

# Methicillin-resistant *Staphylococcus aureus* colonization in schoolteachers in Ontario

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A prospective study of methicillin-resistant *Staphylococcus aureus* (MRSA) colonization was performed involving teachers at a science teachers' conference in Toronto, Ontario. Nasal swabs and questionnaire data were collected from consenting individuals. MRSA colonization was identified in seven of 220 (3.2%) participants. No colonized individuals reported recent contact with the health care system, antimicrobial therapy, residence with health care workers or previous MRSA infections. Methicillin-susceptible *S aureus* colonization was identified in 72 of 220 (33%) individuals. The prevalence of MRSA colonization was higher than expected for a purportedly low-risk population.

**Key Words:** Community; MRSA; *Staphylococcus aureus*

*Staphylococcus aureus* is commonly found in the nasal passages of healthy individuals as part of commensal microflora, and is an important pathogen. Of particular concern is methicillin-resistant *S aureus* (MRSA), which is a critically important hospital-associated pathogen (1,2) and is increasingly being identified as an important cause of community-associated disease (3-5). Methicillin-susceptible *S aureus* (MSSA) can be found in the nasal passages of 27.3% to 32.4% of individuals (6-8). Similarly, MRSA colonization can occur in the absence of disease, albeit at lower rates, typically less than 1.5% (7-9). Given the apparent changes in the epidemiology of MRSA and the regional differences in the incidence of MRSA infections, time- and geographically relevant studies are needed to assess MRSA colonization in people in communities in different regions of Canada, yet minimal information is available. Furthermore, studies evaluating populations more representative of the general population are required, because most studies have focused on specific, typically high-risk groups such as hospitalized individuals (10), intravenous drug users (11) and child care centre attendees (12). One reason for this is the difficulty in identifying and enrolling individuals in an unbiased manner that represent the general population. The objectives of the present study were to evaluate MSSA and MRSA colonization in science teachers at a conference in Ontario, as well as to identify the risk factors for colonization, because this group is not known to be at an increased risk for MRSA colonization.

## Une colonisation à *staphylocoque doré* résistant à la méthicilline chez des enseignants de l'Ontario

Les auteurs ont mené une étude prospective de la colonisation à *staphylocoque doré* résistant à la méthicilline (SARM) auprès d'enseignants participant à un congrès d'enseignants de sciences qui avait lieu à Toronto, en Ontario. Ils ont procédé à des prélèvements nasals et ont colligé des données par questionnaire auprès des personnes consentantes. Ils ont repéré une colonisation à SARM chez sept des 220 (3,2 %) participants. Aucune personne colonisée n'a déclaré de contact récent avec le système de santé, une thérapie antimicrobienne, la résidence avec un travailleur de la santé ou une infection passée par le SARM. Les auteurs ont déposé une colonisation à *staphylocoque doré* susceptible à la méthicilline chez 72 des 220 (33 %) personnes. La prévalence de colonisation à SARM était plus élevée que prévu au sein d'une population supposément à faible risque.

## PATIENTS AND METHODS

### Study population

The present study was conducted at the Annual Conference of the Science Teachers' Association of Ontario/L'association des professeurs des sciences de l'Ontario in Toronto, Ontario, in November 2006. This group included elementary and secondary schoolteachers, predominantly from Ontario. All attendees were eligible for inclusion. An information and sampling booth attended by the investigators was used to enrol volunteers over a two-day period. The booth was situated in a central location that would be passed by all participants. The present study was approved by the Research Ethics Board of the University of Guelph (Guelph, Ontario).

### Sampling procedures

Volunteers collected a single nasal swab from themselves as per instructions provided by the investigators. Swabs were placed in liquid Stuart's medium and maintained at 4°C until processing, which occurred within 48 h.

