Telemedicine, a Quality Initiative for Concussion Management: A Washington State Pilot

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Abstract

A concussion is a form of Traumatic Brain Injury (TBI) and today a leading cause of morbidity and mortality in the United States (CDC, 2014). Concussion in sport is highest in boys' football and girls' soccer. Effective treatment requires proper early identification of concussive symptoms. Unfortunately, primary care providers often lack the necessary training to manage concussion routinely and to provide early interventions. Telemedicine, first developed in the United States in 1973, is a potential opportunity tool for evaluating concussions and has been shown to be as effective as office visits for some types of care. This telemedicine concussion quality improvement project used HIPAA-compliant video technology in Western Washington to address care inequity, patient safety, timeliness to care and provider satisfaction. The project involved one nurse practitioner and twenty-six athletic trainers. The project showed that a telemedicine consultation for concussion provided significant benefits including the elimination of travel for the athlete and their family, initiation of care as early as the day of injury, facilitation of a team approach to care (athlete, athletic trainer and specialist) and provided specialty care regardless of geographic location. The results are reported using the SQUIRE 2.0 guidelines. Telemedicine is one innovative method of care for concussion management with many possibilities.

Keywords: *concussion, telemedicine, nurse practitioner, SQUIRE, quality improvement, athletic trainer*

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Problem Description

Keeping athletes safe after a sports concussion is paramount as research demonstrates much is known about sports concussion and much more is yet to be learned. Concussions have come to the forefront in recent years including the class action lawsuit settled by former NFL players in 2016 against the NFL and helmet manufacturer, Ridell (United States Court of Appeals for the Third Circuit, under "p. Third Circuit opinion affirming final approval"). Also, the movie industry has increased public awareness of concussions. In 2009, Washington State became the first state in the nation to pass legislation requiring specific safety measures for youth athletes who suffer a concussion at a public venue (Access Washington, 2009). The Lystedt law, named for Zachary Lystedt, was the result of Zachary's life-threatening injury during an eighth-grade football game. Zachary was injured and then returned to play not once, but twice during the same game. Shortly after the game, he collapsed and his life was forever altered by the poor management decision to return him to play before he fully recovered (Clarridge, 2009). Currently, a version of the Lystedt Laws is now active in all 50 states and the District of Columbia, drawing more attention to the need for resources for concussion management.

Although there are laws requiring removal from play and web-based resources available for concussion education, there are no real-time, interactive concussion management resources available. Within Washington State, there are geographical barriers including the Cascade Mountain Range and island communities that do not allow for the patient immediate access to a concussion specialist. What does exist in many schools in Washington State is a certified athletic trainer (ATC) to guide the athlete through the initial stages of the recovery process, especially if there is no identified primary care provider. The ATC works in close collaboration with the athlete, coach, and family during the rehabilitation process and can return an athlete to play after concussion (Access Washington, 2009). The ATC must, by Washington law, have established guidelines with another licensed provider, of which nurse practitioners qualify, to provide treatment, rehabilitation, or reconditioning services to athletes (Washington State Legislature, under "p. Title 18"). Unfortunately, many athletic trainers may not have a medical provider experienced in concussion management available to guide them or to refer to for backup assistance, and specialty care may be hours away depending on location. The lack of available providers to support athletic trainers creates a healthcare inequity and a potential safety issue for athletes. Telemedicine is one potential mechanism to address the shortage of concussion specialists, the barrier of geography, the waiting time typically required to initiate care with a specialist and facilitate provider support for the athletic trainer. Telemedicine can provide a real-time resource for both the athletic trainer, the primary care provider, and increase the role of the nurse practitioner in providing care to athletes.

Summary of Available Knowledge

Concussion, a form of Traumatic Brain Injury (TBI), is a leading cause of morbidity and mortality in the United States today. The Centers for Disease Control and Prevention (CDC) estimate TBI is responsible for an estimated 2.5 million Emergency Department (ED) visits and a cost of 76.5 billion dollars a year (Centers for Disease Control and Prevention: National Center for Injury Prevention and Control, 2014; Centers for Disease Control, 2015a). Fishe, Luberti, Master, Arborgast, and Zonfrillo (2016) in a retrospective study found the rates of sports concussions to be the highest among football and girls soccer players. Similarly, Marar, McIlvain, Fields, and Comstock (2012) in a descriptive epidemiology study found although boys' football and girls' soccer have the highest concussion rate in high school sports, concussions occur across a wide range of sports for this age group. They further concluded understanding of injury mechanism, sport-specific concussion rates, and risk factors are the best drivers of prevention and intervention measures (Marar et al., 2012). A meta-analysis by Dismuke, Walker and Egede (2015) concluded more research is needed for the global financial impact of TBI (p. 166). Interestingly, it was noted that in the United States, the highest costs of TBI treatment occurred in the states of California and Washington (Dismuke, Walker, & Egede, p. 165). While sports concussions garnish media attention, falls, motor vehicle accidents, and trauma cause the vast majority of concussions although, the number of reported sports-related concussions appear to be rising (CDC, 2015a; Collins, 2016; Faul, 2010).

It is important that TBI symptoms be monitored by a healthcare provider after removal from play. Suboptimal treatment of TBI may lead to chronic co-morbidities, affect patients and families across the lifespan, and is responsible for thirty percent of injury-related deaths annually (CDC, 2014, 2015a). The effects of TBI can include impaired cognition or memory, coordination or movement difficulties, visual or hearing changes, and emotional functioning such as personality or mood changes (CDC, 2015b). Clark and Guskiewicz (2016), found that activities requiring prolonged concentration such as paying attention in a classroom and doing homework or testing may worsen the physical symptoms associated with TBI. They also found the cognitive symptoms may continue after physical symptoms resolve (Clark & Guskiewicz 2016). The cognitive symptoms related to TBI may require learning accommodations facilitated by a healthcare provider for a gradual return to learn and continued academic success (Graham, Rivara, Ford, & Spicer, 2014, p. 155; Grubenhoff, Deakyne, Comstock, Kirkwood, & Baja, 2015, p. 1189). Wasserman, Bazarian, Mapstone, Block, and Wijngaarden (2016) found concussed athletes took an average of 4 days to return to school and when compared to nonconcussed injured athletes, sixty-one percent still had some learning difficulties one month after the injury.

Sports Related Concussion (SRC)

To address concussion in sport, determining sport-specific risk is important. Gessel, Fields, Collins, Dick, and Comstock (2007) used data collected nation-wide from the 2005-2006 High School Sports-Related Injury Surveillance Study, Reporting Information Online (RIO) on nine high school and college sports-related injuries. They found concussion rates highest in boys' football, followed by girls' soccer, boys' soccer, and the lowest rates in girls' basketball (Gessel et al., 2007). This same study indicated that across all sports, more injuries occurred during game situations when compared to injuries during sport-specific practice (Gessel et al., 2007).

Marar et al., (2012) identified that tackling was responsible for 67.6 percent of the concussions while playing football. In particular, linebackers had a concussion rate of 40.9 percent and running backs had a concussion rate of 29.4 percent (Marar et al., 2012). In response, many football leagues have changed game rules in hopes of reducing the risk of concussion exposure. In 2014, the Washington Interscholastic Activities Association (WIAA) adopted several rules passed by the National Federation of State High School Associations (NFHS) Football Rules Committee designed to make the game safer by reducing tackling exposure (under "p. News Release"). These new rules address targeting, initiating contact with an opponent above the shoulders and adding new requirements for kick-offs (under "p. News Release"). The University of Washington and the Seattle Seahawks have gone to a rugby-style tackle in hopes of reducing players' concussion risk and setting an example of a safer way to tackle (Jude, 2015; Seattle Seahawks, 2016). This method of tackling uses the shoulder instead of the head to target the opposing player's abdomen (Jude, 2015). The area now targeted in a tackle is below the bottom of the jersey number but above the top of the knees (Jude, 2015; Seattle Seahawks, 2016).

O'Kane (2016) noted that there are an estimated 250,000 million youth soccer players in 200 countries worldwide, of which slightly less than half are girls. Gessel et al., (2007) found girls had a statistically significant 15.1 percent risk of concussion injury compared to boys at 9.4 percent. Despite this, the potential for catastrophic head injury for high school soccer remains low when compared to gymnastics, wrestling, field hockey, baseball, cheerleading, and track (Gessel, et al., 2007; O'Kane, 2016). O'Kane found that while the risk of catastrophic head injury was low in soccer, there remained a high risk of concussion in the sport, particularly from head to head contact with other players (2016). O'Kane (2016) further concluded that in young female players between the ages of 11-14, there is an association between heading the ball with a concussion and that more studies on heading the ball in young players are needed. In response to concussion concerns, USA Soccer introduced a safety program in 2015 that included concussion awareness, recommended baseline concussion testing, mandated athletes with suspected concussion be removed from play, and required some levels of play to have athletic trainers at tournaments (under "p. U.S. Soccer Concussion Guidelines"). These same guidelines limit or restrict heading in athletes under age 14 (under "p. U.S. Soccer Concussion Guidelines"). In Washington, the fall sports season includes girls' soccer which due to the higher concussion risk, increases the demand for concussion management resources, particularly combined with boy's football in the same season.

Timely recognition of sports concussion may be difficult to determine despite the availability of both sideline assessment tools and computer-based neurocognitive tools (Glang, et al., 2015) Murphy, Kaufman, Molton, Coppel, Benson, and Herring (2012) sought to determine what methods Washington State football coaches and athletic trainers use to determine concussion (Murphy, et. al., 2012). They studied 30 percent of the high school football coaches and athletic trainers in Washington (Murphy, et. al., 2012). They found statistically significant differences between methods of testing for concussion between respondents from urban and rural districts, between coaches and athletic trainers, and between years of experience in concussion management (Murphy, et. al., 2012). The authors recommended the coaches and athletic trainers receive additional education to stay current in concussion management (Murphy, et. al., 2012). The 2014 Washington Interscholastic Activities Association (WIAA) rules also mandate training for coaches on concussion awareness and tackling procedures (under "p. News Release").

