Skin and soft tissue infections caused by methicillin-resistant *Staphylococcus aureus* (MRSA): an affliction of the underclass

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ABSTRACT

Objective: The objective of this study was to determine whether skin and soft tissue infections (SSTIs) caused by methicillin-resistant *Staphylococcus aureus* (MRSA) in patients presenting to The Ottawa Hospital emergency departments (TOHEDs) differed from SSTIs caused by methicillin-susceptible *Staphylococcus aureus* (MSSA) with regard to risk factors, management, and outcomes.

Methods: All patients seen at TOHEDs in 2006 and 2007 with SSTIs who yielded MRSA or MSSA in cultures from the site of infection were eligible for inclusion. We excluded patients with decubitus ulcers and infections related to diabetes or peripheral vascular disease. We used an unmatched case-control design. Cases were defined as patients with MRSA isolated from the infection site, and controls were defined as patients with MSSA isolated from the infection site. Data were collected retrospectively from health records and laboratory and hospital information systems.

Results: A total of 153 patients were included in the study (81 cases and 72 controls). The mean age of cases was 37 years, compared to 47 years for the controls ($p < 0.001$). Cases were more likely to have transient residence (31% v. 3% [OR 15.6, 95% CI 3.9–61.8, $p < 0.001$]), present with abscesses (64% v. 15% [OR 9.9, 95% CI 4.3–23.7, $p < .001$]), have a documented history of hepatitis C infection (28% v. 3% [OR 13.9, 95% CI 3.9–55.0, $p < 0.001$]), and have a history of substance abuse (53% v. 10% [OR 10.5, 95% CI 4.4–25.1, $p < 0.001$]). Cases most commonly used crack cocaine and injection drugs.

Conclusion: SSTIs caused by MRSA at TOHEDs mainly occur in a population that is young and transient with comorbidities such as hepatitis C and substance abuse.

RÉSUMÉ

Objectif: La présente étude visait à déterminer si les infections de la peau et des tissus mous (IPTM) causées par *Staphylococcus aureus* résistant à la méthicilline (SARM) chez les patients examinés aux services des urgences de l'Hôpital d'Ottawa (SUHO) étaient différentes des IPTM causées par *Staphylococcus aureus* sensible à la méthicilline (SASM) en ce qui concerne les facteurs de risque, la prise en charge, et les résultats.

Méthodes: Tous les patients examinés aux SUHO, en 2006 et 2007, pour des IPTM dont les cultures de prélèvement au foyer d'infection avaient confirmé la présence de SARM ou de SASM étaient admissibles à l'étude. Les patients souffrant d'escarres de décubitus, d'infections liées au diabète, ou de maladies vasculaires périphériques ont été écartés. Il s'agit d'une étude cas/témoins, non appariés. Les cas ont été définis comme la présence de SARM isolé du foyer d'infection et les témoins, comme la présence de SASM isolé du foyer d'infection. Il y a eu une collecte rétrospective de données à partir des dossiers médicaux ainsi que des systèmes d'information de l'hôpital et du laboratoire.

Résultats: Au total, 153 patients ont été retenus dans l'étude (81 cas et 72 témoins). L'âge moyen des cas était de 37 ans contre 47 ans pour les témoins ($p < 0.001$). Les cas étaient plus susceptibles de vivre dans des lieux temporaires (31% contre [c.] 3%; risque relatif approché [RRA]: 15.6; IC à 95%: 3.9–61.8; $p < 0.001$) ou d'avoir des abcès (64% c. 15%; RRA: 9.9; IC à 95%: 4.3–23.7; $p < 0.001$), des antécédents avérés d'hépatite C (28% c. 3%; RRA: 13.9; IC à 95%: 3.9–55.0; $p < 0.001$]), ou des antécédents d'abus d'alcool ou d'autres drogues (53% c. 10%; RRA: 10.5; IC à 95%: 4.4–25.1; $p < 0.001$]). Les cas faisaient surtout usage de crack, ou cocaïne épurée, ou de drogues injectables.

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Conclusion: Les IPTM causées par SARM et examinées aux SUHO s'observaient surtout chez les jeunes, vivant dans des lieux temporaires et souffrant de maladies concomitantes ou faisant un usage abusif d'alcool ou d'autres drogues.