Participants completed a brief questionnaire designed to identify potential risk factors for staphylococcal colonization, including age, sex, previous hospitalization or antimicrobial use, exposure to a correctional facility, residence with a health care worker or veterinary professional, residence with individuals having selected risk factors for MRSA infection, regular participation in group sports activities, previous MRSA infection

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**TABLE 1**  
**Methicillin-susceptible *Staphylococcus aureus* (MSSA) and methicillin-resistant *S aureus* (MRSA) colonization in teachers at a science teachers' conference, with univariable analysis**

Characteristic	All participants (n=220), n (%)	Colonized with MSSA (n=72), n (%)	P	Colonized with MRSA (n=7), n (%)	P
Sex, female	152 (69)	43 (59)	0.045	5 (71)	0.89
Pet ownership (excluding fish)	125 (57)	46 (64)	0.083	5 (71)	0.43
Weekly contact with animals (not own pets)	55 (25)	14 (19)	0.11	1 (14)	0.50
Previous hospitalization (within 90 days)	14 (6.3)	3 (4)	0.24	0 (0)	0.48
Previous antimicrobial use (within 90 days)	24 (11)	6 (8)	0.24	0 (0)	0.34
Resided in or visited a correctional facility	1 (0.5)	0 (0)	0.45	0 (0)	0.86
Residence with a health care worker	21 (10)	6 (8)	0.47	0 (0)	0.38
Residence with a veterinary professional	3 (1)	1 (1)	0.69	0 (0)	0.95
Residence with a correctional facility employee	1 (0.5)	0 (0)	0.45	0 (0)	0.85
Involved in weekly group sporting activities	83 (38)	28 (39)	0.68	3 (43)	0.81
Previously diagnosed with MRSA	1 (0.5)	0 (0)	0.45	0 (0)	0.85

or contact with an individual diagnosed with MRSA, and animal contact.

#### MRSA identification, characterization and typing

Swabs were placed in 2 mL of enrichment broth consisting of 10 g/L tryptone T, 75 g/L sodium chloride, 10 g/L mannitol and 2.5 g/L yeast extract for 24 h at 35°C. An aliquot of broth was inoculated onto mannitol salt agar for isolation of methicillin-susceptible staphylococci and onto selective chromogenic agar (CHROMagar, BD Diagnostics, USA), and was incubated at 35°C. Plates were read at 24 h and 48 h, and presumptive staphylococcal isolates were subcultured and identified based on colony morphology, Gram stain, catalase reaction, tube coagulase assay and *S aureus* latex agglutination test (Pastorex Staph Plus, Bio-Rad Laboratories Ltd, Canada). Methicillin resistance was confirmed by demonstration of growth on Mueller Hinton agar, with 6 µg/mL oxacillin for 24 h at 35°C, and by demonstration of penicillin-binding protein 2a antigen using a latex agglutination antibody screening test (Denka Seiken Co Ltd, Tokyo, Japan). MRSA isolates were typed via *Sma*I pulsed-field gel electrophoresis, and categorized according to Canadian epidemic MRSA (CMRSA) clones (13). Isolates were tested for Panton-Valentine leukocidin (PVL) genes, *lukS* and *lukF* using real-time polymerase chain reaction (14).

#### Statistical analysis

Prevalence and 95% CIs were calculated for overall *S aureus*, MRSA and MSSA colonization. Categorical comparisons were performed using  $\chi^2$  analyses. Logistic regression was used to evaluate the association between age and colonization.  $P < 0.05$  was considered significant for all comparisons. Risk factors for *S aureus* colonization were evaluated via stepwise forward logistic regression. Variables achieving a liberal significance level of  $P \leq 0.15$  in the univariate analyses were

considered for inclusion in the multivariable model. Variables achieving a  $P < 0.05$  level in the final model were considered significant; ORs with 95% CIs were calculated.

#### RESULTS

The conference was attended by 1899 individuals. Nasal swabs were collected from 220 (12%) volunteers – 152 (69%) women and 68 (31%) men – with a mean  $\pm$  SD age of  $39 \pm 10.8$  years. *S aureus* was isolated from 79 of 220 (36%  $\pm$  6%) volunteers. Seventy-two (33%  $\pm$  6.1%) individuals were colonized with MSSA and seven (3.2%  $\pm$  1.6%) were colonized with MRSA (Table 1). There was no association between age and MSSA colonization ( $P = 0.39$ ). Male sex (OR 2.0, 95% CI 1.1 to 3.9;  $P = 0.026$ ) and having pets in the household (OR 2.1, 95% CI 1.1 to 3.8;  $P = 0.020$ ) were identified as being associated with MSSA colonization on multivariable analysis, while having weekly contact with animals other than the individual's pets was associated with a significantly lower risk of MSSA colonization (OR 0.49, 95% CI 0.23 to 0.97;  $P = 0.046$ ).