Concussion assessment. Currently, no universal test or biomarker exists to diagnose a concussion, although there have been various methods examined in an attempt to identify best practice. McCrea, Iverson, Echemendia, Makdissi, and Raftery (2013) reviewed 44 studies on concussion assessment instruments used on the day of injury. They concluded a symptom assessment scale is a critical component, ideally in combination with an evaluation of other domains to produce data that can guide clinical management decisions (McCrea et al., 2013). Putukian et al. (2013) in a systematic review of 89 studies relating to the on-field assessment of adult athletes found symptom assessment alone had a 95 percent sensitivity and 76 percent specificity in accurately diagnosing concussion immediately after the injury. The authors found although there is not one tool better than another to diagnosis concussion, the addition of a baseline assessment improved the usefulness for the clinician (Putukian et al.,2013). However, they noted all tools used for concussion assessment should be used along with clinical judgment

(Putukian et al.,2013; Guskiewicz et al. 2013). Putukian et al. (2013) further concluded in any situation of concern without a medical provider present; it is important to remove the athlete from play and initiate emergency care if necessary. The athlete should never be allowed to return to play until after evaluation by a provider trained in concussion management (Putukian et al., 2013). This same language is found in the Washington Lystedt Law (Access Washington, 2009).

The Sports Concussion Assessment Tool (SCAT) is one tool utilized to assess concussion on the sidelines. It incorporates several validated components including a Glasgow coma scale, symptom severity scale, balance, and memory (Jinguji, et al., 2012; Putukian et al., 2015). In 2015, Putukian et al. sought to evaluate the utility of the Sports Concussion Assessment Tool, Version 2 (SCAT 2) in a sports-related concussion (SCR) among 280 male and female, Division I athletes. All underwent a pre-season baseline assessment and athletes who had a concussion tested using the SCAT 2 again, typically .52-1.18 days post-injury (Putukian et al., 2015). They found the SCAT 2 demonstrated a statistically significant difference between baseline and post-injury scores with the concussed athletes, regardless of sex, previous concussion history or age (Putukian et al., 2015). More importantly, with a baseline SCAT 2 assessment available, a repeat SCAT 2 after injury has a 96% sensitivity and 83% specificity to identify athletes with a concussion if a 3.5 point decrease in the SCAT 2 total score is present (Putukian et al., 2015). Without a baseline, a 74.5 post-injury SCAT 2 total score has a sensitivity of 83% and a specificity of 91% to determine concussion in the Division 1 athlete (Putukian et al., 2015). The authors concluded that it is best to use a baseline and post-injury score, but if a baseline is not available, the SCAT 2 can still be utilized to determine sport-related concussion in the college population (Putukian et al., 2015). Yengo-Kahn et al., (2016) in a review of the SCAT 2 literature examines whether repeated SCAT 2 testing in younger athletes makes them familiar with the questions, thereby reducing the effectiveness of the tool (Yengo-Kahn et al., 2016). The authors have concerns with using the SCAT 2 sequentially to monitor an athlete's improvement in symptoms, particularly to predict recovery (Yengo-Kahn et al., 2016). The authors recommended consideration of these issues as the tool continues to evolve (Yengo-Kahn et al., 2016). Jinguji et al., (2012) in their study of 214 Washington high school athletes found a baseline SCAT helpful for balance testing for concussion management. For high school athletes, the authors do not recommend returning a player to sport based on cognition scores alone without also utilizing a baseline assessment for comparison (Jinguji et al., 2012). The SCAT 2 tool has been upgraded and is now the SCAT 3 (Guskiewicz et al., 2013). In Washington State, many schools have a baseline evaluation completed by an athletic trainer utilizing the SCAT 3 (Appendices A and B), as this tool can be downloaded from the Internet free of charge (Guskiewicz et al., 2013).

Healthcare Provider Knowledge

The CDC's estimate of 2.5 million ED visits annually for TBI, suggest TBI may be a common problem in primary care as well (CDC, 2014). Early intervention is essential, and many primary care providers are not comfortable with management and geographically may not have close access to a concussion specialist (Amoako, Amoako, & Pujalte, 2015; Bell, 2015; CDC, 2014). Zonfrillo et. al. (2012) in a cross-sectional study of 145 pediatricians from a large hospital setting sought to determine pediatricians' knowledge, attitudes, and practice as it relates to the management and treatment of concussed patients. The authors concluded that while pediatric primary care providers and emergency medicine providers regularly care for concussion patients, they may lack the training and support systems to adequately diagnose or manage patients (Zonfrillo et. al., 2012). The authors found that provider education, decision support tools and patient information could both improve and standardize concussion management (Zonfrillo, et. al., 2012). Arbogast et al. (2016) in an extensive pediatric regional network sought to determine the point of entry for most concussion care. The authors studied 8083 concussion cases and found almost 82 percent initially evaluated by a primary care provider, not the ED. This study demonstrated two important points: not only the need to support primary care providers but also because concussion incidence calculations are from ED reporting, the actual concussion numbers in the United States are potentially higher due to how these numbers are calculated (Arbogast et al., 2016). Mrazik et al. (2015) in a systematic review of 2,020 articles published in English-only journals, found athletic trainers continue to provide the majority of care for concussed athletes utilizing standardized practices, particularly after the 2009 passage of the Lysdedt law. Despite standardized practices, many athletic trainers continued to have trouble differentiating between concussion and non-concussion symptoms (Mrazik et al., 2015). Significant skill differences were noted between urban and rural trainers as well (Mrazik et al., 2015). Mrazik et al. (2015) further noted primary care physicians and nurse practitioners might rely on outdated information to guide their concussion management recommendations and many were not familiar with published national and international guidelines. These studies all revealed that while the primary care providers and athletic trainers were essential for the care of the concussed adolescent, these providers need continued support with education and referral resources.

Literature regarding provider treatment of concussion in the ED demonstrated a lack of standardized practice. Bazarian et. al (2005) conducted a secondary analysis of ED populations diagnosed with mild TBI and found this diagnosis associated with expensive procedures. In this study, 44 percent diagnosed with TBI were found to have received a computerized tomography

(CT) scan, 23.9 percent received other non-extremity, non-chest x-rays, 17.1 percent received wound care, and 14.1 percent received intravenous (IV) fluids (Bazarian et al., 2005). Further noted in the Bazarian (2005) study, almost 38 percent of the ED population seen for concussion were discharged without recommendations for follow-up. Babcock et al., (2012) conducted a similar study on concussions evaluated in the ED, this time looking at post-concussion management. The authors concluded that while close follow-up decreases long-term complications, many adolescents and children will develop short-term complications from a concussion because, despite the need, no one trained in concussion management was available for a follow-up (Babcock et al., 2012). These studies show that treatment in the ED may involve unnecessary interventions and specialist follow-up may not occur as one may not be available.

Telemedicine

Telemedicine in the United States is in its beginning stages of utilization. This delivery method, however, was first explored in 1973 (Glaser, 2008). Payne et al. (2013) concluded in a meta-analysis that Health Information Technology (HIT) was essential to the national goal of reducing healthcare costs, improving access, and reducing the current inequity between rural and urban areas. The authors recommended support for fundamental changes in care delivery models (Payne, et. al, 2013). Telemedicine has the potential to improve concussion management and should be explored as an innovative method of care for athletes.

Telemedicine acceptance as a delivery method for patients and providers is essential to the success of this program. Telemedicine has the potential to address pediatric specialists' geographic consolidation, as well as the inadequacy of access to specialists in underserved communities while providing evidence-based care (Marcin, Shaikh, & Steinhom, 2016, p. 174). Gibson et al. (2014) found satisfaction by patients utilizing telemedicine for stroke management, but with stroke patients, the technology added a layer of complexity to the visit. Palen, Price, Shetterly, and Wallace (2012) in a study of 270 patients who completed specialty virtual visits and 270 in-person specialty visits found equal satisfaction by both providers and patients utilizing electronic visits. The results revealed that virtual specialty care may decrease the need for in-person specialty without decreasing patient or provider satisfaction (Palen, Price, Shetterly, & Wallace, 2012). Patient and provider satisfaction will be key to this project and key to the sustainability of the program.

Providing quality care is important, and research demonstrates telemedicine can be as effective as in-person visits. Flodgren, Rachas, Farmer, Inzitari, and Shepperd (2015) conducted a systematic review of 93 random controlled trials of interactive telemedicine literature. The authors concluded a telemedicine visit was as effective as an in-person visit for certain conditions particularly heart failure, and diabetes (Flodgren, Rachas, Farmer, Inzitari, and Shepperd, 2015). This review did not include concussion telemedicine as there were not many studies available for review (Flodgren, Rachas, Farmer, Inzitari, & Shepperd, 2015). Similarly, Aoki, Dunn, Johnson-Troop, and Turley (2004) and Bashshur et al. (2016) concluded that telemedicine utilization needed more outcome research, but for certain conditions, telemedicine decreased emergency room visits, illness severity, and improved health outcomes. These studies, however, did not review telemedicine use with a concussion. The Department of Veteran's Affairs (VA) conducted a randomized controlled trial of 265 patients identified with a diagnosis of Post-Traumatic Stress Disorder (PTSD) to look at telemedicine as a method of care for veterans in rural areas compared to traditional office visits (Fortney, et. al., 2015). The study concluded the group who received telemedicine care experienced significantly greater improvements in PTSD and depression severity (Fortney, et. al., 2015). The authors found that members of the telemedicine group engaged more in behavioral therapy, likely because of the reduction in travel required, making telemedicine a viable method of care for veterans with PTSD (Fortney, et. al., 2015). Together, these studies demonstrated that for a majority of health conditions, telemedicine could be as effective as an office visit.