Keywords: methicillin-resistant *Staphylococcus aureus* (MRSA), skin and soft tissue infections, methicillin-susceptible Staphylococcus aureus

Methicillin-resistant *Staphylococcus aureus* (MRSA) has been a pathogen linked to health care facilities and is a major cause of health care–associated infections. More recently, community-associated strains of MRSA (CA-MRSA) have been found to cause infections in patients with no risk factors for health care–associated MRSA (HA–MRSA). CA-MRSA strains are distinct from health care–associated stains and have been implicated in a number of outbreaks in the United States linked primarily to professional sports teams and inmates of correctional facilities. In Canada, CA-MRSA was first reported in an Aboriginal community in 1990.[1] There are more recent reports of CA-MRSA in other Canadian settings, such as daycare centres and correctional facilities, and in marginalized populations, such as illicit drug users and the homeless.[2–4] The most common strains of CA-MRSA in North America are CMRSA-7 and CMRSA-10, also known as USA400 and USA300 strains, respectively, by American nomenclature.

It is well known that CA-MRSA can cause skin and soft tissue infections (SSTIs).[5,6] In recent years, CA-MRSA has been more frequently encountered in emergency departments (EDs) in Canada and the United States as a major cause of SSTIs.[6–9] Knowledge of risk factors for CA-MRSA may help front-line health care workers to manage SSTIs more effectively with respect to empirical antibiotic therapy and infection control measures. However, epidemiologic data on CA-MRSA patients presenting to Canadian EDs are limited.[3,8–11]

In the Ottawa region, there was a dramatic increase in the number of CA-MRSA strains identified from clinical specimens in 2006.[12] The objective of this study was to determine whether SSTIs caused by MRSA in patients presenting to The Ottawa Hospital emergency departments (TOHEDs) differed from SSTIs caused by methicillin-susceptible *Staphylococcus aureus* (MSSA) with regard to risk factors, empirical management, and outcomes.

METHODS

The study was conducted in the EDs of the two acute care sites of The Ottawa Hospital, the General Campus and the Civic Campus. The TOHEDs are the largest in eastern Ontario, serving over 1.1 million residents, with over 127,000 patient visits per year. Of the patients served, 88% are from eastern Ontario and 10% are from the rest of Ontario and western Quebec. The General Campus is a regional referral centre for oncology, nephrology, thoracic surgery, hematology, and infectious diseases. The Civic Campus is a level I trauma centre and a regional referral centre for neurosciences, vascular surgery, gastroenterology, and cardiac surgery.

Approval was obtained from The Ottawa Hospital Research Ethics Board prior to initiating the study. A retrospective, unmatched, case-control design was used to compare risk factors in cases and controls. Both community- and hospital-acquired risk factors were evaluated. The population of interest included all patients presenting to TOHEDs between January 1, 2006, and December 31, 2007, with SSTIs that were cultured and yielded MRSA or MSSA. All age groups were eligible for inclusion in the study; however, The Ottawa Hospital primarily serves an adult population.

Sample size calculation

At the time of this study, substance abuse was the risk factor most consistently found in other published studies of CA-MRSA.[3,9,11–13] Thus, the sample size was calculated using substance abuse as our main exposure of interest. The Canada Addiction Survey indicates a 16.5% lifetime incidence of substance abuse in the general population.[14] A previous study in Ottawa suggested that 33% of cases were likely to have this exposure.[11] For our calculation, we used more conservative estimates of 10% exposure in controls and 30% exposure in cases. Therefore, assuming a two-tailed alpha error rate of 0.05 and an 80% probability of detecting a significant difference between cases and controls, using a 1:1 ratio of cases to controls, the sample size required is 72 in each group (EpiInfo v3.4.3, Centers for Disease Control and Prevention, Atlanta, GA).

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Case and control definitions

A case was defined as any patient who presented with SSTI and who had MRSA cultured from the infection site in 2006 or 2007. A control was defined as any patient who presented with SSTIs in whom MSSA was cultured from the site of infection.

For the purposes of this study, SSTI includes the following conditions as diagnosed by the attending physician: impetigo, folliculitis, furuncle/carbuncle, paronychia, bursitis, abscess, cellulitis (if accompanied by exudates, pustules, or abscess), hidradenitis, and postoperative wound infections (within 30 days of surgery, for procedures considered clean, involving the trunk, head and neck, and extremities and also including post–cesaraean section wound infections and clean abdominal surgeries [e.g., hernia repairs]). To exclude polymicrobial or chronic infections, patients with chronic decubitus ulcers and those with lower limb ulcers related to diabetes mellitus or peripheral vascular disease were excluded. Patients with human or animal bite wound infections and patients with chronic postsurgical wounds were also excluded.

