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Major article

Environment surface sampling in 33 Washington State fire stations for methicillin-resistant and methicillin-susceptible *Staphylococcus aureus*

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Key Words:
MRSA
MSSA
Staphylococcal sample kit
Fire station disinfection protocols

Background: Methicillin-resistant *Staphylococcus aureus* (MRSA) and methicillin-susceptible *S aureus* (MSSA) were isolated from environment surfaces sampled from 33 Washington State fire stations.
Methods: Samples were collected by fire personnel using commercial testing swabs. One to 6 surfaces were sampled per swab with 20 swabs per station. Biochemical tests were used to confirm MRSA and MSSA isolates. A short survey designed to collect information on cleaning procedures in the stations was included in the kits.
Results: MRSA was isolated from 8.0% and MSSA from 18.5% of the 653 samples. Nineteen fire stations (58.0%) were MRSA positive, 27 stations (82.0%) were MSSA positive, and 14 stations (42.4%) were positive for both MSSA and MRSA. Three stations (9.0%) were negative for MSSA and MRSA. Twelve fire stations (37.5%) reported fire service professionals with MRSA needing medical care. Positive controls were detected at levels of $>10^2$ CFU/mL and negative controls were negative.
Conclusions: The kit system allowed sampling of >2,000 surfaces from fire stations across Washington State. This is the first time an estimate of the level of MRSA-infected fire personnel has been determined from multiple districts within a single state. Further work is needed to determine if these data can be extrapolated to other career-based fire stations across the country.

Staphylococcus aureus is part of the normal human flora and routinely isolated from the anterior nares, skin, axilla, perineum, and pharynx. In healthy humans from the community, 25%-35% carry methicillin-susceptible *S aureus* (MSSA) in their anterior nares.[1] Carriage varies by age with ~60% of the population intermittently colonized with *S aureus*.[2] During the past decade community-acquired methicillin-resistant *S aureus* (MRSA) has emerged as a major cause of disease in the general population with no health care exposure or known classic risk factors.[3] Approximately 60% of hospital patients colonized with MRSA developed a MRSA infection, whereas 25% of colonized patients develop an infection within 12 months of returning home from a hospital stay.[4] About one-third of patients newly identified as MRSA-positive develop subsequent MRSA infections regardless of whether or not they were colonized or previously infected.[5] People colonized or infected with MRSA and/or MSSA shed these bacteria into their environments, contaminating surfaces and fomites at concentrations sufficient for survival for extended periods of time. This allows for transfer to skin, clothing, and other fomites.[6] Hospitalized patients and patients in nursing homes may have MRSA colonization rates reaching 60% and these are the people commonly served by fire personnel and other first responders.

Previously, we sampled 9 different areas in the garages and living quarters at 2 fire stations in 2 districts within western Washington State.[7] In that study,[7] the Replicate Organism Detection and Counting (RODAC) plates detected 10%-40% of seeded bacteria and Sanicult transport swabs (Starplex Scientific, Etobicoke, Ontario, Canada) detected 10-100 CFU/mL under laboratory conditions. The Sanicult swabs identified 82% and the RODAC plates identified 18% of the 44 MRSA-positive samples.[7] Only 1 other study has reported both MRSA- and MSSA-contaminated surfaces in fire-related facilities.[8] In both studies, trained laboratory personnel did the environment sampling and in general 1 surface was collected per swab. In our first Washington State fire study,[7]

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nasal cultures were done on personnel from 1 fire district resulting in 22.5% MRSA-positive samples. One other study has looked at nasal colonization among emergency personnel from 2 fire departments in a small mid-Atlantic state where 6.4% had positive tests for MRSA.[9]

We determined that multiple surfaces ($\geq$2) could be sampled with a single swab. This reduced sampling and processing time for the 33 fire stations and >2,000 surfaces were sampled. Kits were assembled and sent to the fire stations where environment sampling was done by fire personnel. Samples were processed in a laboratory to determine if the percentage of MRSA- and MSSA-positive samples were similar to those obtained in our previous Washington State fire station study.[7] Positive MRSA controls were included in 6 kits to determine quality of the laboratory's detection limits. In addition, a short self-administered survey was developed to collect information on MRSA infections in fire personnel as well as cleaning and disinfection protocol information for individual stations.

