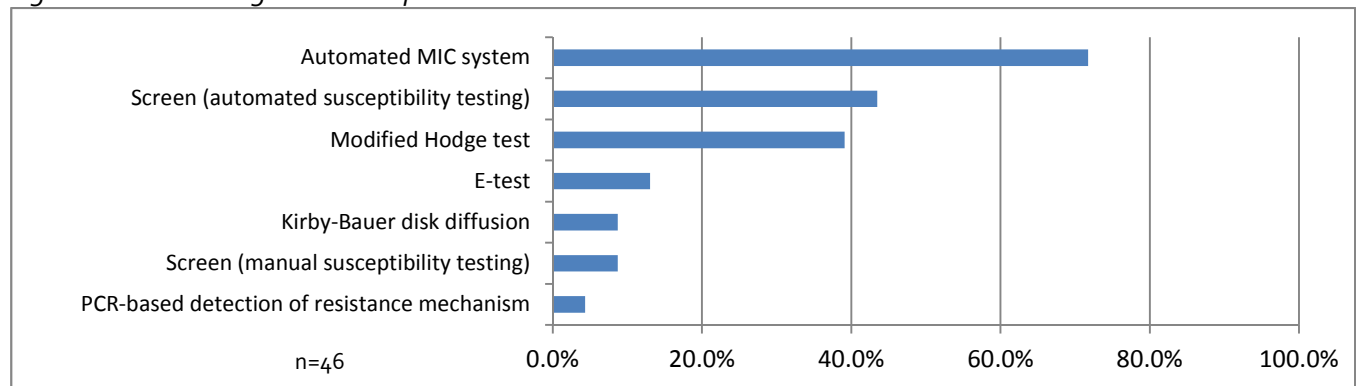
Table 2.1 Number of laboratories reporting CRE during January 1, 2011–June 30, 2012 by region

NCHA Region	No. Laboratories Completing Survey	No. Laboratories with CRE Identified	No. Hospitals Represented By Laboratories	No. Hospitals in Region	% Hospitals Covered by Laboratory Survey	No. Hospitals with CRE Identified
1 (Buncombe)	8	6 (75%)	9	14	64%	7 (78%)
2 (Guilford)	7	7 (100%)	8	15	53%	7 (88%)
3 (Wake)	9	7 (78%)	10	12	83%	8 (80%)
4 (Pitt)	10	7 (70%)	10	15	67%	7 (70%)
5 (New Hanover)	6	6 (100%)	7	13	54%	7 (100%)
6 (Mecklenburg)	6	4 (67%)	13	18	72%	11 (85%)
North Carolina	46	37 (80%)	57	87	66%	47 (83%)

## B. CRE Detection Methods

**1. Test methods.** Laboratories were asked to report all testing methods used to identify CRE in clinical specimens. The majority reported the use of automated MIC systems (72%), followed by screening (44%) and the modified Hodge test (39%). Microscan was used by 26/46 laboratories and Vitek-2 by 20/46 laboratories.

Figure 2.1 CRE testing methods reported



**2. Carbapenem and cephalosporin breakpoints.** An important challenge to developing a standardized definition of CRE is a recent (mid-2010) change in the Clinical and Laboratory Standards Institute (CLSI) interpretative criteria (breakpoints) for determining susceptibility to carbapenems among Enterobacteriaceae. These new recommendations lowered the breakpoints and removed the requirement for testing for carbapenemase (e.g., modified Hodge test) to determine susceptibility. These breakpoints were further modified in January 2012.



Laboratories were asked if these new breakpoints had been implemented and, if not, when they planned to implement them.

a. **Carbapenem breakpoints.** Ten (22%) reporting laboratories reported using the lower breakpoints.