Identification of cases and controls

Cases and controls were identified from the hospital's laboratory information system, which contains details of all bacterial cultures identified from various clinical departments in the hospital, including the ED. The laboratory information system was queried to identify all cultures yielding MRSA and MSSA from wound or skin site swabs in 2006 and 2007. This provided the entire list of potential cases and controls. Cultures were not routinely done for all patients presenting with SSTI, but were obtained at the discretion of the physician. We reviewed the health records of all patients with MRSA identified on this list for possible inclusion in the study. MSSA controls were randomly selected, using a computerized random number generator, from the same list generated by the laboratory information system query to achieve our required sample size of 72 controls. We aimed to have one control for every case. Similarly, all randomly selected MSSA patients' health records were reviewed for possible inclusion as controls in the study.

Data management and analysis

Data were collected from patient health records, entered using a standard electronic data form using *EpiData* v. 3.1 (The EpiData Association, Denmark), and exported for analysis to Microsoft Office *Excel* 2003 (Microsoft Corporation, Redmond, CA) and *SPSS* v16.0 (SPSS Inc, Chicago, IL). The variables of interest included demographics, clinical data, laboratory data, and possible risk factors (Appendix). The variables were determined by the study authors based on previous experience and known published risk factors for MRSA infection/colonization. The primary author (J.V.V.) completed all the data extraction and entry. The data form only included closed-ended questions. Frequencies of variables of interest were calculated along with measures of central tendency for continuous variables. The Student *t*-test was used to compare continuous variables, and the chi-square or Fisher exact test was used where appropriate to compare proportions. Estimates of risk using odds ratio (OR) and 95% confidence intervals (CIs) were calculated using *SPSS* v16.0. A two-sided p value ≤ 0.05 was considered statistically significant. The aim of these analyses was to determine if there were differences between the two groups. Where data were not recorded or unavailable, the variable was assumed not to be present. For example, if there was no mention of previous incarceration in the health record, it was assumed that the patient had no history of previous incarceration.

Laboratory methods

Case isolates were genotyped by pulsed-field gel electrophoresis (PFGE) using *SmaI* digests to identify their strain type as previously described.[15] Isolates were further characterized by determining the presence or absence of the Panton-Valentine leukocidin (*PVL*) gene and typing of their staphylococcal chromosomal cassette (SCC) mec type.[16,17]

RESULTS

Based on ICD-10 codes for SSTIs, there were an estimated 7,575 visits to the TOHEDs for SSTIs in 2006 and 2007. Overall, there were 240,281 visits to the ED during this time period; therefore, SSTIs represented about 3% of all ED visits.

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The hospital laboratory information system generated a list of 90 patients with MRSA and 449 patients with MSSA in 2006 and 2007 from wound and skin site cultures. These represented the total number of patients identified in the laboratory information system with these organisms isolated from wound/skin site cultures from the ED in the 2 years studied. All 90 MRSA patients were considered for the study, and 110 MSSA patients were randomly selected from the total list of 449. Of the 200 patients whose charts were reviewed, 47 were excluded (Figure 1). Of 90 possible MRSA cases, 9 (10%) were excluded, whereas of 110 possible controls, 38 (35%) were excluded (OR 0.2, 95% CI 0.1–0.5, $p < 0.001$). Patients were mainly excluded because the infections were chronic surgical infections or related to complications of diabetes or peripheral vascular disease. Thus, 153 patients were included in the study: 81 cases and 72 controls.

The demographic characteristics of these patients are summarized in Table 1. Cases were younger and more often lived in transient residence compared to the controls.

The most commonly affected anatomic sites in cases and controls were the upper and lower extremities, which accounted for 57 (70%) and 47 (65%) infections, respectively. Cases were more likely to present with infections of the buttock and upper extremities. Buttock infections occurred in 8 (10%) cases and 1 (1%) control (OR 7.8, 95% CI 1.2–49.0, $p = 0.04$). Upper extremity infections occurred in 32 (40%) cases and 16 (22%) controls (OR 2.3, 95% CI 1.1–4.6, $p = 0.02$).

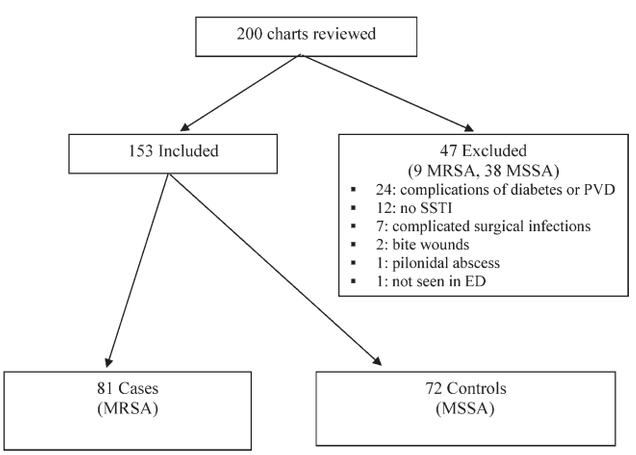

Figure 1. Summary of case ascertainment. ED = emergency department; PVD = peripheral vascular disease; MRSA = methicillin-resistant *Staphylococcus aureus*; MSSA = methicillin-susceptible *Staphylococcus aureus*; SSTI = skin and soft tissue infection.