MATERIALS AND METHODS

Composite surface sampling

We have previous experience with using Sanicult transport swabs with 1 mL solution for sampling fire station surfaces.[7] In that previous study[7] a single surface was sampled/swabbed and a substantial number of people were required to collect the samples and process the samples. One way to streamline the collection and processing was to sample multiple surfaces within a single area using a single swab. This allows for an increased number of surfaces to be sampled while reducing the number of swabs, processing time, and costs. To test this, a characterized environmental MRSA strain 9-48 was grown overnight to approximately 10^8 CFU/mL and then 100 μL fluid containing 10^1, 10^2, 10^3, 10^4, or 10^5 CFU were plated on cleaned sterilized gurney straps provided by a fire station. Multiple spots with 100 μL fluid were spread out to a 5 cm^2 area. The seeded strap was left in the biosafety cabinet for 1 hour to dry and then any remaining liquid was spread out and allowed to completely dry for an additional 1-2.5 hours. Both seeded and sterile areas were included on each strap. Four spots were sampled with each Sanicult swab (by moving the swab back and forth to cover the entire 5 cm^2 area) and then placed back into the tube. Swabbing was repeated with the other 3 areas. In each experiment, the first or last surface was seeded with MRSA the other 3 were not. After all 4 areas were swabbed, the swab was placed back in the tube and 1.5 mL Bacto m *Staphylococcus* broth (1.5×; Difco Laboratories, Sparks, MD) supplemented with a final concentration of 75 μg/mL polymyxin B and 0.01% potassium tellurite (Sigma-Aldrich, St Louis, MO) was added to the Sanicult tube and incubated in 5% carbon dioxide at 36°C as previously described.[7] Tubes were examined for growth at 24 and 48 hours and labeled positive if the liquid was turbid and there was black precipitate present. The experiments were repeated 3 times on separate days. Limited testing with soft surfaces indicated that recovery would be lower (10-100 times) than hard surfaces because the inoculum soaked into the surface rather than remaining on top.

Survival of MRSA on swabs

The MRSA strain 9-48 was grown overnight and 1 mL 10^1-10^5 CFU were added to the Sanicult swab containing 1 mL buffer and stored at room temperature (~22°C). Six tubes of each dilution for each test were set up and the experiment was repeated 3 times. Each day the swabs were vortexed and 0.1 mL samples were removed and placed into fresh tubes with supplemented Bacto m *Staphylococcus* broth and tested for ability to grow after incubation in 5% carbon dioxide at 36.5°C for 24-48 hours. Viability was defined as the ability of the strain to grow by 48 hours. Samples were shipped during the winter months and thus the potential for kits being exposed to 0°C was possible. To determine the effect of cold temperature ($\leq$0°C) on collected surface samples, we tested 2 additional sets of inoculated swabs incubated at 0°C from 6-48 hours before supplemented growth media was added to determine if exposure to low temperatures would reduce recovery of MRSA from positive samples.

Kits

The kits contained all supplies needed to conduct sampling, a survey, and a prepaid US Postal Service Priority Mail envelope for returning samples. The kit included directions and pictures on how to collect samples from various surfaces. Each kit had a WarmMark Indicator (37°C) and a ColdMark Indicator (0°C) (LabelMaster, Chicago, IL) that changed color if the temperature of the kit was above 37°C or below 0°C, a sheet with a list of surfaces to be sampled, and sample number tube labels. Each tube containing a sample swab was wrapped in parafilm and placed into a zippered plastic bag to prevent leakage. The kit was sent for processing via the US Postal Service in the prepaid mailer. A chain of custody form was also included in each kit. The stations were listed by number and the field blanks were randomly labeled in each kit but were not counted in the final results because all were negative and were specifically for quality control. All kits were returned to the Departmental Field Group where the kits were logged and the survey responses entered into a database. The kits were then transferred by Field Group personnel to the laboratory and processed within 2 hours of being received. Positive control samples were added to the kits before they were transported to the laboratory. Samples were processed the day of arrival or stored at room temperature and processed within 18 hours if they arrived late in the afternoon.

