WEARABLE DISTANCING TECHNOLOGIES IN SPORT

DOPING AND THE ATHLETE: MINIMIZING ABUSE OF ANABOLIC STEROIDS

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By
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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.

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The innovation of technology in sport has seen a rapid growth in the past 50 years and will continue to grow rapidly in the next few years, with an estimated compound annual growth rate of 20.63% until 2024 (MarketsandMarkets, 2018). A large part of the growth in the sport technology market can be attributed to the increase in desire for data-driven decisions by managers and athletes alike. Where sport participants before may have previously relied on intuition, they are now able on to analyze data and come up with actionable insights to improve the performance of athletes (Ayers, 2018). This implementation of data in sport has allowed players to compete in safer conditions, training and competition to rise in intensity, and sports fans to be more involved in the statistics of their favorite competitions. While beneficial data-driven technology has made great strides in sport, biotechnologies have also improved in their effectiveness, many of which are used to gain an unfair advantage in competition. Specifically, the use of anabolic steroids (AS) in athletes has been the most common violation of performance-enhancing drugs (PED) in sport, accounting for "48% of [testing] violations" (Alquraini & Auchus, 2018, p. 28).

My technical research will focus on the implementation of wearable technology for distancing measurement, which has become especially important in the current COVID-19 pandemic. My team and I will analyze different wearable sensors and measurement technologies to find the most effective methods of real-time distance measurement for use in University of Virginia (UVA) athletic programs. My STS research will focus on the prevalence of AS abuse in amateur and professional sport competition, and I will provide an analysis of the actors involved in the abuse of AS and how these actors can effectively decrease or limit abuse of AS. My Technical and STS research topics, loosely coupled, will provide a broad view of both the benefits and dangers of technological innovation in sport, and will give a comprehensive look at

the necessity for an analysis on the institutions that are involved in the implementation of these technologies.

WEARABLE DISTANCING TECHNOLOGIES IN SPORT

Systems Engineers Caroline Glazier, Seanna Adam, and Brian Coward, Computer Scientist Evan Magnusson, and I will be researching the most effective methods of analyzing the distance between athletes in real-time for use in UVA's athletic programs under the supervision of Department of Engineering Systems and Environment professor Mehdi Boukhechba. Distance measurement between athletes can have a wide variety of applications in the optimization of strategy and success in sport, but during the COVID-19 pandemic, distance measurement technologies have taken on an increase in importance. The mandate for individuals to practice social distancing by keeping a distance of six feet from others by The Commonwealth of Virginia (Virginia.gov, 2020) gives reason for athletics programs to monitor the distance between athletes in practice. In order to understand the complications with measuring real-time distancing data with limited resources, it is important to first understand the quick rise of data use in sport and the complexity of measurement technologies currently in use by major sports organizations.

The use of statistical analysis on datasets in amateur and professional sport has experienced a rapid growth in the past two decades. The first recognized use of the "prioritization of statistics and data to make personnel decisions in professional sports" came in 2003 when the Oakland Athletics implemented a data-based approach to selecting players (Steinberg, 2015, para. 1-2). The use of big data in making strategic sporting decisions has now become commonplace in today's sport competitions. In specific, the National Basketball Association (NBA) has made great strides in the analysis of in-game data. Through partnering

with SportVU, a sports data technology company, the NBA has been able to implement video technology to analyze "a player's number of dribbles, the proximity of players on defense and offences," and many other data measurements (Baerg, 2015, p. 8). The technology used to measure these metrics is still cutting edge and too expensive to be implemented in collegiate sport, so, in order to measure the distance between athletes for UVA's athletics programs, we must look at finding more cost-effective methods through the use of wearable technologies.

Implementing sensors that measure distance in real-time is not a simple task. Aside from choosing and testing the wearable devices themselves, there are multiple different signals types used to measure distance. In our technical project, we will be assessing the accuracy of Bluetooth, ultra-wideband (UWB), and ultrasound signal capabilities through the use of different wearable sensors. The measurement technology and signal type used will greatly affect the accuracy of the data collected from the sensors, so it is important that, due to the 6 ft distancing guidelines, we find a combination that is optimized for distance measurement within 6 feet.

