

Final Project Report

Ohio Division of EMS Injury Prevention Research Grant

**“Reduction of MRSA Colonization in EMS Personnel and Equipment to  
Prevent Secondary Injury in Ohio Trauma Patients”**

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# **Reduction of MRSA Colonization in EMS Personnel and Equipment to Prevent Secondary Injury in Ohio Trauma Patients**

## **Introduction**

Infection with methicillin resistant *Staphylococcus aureus* (MRSA) has become a significant problem in healthcare and community settings in the United States during recent years. Infection with this organism can result in significant morbidity and mortality and is recognized as a major public health threat. These organisms are capable of causing significant skin and soft tissue infections in patients with open wounds, such as trauma patients, or more severe infections such as bloodstream infections. In recent studies, the mortality rate of patients with invasive MRSA infection was 20%. It has been recognized that these organisms can be spread person to person on the hands or skin of healthcare workers or others and from the contaminated healthcare environment.

Since Emergency Medical Services (EMS) personnel are frequently the first level of healthcare that is provided to traumatically injured patients, they or their equipment could come into contact with open wounds or patients at high risk for infection. If the EMS personnel are colonized on their skin or their equipment contaminated with MRSA, they could serve as the entry point for MRSA to these susceptible patients. There are limited data on the prevalence of EMS colonization or contamination of EMS equipment with MRSA. In our previous study funded by Ohio Department of Public Safety we have previously demonstrated that 50.6% of all agencies had an ambulance that was contaminated with MRSA and EMS personnel were colonized with MRSA at a rate of 4.6%.

The purpose of the outlined research study was to engage a representative sampling of EMS agencies in central Ohio to participate in an educational intervention to enhance hand hygiene and environmental cleaning to reduce the contamination and colonization of EMS equipment and personnel. The aim of this study is to reduce the risk of potential transmission of MRSA from equipment or personnel to patients cared for by the EMS agency.

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### **Executive Summary**

This study represents a significant endeavor to provide an educational intervention aimed at reducing the MRSA contamination of surfaces within ambulances in central Ohio. The education was provided by training DVDs and outlined instructions on appropriate cleaning of surfaces, instructions regarding best cleaning agents, and review of infection prevention practices including hand hygiene. Targeted ambulance surfaces were cultured before the intervention began. All agencies received a detailed training DVD at the beginning with half of the agencies randomized to receive a second refresher DVD at 3 months. Targeted ambulance surfaces were cultured again at the end of the intervention. Compliance with watching the training DVDs was low; 28.6-37.1% of agencies documented watching the

first DVD and 22.9% watching the refresher DVD. Only 12.9% of agencies in the second group reported watching both the initial and refresher DVD. MRSA contamination rates, overall, increased from the baseline (32.9% of agencies with positive cultures) to post-intervention sampling (45.7% of agencies) ( $p=0.028$ ). In the post-intervention sampling there was no difference between the two study groups in terms of number of positive MRSA cultures. The overall increase in MRSA could be reflective of national trend demonstrating increasing MRSA rates. The educational interventions for all agencies and especially those receiving the refresher DVD did not appear to reduce MRSA contamination. This may primarily be due to the low compliance rate of watching the training DVDs. Offering continuing education credit or financial inducements could increase the compliance with watching the training DVDs. One-on-one training (academic detailing) may also enhance the effect of the education and promote behavior changes in the EMS personnel. Further studies in this field are needed to understand the best methods for reducing MRSA contamination in EMS equipment. .

#### **Investigator Qualifications**

**Kurt B. Stevenson, MD, MPH** (Principal Investigator [PI]) is a specialist in clinical infectious disease and healthcare epidemiology and is Professor of Medicine and Epidemiology in the Colleges of Medicine and Public Health at The Ohio State University. He recently completed working as PI on a 5 year CDC-funded Prevention Epicenter which focused on developing strategies for enhanced surveillance and prevention of healthcare-associated infections. One focus of the Epicenter grant has been to elucidate mechanisms of MRSA transmission. His Epicenter team has collected and genotyped 1300 MRSA isolates from across Ohio. He has completed a 5 year term on the Center for Disease Control and Prevention (CDC) Healthcare Infection Control Practices Advisory Committee (HICPAC). He has extensive experience working with both rural and urban health communities on many quality improvement efforts, most particularly improving antimicrobial prescribing and infection control.

