Methicillin-Resistant *Staphylococcus aureus* (MRSA) Surveillance Report 2011

Oregon Active Bacterial Core Surveillance (ABCs)

Center for Public Health Practice

Updated: October 2012

Background

The Active Bacterial Core surveillance (ABCs) program is a core component of the Emerging Infections Program (EIP) Network sponsored by the Centers for Disease Control and Prevention (CDC). The purpose of the ABCs program is to determine the incidence and epidemiologic characteristics of invasive disease due to *Haemophilus influenzae*, *Neisseria meningitidis*, group A streptococcus (GAS), group B streptococcus (GBS), *Streptococcus pneumoniae*, and methicillin-resistant *Staphylococcus aureus* (MRSA). The entire EIP Network for invasive MRSA represents over 19 million persons in 10 surveillance areas around the United States. More information on the EIP/ABCs Network is found at: http://www.cdc.gov/abcs/index.html.

In Oregon, the surveillance area for invasive MRSA comprises the tri-county (Clackamas, Multnomah, and Washington) Portland metropolitan area, with a 2011 estimated population of 1,656,775.[*] More information on the Oregon ABCs program is found at: http://public.health.oregon.gov/DiseasesConditions/CommunicableDisease/EmergingInfections/Pages/ActiveBacterialCoreSurveillance.aspx.

Methods

An invasive MRSA infection[†] is defined as the isolation of MRSA from a normally sterile body site in a tri-county resident. Tri-county hospital laboratories voluntarily submit all sterile-site MRSA isolates to the Oregon State Public Health Laboratory (OSPHL). A subset is sent to CDC for further characterization and antimicrobial susceptibility testing. Additional cases are identified through regular laboratory record reviews. Health record reviews of each case allow standardized reports of demographic characteristics, clinical syndrome, underlying illnesses or conditions, healthcare-associated risk factors, and illness outcome.

Cases of invasive disease are classified into one of three epidemiologic classifications based on the presence or absence of established healthcare risk factors and time of culture collection in relation to hospital admission, as indicated in the medical record.

- Healthcare-onset (HO-) MRSA infections are those in which the initial culture was collected >2 days after hospital admission.

[*] Source: Portland State University Population Research Center (http://www.pdx.edu/prc/)

[†] MRSA *infection* is the invasion of bacteria in the tissues of the host leading to clinical signs and symptoms of illness or infection whereas *colonization* refers to the presence of bacteria but without tissue damage and signs of illness or infection. Colonized patients are also known as asymptomatic carriers.

- Healthcare-associated, community-onset (HACO-) MRSA infections are those in which the initial culture was collected ≤2 days after hospital admission or evaluation, and the medical chart indicates one or more of the following risk factors:
    - A history of hospitalization, surgery, dialysis, or residence in a long term care facility in the previous year, or
    - Presence of a central vascular catheter ≤2 calendar days prior to collection of initial culture.
- Community-associated (CA-) MRSA infections are those in which none of the previously mentioned criteria are met.

Additional technical information on surveillance methodology, including data elements collected, healthcare risk factors, clinical manifestations, and underlying diseases and conditions can be found at the CDC EIP/ABCs Network website listed above.

Surveillance Results

Descriptive Epidemiology

In 2011, the cumulative incidence of invasive MRSA disease was 14.7/100,000 persons. Since the beginning of surveillance in 2004, when 405 cases were reported (26.6/100,000), the incidence of invasive MRSA disease has decreased 45 percent but incidence has not substantially changed in the past two years (Figure 1). Among the total of 243 cases that were identified in 2011, 34 (14%) were recurrent cases (sterile site isolate collected 30 or more days after any previous sterile site MRSA isolate).

The mean and median ages of all cases reported in 2011 were 59 and 60 years, respectively (range: 0–92 years). Fifty-seven percent of all reported cases were male. Race was reported for 192 cases; of these, 87% were white, 7% were black, and 6% were of another race. The highest incidence of invasive MRSA disease occurred among residents of Multnomah county (20.1/100,000); followed by residents in Clackamas (12.9/100,000) and Washington (8.4/100,000) counties.

