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The relation between positive screening results and MRSA infections in burn patients

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ABSTRACT

Introduction: Methicillin-resistant *Staphylococcus aureus* (MRSA) is a key pathogen in burn patients. Several factors put them at increased risk of MRSA infection: partial loss of the skin barrier, the immune-compromising effects of burns, prolonged hospital stays, and invasive procedures. This study aims to find the relation between MRSA screening swab cultures taken within 48 h of admission, weekly surveillance cultures, and MRSA infection secondary to colonization.

Methods: The data of all burns patients admitted to the referral centre for burns from 2012 to 2016 were reviewed. MRSA cultures taken at admission and on weekly surveillance screening, including nasal, perianal, and wound swabs, were reviewed. To determine associations between MRSA colonization and infection rates, both MRSA-positive and MRSA-negative swab cultures were included in the analysis. Several risk factors were considered: age, gender, ethnicity, %TBSA, BAUX index, inhalational injury, ICU admission and days, need for ventilator support and days, length of stay (LOS) in hospital, and complications. Univariate and multiple logistic regression analyses were used to predict correlations between positive swab cultures and risk factors.

Results: Data from 396 patients were reviewed. The median age at admission for the burn patients was 46 (IQR: 31–59) years. On admission, 2.5% of patients were MRSA positive, whereas 17.9% were found to be MRSA positive on weekly surveillance screening. At surveillance, 60.6% developed an infection secondary to MRSA colonization. An MRSA infection was not identified for any patient who did not have at least one positive admission or surveillance swab. A statistically significant association was found between any positive swab and MRSA infection ($P < 0.001$).

The median number of complications reported in the MRSA-positive group was 2 (IQR: 1–3) versus 0 (IQR: 0–1) in the MRSA-negative group and the median length of hospital stay in the MRSA-positive group was 34.5 (IQR: 20.25–56.25) days versus 7 (IQR: 3–16) days in the MRSA-negative group ($P < 0.001$).

Conclusion: Nosocomial MRSA colonization rates are high, and patients incurring infections experience a greater than average LOS in hospital and complications. Over 60% of patients who had a positive swab culture at surveillance developed an infection, whereas, no patient with a negative MRSA swab status developed an infection. Hence, pragmatic prevention strategies have to be implemented.

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1. Background

Methicillin-resistant *Staphylococcus aureus* (MRSA) has been increasingly difficult to combat since it was first described in 1961 [1]. The first hospital outbreak of MRSA was at the Boston City Hospital in the United States in 1968 [2]. In the burns literature, MRSA has been described as a key microorganism in severe burn wounds and has been related to increased rates of morbidity and mortality [3]. Previous studies have noted the anterior nares to be the most common reservoir of MRSA colonization [4]. This has led to screening practices around the world. In many burn centres, the protocol is to screen for MRSA in the perianal and wound areas as well [4,5]. Nasal, perianal, and wound sites are an optimum combination of anatomic sites for specimen sampling for MRSA screening strategies. A combination of these anatomical sites increases the sensitivity of MRSA detection [6,7]. Burn-injured patients are at increased risk of infection secondary to colonization due to their loss of a protective skin barrier, state of immunosuppression, greater number of invasive procedures, and prolonged length of stay (LOS) in hospital due to the extent of their secondary complications, including graft loss [8]. In hospitals, a burn-injured patient's MRSA status can be quickly determined using a non-invasive and cost-effective means of MRSA detection: screening and surveillance swab cultures [9].

The prevalence of antibiotic-resistant organisms (ARO) in the burn patient population admitted to the Burn, Trauma and High Acuity Unit (BTHAU) at Vancouver General Hospital (VGH) was recently described, including how the implementation of universal contact precautions has affected ARO transmission [10]. MRSA was found to be the most common ARO (74.7%) in the burns population. This result is consistent with reports from burn centres around the world [11].

In May 2017, a situation-background-assessment-recommendation (SBAR) report was created by the VGH BTHAU Infection Control Practitioner, who noted a spike in MRSA transmission on the BTHAU. Current interventions–including but not limited to environmental adenosine triphosphate (ATP) swabs, hand hygiene plates, enhanced clean sweep and cleaning due to MRSA bio-burden, and fewer bed moves for the burn patient population on the BTHAU–have not reduced MRSA transmission.

