

Proposal

Title – Characteristics of Community and Healthcare Associated Methicillin Resistant *Staphylococcus aureus*.

Program of Study – Microbiology

Presentation Type – PowerPoint

Mentor(s) and Mentor Email - Dr. Alan Gillen (algillen@liberty.edu)

Student name(s) and email(s) – Michael Cargill (mpcargill@liberty.edu)

Category – Experimental (Basic)

Abstract: Methicillin-resistant *Staphylococcus aureus* (MRSA) emerged in 1961 and has remained a legitimate threat to people to this day (Haung, 2006). The multiple strains of antibiotic resistant *Staphylococcus aureus* are categorized into groups relating to their environment, hospital-associated MRSA (HA-MRSA), and community-associated MRSA (CA-MRSA). The purpose of this research is to investigate the different characteristics of CA-MRSA and HA-MRSA isolated from Liberty Students and determine whether antibiotic resistance is an indicator of increased fitness. While some believe that antibiotic resistance is an evolutionary advancement for bacteria, we investigate whether this resistance to antibacterial agents is an indication of increased fitness. On average, HA-MRSA has a larger array of genes resistant to various antibiotics than CA-MRSA. We hypothesize that due to a lighter “genetic load,” CA-MRSA will have greater fitness than HA-MRSA indicated by a faster growth rate.

My research seeks to identify the antibiotic resistance, virulence factors, and growth rate of MRSA acquired from the community and from the hospital setting. Microbiology students from Liberty University were tested for MRSA in their respective MRSA labs. Once collected, the

isolates were subjected to multiple Kirby-Bauer Disk Diffusions to identify the strain's antibiotic resistance. CA-MRSA strains were distinguished from HA-MRSA strains using ciprofloxacin. CA-MRSA strains are sensitive to ciprofloxacin whereas HA-MRSA is resilient to the antibiotic. Once the antibiotic profiles of the MRSA strains were established, multiple growth curves were conducted. The growth curves served as an indicator of the bacteria's overall fitness. In the wild, bacteria must compete with other species to colonize an area, bacteria with fast dividing rates are able to colonize a host quicker and outcompete slower-dividing bacteria. Finally, isolates were tested for a hemolytic virulence factors found in certain MRSA. Virulence factors provide pathogenic bacteria with a means of colonizing a host.

To this end, current data seems to indicate that CA-MRSA does indeed grow faster than standard HA-MRSA types. It is predicted that on average, CA-MRSA strains grow faster than HA-MRSA strains. In regards to antibiotic resistance, CA-MRSA strains were anticipated to be less resistant to an array of antibiotics than HA-MRSA. It is also predicted that CA-MRSA has more hemolytic capabilities than HA-MRSA. In total, it appears that HA-MRSA isolates with an added genetic load, are less fit than their CA-MRSA counterparts. Implications of these findings include recognizing the potential of CA-MRSA to colonize a population faster than HA-MRSA. For instance, CA-MRSA may spread throughout a dorm quicker than HA-MRSA. Also, this suggests that antibiotic resistance does not necessarily indicate upward-onward evolution. Rather, genetic changes to adapt to an environment are not necessarily always a benefit to bacteria, but a cost the strain pays to better survive in a hostile environment. In this case, HA-MRSA survives in a harmful environment by adapting antibiotic resistance at the cost of a potential decreased growth rate. Future work would include pairwise growth curves and vivo

testing to investigate whether isolates demonstrate the capability to reduce their antibiotic fitness cost.

Christian worldview integration:

My Christian worldview has certainly been the core framework throughout the research process. Antibiotic resistance has often been heralded as evidence of “evolution in action” (thus tied to macroevolution), whereas the Christian worldview argues that antibiotic resistance is evidence of variation and adaptation (i.e. microevolution). The research was structured in a way that allowed both worldviews to compete on an equal arena, and let the nature of antibiotic resistance speak for itself. Two strains of the same species competed in terms of fitness, and it appears that the strain (CA-MRSA) with less antibiotic resistance had greater fitness. In such, it strongly appears that the nature of antibiotic resistance coincides with a Christian Worldview that opposes upward-onward evolution.

In regards to culture, this evidence stands against the misconception that superbugs are further evolved bacteria that represent the next step of bacterial evolution. While we agree that bacteria are indeed changing, we disagree that they are evolving into more fit bacteria than their predecessors. It appears that MRSA strains adopt antibiotic resistance at cost to their fitness in order to adapt to new hostile environments. This is a principle and research impacts the public’s perception of antibiotic resistance. Antibiotic resistance is based on adaptation and natural selection among bacteria. These ‘superbugs’ gain the genetic capability to withstand antibiotics (from their predecessor or another donor) secure their likelihood of living in a harmful environment. When antibiotics are used, bacteria susceptible to the antibiotic are eliminated and those resistant to the antibiotic have the opportunity to proliferate. In this, it is important that culture realizes antibiotics are to be used as a means of totally eliminating an infection and use antibiotics properly. Also, this information targets the popular misconception that antibiotic resistance is “created,” and clarifies that antibiotic resistance is evidence of preexisting genetic characteristics (Anderson, 2005). In light of the advantages both CA-MRSA and HA-

MRSA have, it illuminates the importance of responsible antibiotic usage for individuals and society as a whole.

References:

Anderson, Kevin L. "Is Bacterial Resistance to Antibiotics an Appropriate Example of Evolutionary Change?" *Creation Research Society Quarterly* 41, no. 4 (March 2005): 318-24.

Huang, H., N. M. Flynn, J. H. King, C. Monchaud, M. Morita, and S. H. Cohen. "Comparisons of Community-Associated Methicillin-Resistant *Staphylococcus Aureus* (MRSA) and Hospital-Associated MSRA Infections in Sacramento, California." *Journal of Clinical Microbiology* 44, no. 7 (2006): 2423-427. Accessed February 22, 2016.