**Armando Hoet, DVM, PhD**, (Laboratory Support) is an Assistant Professor in Veterinary Preventive Medicine at Ohio State University. He is trained as a Veterinarian and researcher and is engaged in research into MRSA in pet owners and companion animals. He has expertise in processing nasal and

environmental samples and microbiologic laboratory expertise in identifying MRSA. His laboratory performed all of the MRSA culturing and identification for this study.

**Bo Lu, Ph. D.** (Statistical Support) is Assistant Professor in the Division of Biostatistics at College of Public Health, the Ohio State University. He is an expert on survey sampling and statistical analysis of observational studies and also has extensive experience on analyzing large public surveys, including Behavioral Risk Factor Surveillance System (BRFSS), Health Interview Survey (HIS), National Inpatient Survey (NIS), and National Longitudinal Survey Youth (NLSY). Dr. Lu has provided the statistical support on survey design and data analysis.

### **Literature Review and Significance of the Topic**

Traumatically injured patients are frequently cared for by EMS agencies in Ohio. These trauma patients are at increased risk for secondary injury from infection often due to the nature of their injuries. These patients are more likely to have open wounds than medical patients and are at higher risk of acquiring new infections in the field. They are often admitted to the hospital for prolonged periods and their recovery is frequently complicated by infection. Because of their injuries, they may have reduced capacity to resist infection when exposed to a microbial agent in the immediate post-injury period. According to the Ohio Trauma Acute Care Registry (TACR), there were approximately 25,221 severely injured trauma patients admitted to the hospital in 2006 in Ohio. A severely injured patient is defined as one that is hospitalized for 48 hours or more, or has death at any point during treatment. The majority of these arrived to the emergency department by ambulance. The Registry confirms that among these severely injured patients, 2001(8%) developed at least one infection during admission. Since EMS agencies treat and transport these victims while their wounds are fresh and initially uncovered, any infectious agent introduced early to the patient by either EMS personnel or their equipment may result in secondary infection. These Registry data refer only to the most severely injured patients. The number of less-injured patients that develop post-trauma infections is unknown. Such infections that occur in the course of healthcare delivery are often preventable and are now considered a significant patient safety concern <sup>1 2</sup>.

Among potential agents causing secondary infections, the frequency of methicillin resistant *Staphylococcus aureus* (MRSA) infections has been increasing steadily and at alarming rates over the past several years. The number of MRSA related hospitalizations in the United States in 2005 was estimated at 278,203<sup>3</sup>. Infection with this organism is more likely to cause increased length of stay, increased severity of injury and illness, increased mortality, and increased healthcare costs. A recent alarming study of invasive MRSA infections across the US in 2005 estimated the annual burden of invasive disease at 94,360 cases with an associated mortality of 18,650 patients (20%)<sup>4</sup>. This was higher than previously estimated and MRSA is now considered a major public health issue. Additionally, MRSA is recognized as a very common cause of wound and surgical infections<sup>5</sup>.