The most common SSTI was cellulitis, although patients often had multiple types of SSTI. It was possible to present with abscesses surrounded by areas of cellulitis or impetigo with cellulitis. In total, 106 patients (69% of the study population) had cellulitis. No cases of necrotizing fasciitis were identified. Abscesses were noted to be present among 52 (64%) cases but only 11 (15%) controls. Cases were almost 10 times as likely to present with abscesses compared to controls (OR 9.9, 95% CI 4.3–23.7, $p < 0.001$).

Most patients presented to the ED after having symptoms for 5 to 7 days. No difference was noted between cases and controls with regard to symptom duration prior to the ED visit. There was no significant difference between cases and controls with regard to treatment prior to the ED visit. Prior to visiting the ED, 23 (28%) cases and 20 (28%) controls received some form of treatment (OR 1.0, 95% CI 0.5–2.2, $p=1.0$). Antibiotic use before presentation to the ED was noted in 18 (22%) cases and 14 (19%) controls, which was also not significantly different between the two groups (OR 1.2, 95% CI 0.5–2.8, $p = 0.7$). Interestingly, 6 (7%) cases already had incision and drainage of an abscess performed prior to the ED visit compared to only 1 (1%) control, but this was not statistically significant (OR 5.7, 95% CI 0.7–128.4, $p = 0.1$). This number included patients who performed their own procedures prior to medical care in the ED.

The two most common treatments provided in the ED were intravenous antibiotics and incision and drainage (Table 2). Most patients received more than one type of treatment. Incision and drainage as well as change from the initial antibiotic were significantly more common among cases (see Table 2). For 27 (33%) cases, there was documented clinical improvement prior to treatment with an antibiotic with known in vitro activity against MRSA. However, 20 (74%) of these cases also had incision and drainage performed in the ED.

Seven (5%) patients required hospital admission, including four cases and three controls.

Comorbidities and risk factor data are summarized in Table 3. Cases were nearly 14 times more likely to have had a documented history of hepatitis C compared to controls; 23 (28%) cases and 2 (3%) controls were noted to have hepatitis C (OR 13.9, 95% CI 3.9–55.0, $p < 0.001$). Similarly, a documented

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Table 1. Comparison of demographic characteristics of cases and controls

Characteristic	MRSA cases (n = 81) n (%)	MSSA controls (n = 72) n (%)	OR (95% CI)	p
Transient residence*	25 (31)	2 (3)	15.6 (3.9–61.8)	< 0.001
Male	51 (63)	40 (56)	1.4 (0.7–2.6)	0.41
Mean age (yr)	37	47	N/A	< 0.001

MRSA = methicillin-resistant *Staphylococcus aureus*; MSSA = methicillin-susceptible *Staphylococcus aureus*; N/A = not available.
*Transient residence: no fixed address, in a homeless shelter, or incarcerated.

history of substance abuse was noted in 43 (53%) cases but only 7 (10%) controls (OR 10.5, 95% CI 4.4–25.1, $p < 0.001$). The two most common substance abuse categories identified among cases were crack cocaine in 34 (79%) cases and injection drugs in 27 (63%) cases.

With regard to HA-MRSA risk factors, an ED visit in the previous year, known MRSA infection/colonization at anytime in the past, and antibiotic use in the previous 12 months were significantly more likely in cases compared to controls (see Table 3). Any surgery in the previous year was more common among controls, and this difference was also statistically significant.

Community-associated risk factors were also analyzed and summarized in Table 3. Incarceration, homelessness in the past year, and communal living were significantly more common among cases compared to controls (see Table 3).

Of the 81 case isolates analyzed by PFGE, 68 (84%) were the CMRSA-10 (USA300) strain. All 68 were confirmed to carry the *PVL* gene, and 24 (35%) were confirmed to have SCC mec type IV (SCC mec typing was not available for the other 44 isolates). Seven (9%) case isolates were identified as CMRSA-2 (USA100), and PFGE typing was unavailable for 6 (7%) isolates.