The prevalence of methicillin resistance among *S aureus* isolates was 8.9% (seven of 79 isolates). No significant variables for MRSA colonization were identified using univariable analysis. Multivariable analysis was not performed because of the low prevalence. No individuals reported contact with a household member known to be infected or colonized with MRSA.

Three of seven (43%) MRSA isolates were classified as CMRSA-2. There were single isolates of CMRSA-1, CMRSA-5, CMRSA-6 and CMRSA-10. PVL genes were only identified in the CMRSA-10 isolate.

#### DISCUSSION

The present study is the first to evaluate MRSA colonization in teachers in Canada; the 3.2% colonization rate was unexpectedly high. This is particularly true when one considers that

none of the colonized individuals reported health care use, or health care worker or correctional institutional contacts, all considered to be important risk factors for colonization. While teachers were chosen as a purportedly low-risk group to provide a more accurate population prevalence estimate, it is possible that they are actually at a higher risk for MRSA exposure. High rates of MRSA colonization have been reported in children (15,16); the potential impact of child contact on MRSA colonization should be considered. Similarly, contact with children was also identified as a significant risk factor for MRSA colonization in dogs (17). While one can hypothesize that child contact was a potential reason for the MRSA colonization rate identified here, it was not proven in the present study; future studies should evaluate the role of child contact on community-based colonization rates. It is also plausible that the MRSA colonization rate identified simply reflects an increased baseline community colonization rate. The population prevalence of MRSA colonization in the United States has been estimated to be 0.94% (8); however, that estimate was based on data from 2001 to 2002, and it is unknown whether there has been an increase in colonization since that time. Similar Canadian studies have not been reported, with available studies focusing on high-risk groups, and reporting rates of 32% in hospitalized individuals (10), 7.4% in intravenous drug users (11), 13% in horse owners and veterinarians (18), and 20% in pig farmers (19), but the markedly different populations limit any reasonable comparisons. Further studies of people in the community without identifiable risk factors would be useful.

The predominance of CMRSA-2 was not surprising because this is currently the most common MRSA strain causing infections in Canada (20). Identification of CMRSA-10, also known as USA300, was similarly unsurprising because this PVL-containing clone appears to be emerging in Canada (4,21) and is a tremendous cause of concern in the United States (22,23).

The prevalence of MSSA colonization in the present study (36%) was similar to various other studies. This result, therefore, suggests that the self-sampling and swab handling practices were appropriate and that the MRSA rate reported in the present study was not an underestimation of the true prevalence.

The association between MSSA colonization and the male sex has been reported elsewhere (3,6), but the association between pet ownership and MSSA colonization has not been previously reported. Animal contact risk factors were evaluated because of reports (24-27) linking animals with MRSA infection and colonization in humans. The association of animal contact with MSSA colonization was interesting, and supports the hypothesis that animals can be associated with transmission of MRSA to humans, and that the role of pets in colonization and infection in humans should be further investigated. The protective effect of weekly contact with animals, not including the individuals' household pets (ie, farm animals or other peoples' pets), and MSSA colonization was unexpected, and an explanation for this is not readily apparent. Unfortunately, specific details regarding this type of animal contact were not collected.

Potential limitations of the study and biases of the study population need to be considered. Participation was voluntary, and it is unclear whether that affected the prevalence of MRSA. Random selection of participants would have been ideal, but was not possible for ethical reasons. As discussed above, in hindsight, it is possible that teachers may not reflect the true population prevalence because of frequent contact with children, but this hypothesis is unproven.

The present study has raised questions about whether the prevalence of MRSA colonization in individuals in the community is higher than has been previously considered, or whether schoolteachers may be at a higher risk for MRSA exposure. Further study of both of these questions is indicated to better understand the epidemiology of this concerning pathogen. Furthermore, the association between pet ownership and MSSA colonization, while not readily explained, provides additional support to the role of animals, especially household pets with which people often have close and prolonged contact, in the epidemiology of infectious diseases.

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