Each sensing technology has different capabilities, but all sensors, as demonstrated in Figure 1, become less accurate as distance increases. In Figure 1, sensor 2 will have a higher rate of accuracy than sensor 3 in measuring the signal from sensor 1. In order to find the most accurate combination of wearable device and signal, we will have to test capabilities of multiple different sensors, and to do this, we will be using the Received Signal Strength Indicator (RSSI) metric, which measures the strength of a received signal. Our initial research into signal technology has resulted in an analysis of the accuracy of Bluetooth signal through the use of Huawei Watch 2 sensors. We have found that distances of 1-3 feet are very accurate, but at distances of greater than 3 feet, both the distance measurement accuracy and the RSSI signal strength start to deteriorate.

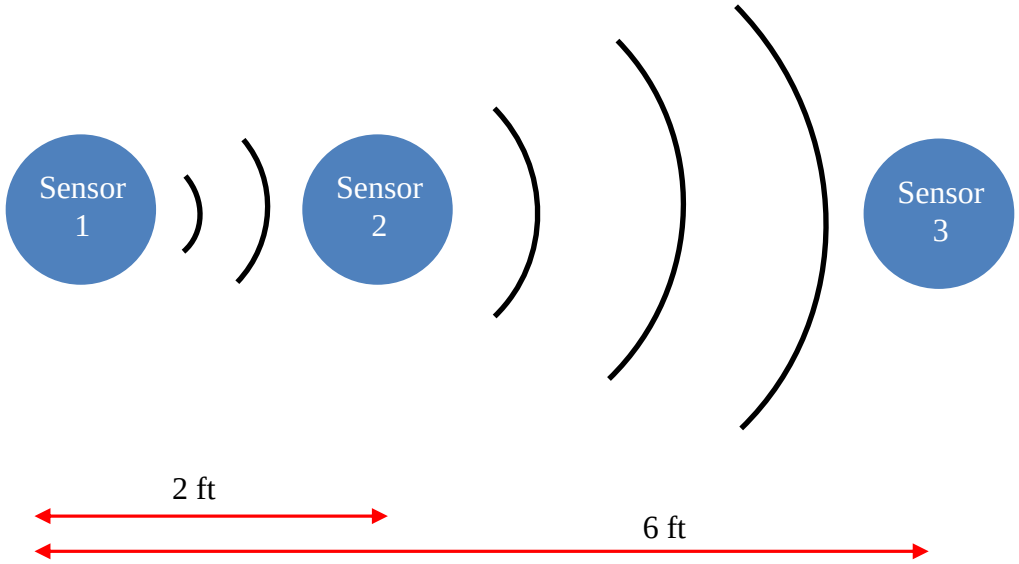

Figure 1: Signal Strength Deterioration: This model, adapted from an article on positioning estimation methods (Oguchi et al., 2014, p. 128), shows how signal strength of sensing technologies dissipates as the distance increases from the signal destination, resulting in higher measurement error (DeBerry, 2020).

As we start to analyze more wearable sensors and signal types, we will compare the measurement accuracies to find the best combination for use in UVA athletics. Once we find this combination, we will work on creating an algorithm that is able to process this data and calculate distance measurements in real-time analysis. Through a conference-style paper, we will discuss the experimental design of our signal measurements for Bluetooth, UWB, and ultrasound technologies, and we will present the algorithm developed for a specific wearable technology and signal type.

DOPING AND THE ATHLETE: MINIMIZING ABUSE OF ANABOLIC STEROIDS

Sport competition has been a facet of human nature for as long as humans have been interested in activities of enjoyment. From hunting prey for sport in prehistoric times to evidence of ball games used by the Aztecs to wrestling for competition in ancient Egypt, humans have

always had a desire to use their physical abilities for competition (Thompson, 2020). This base desire for competition is no different in the modern age, but sport competition is more prevalent and advanced than ever before. The involvement of technology in sport has been a large reason for why sport has become increasingly popular, but the benefits of the advancement of technology for sport also come with serious drawbacks.