DISCUSSION

MRSA was a confirmed pathogen in approximately 1% of all SSTIs presenting to the TOHEDs. The majority of these infections were due to the CMRSA-10 strain. However, MRSA may have represented a higher percentage of all infections because the bacterial etiology is confirmed in only a fraction of all SSTIs. Patients with SSTIs due to MRSA were significantly more likely to present with abscesses, be considered transient, (i.e., homeless, incarcerated, or with no fixed address), have a history of substance abuse, or be infected with hepatitis C compared to patients with MSSA SSTIs. These findings may help clinicians identify which patients are more likely to be infected with MRSA at the time of presentation with SSTIs. These data may aid initial management, facilitate the initiation of appropriate infection control measures to prevent further transmission, and improve patient outcomes.

Of note, one-third of MRSA cases improved before receiving an antibiotic with known in vitro activity against MRSA. Of these, 74% underwent incision and drainage. Our study confirms previous findings that patients with MRSA SSTIs are more likely to present with abscesses and can often be managed without the use of antibiotics.[18,19]

The main limitation of this study is its retrospective nature in that risk factors were not systematically ascertained from cases and controls or may not have been reliably documented. The availability of data was dependent on the quality of the clinical health records. There were no standard criteria for verifying the completeness of an ED record; for example, with respect to diagnosis, the primary or secondary diagnosis

Table 2. Treatment received in the emergency department

Treatment in ED	MRSA cases (n = 81) n (%)	MSSA controls (n = 72) n (%)	OR (95% CI)	p
Change in antibiotic	40 (54)	12 (17)	4.9 (2.2–11.2)	< 0.001
Incision and drainage	55 (68)	25 (35)	4.0 (1.9–8.3)	< 0.001
Oral antibiotics	17 (21)	12 (17)	1.3 (0.6–3.3)	0.5
Hospital admission	4 (5)	3 (4)	1.2 (0.3–5.5)	1.0
Intravenous antibiotics	49 (60)	44 (61)	1.0 (0.5–2.0)	1.0

MRSA = methicillin-resistant *Staphylococcus aureus*; MSSA = methicillin-susceptible *Staphylococcus aureus*.

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Table 3. Comorbid conditions and risk factors: cases versus controls

Comorbid condition	MRSA cases (n = 81) n (%)	MSSA controls (n = 72) n (%)	p	OR (95% CI)
Hepatitis C	23 (28)	2 (3)	< 0.001	13.9 (3.5–55.0)
Substance abuse	43 (53)	7 (10)	< 0.001	10.5 (4.4–25.1)
HIV	6 (7)	1 (1)	0.1	5.7 (0.9–36.6)
History of psychiatric illness	16 (20)	8 (11)	0.2	2.0 (0.8–4.8)
Diabetes mellitus	9 (11)	14 (19)	0.2	0.5 (0.2–1.3)
Eczema/psoriasis	1 (1)	6 (8)	0.05	0.1 (0.02–.9)
Hepatitis B	1 (1)	0	1.0	N/A
Health care–associated risk factor				
Previous known MRSA infection/colonization	12 (15)	1 (1)	0.003	12.3 (1.6–97.5)
Health care employee	5 (6)	1 (1)	0.2	4.7 (0.7–30.7)
Antibiotics in the past year	31 (38)	12 (17)	0.004	3.1 (1.5–6.6)
ED visit in past year	43 (53)	26 (36)	0.05	2.0 (1.05–3.8)
Screen for MRSA in past year	19 (23)	10 (14)	0.15	1.9 0.8–4.4
Previous known MSSA infection/colonization	5 (6)	4 (6)	1.0	1.1 (0.3–4.3)
Hospital admission in past year	20 (25)	23 (32)	0.37	0.7 (0.3–1.4)
Surgery in the past year	13 (16)	23 (32)	0.02	0.4 (0.2–0.9)
Community-associated risk factor				
Homelessness in the past year	25 (31)	2 (3)	< 0.001	15.6 (3.5–68.8)
Communal living	20 (25)	2 (3)	< 0.001	11.5 (2.6–51.1)
Incarceration	20 (25)	2 (3)	< 0.001	11.5 (2.8–45.8)
Visit to USA in past 3 mo	4 (5)	1 (1)	0.4	3.7 (0.5–25.0)
Sex trade worker	2 (2)	0	0.5	N/A

HIV = human immunodeficiency virus; MRSA = methicillin-resistant *Staphylococcus aureus*; MSSA = methicillin-susceptible *Staphylococcus aureus*; N/A = not available.

was not always clear. Patients may have had an abscess and cellulitis, but it was not always clear which was the primary or secondary diagnosis. The findings of this study cannot be generalized to the pediatric population as very few pediatric patients were included in the study. The small sample size precluded multivariate analysis. No conclusions can be made regarding the outcome of these infections in the different groups as outcome data were very limited. Outcome data would be better generated via a prospective study.

