American Journal of Infection Control 42 (2014) 1285-90

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major article

Methicillin-resistant *Staphylococcus aureus* in public transportation vehicles (buses): Another piece to the epidemiologic puzzle

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Key Words:
Methicillin-resistant *Staphylococcus aureus*
Public transportation
Surface contamination

Background: Little is known about the occurrence and epidemiology of methicillin-resistant *Staphylococcus aureus* (MRSA) in public transportation in the United States. This research sought to determine the background prevalence and phenotypic and genotypic characteristics of MRSA strains circulating on buses from a large, metropolitan transportation agency.

Methods: Electrostatic wipes were used to collect 237 surface samples from 40 buses randomly selected from July-October 2010. Six samples were collected from each bus immediately postservice and before any cleaning and disinfection. Positive isolates were analyzed for antibiotic resistance, staphylococcal cassette chromosome mec (SCCmec) type, and pulsed-field gel electrophoresis; and potential epidemiologic factors were examined.

Results: Of the buses, 68% (27/40) were contaminated with *S aureus*, and 63% (25/40) were contaminated with MRSA. Seats and seat rails were the surfaces most frequently contaminated, followed by the back door and stanchions. Most (62.9%) of the MRSA isolates were classified as community-associated MRSA clones (SCCmec type IV), and 22.9% were health care–associated MRSA clones (SCCmec type II). Of the MRSA strains, 65% (5/20) were multidrug resistant.

Conclusion: MRSA was frequently isolated from commonly touched surfaces in buses serving both hospital and community routes. Phenotypic and genotypic analysis demonstrated that buses may be effective mixing vessels for MRSA strains of both community and health care–associated origin.

Public transportation is perhaps one of the most important services in urban life. This critical infrastructure is widely used, with approximately 10.5 billion trips per year in the United States.[1] However, little data exist regarding the prevalence of pathogens on public transportation vehicle surfaces in the United States, and no studies have isolated methicillin-resistant *Staphylococcus aureus* (MRSA) from public transportation vehicles in this country.[2] Previous work has reported the isolation of MRSA on public transportation vehicles, but such research has only been conducted in Europe and Asia.[3-7] In prior reports from Europe, MRSA was isolated in 2 studies (both in Portugal), with 26% (22/85) and 36% (72/199) of sampled buses testing positive for MRSA contamination.[3-6] MRSA contamination was also found in Japanese trains, with 2.3% of vehicles found as positive.[7]

There are several factors that make public transportation vehicles an ideal setting for the movement and spread of MRSA. First, there are undoubtedly colonized and infected individuals using public transportation because the U.S. colonization rate is 0.8%-1.5%.[8,9] Second, hand-to-fomite contact is expected in public transportation vehicles. This type of contact has been previously implicated in community-associated (CA) MRSA transmission.[10] Riders routinely touch stanchions, seat rails, doors, and seats, especially during high-volume usage times (as vehicles become crowded, this hand-to-fomite contact increases). Finally, there is little to no opportunity for hand hygiene during and immediately after

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Conflicts of interest: None to report.

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http://dx.doi.org/10.1016/j.ajic.2014.08.016

Table 1
Descriptive statistics and comparisons for the presence of *Staphylococcus aureus* and MRSA on surfaces sampled in buses from a top urban regional transit authority in a large, Midwestern U.S. city

Variable	*S aureus*, n (%)	Negative *S aureus*, n (%)	OR (95% CI)	MRSA, n (%)	Negative MRSA,* n (%)	OR (95% CI)
Surface samples	41 (17.3)	196 (82.7)	NA	35 (14.8)	202 (85.2)	NA
Sampling date	χ^2 and Fisher exact tests ($P = .134$)			χ^2 and Fisher exact tests ($P = .273$)		
July 12†	14 (24.6)	43 (75.4)	2.5 (0.9-6.7)	13 (22.8)	44 (77.2)	2.2 (0.8-6.1)
August 23	13 (21.7)	47 (78.3)	2.1 (0.8-5.7)	8 (13.3)	52 (86.7)	1.2 (0.4-3.4)
October 11	7 (11.7)	53 (88.3)	1.0 (0.3-3.1)	7 (11.7)	53 (88.3)	1.0 (0.3-3.1)
October 25	7 (11.7)	53 (88.3)	Referent	7 (11.7)	53 (88.3)	Referent
Facility	χ^2 and Fisher exact tests ($P = .864$)			χ^2 and Fisher exact tests ($P = .363$)		
1	21 (17.9)	96 (82.1)	1.1 (0.6-2.1)	20 (17.1)	97 (82.9)	1.4 (0.7-2.9)
2	20 (16.7)	100 (83.3)		15 (12.5)	105 (87.5)	
Sample location	χ^2 and Fisher exact tests ($P < .001$)‡			χ^2 and Fisher exact tests ($P < .01$)‡		
Seats	13 (32.5)	27 (67.5)	5.9 (1.5-22.9)	13 (32.5)	27 (67.5)	18.8 (2.3-152.2)
Seat rails	13 (35.1)	24 (64.9)	6.7 (1.7-25.9)	11 (29.7)	26 (70.3)	16.5 (2.0-135.6)
Back door	7 (17.5)	33 (82.5)	2.6 (0.6-10.9)	6 (15.0)	34 (85.0)	6.9 (0.8-60.1)
Stanchions	5 (12.5)	35 (87.5)	1.8 (0.4-7.9)	4 (10.0)	36 (90.0)	4.3 (0.5-40.6)
Operator's area	3 (7.5)	37 (92.5)	Referent	1 (2.5)	39 (97.5)	Referent
HVAC return vent	0 (0.0)	40 (100)	NA	0 (0.0)	40 (100.0)	NA
Multiple routes	χ^2 and Fisher exact tests ($P = .605$)			χ^2 and Fisher exact tests ($P = .712$)		
Multiple routes	26 (18.4)	115 (81.6)	1.2 (0.6-2.5)	22 (15.6)	119 (84.4)	1.2 (0.6-2.5)
Same route for day	15 (15.6)	81 (84.4)		13 (13.5)	83 (86.5)	
Hospital or nonhospital route	χ^2 and Fisher exact tests ($P = 1.00$)			χ^2 and Fisher exact tests ($P = 1.00$)		
Hospital	27 (17.4)	128 (82.6)	1.0 (0.5-2.1)	23 (14.8)	132 (85.2)	1.0 (0.5-2.2)
Nonhospital	14 (17.1)	68 (82.9)		12 (14.6)	70 (85.4)	
Ridership	χ^2 and Fisher exact tests ($P = .173$)			χ^2 and Fisher exact tests ($P = .258$)		
≥200/d	24 (20.0)	96 (80.0)	1.5 (0.7-2.9)	20 (16.7)	100 (83.3)	1.4 (0.7-2.8)
0-199/d	17 (14.5)	100 (85.5)		15 (12.8)	102 (87.2)	

