Development of a Novel Cardiovascular Vessel Health Monitor

(Technical Paper)

Investigation of the Role of Poker on Poker Players Mental and Physical Health

(STS Paper)

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Brendan Patrick Kenefick
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Technical Project Team Members
Daryl K. Brown II
Justin Z. Yao

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Introduction

Cardiovascular disease (CVD) is the leading cause of death amongst both men and women, accounting for more than one in every four deaths in the United States (Khavjou, Phelps, & Leib, 2016). CVD encompasses all diseases to the heart and blood vessels, which include atherosclerosis, heart failure, heart attack, and stroke. Currently, there are many clinical tools that can measure and identify various cardiac risk factors; however, they are often invasive, expensive, or time consuming (Pereira, Correia, & Cardoso, 2015). As a result, the objective of this technical project is to develop a non-invasive vessel health monitor that will provide critical information about various CVD risk factors to help guide clinical decision-making.

One population that is often affected by CVD is the poker community. Poker is a gambling card game that often cultivates an unhealthy lifestyle and high-stress environment that affects cardiovascular health. Poker has also been shown to have other physiological effects including neurological and hormonal changes (Johansen-Berg & Walsh, 2011). Additionally, poker is often discussed as having even more pronounced effects on players mental health. Previous research has been shown that players have an increased likelihood for mental illnesses, including anxiety, depression, and gambling addictions (Ballon, 2005; Barrault & Varescon, 2013; Jabr, 2013). Therefore, the STS deliverable will be a research paper that investigates how poker adversely effects the mental and physical health of the players.

Technical Topic

As of 2015, 41.5 percent of Americans were diagnosed with at least one cardiovascular disease. Additionally, the global annual medical costs associated with CVD are expected to more than double by 2035, from $318 billion to $749 billion (Khavjou et al., 2016). As a result, CVD is heavily researched and well-known risk factors have been identified. These risks include

hypertension (high blood pressure), diabetes mellitus, high cholesterol levels, and arterial stiffness (Zieman, Melenovsky, & Kass, 2005). Arterial stiffness is the physical hardening of the vasculature that results in a loss of elasticity in the blood vessels (Laurent et al., 2006). Vessels stiffen normally with increased age; however, abnormal stiffening of the vessels has been identified as a risk factor for CVD as well as strokes, dementia, and renal diseases (Zieman et al., 2005).

In order to identify the stiffness of the vessels in a patient's body, cardiologists measure pulse wave velocity (PWV). PWV is the velocity of the blood pressure wave as it travels through a vessel and is directly proportional to arterial stiffness; as arterial stiffness increases, PWV increases (Laurent et al., 2006; Pereira et al., 2015). The ability to quickly and accurately measure PWV provides physicians with an objective measure of a patient's cardiovascular health. Ultimately, this information is used to guide clinical decisions regarding pre-operative clearance and treatment.

The main objective of this technical deliverable is to design a device that accurately and non-invasively measures PWV. Currently, PWV is measured using a variety of techniques including threaded catheterization, echocardiography, sphygmomanometry, and magnetic resonance imaging (MRI). Threaded catheterization and echocardiography, specifically, are commonly used in clinic (Pereira et al., 2015). Threaded catheterization is the most accurate and best method for measuring PWV in the aorta, however, it requires the surgical insertion of a catheter in a peripheral artery and takes approximately 30 minutes to complete. The invasive nature of this procedure has several disadvantages including minor complications and an additional five to nine hours in preparation and recovery time (Pereira et al., 2015). These disadvantages make threaded catheterization an imperfect solution for the use of PWV as a CVD. Like threaded

catheterization, the measurement of PWV using echocardiography takes approximately 30-45 minutes to complete, however, the process is non-invasive (Pereira et al., 2015). While the non-invasive nature of this method is beneficial, echocardiography is expensive and time consuming.

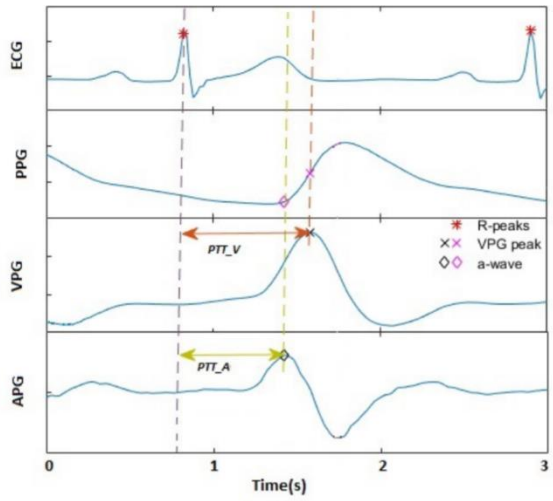

Figure 1. Demonstration of the calculation of pulse transit time (PTT) between the ECG signal (top) and the PPG wave (Shahrbabaki et al., 2016).