Figure 2.2 Proportion of laboratories using lower carbapenem breakpoints

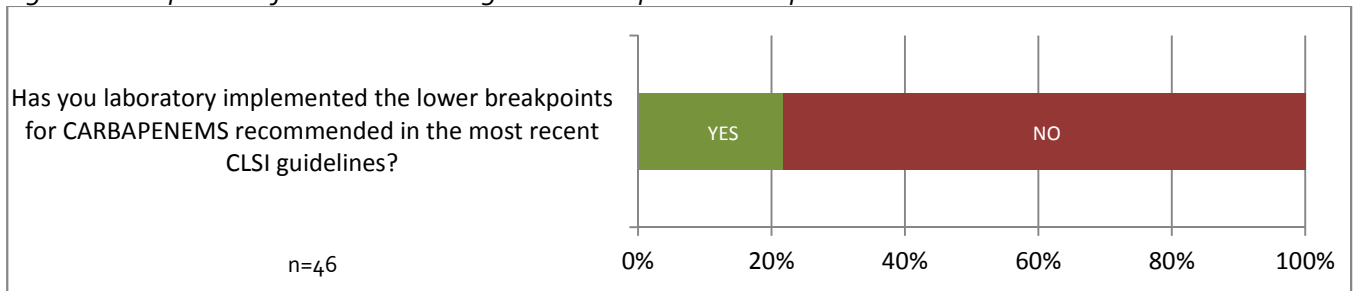
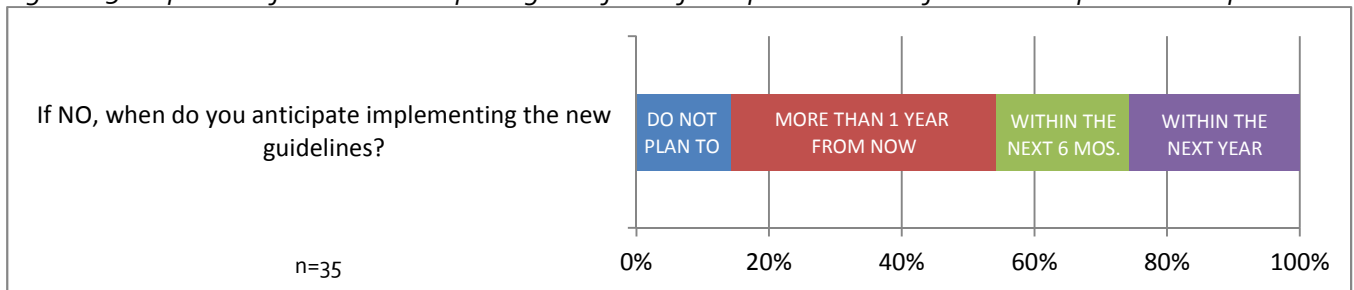


Figure 2.3 Proportion of laboratories reporting time frame for implementation of lower carbapenem breakpoints



b. **Cephalosporin breakpoints.** 16% (n=7) of the 45 laboratories reported using lower breakpoints for cephalosporins.