Though many resources have been directed at its eradication, the MRSA bio-burden persists. Infection control policy still mandates MRSA detection via screening and surveillance, but the use of swab cultures to predict infection has generally been excluded in previous work.

There is a need to further evaluate screening and surveillance culture swabs taken for MRSA. When swabs are taken at admission and weekly thereafter, colonization is found early and preventive measures can be taken to prevent infections. Establishing infection rates secondary to colonization has the potential to inform infection control policies in hospitals and reveal an unmet need for effective, up-to-date, and safe prophylactic measures.

To our knowledge, the relation between positive screening and surveillance swabs (nasal, perianal, and wound) and incidence of infection has not been established in the burn population. The aim of this work is to determine, using screening and surveillance culture swabs, the proportion of burn-injured patients who are colonized with MRSA and determine their risk for developing an infection and subsequent complications. Though swab cultures can only indicate whether MRSA is present, it is important to determine their predictability of infection in order to justify whether prophylactic methods for infection control can be implemented for burns patients. Currently, the method of action is "after the fact"— after a clinical infection presents, antibiotic therapy is started. Our study proposes to show evidence for the use of prophylactic measures to prevent or reduce the likelihood of a clinical infection from incurring in the first place when a positive MRSA swab is received.

2. Patient and methods

2.1. Study population

We retrospectively reviewed the 5-year-data of all burn patients admitted to the BC Professional Firefighters' BTHAU at VGH from January 1, 2012 to December 31, 2016 using the BC Burn Registry database and the hospital's online medical records.

2.2. Study data

The National TRACS software (NTRACS) burns database was used to extract complete patient information, including: age, gender, ethnicity, burn percentage of total body surface area (% TBSA), BAUX index (age + %TBSA), inhalational injury, ICU admission and days, need for ventilator support and days, LOS in hospital, and complications. The Patient Care Information System (PCIS) was used to extract data on screening and surveillance MRSA swab cultures, including nasal, perianal, and wound site. Respiratory, urine and catheter, blood, tissue and bone, cultures, and biopsies data were also correlated. Infection and complications data for the burns patients were extracted using the burns database and through a thorough review of admission, consultation, operating room, discharge, outpatient burns clinic, and dictation notes of all physicians in charge of each patient admitted to the BTHAU during the study period.

2.3. Standard infection control protocol at VGH

2.3.1. Infection control admission screening tool for high-risk units

All patients with any risk factor(s) admitted to high-risk units have intranasal, perianal, and, if applicable, wound MRSA screening swabs collected within 48 h of admission. High-risk units include Bone Marrow Transplant, Solid Organ Transplant, Intensive Care Unit (ICU), and BTHAU. Patients are not screened for MRSA if they are already identified in the BC Electronic Health Record as MRSA carriers. The MRSA risk assessment criteria includes (1) hospital or residential admission in the past 12 months, (2) hemodialysis or chemotherapy in the past 12 months, and/or (3) residence in a shelter, group home, correction facility, or history of homelessness or illegal drug use in the past 12 months. Patients screened positive for MRSA are isolated on admission [12].

2.3.2. BTHAU surveillance protocol

Every patient admitted to the BTHAU is screened for MRSA on admission and every week thereafter on Monday for surveillance, unless the patient is already MRSA positive. Intranasal, perianal, and wound swab cultures are collected. If a patient tests positive for MRSA and has been in hospital <48 h, then it is considered community acquired rather than hospital acquired. Patients colonized or infected with MRSA are put on standard contact precautions, which include a private room or placement in a room with another patient with MRSA, ideally with a private bathroom. Hand washing before entering and leaving the patient's room, and gowning with gowns and gloves are required for both hospital personnel and visitors. The latter are asked to report to the nursing station before entering the patient's room, to ensure they are informed about infection-control protocol.