Furthermore, because the identification of cases and controls was dependent on a positive laboratory result, there is the potential that other MRSA or MSSA cases that were not cultured could have influenced the results of our study. The decision to send a specimen for culture is based on the clinician's judgment and personal practice, and this may have led to some selection bias. It is possible that clinicians were more likely to culture infections from individuals with moderate to severe pyogenic infections compared to those with minor amounts of purulent drainage. A prospective study that mandated every patient to have a culture would minimize this type of bias. In our study, we could not adjust for different sampling practices by ED physicians. However, given that both groups had laboratory samples sent, this type of selection bias should be similar in both groups. It is notable that many more patients with MSSA isolated from wound cultures had to be excluded from the study. This may be related to the fact that MSSA is still much more common than MRSA in The Ottawa Hospital and plays a larger role in chronic infections involving devitalized tissues. Finally, the results of this study cannot be generalized to other MRSA infections (e.g., pneumonia, endocarditis) as we limited our analysis to SSTIs.

Recently, two published studies examined the role of MRSA in SSTIs in Canadian EDs.[8,13] In Toronto, Adam and colleagues found that MRSA was isolated in 19% of patients with staphylococcal SSTIs.[8] CMRSA-10 (USA300) accounted for 50% of these cases. When comparing the patients with CMRSA-10 to patients with other MRSA strains, they found that CMRSA-10 patients were younger, less likely to report recent antibiotic use or health care–related risk factors, and more likely to report community-related risk factors such as living in a shelter or correctional facility. In Vancouver, Stenstrom and colleagues found that over

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50% of SSTIs in which wound cultures were performed were caused by MRSA.[13] Significant risk factors for MRSA SSTIs in their study were previous MRSA infection or colonization, injection drug use, diabetes mellitus, antibiotic use in the previous 8 weeks, presence of an abscess, and admission to hospital in the previous 12 months. In their study, there was no attempt to differentiate between different strains of MRSA, and this may explain why the risk factors are not more consistent with other studies of CA-MRSA. It is known that certain strains such as CMRSA-10 are associated with community risk factors rather than health care–associated risk factors. Our findings were very similar to those of Adam and colleagues' study in which communal living, homelessness, and incarceration were risk factors for CA-MRSA.[8] A recent study from Canada's remote communities found that risk factors did not distinguish CA-MRSA infections from CA-MSSA infections.[20] The authors concluded that standard hygiene measures and proper treatment guidelines would be beneficial in controlling the spread of the organism.

Studies in the United States have also shown that CA-MRSA infections are associated with risk factors similar to those seen in Canadian studies. In a prospective comparison of MRSA and MSSA infections in hospitalized patients, MRSA infection was associated with antibiotic use in the past 6 months, homelessness, a history of incarceration, alcohol abuse, and a history of infection with MRSA.[21] In another study from Detroit, patients hospitalized with CA-MRSA and CA-MSSA infections were prospectively identified.[22] It was more common for patients with CA-MRSA infections to have a household contact with similar infections (14% v. 3%, $p < 0.01$). Other factors associated with having CA-MRSA in that study were pulmonary disease and previous use of antibacterial agents in the past year.[22]

CA-MRSA has become a significant pathogen in SSTIs in many regions of Canada, including Ottawa. This is one of the few Canadian studies to assess the clinical presentation, risk factors, microbiology, and treatment of CA-MRSA infections presenting to the ED. Although the findings are similar to those of other Canadian studies describing the epidemiology of MRSA SSTIs in adults, our study is unique because the assessment of risk factors was based on a case-control design and allows for a more robust comparison between skin and soft tissue infections caused by MRSA versus MSSA. Management strategies are still evolving for these infections, and it remains unclear whether changing empirical therapy for these infections will lead to improved outcomes.

CONCLUSION

MRSA SSTIs in TOHEDs mainly occur in a population that is young and transient with comorbidities such as hepatitis C and substance abuse.