Environment surfaces sampled

Fire station recruiting was done in partnership with the Washington Fire Chief Association. Outreach activities to increase awareness of the project were done by attending firefighter association conferences, regional meetings, and workshops. Letters from personnel authorizing participation in the study were required before sending the kits out to individual stations. The study sampled 13.8% of stations (n = 33) from a total of 240 career-based fire stations in 28 different fire districts. Samples were collected November 2011-May 2012 from 6 eastern Washington State and 27 western Washington State fire stations. The area to be swabbed was a circle of approximately 6-7 cm in diameter (28-38 cm^2). Nineteen swabs were used for composite sampling of assigned surfaces, whereas the 20th swab was used to sample a single surface that each station chose that was not previously sampled. Two extra swabs were included in the kit that were not opened by the stations and used as field blanks (ie, negative controls). The environment surface areas to be sampled were based on 2 previous fire station studies[7,8] that determined which surfaces are most often MRSA positive. In addition, surfaces that had the highest risk of bare skin contact and locations amenable to cleaning and disinfecting were added.

Nine areas were sampled with 19 swabs. Medic truck sample areas included seat belts on driver and passenger sides (2 surfaces); the top and inside of the handles of 2 medical bags recently used inside a person's home during a call (4 surfaces); gurney straps, metal buckle, and ceiling grab bar (4 surfaces); diaphragm of the

stethoscope, inside of the blood pressure cuff, and pulse oximeter (3 surfaces); steering wheel, outside door handle (driver's side), mobile data computer keyboard/mouse, and passenger's arm rest (4 surfaces); and 3 different sections of work surface/bench to the right of the patient care area (3 surfaces). Fire engine/ladder truck test areas included the steering wheel, outside door handle (driver's side), mobile data computer keyboard/mouse, and passenger's arm rest (4 surfaces). Turnout gear test areas included the inside the rim of 2 helmets used recently during a call (2 surfaces) and the inside area of the left and right arm cuff that had been frequently used (2 surfaces). Bedroom test areas included 2 beds used by multiple personnel and the mattress pad at the head of each bed (2 surfaces). Living area surfaces tested included 2 pieces of furniture (a couch and a chair) (2 surfaces); 2 television remote controls and a landline telephone handle (3 surfaces); and 3 different chairs, 1 armrest of each (3 surfaces). In the office the following areas were tested: 3 different desks and their computer keyboard keys and space bar (6 surfaces). Kitchen areas sampled included the kitchen sink handles, refrigerator door handles, coffeepot dispenser, and dishwasher handle (6 surfaces) and 3 different sections of the kitchen table (3 surfaces). Bathroom areas tested included outside doorknob/plate on the men's bathroom, outside doorknob/plate on the women's bathroom, 2 sink handles and 2 toilet handles (6 surfaces), and 3 different sections of the bathroom counter in the men's bathroom (3 surfaces). Gym areas tested included 3 of the most commonly used equipment pieces swabbed where hands are placed (3 surfaces). A station's choice area was also tested, which included an item/surface selected by fire personnel that had not already been sampled (1 surface).

Processing of samples

To each Sanicult swab 1.5 mL Bacto m *Staphylococcus* broth supplemented with a final concentration of 75 μg/mL polymyxin B and 0.01% potassium tellurite (Sigma-Aldrich) (supplemented *Staphylococcus* broth) was added. The tubes were incubated in 5% carbon dioxide at 36.5°C until turbid (24-96 hours). The positive samples were those with growth and black precipitate.[7] Negative tubes were held for 7 days before being labeled as negative for staphylococci.