2.4. Microbiological methods

Swab cultures were collected using eSwab (Copan Diagnostics Inc., Murrieta, CA, USA). Screening swabs were plated to chromogenic agar (MRSA Select, Bio-rad Laboratories (Canada) Ltd, Montreal, QC, Canada) and incubated for 24 h at 35 °C. Pink colonies that were gram positive coagulase positive were then confirmed as *S. aureus* by Maldi-Tof (Bruker MALDI Biotyper, Bruker Library 7311).

To define colonization and infection in burns patients, we used (1) the American Burn Association Consensus Conference to Define Sepsis and Infection in Burns and (2) the Centers for Disease Control (CDC) Surveillance Definitions: National Healthcare Safety Network (NHSN) Patient Safety Component Manual 2018 [13,14]. MRSA colonization is the carriage of MRSA without the pathological, clinical evidence, or signs and symptoms of an infection. An MRSA concentration $<10^5$ pathogens/g tissue is considered colonization [13].

The CDC definitions for specific types of infection, particularly burn infection, encompass two pertinent criteria: (1) the burn wound has a change in characterization or appearance—e.g., rapid eschar separation or discoloration (brown, black, or violaceous) of the eschar; and (2) an organism identified by culture on microbiological testing for clinical diagnosis or treatment [14]. For the purposes of this study, specific infections were identified using the CDC Surveillance Definitions for Specific Types of Infections [14].

2.5. Statistical analysis

All analyses were done using R package for statistical computing (V3.3.3). All statistical tests are two-sided. The statistical significance level was set at 0.05. No corrections for multiple comparisons were undertaken. We considered frequency tables to assess the compliance level of testing at admission and at surveillance. We performed comparisons of colonization detected at admission and colonization detected at surveillance using chi-square tests of independence for categorical variables. We also compared how many who had positive or negative swabs at admission then had positive or negative swabs at surveillance. A logistic regression model was used to estimate the association of having a positive test at admission with the MRSA infection status, after adjusting for the effect of other covariates namely age, gender and the year of admission. We considered associations between clinical variables and screening at surveillance as well as associations between clinical variables and MRSA infections. P-values were computed using a one-way analysis of variance when variables were continuous and a chi-square test when variables were categorical. A logistic regression was performed to determine the characteristics that might have a high association with a positive infection status, adjusting for a positive MRSA result.

3. Results

A total of 396 patients were included in the study analysis. The median age was 46 (IQR: 31–59) years, and 73% were male. A median BAUX index of 60 (IQR: 43–77) and an 8 (IQR: 4–19) % TBSA were recorded. Of this cohort, 10% of patients had inhalational injuries verified with bronchoscopy, 33% were admitted to ICU for a median 10 days (IQR: 4–19) (1.3 day/% TBSA) and 33% were on ventilator support for a median 7 days (IQR: 3–14) (0.9 day/%TBSA), with a total median LOS in hospital of 10 (IQR: 4–25) days (1.3 day/%TBSA).

To determine the relationship between screening and infection due to multiresistant bacteria in burns, we looked at MRSA colonization at admission and surveillance and determined the correlation between positive swab cultures and MRSA infection.

3.1. Part 1. Cultures on admission

In total, 10 (2.5% of the total patients) swabbed positive within 48 h of admission for MRSA at either nasal (5), perianal (3), or wound site (4) and 65 patients were confirmed negative for MRSA with all three swabs. For 321 (81.15%) patients, all swabs that were taken were negative but most of these patients had at least one at-admission swab missing, so the MRSA status could not be conclusively determined. (Table 1).

Out of the 321 patients who did not undergo all three MRSA swabs at admission, the highest noncompliance rate was for wound-site swab tests. Nasal swab compliance (87%) and perianal swab compliance (85%) were high, compared to only 20% for wound-site compliance (Table 1).

Of those who screened positive at admission, 5/10 (50%) developed an MRSA infection during their hospital stay. Of those who screened negative on all three culture swabs at

Table 1 – Percentage of patients that tested positive on swabs at admission.

