Transmission of Antibiotic Resistance Between Pathogenic MRSA and Non-pathogenic Microbes

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Abstract

Rates of Methicillin-resistant *Staphylococcus aureus* (MRSA) infections have been increasing at an alarming rate since the mid-1990s. Although MRSA can be harmlessly carried as part of one's normal nasal or skin flora, infection can occur as a result of translocation to a compromised body site, direct contact with a compromised individual, or transmission via a contaminated fomite.[1] The purpose of our study was to investigate how various microbiological events contribute to the development of nasal carriage of MRSA among college students. The microbiological events that we studied included environmental exposures of the human host, direct transmission of previously adapted bacteria, and gene transfer between species of resident nasal bacteria. The two common nasal bacteria that we studied were *Staphylococcus aureus* (*S. aureus*) and *Staphylococcus epidermidis* (*S. epidermidis*). The genes that we focused our attention on were the MecA gene, which is responsible for resistance to multiple antibiotics, and the Panton-Valentine Leukocidin (PVL) gene that enables the bacterium to infect individuals with intact immune systems.[2] We hypothesized that direct transfer of antibiotic resistance genes from non-disease-causing *S. epidermidis* to the opportunistic pathogen, *S. aureus* accounts for the development of MRSA carriage to a greater extent than previously recognized. Bacteria were obtained from swabs of student subjects' nostrils. These microbes were cultured and genetically analyzed in the laboratory. In order to build a correlation between carriage of genetically unique bacteria and environmental exposures of the host, subjects were asked to complete a questionnaire that identified the extent of various personal exposures including hospital/clinical settings, athletic/fitness facilities, contact sports, and antibiotic use.

Methods

This research was approved by the Waynesburg University Institutional Review Board. Consenting college students completed a survey regarding lifestyles and activities. Bacterial samples were obtained from subjects by swabbing the anterior two thirds of the subjects' nostrils. *Staphylococcus aureus* and *Staphylococcus epidermidis* isolates were identified and enumerated using manitol salt agar (MSA) plates (figure 1). MSA containing methicillin 4ug/mL was used to screen for methicillin resistance. Polymerase chain reaction (PCR) using *MecA*-specific primers were used to screen for the presence of the *MecA* gene among isolates (figure 2).

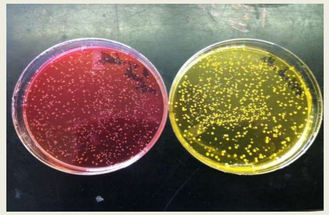

Figure 1. Differential manitol salt agar plates: The plate on the left contains *Staph. epidermidis* and the plate on the right contains *Staph. aureus.*

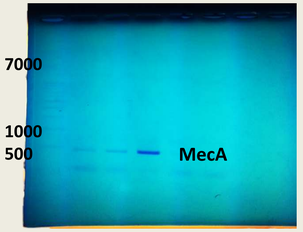

Figure 2: Gel electrophoresis: This gel visualizes the banding pattern of the MecA gene.

Acknowledgements

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References

1. Otto, Michael. "Basis of Virulence in Community- Associated Methicillin-Resistant Staphylococcus Aureus." *Annual Review of Microbiology* 64 (2011): 143-62. Print.
2. Corey, G. R., M.D. "Community-Acquired MRSA: A Virulent Pathogen." *National Foundation for Infectious Disease* XI.1 (2008): 1-6. Print.

Results

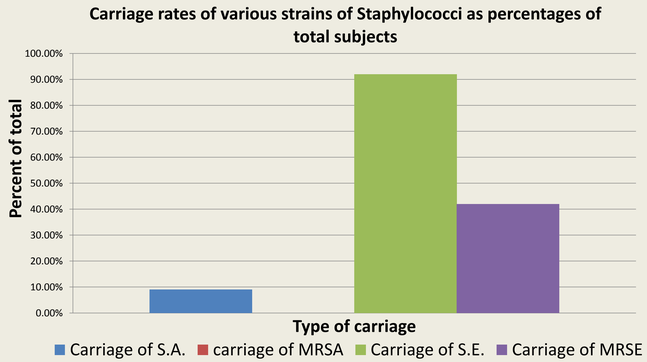

Figure 3: This graph expresses the carriage rates of pathogenic and non-pathogenic Staphylococci strains.

Table 1: Carriage rates based on microbiological events.

Question:	S.A	MRSA	S.E.	MRSE	Total number of participants
Male	9%	0%	91%	38%	46
Female	9%	0%	89%	33%	55
Average Age					20
Worked in Clinical	10%	0%	90%	47%	21
Did not work in clinical	9%	0%	92%	28%	80
Work with patients (high)	11%	0%	89%	56%	18
Work with patients (low)	0%	0%	100%	67%	3
Antibiotics (High)	9%	0%	91%	30%	11
Antibiotics (low)	8%	0%	94%	45%	87
Use of hand sanitizer (high)	10%	0%	91%	39%	67
Use of hand sanitizer (low)	3%	0%	100%	50%	30
Diagnosed with MRSA	33%	0%	67%	0%	3
Identified as MRSA carrier	17%	0%	83%	0%	6
Pneumococcal Vaccine	9%	0%	91%	30%	11
Do not have Vaccine	9%	0%	93%	36%	87
Hospital low (0-20)	9%	0%	94%	43%	92
hospital high (21-50+)	0%	0%	100%	17%	6
Workout High	9%	0%	94%	39%	71
workout low	7%	0%	93%	48%	27

Conclusion

To date, there have been minimal published studies which focus on the dynamics of MRSA carriage rates in college student populations. Additionally, to our knowledge, no studies have been published that address the in vivo transmission of resistant genes between pathogenic and non-pathogenic staphylococci.

- In this study the prevalence of *Staphylococcus aureus* was found to not be significant.
- *Staphylococcus epidermis* carriage rates increased with the use of antibiotics, hand sanitizer as well as working out in a gym.
- MRSE carriage rates were found to increase with exposure to patients as well as to increased clinical exposure.

Overall, the high prevalence of S.E./MRSE supports our hypothesis. Due to the increased prevalence of antibiotic resistant bacteria, horizontal gene transfer is more likely to occur between pathogenic and non-pathogenic microbes. This indicates that more focus should be placed on deciphering factors leading to the establishment of MRSE, an easily overlooked phenomenon due to the pathogenic insignificance of this species.