Figure 2.4 Proportion of laboratories using lower cephalosporin breakpoints

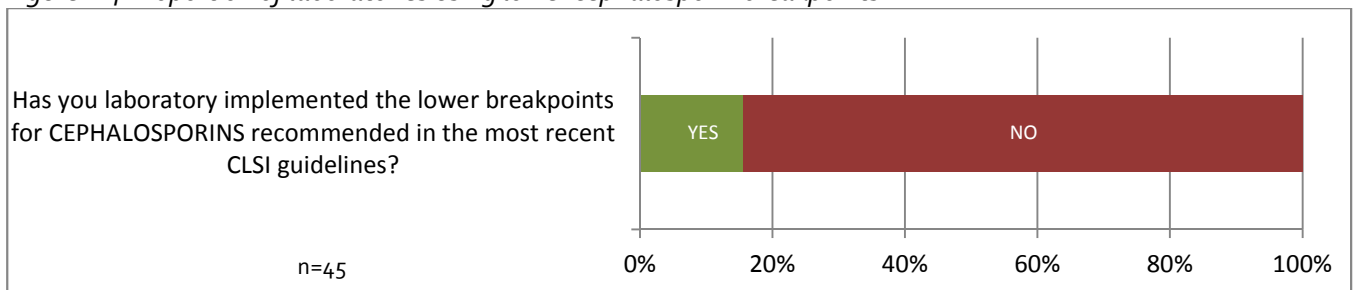
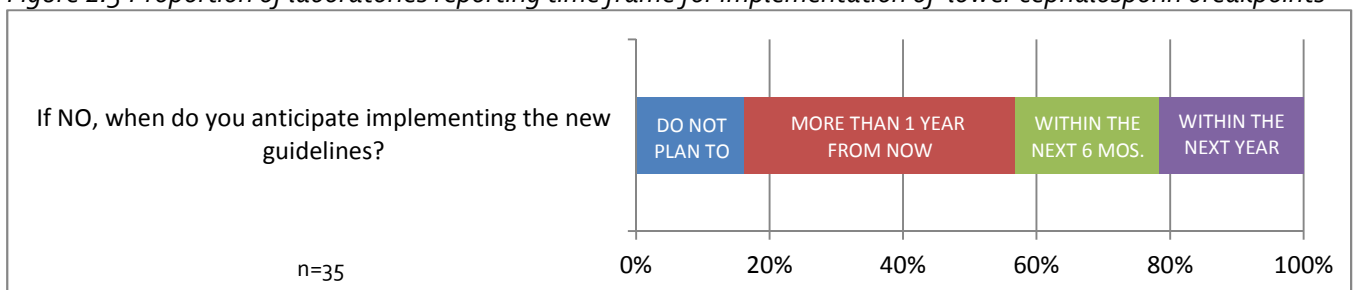


Figure 2.5 Proportion of laboratories reporting time frame for implementation of lower cephalosporin breakpoints



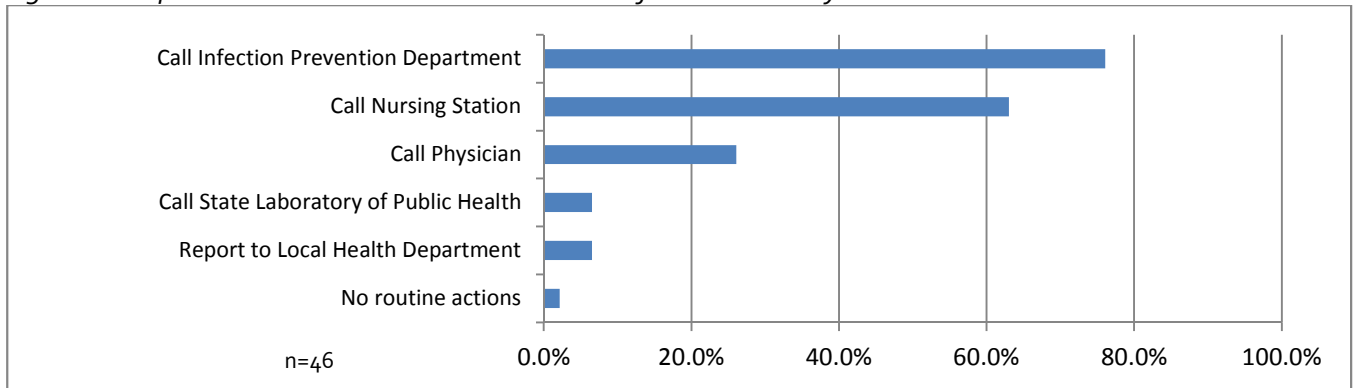
### C. Other Laboratory Results

1. **Actions.** Laboratories were asked to report what actions were taken when CRE were identified.