For concussion-specific telemedicine, while the research is limited, it is promising. The Army Knowledge Online (AKO) teleconsultation program within the Department of Defense (DOD) conducted a retrospective analysis of visits from 2006-2010 (Yurkiewicz et al., 2012). The purpose was to demonstrate concussion teleconsultation as a viable method for overseas providers in remote locations to receive expert recommendations for management, facilitate medical evacuation, and provide on-site care (Yurkiewicz et al., 2012). This study clearly demonstrated telemedicine effectiveness with concussion management (Yurkiewicz et al., 2012). Vargas, Channer, Dodick, and Demaerschalk (2012) in a single case report first utilized the term "Teleconcussion" for telemedicine use specifically for concussion management. They profiled the case of a 15-year-old male soccer player seen by the Arizona Mayo Neurology Clinic from his local clinic via telemedicine 19 days after injury (Vargas, Channer, Dodick, & Demaerschalk, 2012). They concluded telemedicine is an ideal platform for sideline concussion assessment and real-time access to a provider trained in concussion management (Vargas, Channer, Dodick, & Demaerschalk, 2012). They also conclude portable computer tablets and smartphones equipped with encrypted software for privacy protection connecting to either Wi-Fi or a cellular network will be the best way to deliver this method of care (Vargas, Channer, Dodick, & Demaerschalk, 2012). Although not widely researched, these studies show previous management of concussion by telemedicine.

Rationale

Telemedicine implementation is complex because of the many layers required for the program to be successful. The project's success depended on the provider, the patient, and the parent accepting the use of technology to deliver care remotely instead of the traditional in-person contact with a specialist. For this reason, The Normalization Process Theory (NPT) was utilized to implement this project. NPT is a relatively new sociology-based theory developed to assist the clinician in evaluating factors that both facilitate and inhibit routine adaptation of complex healthcare interventions into everyday practice (May et al., 2011). NPT is concerned with how people will work to implement a particularly new practice; not if they understand the practice or why the practice is being adopted (May et al., 2011).

NPT has four main constructs: coherence, cognitive participation, collective action, and reflective monitoring (May, et al., 2009). Coherence is the internal reflection done by individuals or group with operationalizing practices (May et al., 2009). Cognitive participation involves developing relationships to sustain the implementation (May et al.,2009). Collective action is operationalizing the new intervention (May et al., 2009). Reflective monitoring is the evaluation of the intervention both individually and collectively then making revisions when needed (May et al., 2009). Equally critical to the program's success will be determining how much disruption of clinic routines are tolerable and what sideline routines may need to be changed to initiate the telemedicine visit. Developing best practices and collective problem solving by both the athletic trainers and providers will hopefully lead to internalization of the telemedicine as an accepted method of care delivery.

To test whether the changes that occurred were due to improvements in the type of care delivered, this project utilized the Institute for Healthcare Improvement (IHI) and the Associates for Process Improvement's Model for Improvement (2016). This model utilizes Plan-Do-Study-Act-Cycles to analyze and rapidly adjust improvements for quality improvement (Associates for

Process Improvement, under “p. Developing methods”, 2016; Institute for Healthcare Improvement, under “p. Improvement capability”, 2016).

Specific Aims

Problem statement

The number of concussions occurring as a result of participation in sports continues to climb while the availability of specialist trained in concussion management remains small. Primary care providers and athletic trainers in Washington State currently lack the ability to access a concussion specialist using a Health Insurance Portability and Accountability Act (HIPAA)-compliant, real-time video conferencing telemedicine platform. Currently, patients must travel to either Seattle/Tacoma area or Spokane for a concussion specialist consultation. The Cascade Mountains geographically separate the two regions. Even travel within the Seattle/Tacoma area can be problematic due to lack of mass transportation, frequent road construction, and reliance on a ferry system to cross the Puget Sound Narrows waterways. With telemedicine available, the specialist, primary care provider or athletic trainer, the patient, and the parent could all meet without the barrier of geography, utilizing privacy-protection software to conduct a visit equivalent to an in-person consultation. The quality improvement (QI) project described in this paper was carried out to determine if telemedicine consultation would increase athlete safety by providing timely, equitable, efficient, and effective concussion management to high school athletes in Western Washington while demonstrating provider satisfaction with telemedicine care.

Context

The project utilized athletic trainers working with athletes associated with the Washington Interscholastic Activities Association (WIAA). The WIAA is the official athletic association for the State of Washington and directs all school-sanctioned athletic events as the certifying body for over 800 high schools and junior high schools in both the public and the private sector in Washington (2016). The athletes themselves represented a broad spectrum of racial, cultural, economic backgrounds, between 13-18 years of age. The WIAA designates the fall sports season for both girls' soccer and boys' football. These are both high concussion injury sports. ATI Physical Therapy (ATI) is a nationally owned physical therapy company headquartered outside Chicago, Illinois (2016). Currently, ATI operates 25 physical therapy clinics in Washington State. According to the Washington Director of Athletic Training, Joshua Waltier, ATI is contracted currently to provide approximately 5000 Washington athletes in multiple geographic locations and with variable socioeconomic environments. Most of the athletic trainers do not have medical provider back-up readily available (personal communication, J. Waltier, February 23, 2016). Other athletic training programs, both school and physical therapy clinic-based were willing to partner for this project to extend the program by another 500 athletes in the Western Washington region (B. O'Malley, Performance Physical Therapy, and R. Joye, North Mason School District, personal communication, May 31, 2016). According to the pre-season survey of 26 athletic training providers, 65.5 percent were between the ages of 22-30, making them part of a generation that has grown up with rapidly developing technology.

Advanced Registered Nurse Practitioners United of Washington State (AUWS) is the state affiliate organization of the American Academy of Nurse Practitioners (AANP). According to AUWS President Nancy Lawton, there are approximately 6100 Advanced Registered Nurse Practitioners in Washington with many practicing as primary care providers (personal communication, N. Lawton, February 23, 2016). In contrast to the age of the athletic trainers, a 2016 report published by the Washington State Nurses Association and Washington Center for Nursing reports the average age of nurse practitioners to be 50.5 years (Kaplin & Brown, 2016).

For the telemedicine visit itself, a telemedicine software vendor was necessary. The telemedicine portal needed to be easy to access on a computer, smartphone or computer tablet, and HIPPA-compliant, as well as inexpensive so that cost did not prohibit participation.

Intervention

A strengths, weaknesses, opportunities, and threats (SWOT) analysis conducted as part of the business portion of this project (Appendix C: Figure 1). Threats included fear of technology from providers and opportunities included Washington nurse practitioner laws allowing for independent practice. Weaknesses included compensation for sustainability and strengths included athletic trainers asking for the service. AEC Software FastTrack Schedule 10 Project management software was utilized to produce a Gantt chart (Appendix D: Figure 2). This software allows integration of project meetings, phone calls, along with important dates into the project design (AEC Software, Inc., 2016).

This project utilized HippaBridge, the HIPAA-compliant teleconferencing platform by Everbridge). After discussions with Eric Chetwynd, General Manager for Everbridge Healthcare Solutions, it was decided that initially for a demonstration of cost, the free version of this software was utilized, with technology support as needed (E. Chetwynd, personal communication, June 13, 2016). The software was designed for use on both tablets and smartphones. HipaaBridge provides secure communication via text messaging, telephone or video conferencing using either cell or wifi signal, making it portable to multiple environments (Everbridge, 2016).

As one of the largest groups of primary care providers in Washington, nurse practitioner participation was desired as both an opportunity to expand the program into primary care and as a resource for nurse practitioners. Nurse Practitioners were invited to participate beginning in June 2016 at the American Academy of Nurse Practitioners (AANP) annual meeting and on the

Advanced Registered Nurse Practitioners United of Washington State (AUWS) website in mid-August, 2016. Although there were verbal commitments and interest for the project among several nurse practitioners, none participated in the actual intervention.

ATI Physical Therapy and Performance Physical Therapy along with one school-based athletic training program in Western Washington committed to participation. Briefings held in early August 2016 discussed concussion updates, the platform, and the protocol for use. Dissemination of business-sized reminder cards made for the athletic trainers occurred at these briefings and baseline surveys conducted.

A graphic artist created a logo for stationary and a website built for the project: http://www.headhelper.com. The website was designed to provide a central portal for information about the project. It included links to several concussion resources both on the national and Washington State level. The website also included links to HipaaBridge, Spine Institute Northwest, ATI Physical Therapy, and Performance Physical Therapy.

Each school that contracted for athletic training services obtained a routine consent for treatment in the pre-season. Additionally, the consent contained permissive language for the health care provider working with the trainers to give treatment. This consent was a standard consent utilized for all sports participation and not specific for this project. Several pre-season parent meetings were attended by the trainer and coaches to introduce the provider and also introduced the telemedicine concept as an avenue to access care for athletes.