Thirty-nine cases were fatal, for mortality and case fatality rates of 2.4/100,000 and 16 percent, respectively. Among recurrent cases only, the case fatality rate was 9 percent. The mortality rate is 41 percent lower than the rate in 2004, while the case fatality rate is 5 percent higher. The mean and median ages of death due to invasive MRSA infection were 62 and 63 years, respectively, with a range of 0 to 91 years. Risk of death was not associated with increasing age. Among those who died, 49% were 65 and older, and 79 percent were 50 and older. There were three deaths among those younger than 35 years of age. Two of these deaths occurred among injection drug users aged 18 and 31 years. The other death was in an infant born prematurely.

Epidemiologic Classifications

Of the 243 total cases reported, 25 (10%) were HO (1.5/100,000); 132 (54%) were HACO (8.0/100,000); and 86 (35%) were CA (5.2/100,000). Since 2004, the incidence of HO has decreased 76 percent, that of HACO has decreased 45 percent and that of CA has decreased 8 percent (Figure 1).

HO cases have comprised a *decreasing* proportion of all MRSA cases, from 24 percent in 2004 to 10 percent in 2011 (test for trend, $p<0.0001$), while CA cases have comprised an *increasing* proportion of all MRSA cases, from 21 percent in 2004 to 35 percent in 2011 ($p<0.0001$). The proportion of HACO cases has not changed significantly over time.

Epidemiologic classification of cases as HO, HACO, or CA-MRSA was associated with age (Figure 2). The mean and median ages for HACO infections (64 and 65, respectively) were significantly higher than those seen for CA (53 and 57, respectively) and HO infections (53 and 56, respectively). Classification was not associated with sex or race.

Figure 1: Incidence of Invasive MRSA Cases in Tri-county Area

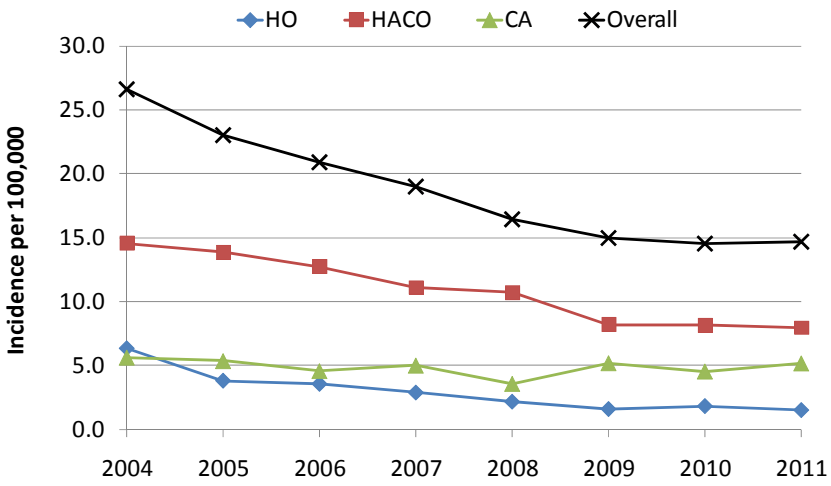
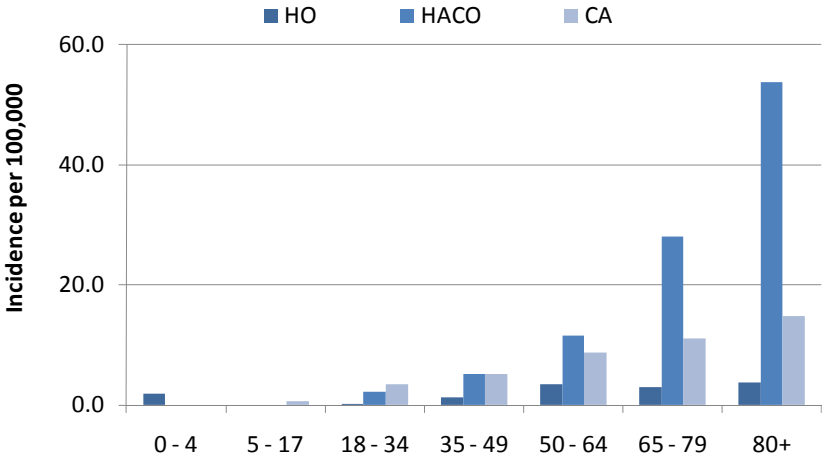


Figure 2: Incidence of Invasive MRSA by Infection Type and Age 2011



Mortality was highest among HACO cases (1.21/100,000), followed by CA (0.91/100,000) and HO (0.24/100,000). There was no significant difference in case fatality by epidemiologic category.