In recent years, photoplethysmography (PPG) has been identified as a promising solution for the non-invasive measurement of PWV. PPG utilizes the emission of red and infrared light into a tissue and, subsequently, measures the changes in absorbance of each wavelength using a photodetector on the opposing side of the tissue (van Velzen, Loeve, Niehof, & Mik, 2017). Changes in absorbance results in the measurement of pulse waveforms that can be used to calculate the PWV. Generally, PWV calculations are performed using two PPG sensors and analyzing the time difference between two pulse waveforms. However, as shown in Figure 1, this project will utilize the time difference between the electrocardiography (ECG) and PPG waveforms, in order to increase the measurement accuracy (A.-B. Liu, Hsu, Chen, & Wu, 2011; Shahrbabaki, Ahmed, Penzel, & Cvetkovic, 2016).

In addition to accurately measuring PWV, the technical deliverable will also investigate the incorporation of metabolic equivalent of task (METS) and continuous blood pressure

measurement. METS is the measurement of energy expenditure and is based on numerous factors including age, gender, body mass, and the physical activity performed (Alinia, Saeedi, Fallahzadeh, Rokni, & Ghasemzadeh, 2016). METS is one of the indicators used to determine or a patient's pre-operative clearance status and as a marker for potential CVD (Israel, 2007).

The continuous measure of blood pressure has long been desired in order to better monitor hypertension and/or hypotension in CVD patients (Martínez et al., 2018). However, currently, continuous blood pressure can only be accurately measured invasively through intravascular measurement. Recent research has focused on using PPG as a non-invasive alternative to intravascular measurement, but international standards for blood pressure measurement accuracy have yet to be met (J. Liu et al., 2019; Martínez et al., 2018). Therefore, we will further investigate the efficacy of using PPG in hopes of meeting international standards for accuracy.

The technical deliverables outlined above will be produced as a single device with fellow biomedical engineers Justin Yao and Daryl Brown, under the advisement of Drs. Sula Mazimba, MD, Nishaki Mehta, MD, and John Hossack, PhD. The team will investigate the efficacy of incorporating both METS and continuous blood pressure measurement into a device with the main objective of accurately and non-invasively measuring pulse wave velocity. The device will be completed by the end of the calendar year. This will allow for a previously approved Institutional Review Board for Health Sciences Research (IRB-HSR) study to be performed in the Spring 2020 semester in order to validate the device and provided information for future iterations. Finally, a technical report will be written outlining the device capabilities and findings from the IRB study.

STS Topic

One of the most well-known and important risk factors for cardiovascular disease is prolonged hypertension. Hypertension causes additional strain and damage to blood vessels due to

the increased intravascular pressure (Smith et al., 2004). Factors that contribute to hypertension include age, race, weight, gender, and family history. Lifestyle factors also contribute and include a high sodium diet, alcohol consumption, smoking, lack of regular exercise, and stress (Greenland et al., 1999; Smith et al., 2004). One environment that often cultivates a lifestyle with many of these factors is the game of poker in casinos and cardrooms. Additionally, the high-stress environment can also have mental effects and cause numerous psychological consequences.

Many professional and semi-professional poker players spend up to 50-60 hours per week playing poker online and/or live in a casino or cardrooms, with many amateur players reporting up to 15-20 hours per week (Little, 2016; Reber, 2019). As a result, these players are sedentary for many hours, which can lead to lifestyle challenges, due to a lack of exercise. Additionally, casinos and cardrooms cultivate atmospheres often conducive to smoking and alcohol consumption (Mcgrath & Barrett, 2009; Molinaro et al., 2018). Finally, poker, and gambling in general, produces a high-stress environment as a result of having to make high pressure decisions with one's own money.

Beyond the physical tole that players experience from playing poker, there is arguably an even larger mental tole. First and foremost, when played at a high level, poker is a mentally taxing activity, requiring a substantial amount of energy and focus to perform mental calculations and "read" (determine the possible card holdings of another player) opponents (Tendler, n.d.). Additionally, after making a mistake and/or losing a money it is common for players to become "tilted." The term "tilted" refers to players becoming upset or frustrated with themselves or their opponents, and often results in additional mistakes and often losing more money (Browne, 1989).