Detection of gene typing

S aureus and presumptive MRSA isolates were verified with the Staphaurex (Remel, Lenexa, KS) and Oxoid penicillin binding protein latex agglutination test (Oxoid Microbiology P, Basingstoke, UK). The MRSA isolates were screened for the presence of the *mecA* gene by polymerase chain reaction assay and were tested for the presence of the staphylococcal cassette chromosome *mec* (SCC*mec*) type I-V using polymerase chain reaction assays.[7,10] Those isolates that were not type I-V were labeled nontypeable (NT). Positive and negative controls were used for all assays. All isolates were frozen at −70°C.

Survey

A survey instrument was designed with questions based on a typical occupational health survey instrument and review of relevant literature that was reviewed by firefighters and, after modifications, piloted at 4 fire stations to determine response reliability. Additional questions were recommended by firefighters in the 4 pilot-test stations and were added to the final survey. Questions included fire station call volume, medical services, types of furniture in the living quarters, cleaning and disinfecting protocols in use at the station, type of cleaning products and disinfectants used, general information on MRSA outbreaks among staff, training, and use of infection control precautionary measures. The survey was self-administered with 1 survey done per station. The survey was completed by someone in the fire station anonymously. The individual who filled out the survey differed by station and this information was not collected. All data were maintained in Microsoft Access (Microsoft Corp, Redmond, Wash) by station number.

Statistical methods

The survey responses by each station were summarized and descriptive statistics or policies and practices were determined. Stations were classified into 2 groups based on presence of absence of MRSA-contaminated surfaces. The 1-sided Fisher exact test was used to test for significant differences ($P < .05$) in policies and practices between the stations that tested positive or negative for MRSA contamination (Fig 1).

RESULTS

Environment sampling

Laboratory testing was done on gurney straps seeded with 10^1-10^5 CFU on 1 out of 4 spots, to determine if composite swabs would detect MRSA on the surfaces. By 48 hours all the tubes inoculated with 10^2-10^5 CFU showed growth and black precipitate, whereas 50% of the 6 tubes with 10^1 CFU were positive, which was similar to previous detection limits.[7] After sampling all 4 seeded areas, we determined if there was detectable carryover at sterile surfaces. At the contamination range of the previous study[7] of *Staphylococcus* spp counts of 10^0 to 10^1 CFU/2.6 cm^2, no carryover between seeded and unseeded surfaces was detected. Limited testing with webbed gurney straps representing soft surfaces indicated that recovery was lower (10-100 times) than hard surfaces because the inoculum soaked into the surface rather than remaining on top.

To mimic shipping conditions, tubes with the swabs and 1 mL transport buffer were inoculated with 10^1-10^5 CFU and left at room temperature. The samples inoculated with 10^2-10^5 CFU were positive after 7 days at room temperature, whereas 50% of the 10^1 CFU tubes were positive regardless of the day after inoculation they were tested. These data indicated that delayed delivery of the samples would not affect recovery if the sample had $>1 \times 10^1$ CFU/mL.

To determine potential die off of MRSA and MSSA if the inoculated samples were left at 0°C for any length, we inoculated swabs and placed them in a refrigerator for 6-48 hours before testing viability. At both 6 and 24 hours at 0°C, MRSA was viable, whereas after 48 hours inoculated samples were all negative. This was the rationale for putting temperature indicators in the kits.

Field use of kits

The composite samples from the 33 fire stations were received and processed 1-8 days after the swab samples were taken. Seventy percent of kits were received within 2 days and 80% within 3 days after sampling. Only 1 kit was received 8 days after sampling (but was positive for MSSA). The low temperature indicators did not change color during shipping to and from the fire stations with the exception of 1 kit where the fire station reported that the indicator was changed when the kit was received. However *S aureus* was recovered from the samples when returned and it was unlikely that the swabs returned to the laboratory had been subjected to 0°C due to warm weather.

