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Trends in *Staphylococcus aureus* Isolation in 28 US Hospitals, 2009–2013

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Abstract

Background: Recent data suggest that healthcare-associated invasive methicillin-resistant *S. aureus* (MRSA) infections are declining in the US (JAMA Intern Med 2013;173:1970). However, such infections are the minority of SA disease. Few studies have examined recent trends in epidemiology of all SA clinical isolates, to include susceptible, community-onset and non-bloodstream isolates. We performed multicenter SA surveillance in 2009, 2011 and 2013.

Methods: We collected SA isolates from July-December in 2009, 2011 and 2013 from a geographically representative sample of US hospitals. 28 centers participated in all 3 surveys, each submitting up to 100 unique (1 isolate/pt) clinically-significant SA, with demographic information, during each survey. Susceptibility testing was performed using CLSI methods and *mecA* PCR. Pulsed field gel electrophoresis (PFGE), spa and SCCmec typing, and PVL detection were performed on all MRSA. We defined as hospital-onset (HO) those SA from cultures obtained >48 h after admission.

Results: A total of 8377 SA isolates were collected (2009:2828, 2011:2767, 2013: 2782). Age distribution of pts was < 5 (6%), 6-20 (10%), 21-64 (59%), and > 65 years (23%), and 55% were male. The most common specimen source was wound/abscess (52%), followed by bloodstream (25%). The % MRSA decreased over time, from 53% of isolates *mecA* + in 2009-2011 to 46% in 2013. Only 15% of SA were HO: among MRSA, the % that were HO decreased from 15-16% in 2009-2011 to 12% in 2013. HO-MRSA accounted for only 5% of all SA clinical isolates in 2013. The USA300 MRSA PFGE type predominated in all three surveys, and by 2013 a single spa type (t008) accounted for 54% of all MRSA, followed by t002 (17.2%), with no other spa type accounting for more than 2% of MRSA. High level mupirocin resistance increased among SA/MRSA from 1.8/2.2% in 2009 to 2.6/3.9% in 2013.

Conclusion: Consistent with reports of declining HO-MRSA infection rates, our microbiology lab-based surveillance reveals that a decreasing proportion of all SA clinical isolates are MRSA or hospital-onset. Rates of resistance to mupirocin, an agent used often in HO-MRSA prevention programs, are rising. Strategies to prevent SA infections beyond HO-MRSA will be needed to substantially impact the burden of SA disease.

Background

- Recent data suggest that healthcare-associated invasive methicillin-resistant *S. aureus* (HA-MRSA) infections are declining in the US[1]
- Invasive infections due to healthcare-associated community-onset MRSA (HACO-MRSA) declined by 28%, and healthcare-onset MRSA (HO-MRSA) declined by 54%, between 2005 and 2011 in the CDC's Emerging Infections Program[1]
- However, invasive HA-MRSA represent the minority of *S. aureus* disease
- Few studies have examined recent trends in epidemiology of all *S. aureus* clinical isolates, to include methicillin-susceptible *S. aureus* (MSSA), community-onset *S. aureus*, and non-invasive isolates (e.g. skin and soft-tissue disease)
- We performed multicenter microbiological surveillance for clinical isolates of *S. aureus* in 2009, 2011 and 2013

Methods

- We collected *S. aureus* isolates from July to December in 2009, 2011 and 2013 from a geographically representative sample of US hospitals
- Twenty-eight centers participated in all three surveys, each submitting up to 100 unique (one isolate/patient) clinically-significant *S. aureus*, with demographic information, during each survey
- Susceptibility testing was performed using CLSI methods and *mecA* PCR, as previously described[2, 3, 7]
- Pulsed-field gel electrophoresis (PFGE), spa and SCCmec typing, and Panton-Valentine leukocidin (PVL) gene detection were performed on all MRSA, as previously described[4–8]