Most laboratories indicated that they called the infection prevention department (76%) or called the nursing station (63%). Fewer reported calls to the physician (26%), reporting to the local health department (7%) or

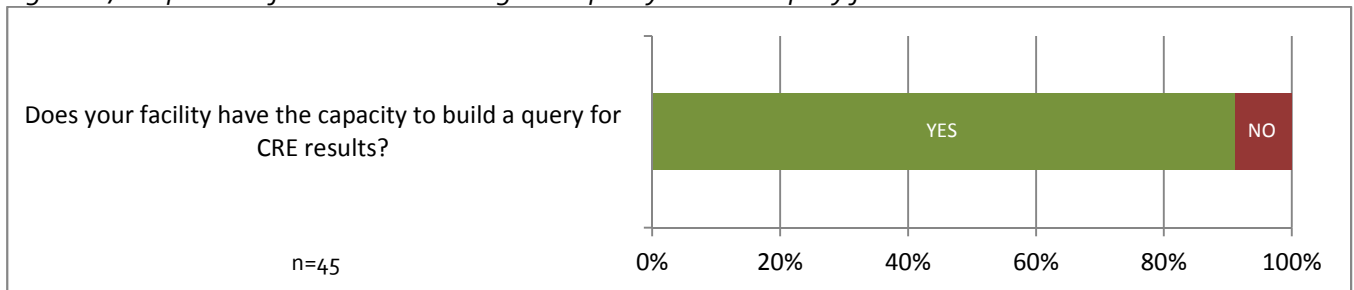
calling the State Laboratory of public health (7%). Thirty-one (67%) laboratories reported doing more than one action.

Figure 2.6 Reported actions taken when CRE are identified in laboratory



2. **CRE query capacity.** Laboratories were asked if they had the capacity to build a query for CRE results. Over 90% (n=41) of laboratories reported that they had the capacity.

Figure 2.7 Proportion of laboratories having the capacity to build a query for CRE



Appendix A. Eligible Acute Care Hospitals by NCHA Region

FACILITY	COUNTY
REGION 1	
BLUE RIDGE REGIONAL HOSPITAL, INC	MITCHELL
CALDWELL MEMORIAL HOSPITAL, INC.	CALDWELL
CATAWBA VALLEY MEDICAL CENTER	CATAWBA
FRYE REGIONAL MEDICAL CENTER	CATAWBA
GRACE HOSPITAL, INC.	BURKE
MARGARET R. PARDEE MEMORIAL HOSPITAL	HENDERSON
MEDWEST HARRIS	JACKSON
MEDWEST HAYWOOD	HAYWOOD
MISSION HOSPITAL	BUNCOMBE
MURPHY MEDICAL CENTER, INC.	CHEROKEE
PARK RIDGE HEALTH	HENDERSON
RUTHERFORD REGIONAL MEDICAL CENTER	RUTHERFORD
THE MCDOWELL HOSPITAL	MCDOWELL
VALDESE GENERAL HOSPITAL, INC.	BURKE
REGION 2	
ALAMANCE REGIONAL MEDICAL CENTER	ALAMANCE
ANNIE PENN HOSPITAL	ROCKINGHAM
CONE HEALTH	GUILFORD
FORSYTH MEMORIAL HOSPITAL	FORSYTH
HIGH POINT REGIONAL HEALTH SYSTEM	GUILFORD
HUGH CHATHAM MEMORIAL HOSPITAL, INC.	SURRY
LEXINGTON MEDICAL CENTER	DAVIDSON
MEDICAL PARK HOSPITAL, INC.	FORSYTH
MOREHEAD MEMORIAL HOSPITAL	ROCKINGHAM
NORTH CAROLINA BAPTIST HOSPITAL	FORSYTH
NORTHERN HOSPITAL OF SURRY COUNTY	SURRY
RANDOLPH HOSPITAL, INC.	RANDOLPH
THOMASVILLE MEDICAL CENTER	DAVIDSON
WATAUGA MEDICAL CENTER, INC.	WATAUGA
WILKES REGIONAL MEDICAL CENTER	WILKES
REGION 3	
DUKE RALEIGH HOSPITAL	WAKE
DUKE UNIVERSITY HOSPITAL	DURHAM
DURHAM REGIONAL HOSPITAL	DURHAM
FRANKLIN REGIONAL MEDICAL CENTER	FRANKLIN
GRANVILLE HEALTH SYSTEM	GRANVILLE
JOHNSTON MEMORIAL HOSPITAL	JOHNSTON
MARIA PARHAM MEDICAL CENTER	VANCE
PERSON MEMORIAL HOSPITAL	PERSON
REX HOSPITAL	WAKE
UNIVERSITY OF NORTH CAROLINA HOSPITALS	ORANGE
WAKEMED	WAKE
WAKEMED CARY HOSPITAL	WAKE
REGION 4	
ALBEMARLE HOSPITAL	PASQUOTANK
CAROLINAEAST MEDICAL CENTER	CRAVEN