Seven hundred twenty-one samples were collected, including 653 composite field samples, 62 field blanks, and 6 positive

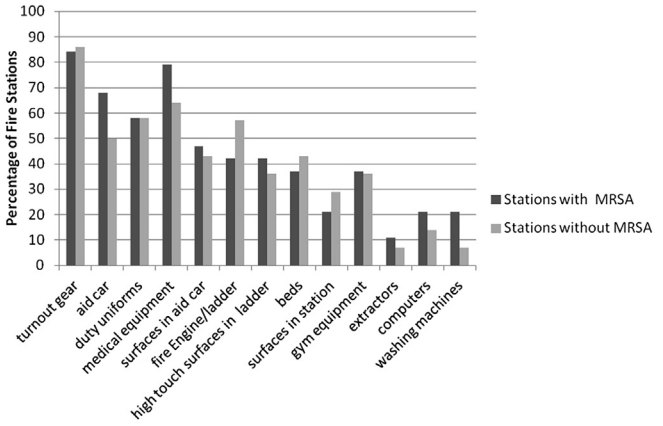

Fig 1. The difference in cleaning policies between stations with and without surfaces contaminated with methicillin-resistant *Staphylococcus aureus* (MRSA).

controls. The 653 composite samples represented approximately 2,100 surfaces. Eight percent of the field samples (52 out of 653) were positive for MRSA and 18.5% (119 out of 653) were positive for MSSA (Table 1). Nineteen stations (57.5%) had ≥1 MRSA-positive sample, and 27 stations (81.8%) had ≥1 MSSA-positive sample. Of 33 stations, 14 stations (42.4%) had samples positive for both MSSA and MRSA. Three stations (9.0%) were negative for MSSA and MRSA. Positive controls which had $\geq 1 \times 10^2$ CFU/mL were positive.

The living areas accounted for 61.5% of the MRSA-positive and 72.3% of the MSSA-positive samples. The garage areas had 38.4% of the MRSA- and 27.7% of the MSSA-positive samples. The living room samples were most often positive for both MRSA and MSSA, with 42 positive surfaces. The medic truck surfaces were the second most likely to be positive for MRSA and MSSA, with 32 positive surfaces, whereas the bathrooms had 21 positive surfaces (Table 1).

Of 52 MRSA isolates, 36 isolates from 16 of the 19 stations were available for SSC*mec* typing. Sixteen (44%) were NT, 15 (42%) were type IV, 4 (11%) were type II, and 1 (3%) were type 1. Ten of 15 type-IV MRSA isolates and 3 of 4 type-II MRSA isolates were found in garages, whereas the NT MRSA isolates were more common in the station living areas (Table 1). Few of the living room isolates were available for SCC*mec* typing, but 6 of 8 isolates that were typed were NT compared with 1 of 11 isolates from the medic truck samples. The type II MRSA came from 2 different stations and the type IV came from 5 stations, whereas the NT MRSA was found in 4 stations (Table 1).

Fire station survey responses

All 33 stations returned the survey, although not every question was always answered (Table 2). The mean fire station call volume was 151 calls per week (range, 5-1,800 calls). The majority of stations (97.0%) had multiple fire professionals using the same bed. The majority of fire stations (96.9%) provided infectious disease training to their fire personnel with 78.8% reporting that they conduct training on MRSA specifically. Of the stations, 60.6% reported cleaning turnout gear after a fire, whereas 75.8% reported cleaning turnout gear after exposure to a bloodborne or airborne pathogen. In contrast, <50% of stations had cleaning policies for routine cleaning and disinfection for high-touch surfaces in the fire station living areas such as door knobs, television remote controls, furniture, gym equipment, and computers. Fewer than 50% reported use of walk-off mats, vacuum cleaners with HEPA filtration, or the use of microfiber mops and/or cloths.