Although the development of technology has improved many aspects of sport competition, the availability and use of performance-enhancing drugs (PED) has seen a drastic increase since the first recorded instances of misuse of anabolic steroids (AS) "during the 1954 Olympics, when Russian weightlifters were given testosterone" (NIDA, 2018, p. 4). As published by the World Anti-Doping Agency (WADA) in the 2017 Anti-Doping Rule Violations Report, 1,804 individuals violated anti-doping rules across 93 sports (2019). The amount of doping violations is also largely undervalued, as WADA is not able test all athletes worldwide, and "new designer drugs constantly become available that can escape detection and put athletes willing to cheat one step ahead of testing efforts" (NIDA, 2018, p. 18). With biotechnologies constantly evolving and athletes taking advantage of these new PED variations, the importance of ensuring fair competition in sport is becoming more important than ever, but this cannot be done by testing alone.

TESTING IS NOT AN ADEQUATE FORM OF PREVENTION

A complication arises when looking at the adequacy of WADA in the prevention AS use. A budget of $37.4 million is no hinderance in the organization's ability to prevent doping; the issues, however, "are with WADA's broken governance, lack of democracy and transparency, and [its habit of] keeping athletes' voices and any [governmental] influence out of decision-making process" (Pells, 2020, para. 5-7). The shortcomings of WADA are echoed by Larry

Bowers (2009), a member of the U.S. Anti-Doping Agency, who says that "support provided for antidoping research, education, and testing is embarrassingly inadequate" (p. 1460). Bowers goes onto explain some of the reasons why anti-doping research has improved, but all of these reasons are based on testing and do not focus on the holistic prevention of AS abuse (2009). In Figure 2, the process for testing athletes is outlined. Adapted from a process detailed by David Mottram (2013) in the Aspetar Sports Medicine Journal, the figure emphasizes the lack of athlete involvement in the process. The key step that needs improvement, highlighted in red, is the interaction phase, where anti-doping officials interact with athletes. Within the interaction

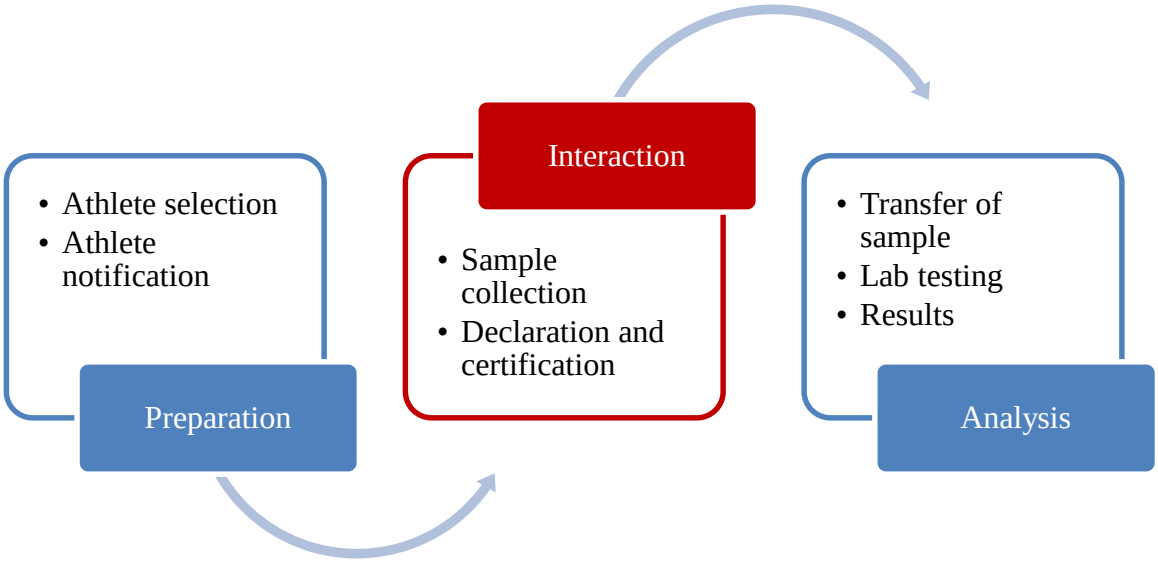

Figure 2: The Anti-doping Testing Process: The current process for testing athletes has very little opportunity to involve the athlete in the process (DeBerry, 2020).

phase, the only steps that are implemented are the collection of samples from the athlete and the declaration of any medications or supplements taken in the last 7 days (Bowers, 2013). Anti-doping officials are missing a key opportunity to interact with athletes to assess their situational circumstances, and this can be complimented by interactions with other institutions as well. It is

obvious that much more could be done to prevent the prevalence of AS abuse, and that the main complication is a lack of interaction and communication between sports organizations, government entities, anti-doping agencies, and the athletes themselves.