	Negative	Positive	Not tested	Compliance
Nasal swab at admission	339 (99%)	5 (1%)	52	344 (87%)
Perianal swab at admission	332 (99%)	3 (1%)	61	335 (85%)
Wound-site swab at admission	76 (95%)	4 (5%)	316	80 (20%)

Note: Percentages calculated for swabs taken.

Table 2 – Cultures at surveillance.

	Negative	Positive	Not tested	Compliance
Nasal swab surveillance	178 (85%)	32 (15%)	186	210 (53%)
Perianal swab surveillance	170 (81%)	40 (19%)	186	210 (53%)
Wound-site swab surveillance	109 (69%)	48 (31%)	239	157 (40%)

Note: Percentages calculated for swabs taken.

admission, 5/65 (7.7%) incurred an MRSA infection. A chi-squared test is statistically significant for the association between any positive swab for MRSA at admission and MRSA infection (p = 0.002).

3.2. *Part 2. Surveillance cultures*

Of the 396 patients, 71 (17.9%) were confirmed positive for MRSA at surveillance, which means that their status converted from MRSA negative (or unknown) to MRSA positive (Table 2). Of the 65 who were confirmed negative for MRSA at admission, only 19 (29%) were screened again using all three culture swabs; of those, 5 (26%) were found to be MRSA positive.

The compliance rate for testing at surveillance was lower than at admission, with only 38% receiving all three negative swab cultures or at least one confirmed positive test (Table 2).

Of the 71 patients who screened positive on the weekly surveillance, 43 (60.6%) developed an MRSA infection. An MRSA infection was not identified for any patient who did not have at least one positive swab. A chi-squared test is statistically significant for the association between any positive swab at surveillance and MRSA infection (P < 0.001) (Table 3).

Table 3 – Percentage of patients who screened positive/negative at surveillance for colonization that later developed MRSA infection.

		MRSA infection at surveillance		
		No	Yes	P-value
Nasal swab at surveillance	Negative	160 (93.6%)	18 (46.2%)	0.000
	Positive	11 (6.4%)	21 (53.8%)	
	Missing	139	7	
Perianal swab at surveillance	Negative	154 (90.1%)	16 (41%)	0.000
	Positive	17 (9.9%)	23 (59%)	
	Missing	139	7	
Wound-site swab at surveillance	Negative	104 (90.4%)	5 (11.9%)	0.000
	Positive	11 (9.6%)	37 (88.1%)	
	Missing	195	4	
Any three swabs at surveillance	Negative	81 (74.3%)	0 (0%)	0.000
	Positive	28 (25.7%)	43 (100%)	
	Missing	201	3	

Note: "Any Three Swabs at Surveillance" is positive if the patient had any positive swabs, negative if all three were negative, and missing if not all three were tested.

3.3. *Part 3. Clinical correlates and infection*

Clinical associations between patient context and MRSA colonization were made to predict who would get an MRSA infection (Table 4). In the population that developed MRSA infection, the median age was 47 (IQR: 31–59) years, the BAUX index was 77 (IQR: 64–93), the %TBSA was 29 (IQR: 13–43), the LOS in hospital was 45 (IQR: 33–66) days (1.6 days/%TBSA), and male predominance was 78%. In comparison, in the population of patients who did not develop infection, there was no difference in the age but the BAUX index, %TBSA, and LOS in hospital were all less in the non-MRSA group. When patients' ethnicities were compared, the largest proportion developing infection were Caucasians (78%), followed by Indigenous (13%). Of the patients who incurred infection, 74% were admitted to ICU, with a median ICU stay of 14 (IQR: 0–22) days (0.48 days/%TBSA), and 74% were on ventilator support for a median 9 (IQR: 0–18) of days (0.31 days/%TBSA). Comparably, in the population of patients who did not develop an infection, less patients were on ventilator support or admitted to ICU for a significantly fewer number of days. No significant change in infection rate was found when comparing year of diagnosis during the study period.

Even after accounting for clinical correlates, any positive MRSA culture is significantly associated with MRSA infection (P < 0.001). All 46 patients who developed an MRSA infection had at least one positive swab culture, whereas no patient without at least one positive MRSA swab developed an infection. In these patients, complications included, pneumonia, bacteremia, septicemia, urinary tract infection, surgical site infection, wound infection, cellulitis, and necrotizing fasciitis.