Table 1
Surfaces testing positive for methicillin-resistant *Staphylococcus aureus* (MRSA) and methicillin-susceptible *S aureus* (MSSA) contamination

Site	MSSA (n = 119)	MRSA (n = 52)	SCC*mec* type (n = 36)*
Fire station living area	86 (72.3)	32 (61.5)	19
Living room	28 (23.5)	13 (25.0)	6 NT, 2 IV
Bathroom	14 (11.8)	7 (13.5)	1 II, 1 IV, 3 NT
Bedroom	9 (7.6)	4 (7.7)	1 NT
Gym	7 (5.9)	3 (5.8)	1 IV
Office	11 (9.2)	3 (5.8)	1 I, 1 IV, 1 NT
Kitchen	13 (10.9)	2 (3.8)	1 NT
Optional	4 (3.4)	0 (0.0)	ND
Apparatus bay	33 (27.7)	20 (38.4)	17
Medic truck	20 (16.8)	12 (23.0)	3 II, 7 IV, 1 NT
Outer fire turnout gear	7 (5.9)	5 (9.6)	3 NT, 1 IV
Fire truck/engine	6 (5.0)	3 (5.7)	2 IV

NOTE. Values are given as n (%).
ND, none of the isolates were characterized; *NT*, nontypeable; that is, not type I-V.
*Thirty-six of 52 MRSA samples were available for SCCmec typing. Total SCC*mec* typed: type I (n = 1; 3%); type II (n = 4; 11%); type IV (n = 15; 42%); NT (n = 16; 44%).

The stations were grouped according to the presence or absence of MRSA-contaminated surfaces to determine if there were differences in their response to survey questions. Survey response on questions regarding policies, practices, cleaning, and disinfecting did not greatly differ between the 2 groups (Fig 1). Stations that kept tools out of the living quarters of the station had fewer MRSA-contaminated surfaces than stations that brought tools into the living quarters ($P = .027$). Stations with walk-off mats had more MRSA-contaminated surfaces than those without the mats ($P = .02$), although so few stations had walk-off mats that this may not be meaningful. Other potential differences in cleaning and disinfection policies and practices were not statistically significant ($P > .05$).

Twelve of 32 stations (37.5%) that answered the question reported MRSA symptoms among fire professionals that required treatment by a health care provider. Dates of the occurrence of the MRSA infections were not asked for or provided. The 12 stations were from 10 different fire districts and all were from western Washington State. The number of calls per week by station varied from 28-400. Of these 12 stations, 6 (50.0%) had MRSA-contaminated surfaces with 5 of the 6 stations positive for both MRSA and MSSA. Four (33.3%) stations had MSSA detected and 2 (16.7%) stations did not have either MSSA or MRSA detected. It is not known if the presence of MRSA-positive fire personnel during some time periods affected the surfaces, either by the infected personnel directly touching (and therefore contaminating) these surfaces or by necessitating thorough cleaning/disinfection processes for station surfaces.

DISCUSSION

Our study used composite samples in the field testing of 33 fire stations in 28 fire districts. From the 653 field samples collected, MRSA was isolated from 8.0% and MSSA 18.5%. In comparison, the first Washington State fire station study[7] isolated MRSA from 4.1% of the samples, whereas the Tucson study[8] isolated MRSA from 6.8% and MSSA from 10.6% of their samples. The use of composite samples in our study would likely have underestimated the total number of surfaces contaminated with MRSA and/or MSSA and the actual number of surfaces contaminated with MRSA and/or MSSA could not be determined in our study. In contrast, our previous Washington State fire station study[7] used a single swab or RODAC plate, whereas the Tucson study[8] used either a single Rediswab or

Table 2
Responses to questions

Question	Response
Do multiple fire professionals use the same bed?	32 (96.9)
Is there a cleaning policy for outer fire turnout gear	25 (75.8)
Is it station policy to wear gloves, goggles, and masks during high-risk environment medical calls?	25 (75.8)
Are there sinks for hand washing in the apparatus bay?	25 (75.8)
Have fire professionals received training on cleaning surfaces for infection control/postcall decontamination procedures?	20 (60.6)
Does the station have a policy to inform fire professionals of when they should wash their hands?	19 (57.6)
Are disinfectant hand-gel dispensers placed at access points between the apparatus bay and fire station?	18 (54.5)
Are there policies for cleaning beds and bedding materials between users?	13 (39.3)
Have any professionals in your station reported methicillin-resistant *Staphylococcus aureus* symptoms that were treated by a health care provider?	12 (37.5)
Does the fire station use signage to inform professionals of when they should wash their hands?	11 (33.3)

NOTE. Values are given as number of stations (% yes).