Game coverage was on-call by the WIAA sports schedule. For any athlete experiencing symptoms suggestive of a concussion, a SCAT 3 symptom scale (Appendix B) was completed by the trainer with the athlete for review during the encounter. After a recommended 15 minute wait on the sideline, if a telemedicine visit was needed, HipaaBridge was accessed, and the visit commenced. If the athlete did not require immediate sideline attention, the visit commenced in the training room as needed and at a scheduled time. During the telemedicine visit, the provider or trainer along with the athlete reviewed the SCAT 3 symptom scale with the remote telemedicine provider and together examined the concussion history. The telemedicine provider would then perform the memory and cognition parts of the SCAT 3 (Appendix B). Finally, the trainer assisted with both balance testing (Appendix B) and a neurologic exam. All parties together discussed interventions, expectations, and education. Return to learn guidance was given at this time if the school district did not have this policy and any referrals written. If an office visit was necessary, it was arranged within 48 hours, except one holiday weekend that required a longer delay. Any athlete suspected of needing EMS support directly from the field due to suspected neck or severe head injury was transported to the ED and not delayed by a telemedicine visit.

Pre-satisfaction surveys using Survey Monkey given to all athletic trainers who participated in the program included demographic information such as age, occupation, education, and years in practice. (Appendix E: Table 1). This data described the telemedicine user. Previous experience with telemedicine, smartphone and tablet availability, as well as internet access availability, was asked to identify early technology issues to address. School affiliation was asked to determine the distance from concussion specialist as a baseline. An Excel spreadsheet was formulated to track participants and their distance from the concussion specialist at Spine Institute Northwest using the data collected in the baseline surveys. Finally, data on previous experience with managing concussions, comfort with managing concussions, and current access to provider trained in concussion management collected gave a description of the athletic trainer.

For the first three weeks of the program, a weekly post-satisfaction survey sent via email to all who enrolled in the program gave process improvement feedback. Included in the weekly assessments was the time from injury to telemedicine acquisition, place of acquisition to determine the distance from concussion specialist, connectivity issues, satisfaction, and recommendations for improvement. Follow up questions for telemedicine utilization determined if there were any process improvements for access to the service to address. Any concerns regarding connectivity or software issues were sent directly to HipaaBridge to address. At the conclusion of the project, a final survey emailed to all athletic trainers determined overall provider satisfaction data and future recommendations. This final survey will continue to be utilized to assess overall user experience and recommendations as the project continues moving forward in the future. The results were reported using Standards for Quality Improvement Reporting Excellence (SQUIRE), Guidelines v. 2.0 (Ogrinc, G. et al., 2015; Goodman, D. et al., 2016).

Washington law permitted reimbursement for telemedicine visits and expanded telemedicine access beginning in 2016 (Washington State Legislature, State Legislature, under "pp. Chapter 68, Laws of 2016"). Despite the potential of reimbursement, the time involved with insurance credentialing as well as the possible exclusion of athletes without insurance was considered for the project. All telemedicine encounters were provided at no charge to avoid reimbursement confusing the project's purpose.

Study of the Intervention

Process management and the Plan-Do-Study-Act (PDSA) cycle was utilized to refine the project (Institute for Healthcare Improvement, 2016). The first PDSA cycle included software tested before implementation, using several software vendors and different distances from the clinic to assure the software chosen was adequate to complete the project. Changes were implemented utilizing the PDSA process to improve both access to the provider as well as the visit process utilizing data collected during the weekly post satisfaction surveys from the athletic trainers. For example, during week one of the program, a visit was hard to complete due to crowd noise. For this reason, the purchase of noise canceling headphones eliminated outside noise on the provider end. Frequent bandwidth issues with the telemedicine software discussed with the software vendor, HipaaBridge resulted in improved software. As the software improved and frequent communication with ATI Head Athletic Trainer Josh Waltier, trainers began using the program more with corporate support and becoming more comfortable discussing problems.

A run chart was created to show the distances the trainers were from the provider using the data provided from the trainers regarding their assigned schools and Spine Institute Northwest, Sports Medicine Clinic where the provider is employed (Appendix F: Figure 3). A second run chart was created to demonstrate the time to visit from initial contact from contact with the trainer to the provider. These visits were either in a clinic or via telemedicine (Appendix G: Figure 4). Finally, a Survey Monkey survey was sent via email link to promote an anonymous and honest response from the original 26 trainers who signed up to participate in refining the program for future development.

Measures

Demonstrate improvement in access to concussion specialist regardless of geographic location to improve health equity. Improvement in access was accomplished by providing training in concussion management to athletic trainers in Washington State and by utilizing secure telemedicine technology assessing athletes on the field sideline, in the training room, and in primary care offices. The telemedicine experience relied on adequate internet connectivity for interaction. Before the start of implementation, all participants were plotted using Google maps and Spine Institute Northwest in Tacoma, Washington (Google, 2016). These distances were recorded on an Excel spreadsheet for later use on the run chart.

Demonstrate improvement in access to concussion specialist by decreasing the time from injury to the specialist to increase athlete safety and improve timeliness to care. Decreasing the time for the athlete to access care was important to increase athlete safety. Recording the time the trainer requests a telemedicine visit to when either a telemedicine visit occurred or when an office visit was scheduled was plotted on a run chart to demonstrate this measure.

Demonstrate provider (athletic trainer) satisfaction of utilizing telemedicine as a source of care. Pre-implementation surveys along with weekly surveys at weeks one through three and upon completion were used to gather this data using Survey Monkey surveys sent via email to all participants.

Analysis

Descriptive statistics were used to describe and summarize the data. A run chart, line graph of data plotted over time allowed for the assessment of time to consultation. A value of one (1) was assigned if the athlete was assessed and treated on the day of contact or additional days added until the athlete was evaluated either on the sidelines or with an in-office visit. A run chart was also used to evaluate the distance between the athlete's school and Spine Institute Northwest Clinic in Tacoma, Washington to establish the distance saved in travel a telemedicine visits. Descriptive statistics were also used to describe the athletic trainers (See Appendix E: Table 1 for demographics). Qualitative data collected from the athletic trainers before the start of the program established demographic information and possible concerns as well as evaluation of the program at the conclusion.

Ethical Issues

It was important to utilize encrypted Health Information Protection and Portability Act (HIPAA) compliant technology at all times. For the purpose of this project, all visits were conducted free of charge. This fee structure eliminated the need to be credentialed with insurance companies and to bill for this project. Adolescent athletes are a vulnerable population. Parental consent for care routinely obtained pre-season by individual schools contracted by the athletic trainers also contained consent for providers working with the trainers for treatment. This consent, a standard consent for treatment, was utilized for all sports participation and not specific for this project. Although not required for practice in Washington State, the principle provider in this project underwent formal Coach credentialing with the Puyallup School District and a Washington State Office of Superintendent of Public Instruction (OSPI) background check, which will be on file for three years.

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Competing interests: None

Ethics approval: Submitted to Frontier Nursing University Institutional Review Board but not required as it was not a research project.

Results

The pre-season survey revealed 79 percent of the athletic trainers enrolled were between the ages of 22-35. These results are summarized in Appendix E: Table 1. Forty-one percent had a master's degree, and all had at least a baccalaureate degree. Twenty-one of the 26 had been in practice eight years or less. Fifty-nine percent had been in practice for four years. All stated they were comfortable managing concussions. Seventy-two percent had no prior experience with telemedicine. Seventy-two percent planned to connect on a smartphone on a cellular network ions. Eighty-three percent of the providers (ATCs) reported no other provider trained in concussion management on-site. Fifty-one percent rely on this provider as a telephone consultant who reflected in the initial survey as having telephone consultation available. Recorded general comments included the following: "When is this coming to Oregon?" " Location/travel distance for inpatient appointments"; "The district does not see the need for practice coverage. Any assistance with this would be appreciated"; "Not in this Washington project, when is it expanding?" "The cost of the research is over and who will pay for the service?" Finally, technology and connection issues were mentioned.

Over the course of this project, which ran August 4, 2016, to October 26, 2016, a total of 23 girls' soccer and boys'football evaluations for concussion by telemedicine were conducted. The athletic trainer initiated the consultation without specific recommendations of when to refer, except their stated in their practice agreement, generally one-week post-injury. According to head athletic trainer Josh Waltier of ATI Physical Therapy, a total of 207 athletes were assessed during this period for concussion (J. Waltier, personal communication, October 24, 2016). The concussions evaluated were on the sidelines and in the training rooms. The visits ranged from shortly after the injury to several days post-concussion with athletes either not improving as expected, or for evaluation to start the return to play protocol. Additional telemedicine calls for other sports-related injuries were conducted but not considered for this project as well as one volleyball concussion.

Appendix F: Figure 3 represents the run chart that was created to demonstrate travel distances. Early in the implementation, a median distance of 27.15 miles of travel was saved in travel one-way (54.30 miles roundtrip). As software connectivity was addressed, it appears the distance trainers were located decreased to a median distance 16.9 miles, (37.8 miles roundtrip) however, this data may not represent concussions that did not occur in more remote areas.

Appendix G: Figure 4 represents the run chart that was created to demonstrate the time in days for the athlete to see the provider after the athletic trainer became aware of an injury or sought assistance. A benchmark was set at a week, as typically a visit with a specialist requires a primary care visit before a specialist appointment. The chart demonstrates a median of same day contact between the athlete, the athletic trainer and the provider, vastly decreasing the time that an athlete would wait for treatment recommendations and interventions.

The final survey sent to all athletic trainers received ten total responses. The overall rating (0-5) was 4.75. The data is summarized in Appendix H: Table 2. Qualitative responses for satisfaction were recorded and included satisfaction at the personal connection telemedicine offered and easy access to a provider telemedicine provided.