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REFERENCES

1. Taylor G, Kirkland T, Kowalewska-Grochowska K, et al. A multistrain cluster of methicillin-resistant Staphylococcus aureus based in a native community. *Can J Infect Dis Med Microbiol* 1990;1:121-6.
2. Shahin R, Johnson IL, Jamieson F, et al. Methicillin-resistant Staphylococcus aureus carriage in a child care center following a case of disease. Toronto Child Care Center Study Group. *Arch Pediatr Adolesc Med* 1999;153:864-8.
3. Gilbert M, Macdonald J, Gregson D, et al. Outbreak in Alberta of community-acquired (USA300) methicillin-resistant Staphylococcus aureus in people with a history of drug use, homelessness or incarceration. *CMAJ* 2006;175:149-54, doi:10.1503/cmaj.051565.
4. Main CL, Jayaratne P, Haley A, et al. Outbreaks of infection caused by community-acquired methicillin-resistant Staphylococcus aureus in a Canadian correctional facility. *Can J Infect Dis Med Microbiol* 2005;16:343-8.
5. Pallin DJ, Egan DJ, Pelletier AJ, et al. Increased US emergency department visits for skin and soft tissue infections, and changes in antibiotic choices, during the emergence of community-associated methicillin-resistant *Staphylococcus aureus*. *Ann Emerg Med* 2008;51:291-8, doi: 10.1016/j.annemergmed.2007.12.004.
6. Moran GJ, Krishnadasan A, Gorwitz RJ, et al. Methicillin-resistant S. aureus infections among patients in the emergency department. *N Engl J Med* 2006;355:666-74, doi:10.1056/NEJMoa055356.
7. Moran GJ, Amii RN, Abrahamian FM, et al. Methicillin-resistant Staphylococcus aureus in community-acquired skin infections. *Emerg Infect Dis* 2005;11:928-30, doi:10.3201/eid1106.040641.
8. Adam HJ, Allen VG, Currie A, et al. Community-associated methicillin-resistant *Staphylococcus aureus*: prevalence in skin and soft tissue infections at emergency departments in the

Greater Toronto Area and associated risk factors. *CJEM* 2009;11:439-46.

9. Al-Rawahi GN, Reynolds S, Porter SD, et al. Community-associated CMRSA-10 (USA-300) is the predominant strain among methicillin-resistant *Staphylococcus aureus* strains causing skin and soft tissue infections in patients presenting to the emergency department of a Canadian tertiary care hospital. *J Emerg Med* 2010;38:6-11, doi:10.1016/j.jemermed.2007.09.030.
10. Charlebois M, Lau W, MacDonald J, et al. Enhanced population-based surveillance for CMRSA10 (USA300) in a large Canadian health region. Poster session presented at the CHICA Canada National Education Conference; 2007 Jun 9–14; Edmonton, AB.
11. Jessamine P, Ramotar K, Desjardins M, et al. Clinical and epidemiologic features of patients with CMRSA-7 or CMRSA-10 at a tertiary care hospital. Poster session presented at the AMMI Canda-CACMID Annual Conference; 2007 Mar 14–18; Halifax NS.
12. Ramotar K, Desjardins M, Roth V, et al. Trends in the molecular epidemiology of methicillin resistant Staphylococcus aureus (MRSA) in eastern Ontario (EO). Poster session presented at the AMMI Canda-CACMID Annual Conference; 2007 Mar 14-18; Halifax, NS.
13. Stenstrom R, Grafstein E, Romney M, et al. Prevalence of and risk factors for methicillin-resistant *Staphylococcus aureus* skin and soft tissue infection in a Canadian emergency department. *CJEM* 2009;11:430-8.
14. Adlaf EM, Begin P, Sawka E, editors. *Canadian Addiction Survey (CAS): a national survey of Canadians' use of alcohol and other drugs: prevalence of use and related harms: detailed report*. Ottawa: Canadian Centre on Substance Abuse, Health Canada; 2005.
15. Embil J, Ramotar K, Romance L, et al. Methicillin-resistant *Staphylococcus aureus* in tertiary care institutions on the Canadian prairies 1990-1992. *Infect Control Hosp Epidemiol* 1994;15:646-51, doi:10.1086/646827.
16. Lina G, Piémont Y, Godail-Gamot F, et al. Involvement of Panton-Valentine leukocidin-producing *Staphylococcus aureus* in primary skin infections and pneumonia. *Clin Infect Dis* 1999;29:1128-32, doi:10.1086/313461.
17. Oliveira DC, Tomasz A, de Lencastre H. Secrets of success of a human pathogen: molecular evolution of pandemic clones of methicillin-resistant *Staphylococcus aureus*. *Lancet Infect Dis* 2002;2:180-9, doi:10.1016/S1473-3099(02)00227-X.
18. Duong M, Markwell S, Peter J, et al. Randomized, controlled trial of antibiotics in the management of community-acquired skin abscesses in the pediatric patient. *Ann Emerg Med* 2010;55:401-7, doi:10.1016/j.annemergmed.2009.03.014.
19. Schmitz GR, Bruner D, Pitotti R, et al. Randomized controlled trial of trimethoprim-sulfamethoxazole for uncomplicated skin abscesses in patients at risk for community-associated methicillin-resistant *Staphylococcus aureus* infection. *Ann Emerg Med* 2010;56:283-7, doi:10.1016/j.annemergmed.2010.03.002.
20. Golding GR, Levett PN, McDonald RR, et al. A comparison of risk factors associated with community-associated methicillin-resistant and -susceptible *Staphylococcus aureus* infections in remote communities. *Epidemiol Infect* 2010;138:730-7, doi:10.1017/S0950268809991488.
21. Skiest DJ, Brown K, Cooper TW, et al. Prospective comparison of methicillin susceptible and methicillin-resistant community-associated Staphylococcus aureus infections in hospitalized patients. *J Infect* 2007;54:427-34, doi:10.1016/j.jinf.2006.09.012.
22. Davis SL, Perri MB, Donabedian SM, et al. Epidemiology and outcomes of community-associated methicillin-resistant *Staphylococcus aureus* infection. *J Clin Microbiol* 2007;45:1705-11, doi:10.1128/JCM.02311-06.

