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### Recommended Citation

Burks, Brittany. "Does Cariogenic Streptococcus mutans Play a Role in Cardiovascular Disease?." *The Review: A Journal of Undergraduate Student Research* 15 (2014): 1-3. Web. [date of access]. <<http://fisherpub.sjfc.edu/ur/vol15/iss1/3>>.

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## **Abstract**

The link that exists between oral health and the entire well-being of the body is continuously becoming more emphasized. As illnesses such as cardiovascular disease become more prevalent, dentists and researchers have suggested that a link between the transfer of bacteria in the mouth into the blood stream plays a direct cause in onset of the disease in some patients. The American Dental Association has begun stressing the importance of preventive care techniques and also the importance of understanding the role the mouth plays in a multitude of processes that occur in the body. *Streptococcus mutans*, which is the main bacteria found in the mouth, will be reviewed, including its physical makeup and how it manages to find its way into the bloodstream. In addition, a specific form of cardiovascular disease will be discussed as well as the bacteria's suggested mechanism for causing the disease.

## ***Does Cariogenic Streptococcus mutans Play a Role in Cardiovascular Disease?***

*Brittany Burks*

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The link that exists between oral health and the entire well-being of the body is continuously becoming more emphasized. As illnesses such as cardiovascular disease become more prevalent, dentists and researchers have suggested that a link between the transfer of bacteria in the mouth into the blood stream plays a direct cause in onset of the disease in some patients. The American Dental Association has begun stressing the importance of preventive care techniques and also the importance of understanding the role the mouth plays in a multitude of processes that occur in the body. *Streptococcus mutans*, which is the main bacteria found in the mouth, will be reviewed, including its physical makeup and how it manages to find its way into the bloodstream. In addition, a specific form of cardiovascular disease will be discussed as well as the bacteria's suggested mechanism for causing the disease.

Tooth decay remains one of the largest and most common issues facing the oral health of both children and adults. The bacterium *Streptococcus mutans* is recognized as the leading contributor in the formation of dental caries all across the world. Maintaining proper oral health and functionality in the teeth is necessary as it plays a role in mastication, speech, and overall structure and appearance of the face. As a result, much attention is placed upon methods that prevent the buildup of the bacterium in the mouth which interacts with the harsh environment, ultimately causing cavity development. In addition to being the cause of caries, the bacterium is thought to play a role in cardiovascular disease. A surge of studies began to identify traces of *Streptococcus mutans* to be present in the

blood stream of patients with endocarditis, a form of cardiovascular disease. Although the topic was slow to gain supporting evidence, this suggested that a link existed between the oral microbe and the disease. Recently, groundbreaking information reported from various outlets has continued to suggest this relationship, causing the topic to move to the forefront of preventive care.

*Streptococcus mutans* is a gram positive coccus-shaped bacterium found mainly in the oral cavity. It is a facultative anaerobe and an opportunistic pathogen that is found as a component of the normal flora of the mouth and is not always harmful. The typical oral flora is very complex and can consist of over one million strains of bacteria. These strains are essential to the physical makeup of the mouth and can include species such as streptococci and lactobacilli (Nakano, 2006). The bacterium only becomes harmful when it metabolizes the carbohydrates present in the mouth and creates an even more acidic environment, causing the onset of the tooth decay process. Once the bacterium has adapted, finding a way to survive the harsh conditions of the mouth, there is a risk for it to eventually enter the bloodstream. This commonly occurs during professional dental procedures such as cleanings and extractions, as well as during daily oral care practices such as brushing, flossing, and even chewing (Nakano, 2006). As a result, it is hypothesized that cariogenic *Streptococcus mutans* may be a direct causative agent in the infection of the heart. As the topic continues to gain exposure, researchers have conducted tests on patients with heart disease. Because cardiovascular disease is such a serious health issue, major attention has been placed on providing the proper evidence to show there is a link between the

bacterium and the disease so that more can be done to develop preventive methods.