Considering the total population (N = 396), 38% of patients (MRSA positive and non-positive) had complications, of these patients, notably, 55.7% patients had respiratory complications and 52.35% had integumentary (skin, wound, soft tissue, and graft loss) complications (Fig. 1). The pulmonary complications were recorded mainly in those patients who received ventilator support; 77/131 (58.7%) patients who received ventilatory support developed pulmonary complications. The median number of complications reported in the MRSA-positive group was 2 (IQR: 1–3) versus 0 (IQR: 0–1) in the MRSA-negative group (Fig. 2). In the MRSA positive group, approximately half of the patients who presented with infection had graft loss and an additional 6 patients colonized with MRSA had graft loss. Whereas, only 18 of the non-colonized patients had graft loss. The median length of hospital stay in the MRSA-positive group was 34.5 (IQR: 20.25–56.25) days versus 7 (IQR: 3–16) days in the MRSA-negative group (P < 0.001) (Fig. 3). Positive MRSA swab or MRSA infection (at admission or at surveillance) was associated with a greater number of complications in hospital.

4. Discussion

Screening and surveillance cultures remain the gold standard for the detection of MRSA colonization. Routine swab cultures for detection are favored over quantitative sampling such as tissue biopsies, owing to their non-invasive nature and cost-

Table 4 – Clinical associations with MRSA infection.

		MRSA infection			
		No	Yes	Total	P-value
	N	310	46	396	
Age at diagnosis	Median (IQR)	46.5 (32–60)	46.9 (31–59)	46.3 (31–59)	0.872
BAUX index	Median (IQR)	59.4 (42–76)	76.9 (64–93)	59.8 (43–77)	<0.001
%TBSA	Median (IQR)	8.5 (4–18)	29 (13–43)	8.5 (4–19)	<0.001
ICU admission days	Median (IQR)	0 (0–2)	13.5 (0–22)	0 (0–4)	<0.001
Ventilator days	Median (IQR)	0 (0–1)	9 (0–18)	0 (0–2)	<0.001
LOS in hospital	Median (IQR)	9.5 (4–19)	45 (33–66)	10 (4–25)	<0.001
Gender	F	83 (26.8%)	10 (21.7%)	93 (26.1%)	0.585
	M	227 (73.2%)	36 (78.3%)	263 (73.9%)	
Ethnicity	Indigenous	15 (4.9%)	6 (13%)	21 (6%)	0.204
	Asian	36 (11.8%)	2 (4.3%)	38 (10.8%)	
	Black	6 (2%)	0 (0%)	6 (1.7%)	
	East Indian	15 (4.9%)	1 (2.2%)	16 (4.6%)	
	Hispanic	2 (0.7%)	0 (0%)	2 (0.6%)	
	Other	5 (1.6%)	1 (2.2%)	6 (1.7%)	
	Caucasian	226 (74.1%)	36 (78.3%)	262 (74.6%)	
Inhalational injury	No	283 (91.3%)	35 (76.1%)	318 (89.3%)	0.004
	Yes	27 (8.7%)	11 (23.9%)	38 (10.7%)	
ICU admission	No	221 (71.3%)	12 (26.1%)	233 (65.4%)	<0.001
	Yes	89 (28.7%)	34 (73.9%)	123 (34.6%)	
Ventilator support	No	219 (70.6%)	12 (26.1%)	231 (64.9%)	<0.001
	Yes	91 (29.4%)	34 (73.9%)	125 (35.1%)	
Any positive MRSA test	No*	14 (30.4%)	0 (0%)	14 (15.2%)	<0.001
	Yes*	32 (69.6%)	46 (100%)	78 (84.8%)	

Note: No — These patients had all swabs (intranasal, perianal, and wound) negative at admission and at surveillance.
Yes — These patients had at least one positive swab at admission and/or at surveillance.