CARTERET GENERAL HOSPITAL	CARTERET
HALIFAX REGIONAL MEDICAL CENTER, INC.	HALIFAX
LENOIR MEMORIAL HOSPITAL, INC.	LENOIR
MARTIN GENERAL HOSPITAL	MARTIN
NASH GENERAL HOSPITAL	NASH
ONSLow MEMORIAL HOSPITAL, INC.	ONSLow
VIDANT EDGEcombe HOSPITAL	EDGEcombe
VIDANT BEAUFORT HOSPITAL	BEAUFORT
VIDANT DUPLIN HOSPITAL	DUPLIN
VIDANT MEDICAL CENTER	PITT
VIDANT ROANOKE-CHOWAN HOSPITAL	HERTFORD
WAYNE MEMORIAL HOSPITAL, INC.	WAYNE
WILSON MEDICAL CENTER	WILSON
REGION 5	
ANSON COMMUNITY HOSPITAL	ANSON
BETSY JOHNSON HOSPITAL	HARNETT
BRUNSWICK NOVANT MEDICAL CENTER	BRUNSWICK
CAPE FEAR VALLEY MEDICAL CENTER	CUMBERLAND
CENTRAL CAROLINA HOSPITAL	LEE
COLUMBUS REGIONAL HEALTHCARE SYSTEM	COLUMBUS
FIRSTHEALTH MOORE REG. HOSPITAL	MOORE
FIRSTHEALTH RICHMOND MEMORIAL HOSPITAL	RICHMOND
NEW HANOVER REGIONAL MEDICAL CENTER	NEW HANOVER
SAMPSON REGIONAL MEDICAL CENTER	SAMPSON
SANDHILLS REGIONAL MEDICAL CENTER	RICHMOND
SCOTLAND MEMORIAL HOSPITAL AND EDWIN MORGAN CENTER	SCOTLAND
SOUTHEASTERN REGIONAL MEDICAL CENTER	ROBESON
REGION 6	
CAROLINAS MEDICAL CENTER- LINCOLN	LINCOLN
CAROLINAS MEDICAL CENTER MERCY	MECKLENBURG
CAROLINAS MEDICAL CENTER PINEVILLE	MECKLENBURG
CAROLINAS MEDICAL CENTER	MECKLENBURG
CAROLINAS MEDICAL CENTER-NORTHEAST	CABARRUS
CAROLINAS MEDICAL CENTER-UNION	UNION
CAROLINAS MEDICAL CENTER-UNIVERSITY	MECKLENBURG
CLEVELAND REGIONAL MEDICAL CENTER	CLEVELAND
DAVIS REGIONAL MEDICAL CENTER	IREDELL
GASTON MEMORIAL HOSPITAL	GASTON
IREDELL MEMORIAL HOSPITAL, INC.	IREDELL
KINGS MOUNTAIN HOSPITAL	CLEVELAND
LAKE NORMAN REGIONAL MEDICAL CENTER	IREDELL
PRESBYTERIAN HOSPITAL	MECKLENBURG
PRESBYTERIAN HOSPITAL HUNTERSVILLE	MECKLENBURG
PRESBYTERIAN HOSPITAL MATTHEWS	MECKLENBURG
ROWAN REGIONAL MEDICAL CENTER	ROWAN
STANLY REGIONAL MEDICAL CENTER	STANLY