Clinical Syndromes

The most common (reported in at least 10% of 2011 cases) clinical manifestations of invasive MRSA infections are displayed in Table 1. CA cases were more likely to manifest as osteomyelitis (OR 2.3; CI 1.1, 5.1) than cases with healthcare associated risk factors (HO and HACO cases). Other syndromes were reported similarly across infection types.

Table 1: Common Clinical Manifestations of Invasive MRSA Cases† by Epidemiologic Classification, 2011

Clinical Manifestations	HO n=25 n (%)	HACO n=132 n (%)	CA n=86 n (%)	Total n=243 n (%)
Bacteremia	17 (68)	121 (92)	67 (78)	205 (84)
Pneumonia*	3 (12)	27 (20)	19 (22)	49 (20)
Endocarditis	4 (16)	14 (11)	14 (16)	32 (13)
Septic shock	1 (4)	16 (12)	14 (16)	31 (13)
Osteomyelitis	2 (8)	12 (9)	16 (19)	30 (12)
None	4 (16)	4 (3)	3 (3)	11 (5)

† Some cases report more than 1 syndrome.

* Only those cases of pneumonia with a sterile site isolate are included. Sputum or endotracheal aspirates are not considered sterile sites.

Underlying Conditions

Almost all (95%) invasive MRSA cases were in individuals reporting one or more underlying diseases or conditions (Table 2). More than one third of cases reported diabetes or smoking. Based on univariate analyses, cases with healthcare-associated risk factors (including HO and HACO) were *more* likely to report renal insufficiency (OR 5.3; CI 2.5, 11.3), and *less* likely to report abscess/boils (OR 0.2; CI 0.1, 0.6), intravenous drug use (IVDU) (OR 0.2; CI 0.1, 0.5), and smoking (OR 0.4; CI 0.2, 0.6) than CA cases. After controlling for age, none of the underlying conditions were individually associated with fatal outcome.

Table 2: Common Underlying Conditions Reported Among Invasive MRSA Cases† by Epidemiologic Classification, 2011

Underlying Conditions	HO n=25 n (%)	HACO n=132 n (%)	CA n=86 n (%)	Total n=243 n (%)
Diabetes	3 (12)	61 (46)	26 (30)	90 (37)
Smoking	9 (36)	29 (22)	41 (48)	79 (33)
Chronic renal insufficiency	5 (20)	55 (42)	9 (10)	69 (28)
Chronic skin breakdown	2 (8)	36 (27)	16 (19)	54 (22)
Cardiovascular disease	4 (16)	36 (27)	10 (12)	50 (21)
Intravenous drug use	1 (4)	11 (8)	22 (26)	34 (14)
Decubitus/pressure ulcer	0 (0)	18 (14)	10 (12)	28 (12)
Solid organ malignancy	4 (16)	19 (14)	3 (3)	26 (11)

Underlying Conditions	HO n=25 n (%)	HACO n=132 n (%)	CA n=86 n (%)	Total n=243 n (%)
Stroke/CVA	2 (8)	15 (11)	7 (8)	24 (10)
Abscess/boil	1 (4)	6 (5)	15 (17)	22 (9)
Obesity	2 (8)	15 (11)	5 (6)	22 (9)
Peripheral vascular disease	2 (8)	15 (11)	4 (5)	21 (9)
Dementia	1 (4)	11 (8)	5 (6)	17 (7)
Cirrhosis	2 (8)	9 (7)	1 (1)	12 (5)
None	4 (16)	2 (2)	7 (8)	13 (5)