effectiveness for the laboratory in terms of technical and processing time and media requirements [15]. Yet swab compliance rates are low, and MRSA infections continue to affect a large percentage of patients admitted to the BTHAU. Our study shows that 2.5% of patients admitted to the unit were colonized with MRSA at admission, which is higher than the 1.0% MRSA carriage for cardiac, orthopedic, spinal, vascular, thoracic, and neurosurgical patients admitted to VGH for elective surgery [16]. At surveillance-which is considered any time after 48 h since admission to the BTHAU-17.9% of burns patients were found to be colonized with MRSA. Approximately 60% of the patients colonized with MRSA at surveillance went on to develop an MRSA infection secondary to having a positive MRSA swab culture. Every patient who incurred an infection had at least one swab (nasal, perianal, or wound) positive for MRSA, whereas no patient

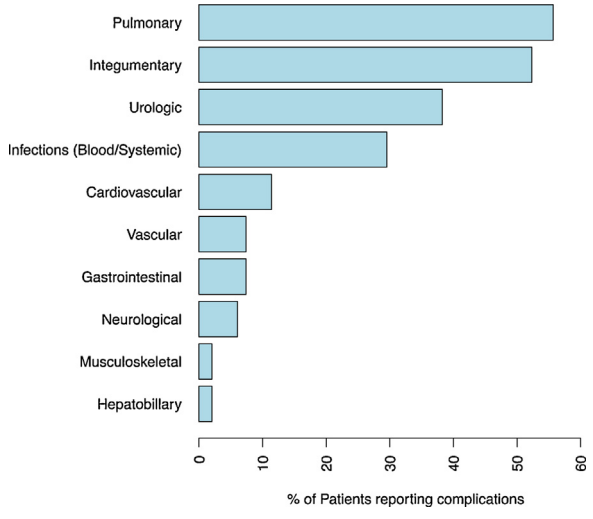

Fig. 1 – Complications reported in the percentage of patients (N = 149) who had a complication.

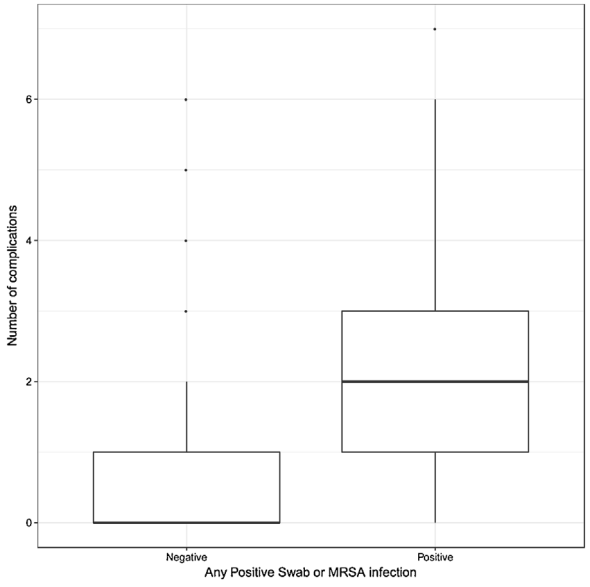

Fig. 2 – MRSA positive swab or MRSA infection (at admission or at surveillance) associated with median number of complications ($p < 0.001$).

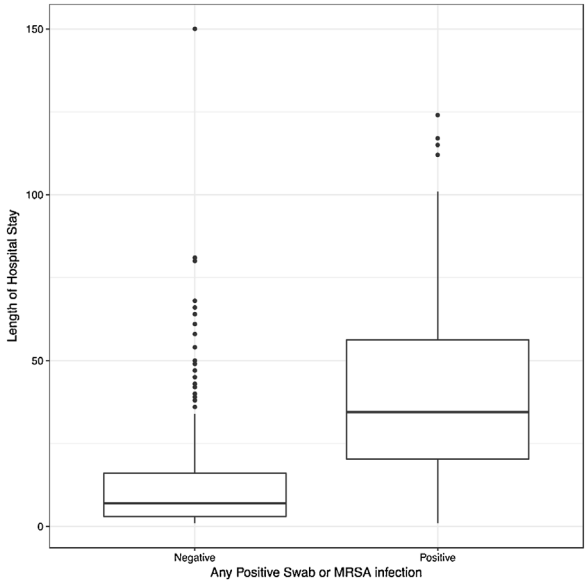

Fig. 3 – MRSA positive swab or MRSA infection (at admission or at surveillance) associated with median LOS in hospital ($p < 0.001$).

with MRSA-negative status developed an infection. A positive MRSA swab is strongly correlated with infection ($P < 0.001$).