Results

- We defined as healthcare-onset (HO) those *S. aureus* from cultures obtained more than 48 h after admission[1]
- 8377 *S. aureus* isolates were collected (2009: 2828; 2011: 2767; 2013: 2782)
- Age distribution of patients was < 5 (6%), 6-20 (10%), 21-64 (59%), and > 65 years (23%); and 55% were male
- The most common specimen source was wound/abscess (52%), followed by bloodstream (25%) **(Table 1)**
- The % MRSA decreased over time, from 53% of isolates *mecA*+ between 2009 and 2011 to 46% in 2013. This decrease was seen for all specimen sources, all age groups, inpatient and outpatient isolates, and for both HO and non-HO SA isolates **(see Table 1 and Figures 1 and 2)**
- Susceptibility rates of MRSA and MSSA isolates to other tested antimicrobials were stable over the 5 years of the study **(Table 2, Figure 3)**
- Only 15% of *S. aureus* were HO; among MRSA, the % that were HO decreased from 15%-16% in 2009-2011 to 12% in 2013 **(Table 1)**
- HO-MRSA accounted for only 5% of all S. aureus clinical isolates in 2013 **(Figure 4)**
- The USA300 MRSA PFGE type predominated in all three surveys, and by 2013 a single spa type (t008) accounted for 54% of all MRSA, followed by t002 (17.2%), with no other spa type accounting for more than 2% of MRSA **(Table 3)**
- High-level mupirocin resistance increased among *S. aureus* / MRSA from 1.8% / 2.2% in 2009 to 2.6% / 3.9% in 2013 **(Figure 5)**

Figure 1. MRSA rate among *S. aureus* clinical isolates in 28 US hospitals by specimen source, 2009–2013

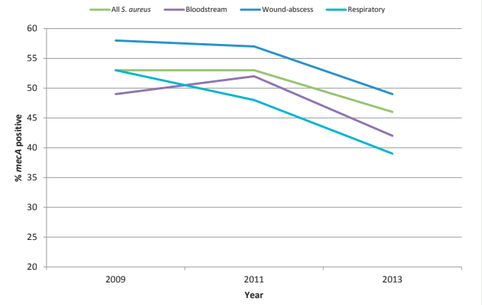
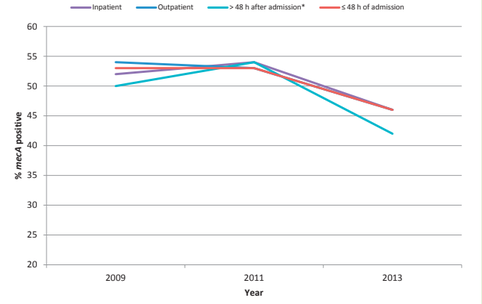


Figure 2. MRSA rate among *S. aureus* clinical isolates in 28 US hospitals by location and time of culture



*defined as "healthcare-onset"

Table 1. Characteristics of *S. aureus* collected from 28 centers in 2009–2013

Variable	2009	2011	2013
N isolates collected	2828	2767	2782
Source patient male (%)	56	57	55
Source patient age distribution (% in category)			
0–5 years	7	5	5
6–20	9	10	10
21–64	59	61	60
≥65	24	21	22
Specimen source (%):			
Wound/abscess	46	51	60
Blood	29	27	19
Lower respiratory	12	13	11
Other[a]	13	9	10
Inpatient (%)	54	55	51
Hospital-onset[b] (%)	15	16	12
mecA positive (%)	53	53	46

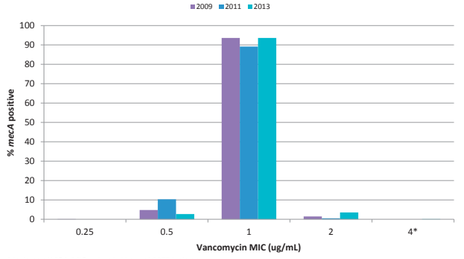
[a]Includes joint fluid, CSF, and deep tissue samples
[b]Defined as sample being obtained more than 48 h after hospital admission