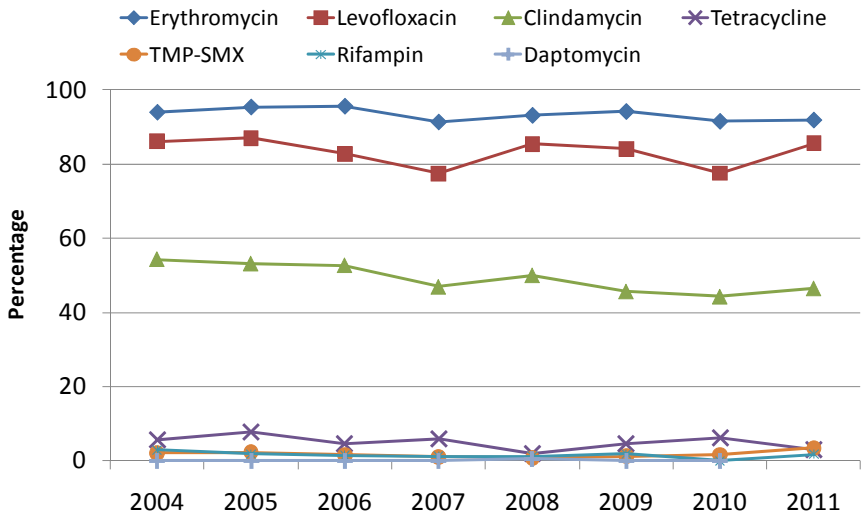
† Some cases report more than 1 syndrome.

Antibiotic Susceptibilities

By definition, all MRSA isolates are resistant to β-lactam antibiotics, including penicillin and methicillin. Additionally, among isolates tested, a proportion displayed intermediate/full resistance or decreased susceptibility to several commonly assayed antibiotics in 2011, including: erythromycin (92%, n=174), levofloxacin (86%, n=174), clindamycin (47%, n=172), trimethoprim-sulfa (4%, n=174), tetracycline (3%, n=174), and rifampin (2%, n=174). None of the tested isolates in 2011 were resistant to daptomycin, linezolid, or vancomycin.

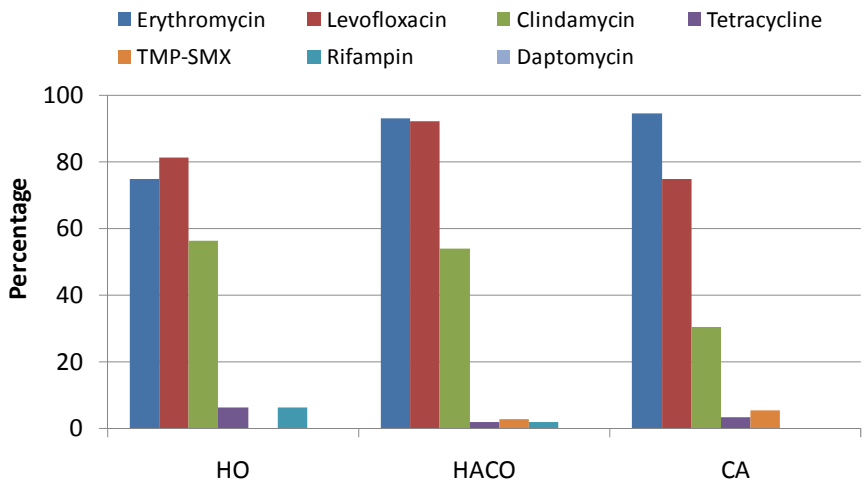
Since 2004, the percentages of invasive MRSA isolates with decreased susceptibility to these select antibiotics have remained relatively stable (Figure 3). No isolates of vancomycin intermediate *S. aureus* were identified.

Figure 3: Percentage of Invasive MRSA Isolates with Decreased Susceptibility (Intermediate or Full Resistance) to Select Antibiotics



In 2011, HO and HACO cases, combined, were three times more likely to display decreased susceptibility to clindamycin (95% CI 1.4, 5.4) and levofloxacin (95% CI 1.4, 7.7) than community-associated cases (Figure 4). Other differences were not statistically significant or were unable to be tested due to insufficient sample size.