The compliance in taking wound swabs on admission was poor. This gives reason for speculation what the true rates of MRSA positive/negative patients were at that given time. The incidence of MRSA positives on admission was 2.5% with only 16.9% of patients receiving all three screening swabs. Eighty three percent of patients did not have all swabs taken. If the remaining 83% were all truly negative, the incidence would drop to 2.5%. On the other hand, true positive wound swabs (that were taken) were found in 5% of patients (Table 1). If the non-screened 316 patients had 5% positive wounds swabs as well, the incidence of positive wound swabs in the whole study population would be 20 patients giving a 5% incidence (20/396), which is quite high.

MRSA screening and surveillance compliance was revealed to be staggeringly low, the lowest compliance being with wound-site swabs, yet a positive wound culture has the strongest correlation with MRSA infection ($P < 0.001$). The likely reason that could account for low wound-site swab compliance is that the wounds are covered with dressings when other swab cultures are taken.

The compliance rate for wound-site swabs is 20% at admission and 40% at surveillance; both figures are lower than for nasal and perianal compliance at admission and surveillance. Patients admitted to a burn unit are a unique subset at higher risk of invasive infections. Due to varying degrees of skin loss and immunosuppression, it is important that all wounds be swabbed and cultured [17,18]. There is a risk of creating a point source and reservoir for MRSA when a patient is missed on admission for routine screening and cultures [19]. Modes of transmission of MRSA can include contact, droplet and airborne; direct or indirect contact by either the hands of healthcare providers caring for the patient or from contact with equipment in the patients' room that has not been adequately decontaminated [20]. As noted earlier, environmental ATP swabs, hand hygiene plates, enhanced clean sweeps and cleaning due to MRSA bio-burden, and reduced bed moves for patients on the BTHAU have not significantly reduced transmission. One reason could be that some patients are point sources, but because they are not being swabbed according to infection control protocols, the MRSA burden on the unit is being increased. Knowledge of colonization prompts the mobilization of isolation precautions and may prevent the transmission of organisms between patients and healthcare personnel as well as to future patients admitted to the unit [21,22].

Although burn centres perform bacteriological swab cultures for MRSA as screening and surveillance infection control measures, their value is not being fully utilized, especially if compliance and surveillance is low and no prophylactic infection strategies are implemented when a positive swab culture is received. Hence, we question whether we reap full utility of taking surveillance swab cultures if no steps are taken to reduce the MRSA colonization load until an infection has clinically resulted. Therefore, active measures, in addition to protocol adherence and increased screening vigilance, should be implemented when positive surveillance swab results occur.

Clinical infection may lead to greater use of vancomycin on units, as it remains the mainstay antibiotic to combat MRSA [23]. In our centre, all antibiotics are initiated based on sensitivity reports. In more serious infections IV Vancomycin was used. Since its discovery, no other drug has been used to the same extent, but its rampant use has been discouraged by hospital infection control advisory committees to prevent vancomycin resistance in general and specifically vancomycin-resistant enterococci (VRE) [23,24]. Following the introduction of environmental cleaning and antimicrobial stewardship horizontal infection control measures, the rates of VRE infection have significantly decreased at VGH [25]. Further, other studies and a meta-analysis have linked antibiotic exposure to a 1.8-fold increase in the chance of MRSA acquisition, further leading us to question the appropriateness of using vancomycin for infection control purposes [9]. On the other hand, MRSA infections lead to complications and increased healthcare costs, so some kind of prophylactic measure should be taken when MRSA colonization is recognized [8].