THE IMPORTANCE OF THE ATHLETE IN ANTI-DOPING EFFORTS

In order to decrease the prevalence of abuse of AS, there needs to be an inclusion of the athlete in the anti-doping network. In fact, the athlete should be at the center of all efforts made by anti-doping agencies, government regulatory agencies, and sports organizations. In Figure 3, adapted from the Technology and Social Relationships framework in the STS Frameworks handout (Carlson, Baritaud, 2009), the importance of the interaction of these entities is emphasized through two-way interaction between each actor. The input of athletes is widely

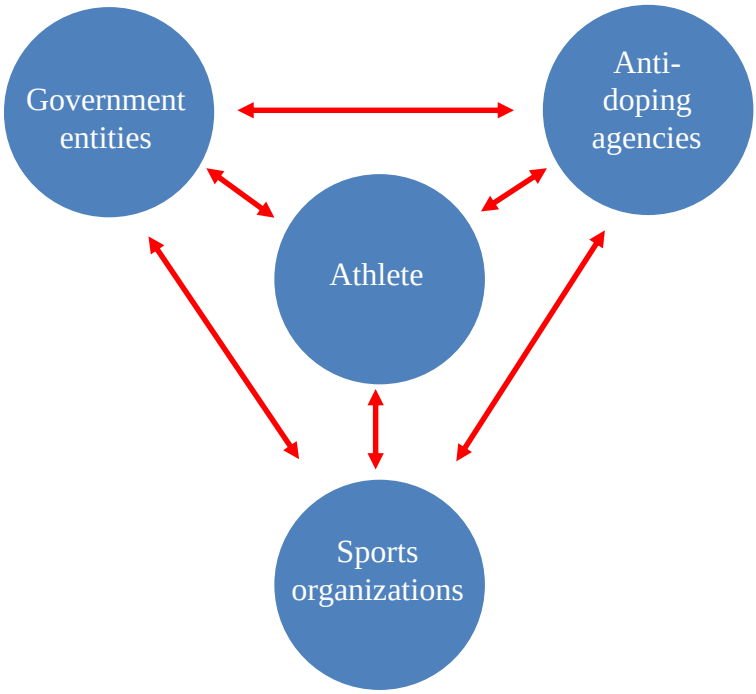

Figure 3: Improved Interaction Among Actors Involved in Anti-doping: The prevention of AS abuse has to start with the athlete and lead to communication with all entities involved in both the monitoring and the success of the athlete (DeBerry, 2020).

disregarded, and, in many cases, the athlete unfairly bears the full weight of the consequences. The commonplace of giving full blame to the athlete can ignore other factors, such as "the impact of athlete support personnel (ASP) on athletes regarding doping and anti-doping matters" (Qvarfordt et al., 2019, p. 2). This highlights the importance of anti-doping agencies' communication with both the athletes and the sports organizations that the athletes play for. Additionally, the interaction of government entities with both athletes and anti-doping agencies will open up a line of communication that would allow for the development of new preventative programs aimed at decreasing the prevalence of AS use. Ultimately, these connections are imperative to the development of an interactive network between athletes and organizations. There needs to be greater emphasis on preventative measures beyond testing, as "the first level of addressing the problem of drug abuse by athletes is prevention" (Reardon & Creado, 2020). The increased interaction between these actors is the first step.

My research into the necessity of increased interaction between athletes and organizations will result in a proposal for new strategies to prevent doping scandals beyond randomized testing and will likely describe in detail how the increase in information flow should occur between actors. The research, culminating in a scholarly article, will attempt to answer the following question: How can we prevent AS abuse through improved preventative methods in tandem with established reactionary methods?

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