Colonization with MRSA is common and is defined as the presence of MRSA on the surface or skin of the subject without evidence of infection<sup>6 7</sup>. The most frequent site of colonization with MRSA is the anterior nares or nasopharynx. Patients colonized with MRSA often progress to infection<sup>7 8 9</sup>. The prevalence of MRSA nasal colonization of otherwise healthy adults was estimated to be 1% in 2001-2002<sup>10</sup>. In allied health workers and physicians the rate is much higher, estimated to be between 2 and 7.5%<sup>11</sup><sup>12</sup>. One of the necessary components of infection is the presence of the infectious agent in the environment of the injured patient. Colonized healthcare workers and patients are thus a reservoir for transmission of MRSA to other patients with transmission occurring persons to person<sup>7</sup> (see also [www.cdc.gov/ncidod/dhqp/pdf/guidelines/Isolation2007\\_appendixA.pdf](http://www.cdc.gov/ncidod/dhqp/pdf/guidelines/Isolation2007_appendixA.pdf)). Recent studies have also confirmed that environmental contamination of MRSA is widespread and likely plays a role in transmission to patients<sup>13</sup>. Traditionally, MRSA (USA 100 strain type) has been considered a hospital-acquired organism but numerous reports over the past 5-10 years have demonstrated a new community strain (called the USA 300 strain type) capable of infecting patients with limited healthcare or hospital exposure<sup>14 15</sup>. Community-onset MRSA infections may be more prevalent in rural communities<sup>16</sup> than urban communities<sup>17</sup>. The traditional strain is very common in all healthcare settings<sup>16 17</sup> but it is recently recognized that the community strain is also becoming established in the hospital setting<sup>18</sup>.

Two recent studies have demonstrated the significant increase of MRSA infections among patients visiting emergency departments (ED)<sup>19 20</sup>. In the first study, patients with skin and soft tissue infections from 11 university-affiliated EDs were evaluated<sup>19</sup>. MRSA was isolated from 320/422 patients

(76%) and most of the isolates were the community strain. In another study, emergency room visits for skin and soft tissue infections from all 50 states were examined from the National Hospital Ambulatory Medical Care Survey for 1993-2005. The number of ED visits for these infections increased from 1.2 million in 1993 to 3.4 million in 2005 correlating temporally with the emergence of community MRSA infections. Thus, ED and EMS workers likely have high exposure to and opportunity for colonization with MRSA. EMS equipment is also at high risk for contamination with MRSA given the increase of MRSA in the community and the high prevalence in the ED setting. If only 10% of the known infections occur due to pre-hospital MRSA exposure, this would amount to 201 excess infections using the 2006 rates in Ohio.

Our initial study funded by the Ohio Department of Public Safety (ODPS) has identified a high prevalence of MRSA contamination on EMS equipment and colonization in EMS personnel, compared to the general population. We have found 50.6% of the Ohio EMS agencies sampled had at least one ambulance sample positive for MRSA. The MRSA colonization rate among EMS personnel was 4.6%. Since we have demonstrated significant rates of MRSA colonization in EMS personnel and on the surfaces of EMS equipment in the ambulance, this may represent a significant risk factor for the subsequent development of infection for high risk trauma patients in Ohio. If these proportions are true for the remainder of the state, this would represent an estimated 8,000 Ohio EMS personnel colonized with MRSA and 555 transporting EMS agencies with at least one sample positive for MRSA.

The presence of MRSA exposure and subsequent infection in the EMS setting presents a significant risk of secondary injury to traumatically injured patients. This is a preventable injury that may be controlled by proper disinfection or decolonization techniques. **The major objective of this study was to determine the effectiveness of an educational intervention at reducing MRSA contamination of EMS equipment and ambulances in Ohio which poses a risk for secondary infections in patients with trauma in Ohio.**

Since we have found significant levels of MRSA, this study was designed to call attention to the magnitude of the problem and provide the impetus for active interventions. In the case of equipment and ambulances, special attention was made to rigorous compliance with proven disinfection practices and decontamination of surfaces that are frequently touched by patients and EMS personnel<sup>21 13</sup>. Our initial hypothesis was that EMS practitioners were currently unaware of the magnitude of this problem. Since

we have shown in the initial study that the rates of MRSA colonization are high, we proposed that EMS personnel in Ohio may be more willing to follow appropriate hygiene and disinfection standards with the aim that this may ultimately lead to a decrease in transmission of MRSA in the pre-hospital setting with associated decreases in morbidity and mortality due to MRSA infections in traumatically injured patients in Ohio. As a consequence, patient safety will be improved.