Cardiovascular disease is a major cause of both disability and death in many developed countries such as the United States. It is projected that within the next decade, heart disease will be the leading cause of death in both men and women (Taylor, 2013). Because this trend is hypothesized to cause so many deaths within the next ten years, efforts to decrease some of the underlying causes of the disease are very important. Understanding what the term “cardiovascular disease” encompasses is essential to understanding the different effects it has on people. The term is used to refer to a number of illnesses which affect the heart, blood vessels, or both. Some of these various classifications include coronary artery disease, congenital heart disease, and endocarditis. The causes of these diseases are very broad and mostly include factors such as age, sex, and diet. However, as the latest research has proposed, the risk of heart disease can now also arise from invasion of the bloodstream by the bacterium *Streptococcus mutans*.

Endocarditis is an inflammatory form of heart disease. More specifically, it is an infection of the inner lining of the heart chambers and valves (Bayer, 1998). This form of heart disease is considered to be very dangerous not only because it is still somewhat uncommon, but also because it can lead to a damaged heart which can ultimately cause lethal complications. It is very typical for endocarditis to begin when foreign bacteria, fungi, or other germs invade the bloodstream and attach to the endothelial cells and valves of the heart (Sandoe, 2013). Causes of endocarditis include poor dental hygiene, namely, unhealthy gums. Endocarditis was previously very rare with only three to ten cases being reported each year (Sandoe,

2013). This trend has begun to take a turn with the incidence of the disease continuously rising. Symptoms of this inflammatory condition include presence of a heart murmur, blood in the urine, and painful red bumps under the skin on the fingers or toes. However, these symptoms can also be a sign of innumerable other diseases, making diagnosis very difficult.

The main question surrounding *Streptococcus mutans* regards the survival of the bacterium in the heart valves of patients. A research study has shown that the bacteria depend on a collagen binding protein called CNM to invade heart tissue (Abranches, 2011). In order for the bacterium to cause infective endocarditis, it must attach to the endothelial cells which line the heart. It is hypothesized that the bacteria achieve this through attachment to the extracellular matrix of the cells. The main components of this matrix include elastin, laminin, and collagen, which all have the ability to serve as receptors for *Streptococcus mutans* (Abranches, 2011). Furthermore, the bacterium itself possesses a multitude of surface proteins and glucosyltransferases which assist with its adhesion to endothelial tissues.

In addition to the surface proteins that are well known, the discovery of CNM, which possesses collagen and laminin binding properties, has suggested that the bacteria have found a new way to invade the heart (Abranches, 2011). In order to further test this hypothesis, a study was conducted using strains of the bacteria isolated from patients suffering from endocarditis. The strains were then plated using Brain Heart Infusion Agar as the medium. Through use of Polymerase Chain Reaction (PCR), primers were used to detect the presence of the *cnm* gene within the bacterial strains. To see whether this gene could truly be responsible for helping the bacteria invade

heart tissue, a comparative test was performed with use of a worm model organism called *Galleria mellonella*. This worm is commonly used to test the pathogenesis of different bacteria. Some of the worms were injected with *Streptococcus mutans* strains containing the *cnm* gene and others were injected with strains that did not contain the gene. The experiment was able to show that the worms injected with strains containing the gene had a much higher mortality rate than those injected with noninvasive strains of the bacteria (Abranches, 2011). In addition, a similar mechanism was used on human coronary endothelial cells to test the invasiveness of the *cnm* gene. The endothelial cells were subjected to both strains of *Streptococcus mutans*, one containing the gene and one without the gene. The results showed that the strains lacking the *cnm* gene could not attach to human endothelial cells, further supporting the theory proposed by the study.

This research and its results can prove very beneficial to not only the scientific world but more specifically, the dental community. It suggests that a relationship does exist between *Streptococcus mutans* and cardiovascular disease, specifically endocarditis, the inflammatory form of the disease. Endocarditis has evolved from being a very rare disease to becoming more prevalent in our society due to infections of the bloodstream with bacteria such as *Streptococcus mutans*. At this point, more work has to be done in order to find methods to prevent this bacterium from invading the bloodstream and eventually the endothelial tissues of the heart. Since these methods have yet to progress, preventive techniques such as proper flossing and brushing, essentially keeping the mouth as free from the bacteria as possible, is the only approach many patients can follow. However, the results of the research experiment can help

dentists to gauge if certain patients will be more vulnerable to developing endocarditis based on the possible presence of the *cnm* gene in the bacterial strains of their mouth.

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