Figure 4: Percentage of Invasive MRSA Isolates with Decreased Susceptibility (Intermediate or Full Resistance) to Select Antibiotics by Infection Type, 2011



Strain Typing

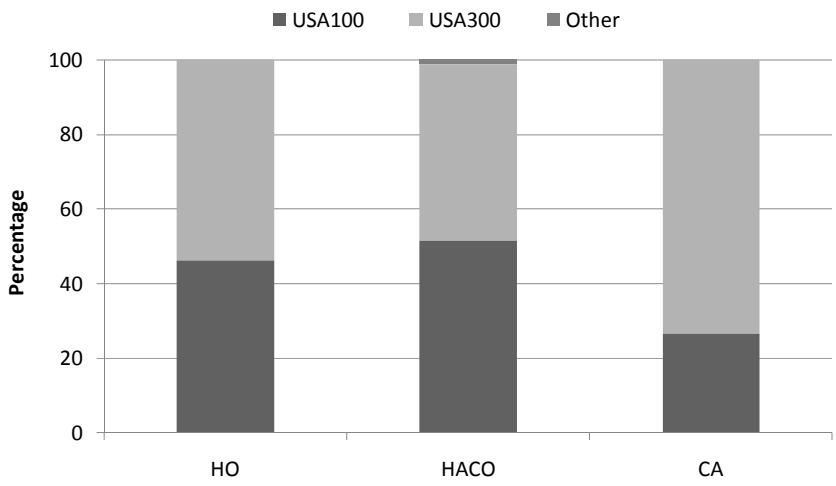
In 2011, strain typing results by pulsed-field gel electrophoresis (PFGE) were available for a subset of invasive MRSA cases (153/243 (63%)). Of the 153 isolates, 66 (43%) were USA100, 86 (56%) were USA300, and 1 (<1%) were other types (i.e. USA500). (Historically, USA100, USA200, and USA500 were predominantly from healthcare-associated infections and were considered to be of healthcare origin, while USA300, USA400, USA1000, and USA1100 were obtained primarily from community infections and were considered to be of community origin.[1])

Figure 5 displays the percentage of cases of isolates determined to be USA100, USA300, and other strain type, by epidemiologically classified infection type.

Figure 6 displays the percentage of HO and CA cases by year and strain type.

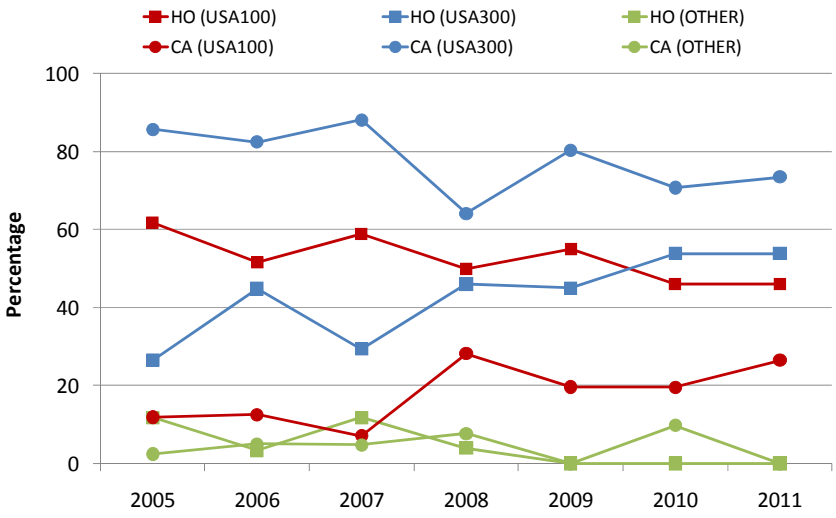
Among cases for which PFGE results were available, bacteremia was by far the most common clinical

Figure 5: Percentage of Isolates Typed as USA100, USA300, and Other by Infection Type, 2011



manifestation among those with USA100 (91%) and USA300 (90%). All other clinical syndromes were present in fewer than 15 percent of the USA100 cases and fewer than 25 percent of the USA300 cases. The most common underlying conditions among cases with USA100 were diabetes (41%), renal failure (39%), and cardiovascular disease (26%), while the most common underlying conditions were smoking (38%), diabetes (26%), intravenous drug use (22%), and renal failure (22%) among cases with USA300.