## **Research Methods**

### **Study Design and Sample Size Determination**

We randomly selected EMS agencies located in central Ohio to participate in this study. This was accomplished by randomly selecting representative agencies from Region 5 and the adjoining regions in urban and rural counties. Each participating agency was randomized to one of the two arms: an initial educational session alone or an initial educational session with plus a 3-6 month educational follow-up.

Samples were taken, as outlined below, from the ambulances at each participating agency at baseline (right before the initial educational session takes place) and at six-nine months. No human samples were taken. We had expected to see a MRSA prevalence difference of 25% at six month between those agencies assigned to the arm without follow-up educational session (50%) and those agencies assigned to the arm with follow-up educational session (25%). In order to calculate accurate sample size we used a two-sample independent z-test to compare proportions<sup>27</sup>. With 66 agencies in each arm, we would be able to detect the desired difference with 80% power (type I error is set at 0.05). Thus, we sampled 70 agencies in each arm for a total of 140 to account for any problems with collection or in the laboratory.

### **Agency Recruitment and Description of the Educational Intervention**

The Ohio State University Office of Responsible Research practices Institutional Review Board approved the study. The director of all agencies randomized for inclusion was contacted and provided verbal consent to participate. Members of the investigative team traveled to each EMS agency that agreed to participate and performed environmental swabs of multiple sites in each ambulance in the participating department. All samples were be coded with a unique identifier code that protected the identity of the agency.

Initially, an educational intervention using a pre-recorded DVD on the importance and techniques of cleaning, locations that are most important to clean, and locations that were found to have frequent MRSA contamination in our initial study was conducted. Each EMS employee was instructed to provide a written consent prior to participating in the education session. In the DVD, we explained the importance of cleaning certain equipment and locations after every call and other sites on a routine schedule. The cleaning methods to be used were demonstrated with instruction on appropriate cleaning supplies that are effective against MRSA on surfaces. We reviewed infection control practices such as hand hygiene, appropriate wearing of gloves and other personal protective equipment at each agency using a framework for behavior change. We provided posters for the station of each agency and smaller cards for posting inside each ambulance at each agency to provide visible reminders of the need for cleaning and hand hygiene. Additional new posters were provided with the refresher DVD. We provided alcohol hand sanitizer for use in the field until regular hand washing could be accomplished at the destination hospital.

We randomly selected agencies to one of two treatment groups. The first group (Group A or control group) received only initial education without any further education intervention, but samples will be taken from equipment at 6 months after the initial education intervention. The second group (Group B or intervention group) received a refresher educational intervention at 3-6 months after the initial session using a modified training DVD which highlighted the major points of the first DVD. In both groups, environmental samples were taken before the initial training and within 6-9 months.

The EMS agency participating in each training session were instructed to complete a form indicating who attended and that they consented to participate in this education session as part of a research study. This form was to be mailed back to the investigators after completion of the training. Telephone follow up to the director was also attempted to confirm that their agency watched the educational DVD and be certain that they return the approved consent materials.

### **Environmental Culturing**

The swab or swiffer collection method was used for the EMS equipment. These swabs were placed immediately in Stuart's media for transport to Dr. Hoet's laboratory at the Ohio State University College of Veterinary Medicine where they were processed to determine the presence of MRSA following standard methods<sup>22 23</sup>. Initial incubation occurred in tryptone soy broth media followed by culturing on

mannitol salt agar supplemented with 2 µg/mL of oxacillin. After incubation, 3 typical MRSA colonies were plated on blood agar followed by confirmatory testing according to standard protocols (standard colony morphology on mannitol salt agar and blood agar, gram stain reaction, catalase reaction, coagulase reaction, and latex agglutination reaction for selected *S. aureus* antigens/proteins). Final confirmation for MRSA was completed by growth on Mueller-Hinton agar supplemented with 4% NaCl and oxacillin (6µg/ml) incubated at 35-36°C for 24-48 hours.