APPENDIX: VARIABLES OF INTEREST

Demographics

- Sex
- Date of visit to ED
- Date of birth/age
- Address/current residence category

Clinical

- Presenting type of SSTI (e.g., impetigo, boil, abscess, cellulitis, necrotizing fasciitis, other)
- Presence of accompanying pneumonia, sepsis, or other type of infection
- Number of sites involved for SSTIs
- Anatomic location of the SSTI
- Date of symptom onset if available
- Number of days from symptom onset to the ED visit
- Treatment prior to the ED visit
- Type of treatment received prior to the ED visit
- If an antibiotic was prescribed and what type of antibiotic
- Duration of treatment with the antibiotic prior to the ED visit
- Types of treatment received in the ED (including types of antibiotics)
- If there was a change from the initial class of antibiotic chosen to treat the patient
- Disposition (e.g., admitted or discharged)
- Antibiotics prescribed on discharge from the ED
- Type of treatment prescribed if the patient was admitted
- If there was a change from the ED choice of antibiotics prescribed
- Number of days between the ED visit and the treatment change while in hospital

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- Outcome of the hospital admission
- Outcome within 30 days of discharge from the ED if available
- If there were other episodes of SSTI in the year prior to or after this episode as documented in the health record
- Date of other episodes
- Previous or subsequent cultures taken
- Pathogen isolated on previous or subsequent cultures
- Presence of comorbid conditions (HIV, hepatitis B or C, diabetes mellitus, chronic skin disease [e.g., eczema, psoriasis], psychiatric history, substance abuse history)
- If substance abuse history present, the types of substances used
- Antibiotic received prior to the ED visit, in the ED, or while admitted to hospital and its appropriateness based on the susceptibility profile of the organism
- Timing of appropriate antibiotics in relation to the ED visit
- Clinical improvement prior to the patient receiving appropriate antibiotics if MRSA was isolated

Laboratory

- Result of cultures taken from the site of infection
- Susceptibility profile of the organism isolated
- Strain type based on PFGE analysis and the Canadian MRSA classification system
- SCC mec type based on molecular analysis
- *PVL* assay results
- Results of other cultures taken and types of cultures that were taken

Risk Factors

- Occupation (e.g., health care worker)
- ED visit in the 12 months prior to presentation with SSTI
- Hospital admission in 12 months prior to presentation with SSTI
- Outpatient clinic visit in the 12 months prior to presentation with SSTI
- Home care services in the 12 months prior to presentation with SSTI
- Presence of indwelling medical device and type of device at the time of the ED visit or in the 12 months prior to presentation with SSTI
- Dialysis therapy
- Resident in a long-term care facility in the 12 months prior to presentation with SSTI
- Surgery in the 12 months prior to presentation with SSTI
- Colonization or infection with MRSA in the past at any time
- Colonization or infection with MSSA in the past at any time
- Screening cultures for MRSA in the year prior to presentation with SSTI
- Antibiotic treatment in the 12 months prior to presentation with SSTI
- Incarceration at the time of the presentation with SSTI
- Past incarceration (at any time)
- Homelessness in the 12 months prior to presentation with SSTI
- Sex trade worker in the 12 months prior to presentation with SSTI
- Aboriginal ethnicity
- Travel to the United States in the 3 months prior to presentation with SSTI
- Travel to other parts of Canada in 3 months prior to presentation with SSTI
- Member of armed forces
- Living in a group home or shelter in the 12 months prior to presentation with SSTI
- Daycare attendance if a child
- Contacts with SSTI symptoms
- Member of other high-risk group such as athletes or men who have sex with men

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