

SHORT REPORT

Incidence and risk factors for community-associated methicillin-resistant *Staphylococcus aureus* in New York City, 2006–2012

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SUMMARY

This study aims to describe changes in incidence and risk factors for community-associated methicillin resistant *Staphylococcus aureus* (CA-MRSA) infections upon admission to two New York City hospitals from 2006 to 2012. We examined the first hospitalization for adult patients using electronic health record and administrative data and determined the annual incidence/1000 admissions of total *S. aureus*, total MRSA, and CA-MRSA (within 48 h of admission) in clinical specimens over the study period. Logistic regression was used to identify factors associated with CA-MRSA in 2006 and 2012. In 137 350 admissions, the incidence of *S. aureus*, MRSA, and CA-MRSA/1000 admissions were 15·6, 7·0, and 3·5, respectively. The total *S. aureus* and MRSA isolations decreased significantly over the study period (27% and 25%, respectively) while CA-MRSA incidence was unchanged. CA-MRSA increased as a proportion of all MRSA between 2006 (46%) and 2012 (62%), and was most frequently isolated from respiratory (1·5/1000) and blood (0·7/1000) cultures. Logistic regression analysis of factors associated with isolation of CA-MRSA showed that age ≥ 65 years [odds ratio (OR) 2·3, 95% confidence interval (CI) 1·2–4·5], male gender (OR 1·8, 95% CI 1·2–2·8) and history of renal failure (OR 2·6, 95% CI 1·6–4·2) were significant predictors of infection in 2006. No predictors were identified in 2012.

Key words: Methicillin-resistant *S. aureus* (MRSA).

Methicillin-resistant *Staphylococcus aureus* (MRSA) has been an endemic nosocomial pathogen since the 1960s [1] but the incidence of community-associated MRSA (CA-MRSA) has increased markedly since it was first observed in the 1980s [2]. Although CA-MRSA strains were initially associated with phenotypes and genotypes different from those found in hospital settings (e.g. the USA300 clone), the distinction between hospital-acquired MRSA (HA-MRSA)

and CA-MRSA strains has become blurred in recent years [3, 4]. Evidence suggests that the population at risk for developing CA-MRSA may also be changing, as the majority of those who acquire these strains today now have at least one documented healthcare exposure [5, 6]. Further, the incidence of both HA-MRSA and CA-MRSA has risen steadily over the past few decades, and CA-MRSA has increased as a proportion of total MRSA [7, 8].

In New York City, the incidence of CA-MRSA infections increased from 1·5/100 000 hospitalizations in 1997 to 10·7/100 000 in 2006 [9]. In light of the rapidly evolving epidemiology of CA-MRSA, it is

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therefore important to monitor changes in incidence as well as patients' characteristics associated with acquiring such infections. To this end we aimed to document the incidence and risk factors associated with CA-MRSA upon hospital admission to two New York City hospitals from 2006 to 2012.

Data for this study were obtained retrospectively from an institutionally developed database that integrates electronic records for all patients discharged from a single hospital network in New York City from 2006 to 2012. All adult inpatients (≥ 18 years) discharged during this period from two tertiary/quaternary care hospitals (914 beds and 647 beds) were included in the analysis. If a patient had multiple discharges during the study period, only the first was included. The study was approved by the Institutional Review Boards of Columbia University Medical Center and Weill-Cornell Medical Center.

The database, described previously [10], merged information from the electronic health record, admission-discharge-transfer, financial services, perioperative services, medication administration, and clinical laboratory record systems used throughout the study institution. All patients with blood, respiratory, urine, or wound cultures positive for *S. aureus* were identified from the laboratory data, and antimicrobial resistance was determined based on the antibiogram. Patients' admission dates were used to determine whether MRSA was community onset (i.e. positive culture < 48 h after admission). Although some intensive-care units implemented universal screening for MRSA at intervals throughout the study period, most units did not and the majority of cultures were drawn based on clinical indication. Data on comorbid conditions including HIV infection, malignancy, histories of renal failure, heart failure or diabetes, and Charlson comorbidity index were obtained from International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) discharge diagnosis codes.

The annual and overall incidence of all positive cultures for *S. aureus*, total MRSA, and CA-MRSA infections were expressed per 1000 patient admissions. For CA-MRSA, incidence was also measured as a proportion of total MRSA for each study year and stratified by body site. Percent changes in incidence/1000 admissions from the beginning of the study period in 2006 to the end of 2012 were calculated for each culture site and the Cochran–Armitage test for trend was used to detect significant changes in incidence over the study period.

To examine patients' characteristics associated with having CA-MRSA and how these may differ over time, multivariable logistic regression models were constructed for the first (2006) and last (2012) years of the study. Demographic characteristics (sex, age) as well as the comorbid conditions described above were included in the models. All statistical analysis was performed with SAS version 9.3 (SAS Institute, USA).