The targeted ambulance equipment sites sampled were the areas that were found to be most likely to be contaminated in our initial study: the ambulance cot, the steering wheel, the bench seat and other likely contaminated areas. These sites were also chosen because of the direct skin contact that could occur to allow transfer of MRSA to the traumatically injured patient. These are non-consumable pieces of equipment that will be used on virtually every patient that is transported in that ambulance.

### **Statistical Analysis**

Descriptive statistics were conducted using chi-square analysis comparison of the proportions of contaminated surfaces or agencies (EPI INFO version 3.5.1, Centers for Disease Control, Atlanta, GA).

### **Molecular Typing**

Molecular analysis using pulsed field gel electrophoresis (PFGE) and multilocus SCC typing of the *mecA* gene of selected isolates obtained from our initial study and from selected samples from this study will also be performed by Dr. Hoet. The typing methods proposed will allow the investigators to determine if the MRSA isolated from personnel and equipment are of the same type confirming occupational exposure as the risk for colonization. Characterization of strains by PFGE will help to assess for healthcare-associated types (USA 100 strain) and community-onset types (USA 300 strain). SCC *mecA* typing further discriminates the clonal typing of organisms. Other genotyping analyses may also be conducted (e.g. REP-PCR, MLST, or others). These data will be included in upcoming publications of this study.

### **Protection of Human Subjects from Research Risk**

This study was approved by the Institutional Review Board of the Office of Responsible Research Practices at Ohio State University Research Foundation for review. The study design required that the EMS transport agencies remain known to the investigators, but will be kept confidential. There are no plans to provide any information about the agencies participating. In the data analysis and dissemination of the final results of the study, no identifiable information was used.

### **Analysis of the Research Findings**

Among the 140 agencies participating in the study, 70 were randomized to Group A (control group) and 70 randomized to Group B (intervention group). Unfortunately, only 20 of 70 (28.6%) of Group A and 26/70 (37.1%) of Group B returned the consent materials indicating that they had actually watched the first training DVD. Only 16/70 (22.9%) of Group B returned consent materials indicating they had watched the refresher training DVD. In Group B only 9/70 (12.9%) watched both the initial and refresher DVD. Telephone calls indicated that the compliance may have been higher but this was not confirmed by the return of the consent materials.

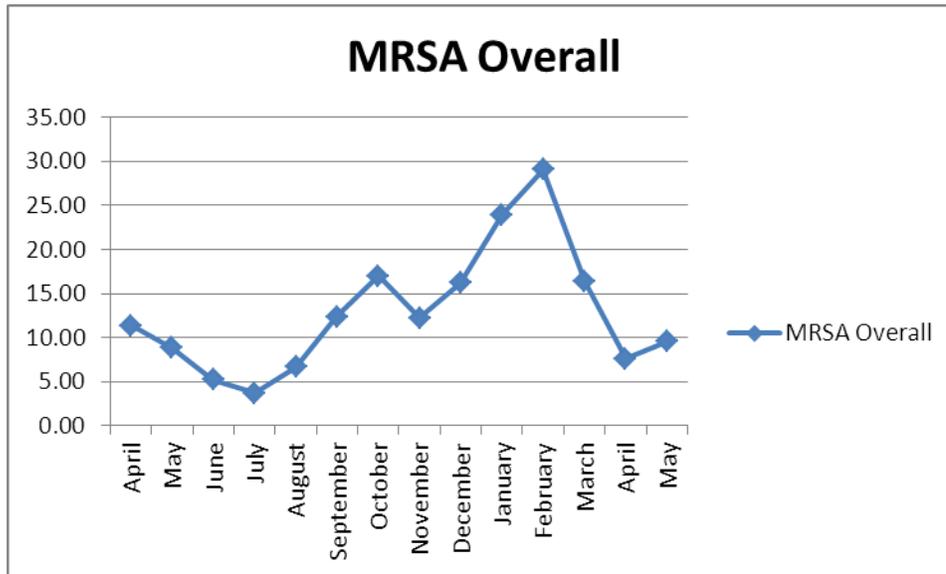
In the baseline sampling, 777 surfaces were sampled from 140 agencies. Among these, 74/777 (9.5%) surfaces were positive for MRSA. Viewed differently, 46/140 (32.9%) agencies tested positive for MRSA on equipment in their ambulances. In the post-intervention sampling, MRSA contamination actually increased with 143/753 (19%) of surfaces testing positive for MRSA and 64/140 (45.7%) agencies testing positive for MRSA on equipment in their ambulances. The differences between the two sampling times were statistically significant (surfaces  $p=0.0000001$ ; agencies  $p=0.028$ ) indicating a significant increase in MRSA present on cultures between the two time periods.