Nurse practitioners may not have taken part in the process for a variety of reasons. There are earlier studies that addressed the confusion for reimbursement as a barrier to telemedicine implementation in the clinical environment (Davis, Freeman, Kaye, Vuckovic, & Buckley, 2014). Age may have also played a role, with 65% of the athletic trainers between the ages of 22-30 from the pre-intervention survey. The athletic trainers have grown up with rapidly evolving technology and readily accept the routine use of smartphones, social media, and Internet searches in their daily lives. This data contrasts with the results of a 2016 report published by the Washington State Nurses' Association and Washington Center for Nursing which reports the average age of nurse practitioners in Washington at 50.5 years (Kaplin & Brown, 2016). The nurse practitioners have had to learn to adapt to technology and taught how to integrate technology into daily practices. For the athletic trainers, access to an on-demand resource is a natural occurrence.

Summary

Although this was a focused project and did not include anyone from outside the Seattle/Tacoma area, it did reduce travel time to a specialist and increase access to a provider for concussion management. Those who completed the survey were satisfied with telemedicine and felt that it gave them the support of a provider when needed. Travel in the Seattle/Tacoma area can often be a time burden, particularly with traffic and require parents to take off from work resulting in lost wages. This project is the first project on telemedicine and concussion done in Washington State. If this project broadened with more resources available to include money for technology and compensation for consultant providers, telemedicine could potentially change the care of the high school athlete. This model would be patient-centered with the athletic trainer a key resource in providing care within in the athlete's local area. Nurse practitioners around Washington could be an important part of this model by forming partnerships with athletic trainers to support the care of an athlete immediately after injury and throughout the rehabilitation process. Also, nurse practitioners can expand business opportunities in partnering with athletic trainers to facilitate a broader use of athletic trainers in multiple sporting venues with athletes of all ages, across the state.

Interpretation

Technology is rapidly advancing in healthcare today. For this reason, only a limited number of studies have been performed with concussion telemedicine. Despite this opportunity, concussion injuries are not declining, and the adverse impact of untreated injuries may continue throughout an athlete's life. Also, as younger generations of healthcare providers move into providing care, it is hoped this generation will embrace the use of technology for care delivery. Possibly, part of the lackluster participation by nurse practitioners was due to misunderstanding telemedicine, as the nurse practitioners were a much older demographic. Also, although this project originally set out to address rural/urban inequity, the inequity of working parents having to choose between their jobs and income with taking care of their athlete became apparent. On one team, parental networking with other parents encouraged students to request telemedicine consultations so that athletes could get care without parents needing to leave work and resulting lost wages. The athletic trainers felt supported with the technology. The trainers will continue to support the growth and development of telemedicine as they have a good connection to access care for their athletes. The growth of telemedicine and use of athletic trainers may create opportunities for nurse practitioners to form partnerships in improve care for athletes. Finally, costs of the technology will continue to decline as more develop and use systems.

Limitations

This project revealed several limitations. The project focused on a small group with one nurse practitioner and twenty-six athletic trainers. The project itself was limited to several weeks in length due to the duration of the DNP program. The measures were not rigorous but designed as a feasibility study to show that telemedicine could be a potential solution to address healthcare quality for athletes with concussion. Separate data was not kept on sideline consultation and training room consultation to delineate where the care occurred. Budget restrictions kept the trainers from receiving same equipment or a wifi boosters to see if same technology devices improved the service.

Conclusion

Telemedicine is becoming more mainstream in the delivery of care in the United States, especially since the shift to equalize care across geographic areas. Building on this principle, this quality improvement project is one step towards improving safety by providing care to athletes both on the field and in their home environment. Funding will be needed on a more permanent and consistent basis to develop more rigorous processes and infrastructure for sustainability. Bandwidth issues in more rural areas will need to be addressed, or connectivity will not be a possibility. Companies such as Google and Facebook continue to explore opening the digital divide, and this will not likely be an issue within the next five years. It is feasible that the use of telemedicine could also be utilized for other sports medicine injuries, particularly if the trainer thought imaging might be needed before an in-person visit.

The long-term goal of this project is for student-athletes to continue with active lives well past their high school years, particularly if they have suffered a concussion. Telemedicine can be used for primary care providers to have access to a specialist on demand, for interactive education and consultation utilizing a smartphone, much like a poison control hotline is available in many states. Nurse practitioners and athletic trainers can collaboratively manage athletes with a concussion as more providers with concussion knowledge are needed. This project, while not perfect, shows that with the right team, Internet connection, and funding, there is a foundation upon which to build.

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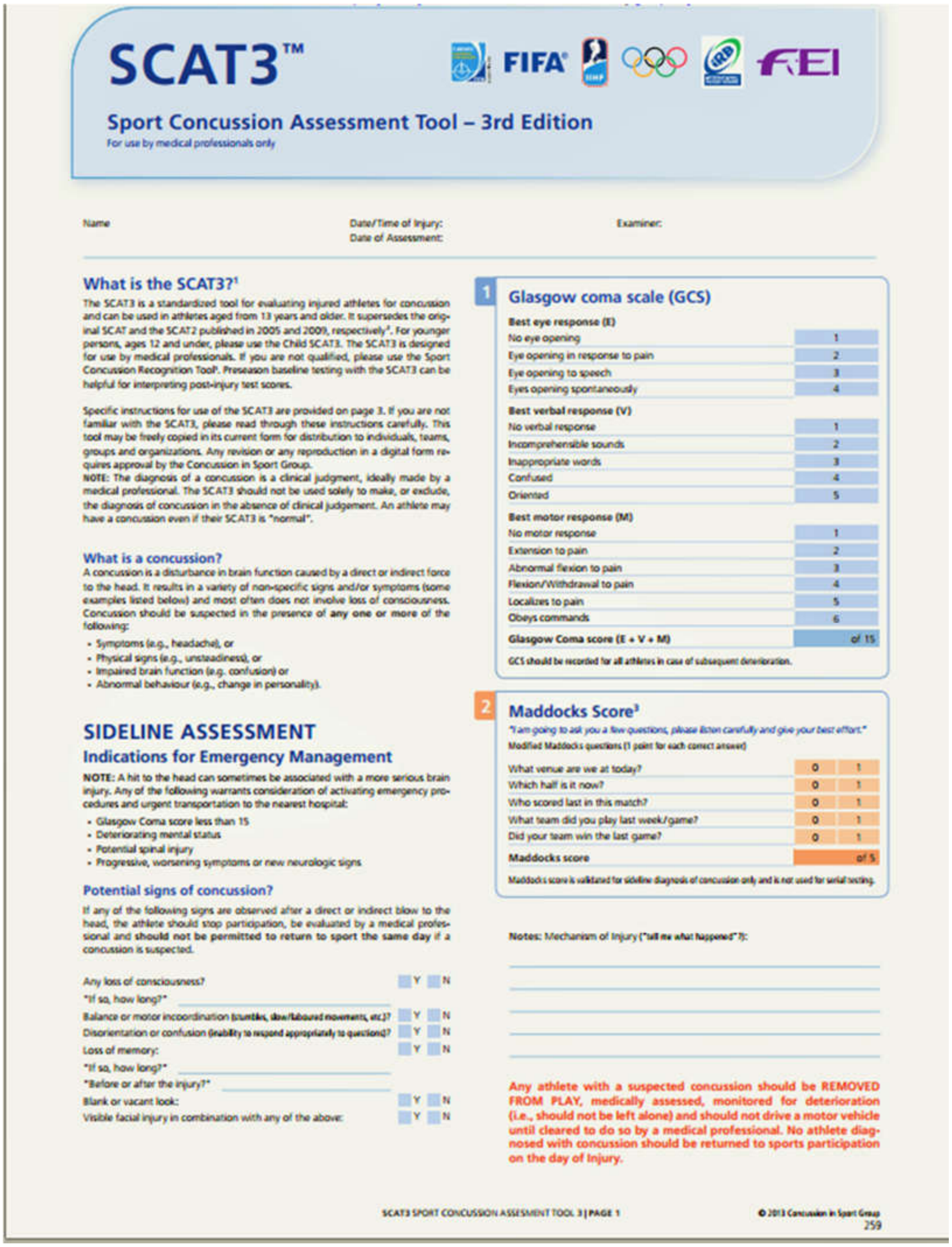
Appendix A

Sports Concussion Assessment Tool, Third Edition, (SCAT 3) Page 1



SCAT3™

FIFA

Sport Concussion Assessment Tool – 3rd Edition

For use by medical professionals only

Name

Date/Time of Injury:
Date of Assessment:

Examiner:

What is the SCAT3?[1]

The SCAT3 is a standardized tool for evaluating injured athletes for concussion and can be used in athletes aged from 13 years and older. It supersedes the original SCAT and the SCAT2 published in 2005 and 2009, respectively[2]. For younger persons, ages 12 and under, please use the Child SCAT3. The SCAT3 is designed for use by medical professionals. If you are not qualified, please use the Sport Concussion Recognition Tool[1]. Preseason baseline testing with the SCAT3 can be helpful for interpreting post-injury test scores.

Specific instructions for use of the SCAT3 are provided on page 3. If you are not familiar with the SCAT3, please read through these instructions carefully. This tool may be freely copied in its current form for distribution to individuals, teams, groups and organizations. Any revision or any reproduction in a digital form requires approval by the Concussion in Sport Group.

NOTE: The diagnosis of a concussion is a clinical judgment, ideally made by a medical professional. The SCAT3 should not be used solely to make, or exclude, the diagnosis of concussion in the absence of clinical judgement. An athlete may have a concussion even if their SCAT3 is "normal".

What is a concussion?

A concussion is a disturbance in brain function caused by a direct or indirect force to the head. It results in a variety of non-specific signs and/or symptoms (some examples listed below) and most often does not involve loss of consciousness. Concussion should be suspected in the presence of **any one or more** of the following:

- Symptoms (e.g., headache), or
- Physical signs (e.g., unsteadiness), or
- Impaired brain function (e.g. confusion) or
- Abnormal behaviour (e.g., change in personality).