Poker, like other forms of gambling, can stimulate a person's brain in a similar fashion to alcohol and other drugs, which can result in compulsive gambling (Jabr, 2013). The idea that an

individual can become rich off of gambling is the driving force behind U.S. casino industry. However, in almost all forms of gambling the majority lose money. Specifically in poker, it is estimated that only 10-15% of poker players make money in a given year (Little, 2016). Therefore, this financial loss can often lead to gambling addictions as players spiral down a path of risking more and more money in order to recoup their initial losses. Gambling addiction is often also associated with additional mental illnesses, including anxiety and depression (Barrault & Varescon, 2013). Other mental illnesses, including ADHD and bipolar disorder, have also been connected to gambling addiction (Ballon, 2005). Most significantly, however, is that gambling addiction has also been correlated higher suicide rates (Karlsson & Håkansson, 2018).

The obvious stakeholders in this issue are the poker players and gamblers themselves, as they are the affected population. However, additional stakeholders include family members of these individuals, the doctors and psychologists who treat the mental and physical illnesses caused by poker, and the casinos and cardrooms that help to cultivate the environment and problem. The outcome of this research investigation will provide beneficial information for all involved.

To supplement this research, Ulrich Beck's risk analysis theory outlined in *Risk Society Revisited: Theory, Politics, and Research Programmes* will be utilized to analyze the effects of both the physical and non-physical artifacts of the issue (Beck, 2000). The physical artifacts that will be analyzed will include the casinos and cardrooms as they provide the platform for the game of poker to be played. Additionally, the game of poker itself will be analyzed as a non-physical artifact in how it affects the players. Beck's theory is most appropriate because of the nature of the game of poker. Risk analysis will be used to demonstrate the mental and physical health risks associated with poker and gambling. However, it will be important to consider the critiques of Beck's work when shaping the use of this framework. Previously, Beck has been criticized for

presenting “risk society as riddled with risks of which we can have neither knowledge or measure” and also for not sufficiently determining how risk is distributed between social and geographic divisions (Aradau & Van Munster, 2007; Ormrod, 2013). In the context of poker, these critiques are important to consider because while the risks of playing poker (losing money) can often be mathematically determined and weighed against the benefits of making a decision, the mental and physical strains on a player may not be as easily quantified. Additionally, risks may also be unevenly distributed amongst social classes as richer professional players will not likely face the same pressures as those players who are playing as a means of paying bills.

Overall, the detrimental health risks of playing poker is an issue that effects millions of people around the world. While it is difficult to estimate the exact number of poker players, as of 2010, it is estimated that over 22 million people play for money worldwide (“Number of poker players who play for money 2006-2010,” 2013). Therefore, this research may be important for identifying mental and physical health risks for a large global population.

Methods

Research question: How does the environment cultivated by casinos and cardrooms contribute to the mental and physical effects of poker on the players?

In order to fully understand and answer the research question, above, ethnography, discourse analysis, and documentary research methods will be utilized. Documentary research methods and discourse analysis will be applied by analyzing information from review and research articles to provide a background for the mental and physiological effects of stress and poker. Additionally, these methods will be used to provide evidence of the adverse health effects, when formulating a response to the research question. Ethnography and discourse analysis will be utilized by analyzing YouTube videos. The identified videos include video blogs from Daniel

Negreanu, a current professional poker player who was inducted into the World Series of Poker (WSOP) Hall of Fame in 2014, in which he details his day-to-day life during the WSOP each year (Willis, 2014). Additionally, video blogs from Brad Owen and Andrew Neeme, both of whom play smaller buy-in games, who detail their experiences grinding low-stakes cash games. These videos will provide valuable information about the mental and physical toles that both high-stake players and "grinders" (low-stake players) undergo, as the "vloggers" are often honest about their struggles. By using the techniques described above, the outcome of this research will provide a valuable understanding of the health effects of poker. To complete this deliverable, research will be concluded by early in the Spring 2020 semester and a paper detailing the findings will be published by the end of the same semester.

Conclusion

The ultimate objective of the technical project is to produce a working prototype for a non-invasive device that integrates the measurements of PWV, METS, and continuous blood pressure measurement in order to improve CVD clinical decision-making. The technical deliverable will represent a significant advancement in the field of cardiology as there has yet to be a non-invasive method that accurately incorporates the three measurements. In addition, the team will produce a technical report summarizing our results. Similarly, the STS deliverable will be a paper that outlines the research performed on the topic of the mental and physical health of poker players. The outcome of the paper will provide stakeholders with valuable information that they can use to identify potential health concerns in their lives and make lifestyle changes if needed. In conclusion, both deliverables are significant in that they will both be providing valuable information regarding the health of large global populations.

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