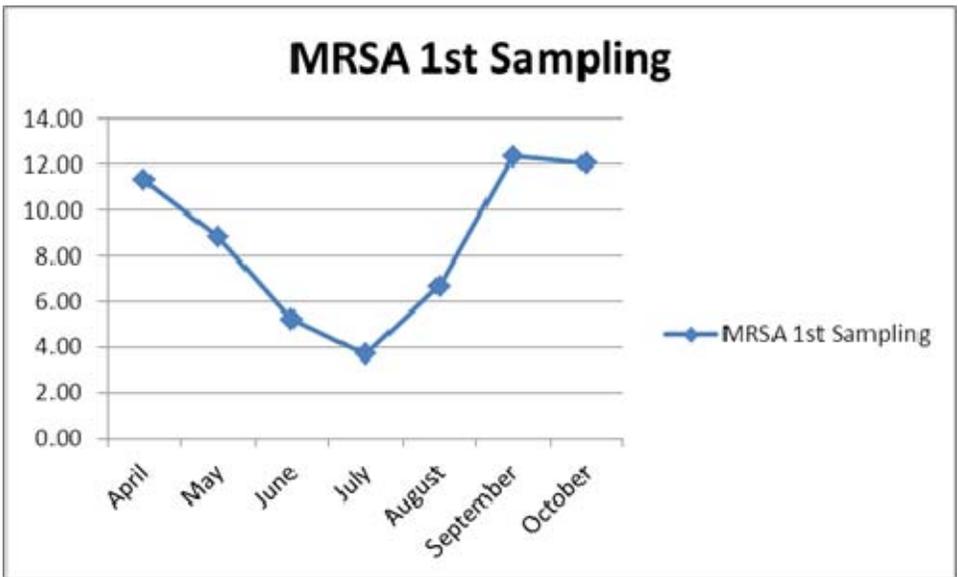
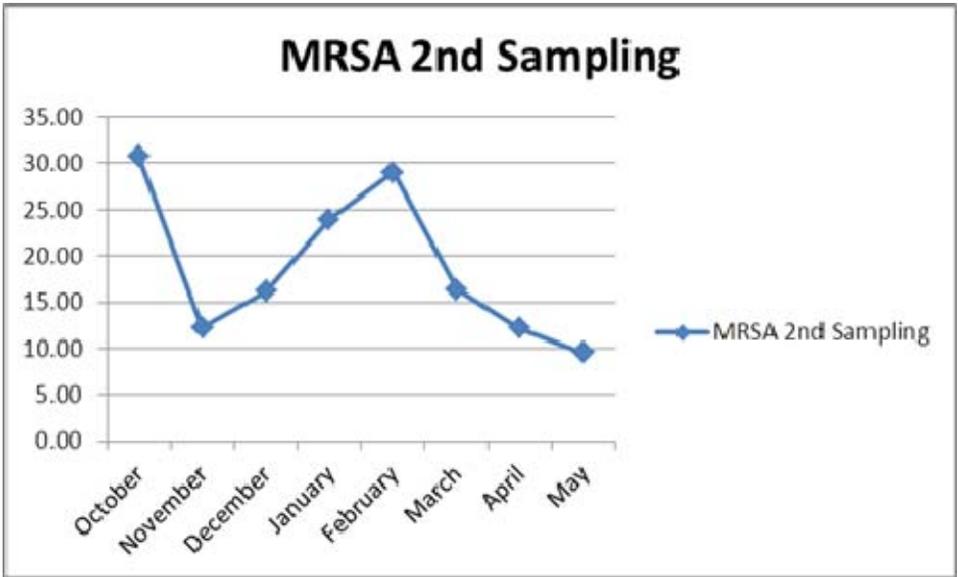
The MRSA culture results stratified by group are displayed in the following table. There was no significant difference in the number of positive cultures prior to the launch of the education intervention and at the end of the intervention whether looking at the department, ambulance, or surface levels.