SIDELINE ASSESSMENT

Indications for Emergency Management

NOTE: A hit to the head can sometimes be associated with a more serious brain injury. Any of the following warrants consideration of activating emergency procedures and urgent transportation to the nearest hospital:

- Glasgow Coma score less than 15
- Deteriorating mental status
- Potential spinal injury
- Progressive, worsening symptoms or new neurologic signs

Potential signs of concussion?

If any of the following signs are observed after a direct or indirect blow to the head, the athlete should stop participation, be evaluated by a medical professional and **should not be permitted to return to sport the same day** if a concussion is suspected.

Any loss of consciousness?	Y	N
"If so, how long?"		
Balance or motor incoordination (stumbles, slow/laboured movements, etc.)?	Y	N
Disorientation or confusion (inability to respond appropriately to questions)?	Y	N
Loss of memory:	Y	N
"If so, how long?"		
"Before or after the injury?"		
Blank or vacant look:	Y	N
Visible facial injury in combination with any of the above:	Y	N

1 Glasgow coma scale (GCS)

Best eye response (E)	
No eye opening	1
Eye opening in response to pain	2
Eye opening to speech	3
Eyes opening spontaneously	4
Best verbal response (V)	
No verbal response	1
Incomprehensible sounds	2
Inappropriate words	3
Confused	4
Oriented	5
Best motor response (M)	
No motor response	1
Extension to pain	2
Abnormal flexion to pain	3
Flexion/Withdrawal to pain	4
Localizes to pain	5
Obeys commands	6
Glasgow Coma score (E + V + M)	of 15

GCS should be recorded for all athletes in case of subsequent deterioration.

2 Maddocks Score[3]

"I am going to ask you a few questions, please listen carefully and give your best effort."

Modified Maddocks questions (1 point for each correct answer)

What venue are we at today?	0	1
Which half is it now?	0	1
Who scored last in this match?	0	1
What team did you play last week/game?	0	1
Did your team win the last game?	0	1
Maddocks score		of 5

Maddocks score is validated for sideline diagnosis of concussion only and is not used for serial testing.

Notes: Mechanism of Injury ("tell me what happened"?):

Any athlete with a suspected concussion should be REMOVED FROM PLAY, medically assessed, monitored for deterioration (i.e., should not be left alone) and should not drive a motor vehicle until cleared to do so by a medical professional. No athlete diagnosed with concussion should be returned to sports participation on the day of injury.

SCAT3 SPORT CONCUSSION ASSESMENT TOOL 3 | PAGE 1

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(Guskiewicz et al., 2013)

Appendix B

Sports Concussion Assessment Tool, Third Edition, (SCAT 3) Page 2

BACKGROUND

Name: ______ Date: ______
Examiner: ______
Sport/team/school: ______ Date/time of injury: ______
Age: ______ Gender: M F
Years of education completed: ______
Dominant hand: right left neither
How many concussions do you think you have had in the past? ______
When was the most recent concussion? ______
How long was your recovery from the most recent concussion? ______
Have you ever been hospitalized or had medical imaging done for a head injury? Y N
Have you ever been diagnosed with headaches or migraines? Y N
Do you have a learning disability, dyslexia, ADD/ADHD? Y N
Have you ever been diagnosed with depression, anxiety or other psychiatric disorder? Y N
Has anyone in your family ever been diagnosed with any of these problems? Y N
Are you on any medications? If yes, please list: Y N

SCAT3 to be done in resting state. Best done 10 or more minutes post excercise.

SYMPTOM EVALUATION

3 How do you feel?

"You should score yourself on the following symptoms, based on how you feel now".

	none	mild		moderate		severe	
Headache	0	1	2	3	4	5	6
"Pressure in head"	0	1	2	3	4	5	6
Neck Pain	0	1	2	3	4	5	6
Nausea or vomiting	0	1	2	3	4	5	6
Dizziness	0	1	2	3	4	5	6
Blurred vision	0	1	2	3	4	5	6
Balance problems	0	1	2	3	4	5	6
Sensitivity to light	0	1	2	3	4	5	6
Sensitivity to noise	0	1	2	3	4	5	6
Feeling slowed down	0	1	2	3	4	5	6
Feeling like "in a fog"	0	1	2	3	4	5	6
"Don't feel right"	0	1	2	3	4	5	6
Difficulty concentrating	0	1	2	3	4	5	6
Difficulty remembering	0	1	2	3	4	5	6
Fatigue or low energy	0	1	2	3	4	5	6
Confusion	0	1	2	3	4	5	6
Drowsiness	0	1	2	3	4	5	6
Trouble falling asleep	0	1	2	3	4	5	6
More emotional	0	1	2	3	4	5	6
Irritability	0	1	2	3	4	5	6
Sadness	0	1	2	3	4	5	6
Nervous or Anxious	0	1	2	3	4	5	6

Total number of symptoms (Maximum possible 22)
Symptom severity score (Maximum possible 132)

Do the symptoms get worse with physical activity? Y N
Do the symptoms get worse with mental activity? Y N

self rated — self rated and clinician monitored
clinician interview — self rated with parent input

Overall rating: If you know the athlete well prior to the injury, how different is the athlete acting compared to his/her usual self?

Please circle one response:

no different	very different	unsure	N/A

Scoring on the SCAT3 should not be used as a stand-alone method to diagnose concussion, measure recovery or make decisions about an athlete's readiness to return to competition after concussion. Since signs and symptoms may evolve over time, it is important to consider repeat evaluation in the acute assessment of concussion.

COGNITIVE & PHYSICAL EVALUATION

4 Cognitive assessment

Standardized Assessment of Concussion (SAC)[4]

Orientation (1 point for each correct answer)

What month is it?	0	1
What is the date today?	0	1
What is the day of the week?	0	1
What year is it?	0	1
What time is it right now? (within 1 hour)	0	1
Orientation score		of 5

Immediate memory

List	Trial 1		Trial 2		Trial 3		Alternative word list		
elbow	0	1	0	1	0	1	candle	baby	finger
apple	0	1	0	1	0	1	paper	monkey	penny
carpet	0	1	0	1	0	1	sugar	perfume	blanket
saddle	0	1	0	1	0	1	sandwich	sunset	lemon
bubble	0	1	0	1	0	1	wagon	iron	insect
Total									

Immediate memory score total of 15

Concentration: **Digits Backward**

List	Trial 1		Alternative digit list		
4-9-3	0	1	6-2-9	5-2-6	4-1-5
3-8-1-4	0	1	3-2-7-9	1-7-9-5	4-9-6-8
6-2-9-7-1	0	1	1-5-2-8-6	3-8-5-2-7	6-1-8-4-3
7-1-8-4-6-2	0	1	5-3-9-1-4-8	8-3-1-9-6-4	7-2-4-8-5-6
Total of 4					

Concentration: **Month in Reverse Order** (1 pt. for entire sequence correct)

Dec-Nov-Oct-Sept-Aug-Jul-Jun-May-Apr-Mar-Feb-Jan	0	1
Concentration score		of 5

5 Neck Examination:

Range of motion Tenderness Upper and lower limb sensation & strength
Findings: ______

6 Balance examination

Do one or both of the following tests.
Footwear (shoes, barefoot, braces, tape, etc.) ______

Modified Balance Error Scoring System (BESS) testing[5]
Which foot was tested (i.e. which is the non-dominant foot) Left Right
Testing surface (hard floor, field, etc.) ______

Condition	
Double leg stance:	Errors
Single leg stance (non-dominant foot):	Errors
Tandem stance (non-dominant foot at back):	Errors

And / Or

Tandem gait[6,7]
Time (best of 4 trials): ______ seconds

7 Coordination examination

Upper limb coordination
Which arm was tested: Left Right
Coordination score of 1

8 SAC Delayed Recall[4]

Delayed recall score of 5

260 SCAT3 SPORT CONCUSSION ASSESMENT TOOL 3 | PAGE 2

(Guskiewicz et al., 2013)