Spongesicle (Biotrace, Forest City, IA) for sampling each surface/object, which allowed for the number of contaminated surfaces/objects to be determined. However, the number of MRSA-positive composite samples in our study were double that found in the first Washington State fire station study[7] and higher than in the Tucson study.[8] The higher detection levels of MRSA and MSSA from our study could be due in part because of the increased number (2-20 times) of surfaces sampled in this versus previous studies. The higher detection of MRSA/MSSA could also be due to the increased number of stations (33 vs 2-5 stations) and/or the number of different districts sampled (28 vs 1-2). In our study, surfaces were selected that were MRSA and MSSA contaminated in the previous 2 studies and those with high hand contact with bare skin, which could have also influenced the detection rate in our study. The influence, if any, of using of fire personnel for sampling vs laboratory personnel for sampling is not clear. Similarly what potential influence composite swab vs single swab sampling had on the results is unknown.

In our study, 72.3% of the MSSA- and 61.5% of the MRSA-positive samples were in the fire station living areas compared with 27.7% of the MSSA- and 38.4% of the MRSA-positive samples in the garage areas. This could be correlated with the presence of cleaning/disinfectant protocols in most fire stations for garages and medic trucks but no similar protocols for the living areas. In contrast, in the first Washington State fire stations study[7] the percentage of MRSA-positive surfaces were 57% from garages and 43% from living areas. Both the current and previous Washington State studies differ from the Tucson study,[8] where no fire apparatus samples were found to be contaminated with MRSA. However, studies from Maine, Colorado, Chicago, and the United Kingdom[11-13] found >40% of ambulances were contaminated with MRSA.

Our study characterized 36 isolates by SCC*mec* typing. Of these, 42% SCC*mec* type IV compared with the first study where of the 44 isolates characterized 18% of the isolates were SCC*mec* type IV of which 5 were USA300.[7] We do not know if some of the SCC*mec* type IV MRSA are USA300 in our study but it is possible given that this strain is widespread.[14] The differences in distribution of SCC*mec* types between the 2 studies could be due to 33 (current study) vs 2 stations (previous Washington State study[7]) sampled. There were also differences in study design and potential differences of MRSA strains circulating in the hospitals and communities when each study was performed.

One unexpected result of the survey was that 37.5% (12 out of 32) of stations reported that the station had personnel with MRSA infections requiring medical attention (Table 2). To our knowledge this is the first time information on MRSA infections in fire personnel has been collected from multiple districts. It is unclear if the number of MRSA infections reported in our study is representative across Washington State career fire stations or how this level compares with fire stations across the country. It is also unclear what the clinical implications are to fire personnel working in environments where 8% of surfaces are contaminated with MRSA. What level of MRSA and MSSA carriage occurs among the fire personnel in the stations in our study was not tested, thus it is unknown if their MRSA carriage is above or below the previously reported level of 22.5% of Washington State fire personnel.[7] A recent study suggests that self-sampling for nasal colonization can be done and provides adequate results compared with having trained personnel doing the sampling.[15] In the future, it would be possible to include swabs for environmental and nasal cultures in the kits. However, the nasal swabs would require biohazard packaging using a private courier service for shipment back to the laboratory.

Our study demonstrates that we can increase the geographic range of fire station sampling in any region where 1-2 day mail service is available based on the controlled temperature and storage time of laboratory results. More recently 2 stations in central Oregon successfully tested the kits, suggesting that kit use is not restricted to within a single state but has the potential for use across North America.

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