The incidence of total *S. aureus*, MRSA, and CA-MRSA in the 137 350 patient admissions included in the analysis is summarized in Table 1. Total *S. aureus* and MRSA decreased significantly over the study period (27% and 25%, respectively) while CA-MRSA incidence remained stable ($P = 0.84$). CA-MRSA increased as a proportion of all MRSA from 46% in 2006 to 62% in 2012. The most common sites for CA-MRSA were respiratory (1.5/1000 admissions) and blood (0.7/1000 admissions) cultures. In the multiple logistic regression model, age ≥ 65 years [odds ratio (OR) 2.29, 95% confidence interval (CI) 1.17–4.46, reference 18–44 years], male gender (OR 1.81, 95% CI 1.19–2.76), and renal failure (OR 2.56, 95% CI 1.55–4.24) were significant predictors of CA-MRSA in 2006. There were no significant predictors of CA-MRSA in 2012.

Despite a significant decrease in the number of positive cultures for all *S. aureus* and MRSA, the incidence of CA-MRSA remained unchanged with an average of 3.5/1000 patient admissions. In a recent meta-analysis of studies conducted throughout the United States, Dukic *et al.* [11] demonstrated that CA-MRSA as a proportion of all MRSA in healthcare facilities increased markedly throughout the 1990s, levelling off at 70% in the late 2000s. Our study yielded similar results, with the proportion of CA-MRSA rising to 62% by the end of the study in 2012. CA-MRSA as a proportion of total MRSA averaged 49% across 2006–2012, representing a sharp increase from a previous New York City-based report which found that only 20% of MRSA was community associated in 1997–2006 [9].

In the hospital setting, CA-MRSA is distinguished from HA-MRSA occurring within 48 h of hospital admission. However, some CA-MRSA may originate from contact with the healthcare system, either from a previous hospitalization or outpatient procedure [5, 6]. Antibiotics used for prophylaxis or to treat prior infections may also increase patients' risk of acquiring CA-MRSA [12]. Since the data in this study were limited to inpatient records, we were unable to determine patients' previous exposure to antibiotics,

Table 1. Incidence of *Staphylococcus aureus*, methicillin-resistant *S. aureus* (MRSA), and community-associated MRSA in two New York City hospitals, 2006–2012

Culture	2006 (N = 25 767)	2007 (N = 21 477)	2008 (N = 19 803)	2009 (N = 18 085)	2010 (N = 18 400)	2011 (N = 17 034)	2012 (N = 16 784)	Total (N = 137 350)	% change 2006–2012	P†
	Incidence/1000 admissions (total incidence)									
All <i>S. aureus</i>	18.2 (468)	19.0 (408)	14.7 (292)	15.1 (273)	13.0 (240)	14.1 (240)	13.2 (221)	15.6 (2142)	-27%	<0.001
All MRSA	8.0 (205)	8.6 (184)	6.5 (128)	7.1 (129)	5.9 (109)	6.4 (109)	6.0 (101)	7.0 (965)	-25%	0.01
CA-MRSA	3.7 (95)	3.6 (78)	3.4 (68)	3.5 (63)	3.0 (56)	3.1 (52)	3.8 (63)	3.5 (475)	+3%	0.84
Blood*	1.0 (27)	0.6 (12)	0.4 (8)	0.7 (13)	0.7 (12)	0.5 (9)	0.6 (10)	0.7 (91)	-40%	0.19
Respiratory*	1.5 (38)	2.1 (46)	1.8 (36)	1.1 (19)	0.9 (16)	1.6 (28)	1.5 (26)	1.5 (210)	0%	0.03
Urinary*	0.9 (22)	0.6 (12)	0.4 (8)	0.5 (9)	0.4 (8)	0.1 (2)	0.2 (3)	0.5 (64)	-78%	0.01
Wound*	0.1 (2)	0.1 (2)	0.2 (4)	0.3 (6)	0.2 (4)	0.1 (1)	0.4 (6)	0.2 (25)	+300%	0.16

MRSA, Methicillin-resistant *S. aureus*; CA-MRSA, community-associated MRSA.

* Includes only cultures obtained within 48 h of admission.

† Cochran–Armitage test for trend.

which may be an important risk factor for hospitalization with CA-MRSA. In addition, because the data were limited to a single hospital system, we were unable to determine whether patients had been previously hospitalized in an out-of-network facility or whether they underwent outpatient procedures prior to onset of CA-MRSA.

In the multivariable analysis of factors associated with CA-MRSA, only age ≥ 65 years, male gender, and renal failure were significant predictors in 2006. This differs from previous studies which have reported significant positive associations with HIV, diabetes, and other chronic illnesses [5, 9]. A likely reason for this difference is that this study has limited power to detect such associations due to its small sample size. Limited sample size may also explain why no significant associations were found for any of the demographic and comorbid conditions in 2012. Moreover, this study relied on retrospective clinical and billing data to identify comorbidities, which may have limited sensitivity.

In conclusion, this study demonstrated modest decreases in total *S. aureus* and MRSA in hospitalized patients. Although the overall incidence of CA-MRSA remained stable during the study period, incidence did drop for certain body sites including urine and blood. As the burden of CA-MRSA relative to HA-MRSA increases, CA-MRSA in the respiratory tract, which represents the largest proportion of positive CA-MRSA cultures (44%), may be an important target for prevention.

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DECLARATION OF INTEREST

None.

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