Table 2. Susceptibility (%) of MSSA and MRSA over time

Agent	MSSA			MRSA		
	2009	2011	2013	2009	2011	2013
Erythromycin	65	59	51	9	9	9
Clindamycin[a]	80	81	81	60	65	67
Gentamicin	---	99	99	---	97	98
Tetracycline	95	96	95	96	96	94
TMP/SMX	99	98	98	98	97	97
Levofloxacin	89	91	89	34	36	39
Linezolid	100	100	100	>99	>99	100
Tigecycline[b]	100	100	100	100	99	99
Daptomycin	>99	>99	100	>99	>99	>99
Vancomycin[c]	100	100	100	100	100	>99
Ceftaroline[d]	100	100	>99	98	99	99

[a]Includes testing for inducible clindamycin resistance (D-test)
[b]FDA breakpoint utilized (≤0.5 µg/mL for susceptibility)
[c]See **Figure 3** for full vancomycin MIC distributions for all *S. aureus* each year
[d]No isolates were resistant to ceftaroline; all non-susceptible had MIC = 2 µg/mL

Figure 3. Vancomycin MIC trend among *S. aureus* clinical isolates at 28 US hospitals, 2009–2013



*N = 2 isolates of VISA (MIC = 4 µg/mL) out of 8377 isolates

Figure 4. Portion of *S. aureus* clinical isolates that are healthcare-onset (HO) MRSA or MSSA, 2013

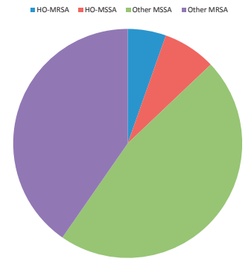


Figure 5. High-level mupirocin resistance among *S. aureus* clinical isolates in 28 US hospitals, 2009–2013

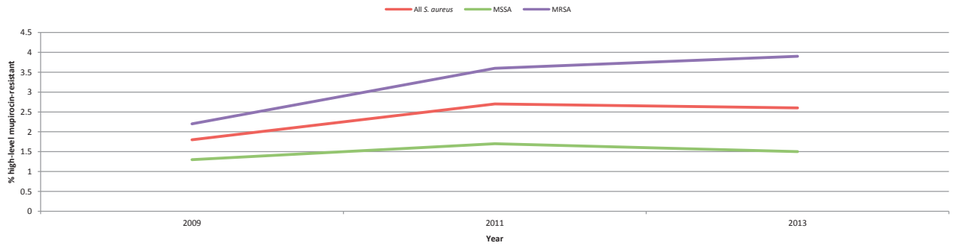


Table 3. Molecular epidemiology of *S. aureus* at 28 US hospitals, 2009–2013

PFGE or spa type	2009a	2011	2013
PFGE types (N, %)			
USA100	273 (18)	261 (18)	242 (19)
USA300	721 (48)	899 (61)	735 (58)
spa types (N, %)[b]			
CC 008			
t008	--	769 (52)	685 (54)
t024	--	26 (2)	30 (2)
t064	--	14 (<1)	8 (<1)
t068	--	13 (<1)	13 (<1)
t121	--	14 (<1)	10 (<1)
t211	--	12 (<1)	9 (<1)
t622	--	14 (<1)	15 (1)
CC 002			
t002	--	269 (18)	219 (17)
t045	--	17 (1)	18 (1)
t067	--	21 (1)	9 (<1)
t088	--	11 (<1)	7 (<1)
t242	--	22 (1)	17 (1)
t548	--	11 (<1)	5 (<1)
t688	--	11 (<1)	12 (<1)

[a]spa typing not performed in 2009; PFGE cutoffs for USA types also differed in 2009
[b]Includes only spa types with 10 or more clinical isolates during a surveillance period

Conclusions

- **The proportion of all *S. aureus* clinical isolates that are MRSA or hospital-onset is decreasing**
- **Rates of resistance to mupirocin, an agent used often in HO-MRSA prevention programs, remain <5% overall but are increasing**
- **Strategies to prevent *S. aureus* infections beyond HO-MRSA will be needed to substantially impact the burden of *S. aureus* disease**

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