Appendix C: *Figure 1*
SWOT

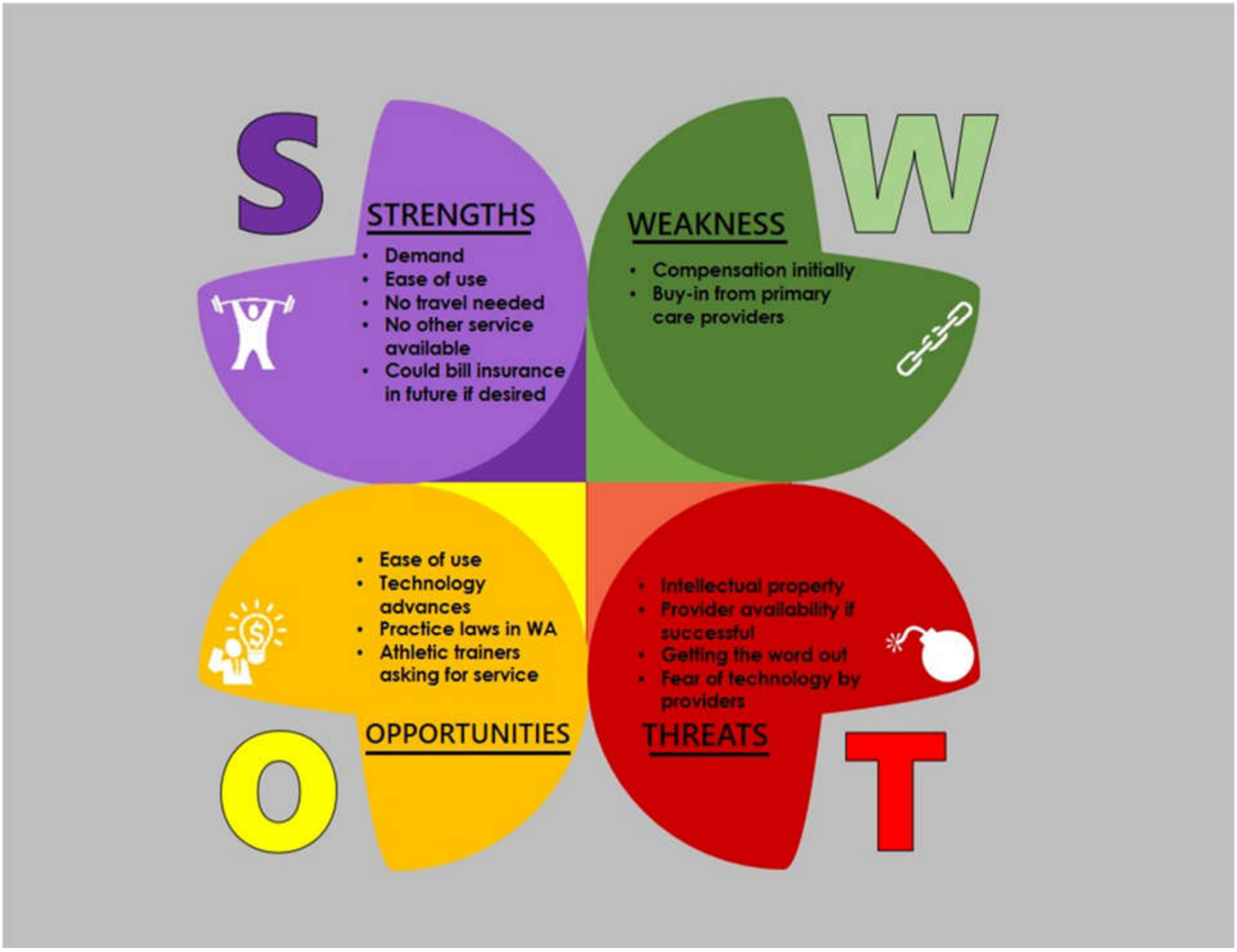


Figure 1 Strengths, Weaknesses, Opportunites, Threats (SWOT) analysis created with Microsoft PowerPoint template.

Appendix D: Figure 2

Gantt

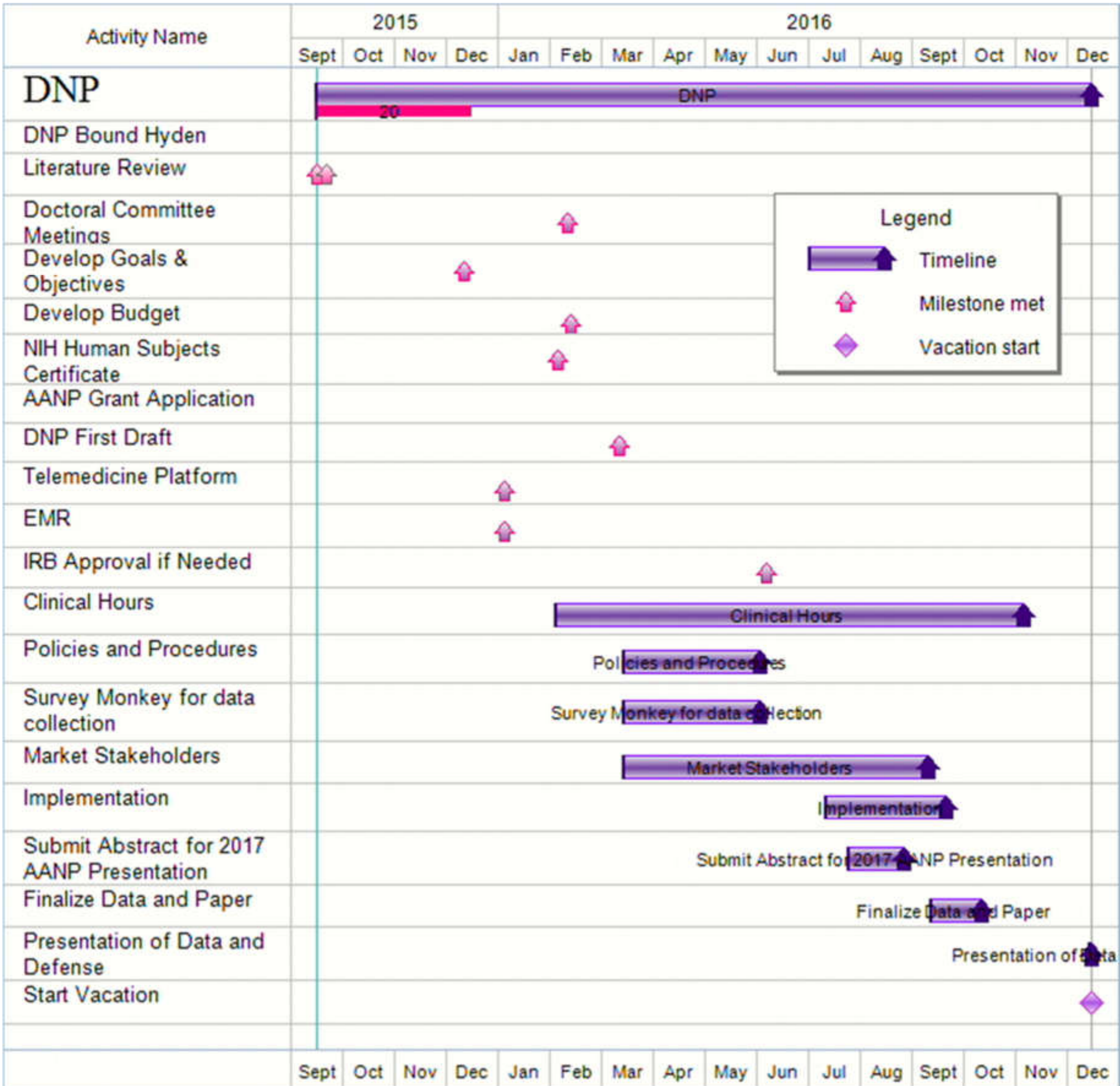


Figure 2 Gantt chart to track project for orientation through completion using AEC Software.

AEC Software copyright 2015.

Appendix E: Table 1

Pre-implementation Survey Responses (N=26)

What is your age?	22-25 26-30 31-35 36-40 41-45 46-50	37.9% 27.6% 13.8% 3.4% 0.0% 6.9%
What is your highest level of education?	Bachelors Masters	50.0% 50.0%
How many years have you been in practice?	0-2 3-5 6-8 9-11 12-15 16-20 21-25	37.9% 24.1% 10.3% 3.4% 6.9% 3.4% 3.4%
How many years have you been managing concussions?	0-4 5-10 11-15 16-20	58.6% 20.7% 6.9% 3.4%
Are you comfortable managing concussions?	Yes No Most of the time	72.4% 0.0% 27.6%
Does your setting currently always have a provider trained in concussion management available on-site for games and practices to consult with if needed?	Yes No Not on-site but I can communicate over the phone if I need later	20.69% 31.03% 51.72%
Do you have previous experience using telemedicine?	Yes No	27.6% 72.4%
If yes, how many times have you used telemedicine? (response count 8)	1-2 times 2-5 times more than 5 times	37.5% 25.0% 37.5%
Which will you use most often to connect if needed:	smart phone on cellular smartphone on wifi tablet on cellular tablet on wifi Other (please specify)	72.4% 13.8% 3.4% 10.3% 0.0%
Do you have any concerns initially about the project?	Yes No Please describe: • Technology and connection issues • Service for away game	20.7% 79.3%

	• Location/travel distance for inpatient appointments • Not in this Washington project, when is it expanding? • When is this coming to Oregon? • Cost after the research is over and who will pay for the service? • The district doesn't see the need for practice coverage. Any assistance with this would be appreciated.