Our study shows that patients who were MRSA positive or developed an infection secondary to MRSA had a 5-times longer LOS and twice the number of complications compared to patients who were MRSA negative. No patients in our study who incurred an MRSA-infection were MRSA negative on surveillance. Over 50% of patients with positive MRSA swabs had respiratory, skin, wound, and soft tissue complications, and a higher number of graft loss complications. This data confirms the fact that MRSA infection in a burn patient remains a serious complication and more laborious precautions are justified for prevention.

Nasal mupirocin and baths with 2% chlorhexidine are effective measures to reduce the MRSA burden and decrease infection in the burns population [8,26]. Though a reduced rate of hospital-acquired infections was found after the implementation of prophylactic decolonization procedures,

concerns about mupirocin and chlorhexidine resistance persist [8]. To assess decolonization therapy pre-operatively, a study using a novel approach of intranasal antimicrobial photodisinfection therapy in combination with chlorohexidine wipes for the reduction of surgical site infections for elective cardiac, orthopaedic, spinal, vascular, thoracic and neurosurgical surgeries at our centre, Vancouver General Hospital. The photodisinfection component of the decolonization therapy included applying a photosensitizer dye of 0.1% methylene blue solution to the anterior nares with illumination of a non-thermal red light (655 nm) [16]. This method was effective in reducing the *Staphylococcus* bioburden in the anterior nares, the most common site for MRSA colonization. However, in our study we also found higher rates of infection in those patients with wound-positive cultures compared to intranasal-positive cultures. This shows that for burns patients, in addition to nasal decolonization, wound decolonization may be a viable adjunctive method of germicidal targeting than intranasal mupirocin alone.

The germicidal efficacy of far-UVC light in reducing wound MRSA colonization has been shown without inducing mammalian skin damage [27,28]. Far-UVC light in the wavelength range of 207–222 nm has germicidal efficacy for microbe sterilization, making this a potential method for preventing MRSA colonization. Burns patients are especially at risk for MRSA colonization, as they are exposed to various hospital settings, including but not limited to the operating room, ICU, and burn unit [29]. Airborne transmission has been implicated as a route of transmission for drug-resistant bacteria, including MRSA [30]. Ultraviolet (UV) light is well known for its germicidal efficacy in combatting air-borne pathogens [31]. While intriguing, use of light therapy for prophylaxis pre-operatively may help reduce bio-burden, however, further study is necessary to assess any posed risks to both patient and hospital personnel.

Drug resistance of microorganisms to antimicrobial drugs has become a major barrier to treating infection; successful treatment in the burns population requires further study of novel infection control approaches [32]. Along with innovation, monitoring of antibiotic consumption is necessary to ensure that these drugs are only administered when all other treatments have failed [33].

Our study has some limitations. First, the study was retrospective in nature. Secondly, due to low compliance rates for obtaining screening and surveillance cultures, complete data for all culture swabs (nasal, perianal, and wound) were not available for analysis. There is a possibility that the incidence rate of colonization and infection may have differed on the BTHAU, had all admission and surveillance swabs been taken. Thirdly, because this was a retrospective study, isolates of strains were not available for analysis as it is not the practice of the microbiology lab to save isolates for future purposes. Lastly, to obtain the most reliable bacterial counts we analyzed mainly culture swabs. For those patients who had tissue biopsies collected in the operating room; we also analyzed tissue biopsies, as well. Though there is limited evidence for this, to increase the sensitivity, it may be of benefit to have both swab and tissue biopsy results for all patients. Despite these limitations, the retrospective analysis included data from patients admitted to the BTHAU within the last five years, providing a current and representative sample of the colonization and infection burden on the unit.

5. Conclusion

Our study shows that swab cultures, especially those gathered at the wound site that are MRSA positive, have a positive predictive association with developing an infection. On the BTHAU over 60% of patients who had a positive swab culture at surveillance developed an infection, whereas, no patient with a negative MRSA swab status developed an infection. Novel studies and technologies should be considered as alternative germicidal methods to antibiotic therapy, to combat MRSA colonization when it is detected. Prophylactic methods should be implemented when an MRSA-positive swab culture is found, to mitigate or reduce the occurrence of subsequent infections and complications affecting patient morbidity and mortality.

Conflicts of interest

None.

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