CI, confidence interval; *HVAC*, heating, ventilating, and air conditioning; *MRSA*, methicillin-resistant *Staphylococcus aureus*; *NA*, not applicable; *OR*, odds ratio.
*Includes methicillin-susceptible *S aureus* and all negative results.
†On July 12, 57 samples were collected because 3 buses did not have seat rails; 60 samples were collected for each of the remaining sampling dates.
‡Statistically significant χ^2 and Fisher exact tests at $P \leq .05$ level.

transportation usage. Previous research has demonstrated that hand hygiene is the primary method for the prevention of MRSA transmission.[11,12]

Little is known about the background prevalence or variation of MRSA strains circulating in the community, especially on fomite surfaces in public transportation vehicles. In this research, the aim was to determine the background prevalence and phenotypic and genotypic characteristics of MRSA strains contaminating public transportation vehicle surfaces in a large, metropolitan setting. Here, the results of a cross-sectional study conducted on 40 buses from a Midwestern United States transportation agency are described. The results of this work provide critical data on the epidemiologic characteristics and clonal distribution of MRSA strains contaminating a public environment in this important community setting.

METHODS

Transportation agency

The studied transportation agency is a top 50 (U.S.) urban-anchored regional transit authority from a large, metropolitan area. The research team sampled 17% (40/239) of the bus fleet (based on a daily average for each facility), including the selection of an equal number of buses from each depot facility (facilities 1 and 2). Specific routes were targeted for sampling using the transportation agency's system map. Such routes were chosen based on the following criteria: (1) those that served major hospitals and nonhospital-related routes (to evaluate the possible variation in hospital-associated [HA] vs CA strains), (2) routes with high ridership and low ridership (to determine potential effect of crowding and human density), and (3) those that served 1 route or multiple routes (to assess possible differences in the number of strains isolated).

Surfaces sampled and methodology

Sampling was conducted over 4 sampling days, starting in July 2010 and ending in October 2010 (Table 1). The sampling dates were chosen based on project goals and the transportation agency's availability; each facility was visited twice. In each sampling date, 10 buses were randomly selected from those available to be sampled at the time of visit. Six predetermined sample locations (stanchions; seats; seat rails; back door; driver's area; heating, ventilating, and air conditioning return vent) were collected from each bus (total of 240 surfaces). Sample locations inside the buses were chosen as those having potentially high levels of skin-to-surface contact.

Sampling was conducted using commercially available electrostatic wipes (Swiffer, Procter & Gamble, Cincinnati, OH), as previously described.[13] A wipe was unfolded and placed over the surface to be sampled in a manner which maximized surface area contact. Once the sample was collected, the wipe was folded and placed into a sterile, labeled stomacher bag (Nasco, Fort Atkinson, WI). To enhance sampling efficiency, some samples were collected as a pool. These pooled (composite) samples were collected from the stanchions, seats, seat rails, and vehicle operator's area (which included the steering wheel, arm rests, knobs, and headrest). For pooled samples, the same electrostatic cloth was used to wipe all the units of the same surface type (eg, 9-10 seat rails were sampled with the same cloth), and an attempt was made to sample the same number of seats, seat rails, and similar linear footage of stanchions per bus. Sampling was always conducted by the same researcher, focusing only on the surfaces on one side (driver's side) of the bus (to control for any potential differences between the 2 sides, which were of different configuration). All sampling was conducted while vehicles were immediately postservice and before any cleaning and disinfection.