Figure 6: Strain Type by Epidemiologic Classification and Year



Analysis of Risk Factors Among HACO Cases

The distribution of healthcare risk factors among HACO cases is shown in Table 3. HACO infections are those in which the initial MRSA culture was collected ≤2 days after hospital admission or evaluation, and the medical chart indicates a history of hospitalization, surgery*, residence in a long term care facility, dialysis in the previous year, or the presence of a central vascular catheter† ≤2 calendar days prior to collection of initial culture. Among HACO cases in 2011, 40 (30%) had one healthcare risk factor; 52 (39%) had two; 26 (20%) had three; 13 (10%) had four; 1 (1%) had five.

Table 3: Distribution of Healthcare Risk Factors Among HACO

Risk Factors	2011 n=132 n (%)	2010 n=134 n (%)
Hospitalization[2]	125 (95)	125 (93)
Surgery[2]	67 (51)	86 (64)
LTCF Residence[2]	37 (28)	41 (31)
Dialysis[2]	24 (18)	25 (19)
Central Venous Catheter[1]	26 (20)	19 (14)

[1] In place ≤2 calendar days prior to initial culture
[2] Within year before date of initial culture

Since 2004, we have identified 327 (14%) patients with invasive MRSA who underwent dialysis within the year before their initial culture date. Of these individuals, 63 percent were male, 86 percent were hospitalized, 13 percent had a fatal outcome, and 60 percent of 150 cases with

* The definition of this variable changed in 2009. *Old definition*: Surgery within year before index culture date. *New definition*: Surgery within year before initial culture date.
† The definition of this variable changed in 2009. *Old definition*: Central vascular catheter in place at time of admission/evaluation. *New definition*: Central vascular catheter in place at any time in the 2 calendar days prior to initial culture.

known PFGE pattern were considered to be of healthcare origin (i.e. USA100, USA200, USA500). The mean and median ages were both 61 years, respectively (range: 14-90 years).

Beginning in 2009, our surveillance program began collecting information on whether or not patients were receiving chronic dialysis at the time of their MRSA infection. Of the 65 (9%) patients who underwent chronic dialysis, all had hemodialysis treatment, with the exception of one patient who underwent peritoneal dialysis. Of the 64 hemodialysis patients with MRSA, 54 percent had an AV fistula, 38 percent had a central vascular catheter, and the remaining had unknown access type. The U.S. Department of Health and Human Services' National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) reports that an estimated 55 percent of dialysis patients in the United States have an AV fistula and almost 20 percent have a central vascular catheter.[2]

Discussion

Since the beginning of MRSA surveillance in Oregon in 2004, the incidence of invasive disease has decreased substantially, with the greatest decrease seen among HO cases.

Results from 2011 are consistent with previous years, in that invasive MRSA disease—including community associated cases—manifests largely in those with an underlying condition or behavior that is related to their infection. Almost all cases in those with healthcare-defining risk factors were in those with underlying chronic diseases, such as diabetes, cardiovascular disease, renal failure, etc., that require frequent encounters with the healthcare system or invasive medical procedures. Tobacco cessation and proper management or prevention of diabetes may help prevent MRSA infection since over one third of cases reported one of these two risk factors. Over one quarter of community associated cases occurred among persons with a documented history of injection drug use. Invasive MRSA cases generally increase with age and occur primarily among those 50 and older.

The use of molecular strain type information has demonstrated an increase in the traditional community-associated USA300 strain among cases classified epidemiologically as healthcare-associated. This finding raises two possibilities: The frequency of transmission of USA300 strains within the healthcare setting could be increasing (an observation supported in recently-published literature); or cases may be misclassified as healthcare-associated, due to the presence of the established "risk factors", when colonization or infection was actually acquired in the community.[3,4] Although both factors likely play some role, further investigation is needed to better understand the dynamics of MRSA transmission between healthcare and community settings.

References

1. Centers for Disease Control and Prevention. Invasive Methicillin-Resistant *Staphylococcus aureus* Infections Among Dialysis Patients – United States, 2005. MMWR 2007;56:09. Available via the Internet: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5609a3.htm. Accessed 18 Oct 2012.

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4. Boyce JM. Community-associated Methicillin-Resistant *Staphylococcus aureus* as a cause of healthcare-associated infection. *Clin Infect Dis*. 2008;46:795-8.