**Table. MRSA Culturing stratified by Group**

| Baseline Sampling          |                |                |         |
|----------------------------|----------------|----------------|---------|
|                            | Group A        | Group B        | P value |
| <b>Departments</b>         | 23/70 (32.9%)  | 23/70 (32.9%)  | 1       |
| <b>Ambulances</b>          | 25/130 (19.2%) | 29/129 (22.5%) | 0.520   |
| <b>Surfaces</b>            | 30/390 (7.7%)  | 44/387 (11.4%) | 0.081   |
| Post-Intervention Sampling |                |                |         |
|                            | Group A        | Group B        | P Value |
| <b>Departments</b>         | 34/70 (48.6%)  | 30/70 (42.9%)  | 0.497   |
| <b>Ambulances</b>          | 42/126 (33.3%) | 44/125 (35.2%) | 0.755   |
| <b>Surfaces</b>            | 65/378 (17.2%) | 78/375 (20.8%) | 0.207   |

Because the sampling was conducted over several months, the distribution of positive MRSA cultures by month was plotted to determine if there was any seasonal differences. These graphs are displayed as the aggregated total or by first or second sampling time as below. There appears to be a higher rate of positive MRSA cultures during the winter months.





**Conclusions**

This study represents a significant endeavor to provide an educational intervention aimed at reducing the MRSA contamination of surfaces within ambulances in central Ohio. Among agencies in central Ohio, 140 were recruited and 70 were randomized to receive an initial education program and 70 were randomized to receive an initial training program combined with a refresher program after 3-6 months. The education was provided by training DVDs and outlined instructions on appropriate cleaning of surfaces, instructions regarding best cleaning agents, and review of infection prevention practices

including hand hygiene. The refresher DVD was an abbreviated version that highlighted the key points of the first DVD. Targeted ambulance surfaces were cultured before the intervention began and at the end of all interventions. Unfortunately, compliance with watching the training DVDs was low; 28.6-37.1% of agencies documenting watching the first DVD and 22.9% watching the refresher DVD. Only 12.9% of agencies in the second group reported watching both the initial and refresher DVD. MRSA contamination rates, overall, increased from the baseline (32.9% of agencies with positive cultures) to post-intervention time period(45.7% of agencies) ( $p=0.028$ ). In the post-intervention sampling there was no difference between the two study groups in terms of number of positive MRSA cultures. The overall increase in MRSA could be reflective of national trend demonstrating increasing MRSA rates, both in the healthcare setting and the community. The educational intervention for all agencies and especially those receiving the refresher DVD did not appear to reduce MRSA contamination over the time of the study. There was no difference in MRSA rates at the end between the two study groups. This apparent lack of effect of the educational component is most likely explained by the low compliance rate of watching the training DVDs. There also appeared to be a higher rate of positive MRSA cultures in the winter months. The significance of this finding needs to be further investigated.

### **Recommendations**

Given that MRSA rates appear to be increasing nationally with a parallel increase in EMS equipment contamination, consideration could be made for obtaining routine surveillance cultures of personnel and equipment. Education for improved cleaning and infection prevention makes good sense but did not appear to impact MRSA rates in this analysis. This is likely due to the poor compliance with watching and applying the material from the training DVDs. Offering continuing education credit or financial inducements could increase the compliance with watching the training DVDs. One-on-one personalized training (academic detailing) may also enhance the effect of the education and promote behavior changes in the EMS personnel. Further studies in this field are needed to understand the best methods for reducing MRSA contamination in EMS equipment.

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