Appendix F: Figure 3

Run Chart Distance

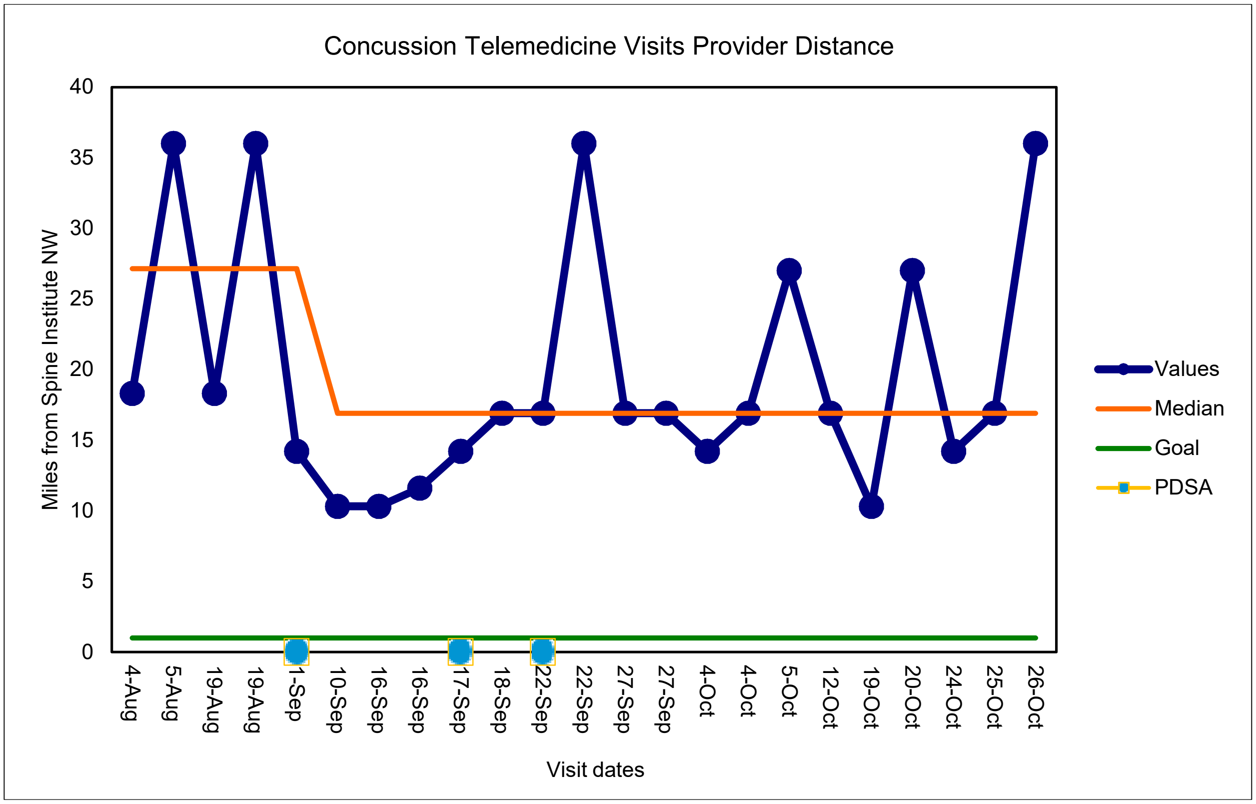


Figure 3. Run chart for distance one-way in miles from the athletic trainer's school to Spine Institute Northwest in Tacoma, Washington on dates telemedicine service was used. The goal was to eliminate travel utilizing telemedicine. PDSA interventions are marked by blue on the date line. Adapted from "Run Chart Tools, v2" by R. Scoville, 2016, Institute for Healthcare Improvement, http://www.ihi.org/resources/Pages/Tools/RunChart.aspx. Copyright 2016 by the Institute for Healthcare Improvement.

Appendix G: Figure 4

Run Chart Time

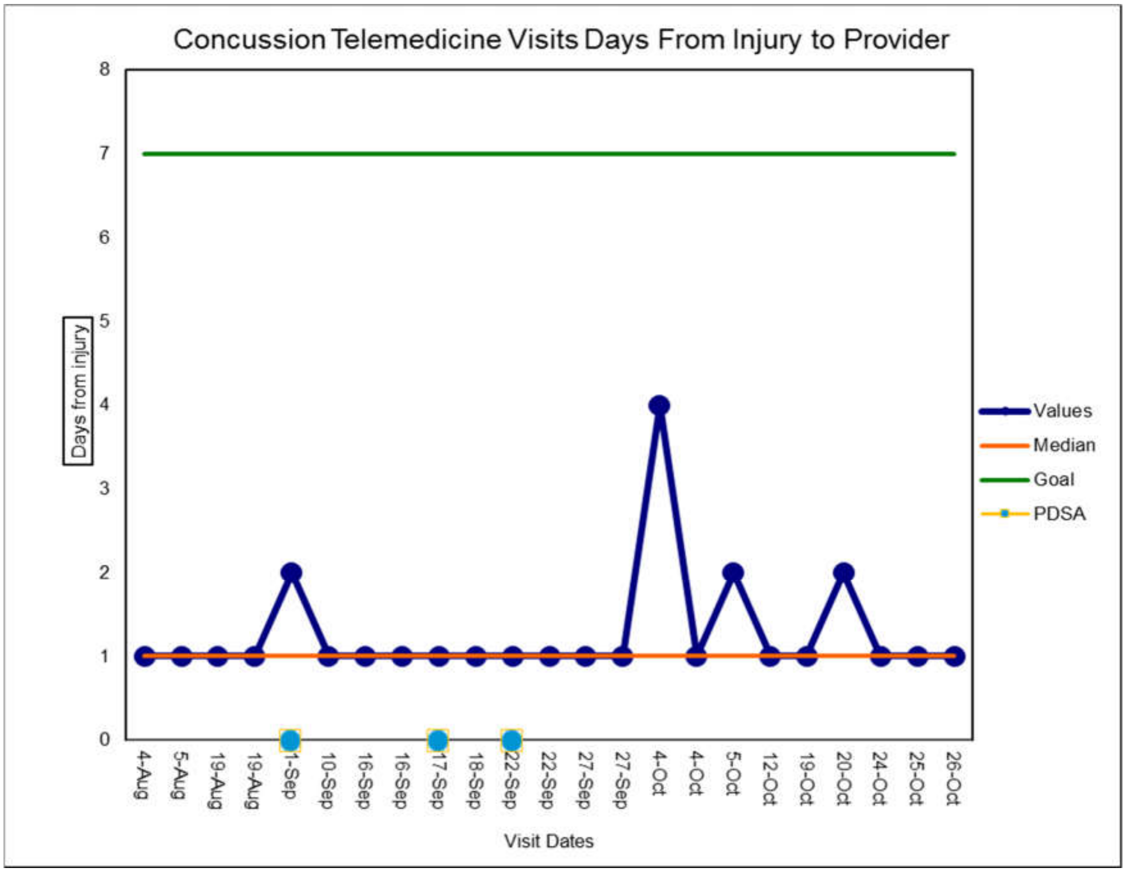


Figure 4. Run chart for time to a specialist from the date of injury. The goal was less than seven days. PDSA interventions are marked by blue on the date line. Adapted from "Run Chart Tools v.2," by R. Scoville, 2016, Institute for Healthcare Improvement, http://www.ihi.org/resources/Pages/Tools/RunChart.aspx. Copyright 2016 by the Institute for Healthcare Improvement.

Appendix H: Table 2

Post-Implementation Survey Responses

N=10

Do you consider your school:	Urban 40.0% Suburban 40.0% Rural 20.0%
Did you use the telemedicine program?	Yes 80.0% No 20.0%
If your answer to the previous question was no, please help me understand why it was not helpful. Thank you again for your assistance with this project	I had no concussions during this period 0.0% None of the concussions needed care 100.0%
If yes, please rate your satisfaction: 1 (Didn't like)-5 (I loved it)	I didn't like 0 Just okay 0 Average 0 Good most of the time 2 I loved it 6 N/A 1 **Rating Average 4.75** Response Count 9
What did you like best?	• The accessibility was awesome! Very easy to use. • Access to concussion specialist from the sidelines of a game, even if the specialist is not physically present • Cyd was available when the athletes needed to be seen (i.e. on Saturdays and Sundays). She was able to discuss with parents best care for their child which was extremely helpful in cases when the child would not have access to follow-up (i.e. youth leagues and away games). • Easy to use. • Easy access to team doctors • Cost-effective way to manage concussions. • Ensures no time is lost in treating concussions
What improvements would you recommend? Please be honest so that it can improve.	• Outside of technical issues with HipaaBridge, I didn't have any problems. Everything went really well! • The connection was sometimes slow depending on the area being used. Sometimes could not send a message even when had decent signal. • This is an excellent resource! Perhaps establishing a clear process for athletes without consistent care would be beneficial,

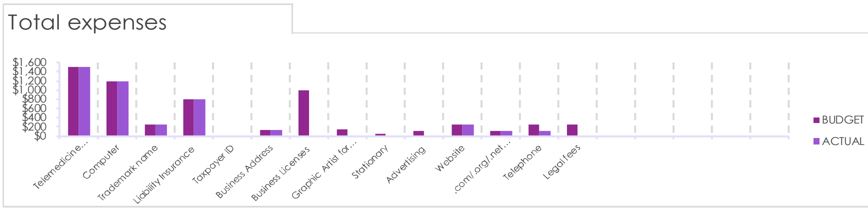
	such as the athletes which are seen once at the time of injury but will not see anyone within sports medicine again. Perhaps defining your vision would help with researching follow-up care (is the big picture with this technology to promote it as a resource for the ER or for individual access with the athlete?) Parents seemed to be confused on the 'next step' and 'final clearance' in these cases. • Would be nice if it worked better over my schools wifi, and most of the time hard to hear on the other end. • Increased opportunity for provider to be on site. Allows kids/coaches to have a better sense of who they are talking to on the other side. That personal connection. • Sound. I need to remember to bring speakers for my phone. The ATR can be a bit noisy.
Who is your cell phone carrier?	Verizon 66.7% N=6 AT&T 11.1% 1 Sprint 11.1% 1 T-Mobile 0.0% 0 Other 11.1% 1

Appendix I: Figure 5

Budget

DNP Project Budget

Telemedicine Concussion



STATUS	OPERATING	BUDGET	ACTUAL	DIFFERENCE ($)	DIFFERENCE (%)
	Telemedicine Platform	$1,500.00	$1,500.00	$0.00	0%
	Computer	$1,200.00	$1,200.00	$0.00	0%
	Trademark name	$250.00	$250.00	$0.00	0%
	Liability Insurance	$800.00	$800.00	$0.00	0%
	Taxpayer ID	$0.00	$0.00	$0.00	
	Business Address	$120.00	$120.00	$0.00	0%
	Business Licenses	$1,000.00		$1,000.00	100%
	Graphic Artist for Logo	$150.00		$150.00	100%
	Stationary	$50.00		$50.00	100%
	Advertising	$100.00		$100.00	100%
	Website	$250.00	$250.00	$0.00	0%
	.com/.org/.net addresse	$100.00	$100.00	$0.00	0%
	Telephone	$250.00	$100.00	$150.00	60%
	Legal fees	$250.00			0%
	Total Expenses	**$6,020.00**	**$4,320.00**	**$1,450.00**	**24%**