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ABSTRACT

Purpose: Failure to provide timely assessment and management of patients with concussions creates prolonged challenges for patients and primary care providers by disrupting work and school, interpersonal and family relationships, and placing patients at risk of injury. Thus, it is essential to provide timely and appropriate care to minimize post-concussion symptoms. The development of a virtual concussion clinic with a central referral and care coordination system is described. Additionally, key identifiers of virtual clinic patients are presented.

Methods: Intake and referral processes were implemented within 18 specialty clinics and 3 emergency departments. All patients (n= 623) completed a modified version of the Centers for Disease Control (CDC) Acute Concussion Evaluation (ACE) Form prior to their referred appointment with a clinician. Data was collected over a year and a half period.

General linear models compared the ACE domains and overall ACE scores with fixed variables of gender and cause of concussion.

Results: For our sample, most referrals came from emergency departments and primary care physicians. The sample was majority male (57%), with mean age 21.8 years. Females playing soccer, basketball, and cheerleading were most likely to have a concussion, whereas football represented 65% of concussions in male patients.

Significant effects for gender ($p < 0.02$) were observed for all ACE domains except for Cognitive, and cause of concussion ($p < .001$ was significant for all ace domains. the interaction between gender and cause of concussion on physical domain significant.>Conclusions: A virtual concussion clinic can successfully match the patient and his/her individual health care needs to an appropriate provider. Results demonstrate gender and cause of concussion impact evaluation, and warrants further research to discern optimal care for patients with concussion.

Keywords: virtual clinic, concussion, standard of care, care coordination

INTRODUCTION

Concussions are considered to be a subset of mild traumatic brain injury (mTBI), yet these terms are often used interchangeably, leading to public misconceptions about their symptomology. Although there is currently no universally accepted definition of concussion, concussions are typically marked by the rapid onset of transient neurologic dysfunction resolving spontaneously, and catalyzed by direct or indirect biomechanical forces acting on the brain.(1) In contrast to more severe traumatic brain injuries (TBIs), concussions are not associated with macrostructural injury to the brain, thus brain pathologies are not visible on standard neuroimaging studies. In recent years, concussions have been recognized as a significant health problem worldwide, with the potential for short and long-term sequelae.(1) In the United States, there are an estimated 1.6 to 3.8 million sports and activity-related TBIs per year(13), the majority of which are concussions, highlighting the need to further examine the pathologies, management and outcomes of concussions.

Because of the neurometabolic cascade initiated by concussions, patients with a concussion require prompt assessments to rule out more serious injuries and may require long-term multidisciplinary care for optimal outcomes.(5,10,16) For example, about 14% of children will remain persistently symptomatic three months after a concussion,(12) and roughly half of military veterans sustaining an mTBI met DSM IV criteria for post-concussion syndrome 6-36 months post-injury.(8)

There is a need for improvement in short, intermediate, and long-term care of patients with concussions. Failure to provide timely assessment and management of patients with concussion may create prolonged challenges for both the patient and his/her primary care provider by disrupting work and school, interfering with interpersonal and family relationships, and placing the patient at risk of injury.

Several barriers to optimal patient concussion care exist, including a lack of well-studied short and long-term therapies.(11,12) Further challenges exist with the range in type of providers that may evaluate patients with concussion, as they may utilize different standards of concussion assessment and management.(10) The multi-faceted nature of concussions provides many challenges such as neurobehavioral or cognitive difficulties in returning to work, school, physical activity, or lifestyle requirements.(6,10) When athletes return to play, care management challenges exist from likely periods of patient vulnerability leading to recurrent concussions or more severe injuries from a premature return to sport. These potential outcomes necessitate medical supervision during the recovery process as the standard of care.(5,10)

With increasing numbers of patients presenting for evaluation of mTBI symptomology, health care systems are challenged to efficiently organize their injury and treatment care resources. (10) The disjointed medical management of many patients with concussion suggests that provisions be made for evidence-based standardized referrals, as well as assessment and follow up for these patients. Specialized “concussion clinics” have been developed throughout multiple health care systems in the United States (U.S.) over the last several years, demonstrating positive changes towards developing improved treatment. However, many of these clinics are organized and marketed specifically for sports-related concussion patients, leaving a major gap in potential insights on treatment methodology for non-sports related concussion patients. Furthermore, little has been published about the formation of these sport concussion clinics or the exact populations impacted, though limited studies report the majority of clinic patients are male adolescents.(13,14)

To the authors’ knowledge, the development and implementation of “virtual” concussion clinics such as ours, which operates by utilizing a central intake and referral system rather than a single physical location to expedite patient access to appropriate services, has never been described in the literature. The purpose of this report is first, to describe the organizational process of establishing and operating a multidisciplinary virtual concussion clinic in a midsize Northwest city. Secondly, we aim to describe the patients accessing our virtual clinic according to key features such as the cause of concussion and symptomology.

METHODS

Formation and planning of the St. Luke's Concussion Clinic began in the fall of 2011, and was sponsored by a regional medical center with 12,000 employees serving on average 2.2 million patient visits per year throughout Idaho. The potential of a multidisciplinary virtual Concussion Clinic was prompted by several observations: 1) recurring time lags in patient referrals to see providers; 2) patients unable to access appropriate specialty providers; 3) variability and inconsistency in diagnosis and management of patients with concussion; 4) lack of awareness of supporting therapeutic or subspecialty referral resources; 5) inconsistent discharge practices from emergency departments; 6) inadequate communication with schools and employers about resuming classroom and/or occupational duties; and, 7) inconsistent return to play timelines within sport guidelines in the community. A commitment was made to develop a virtual Concussion Clinic to coordinate services across provider groups within the Treasure Valley (located in southwest Idaho, the most populated area of Idaho), regardless of physical location. It was hypothesized that a virtual clinic might efficiently organize resources, streamline patient care and management, and improve accessibility to patients by broadening the provider base, rather than having a single brick and mortar facility which may present travel limitations. This model also provides improved standard of care, inter-provider communication and immediate educational and other resource information.

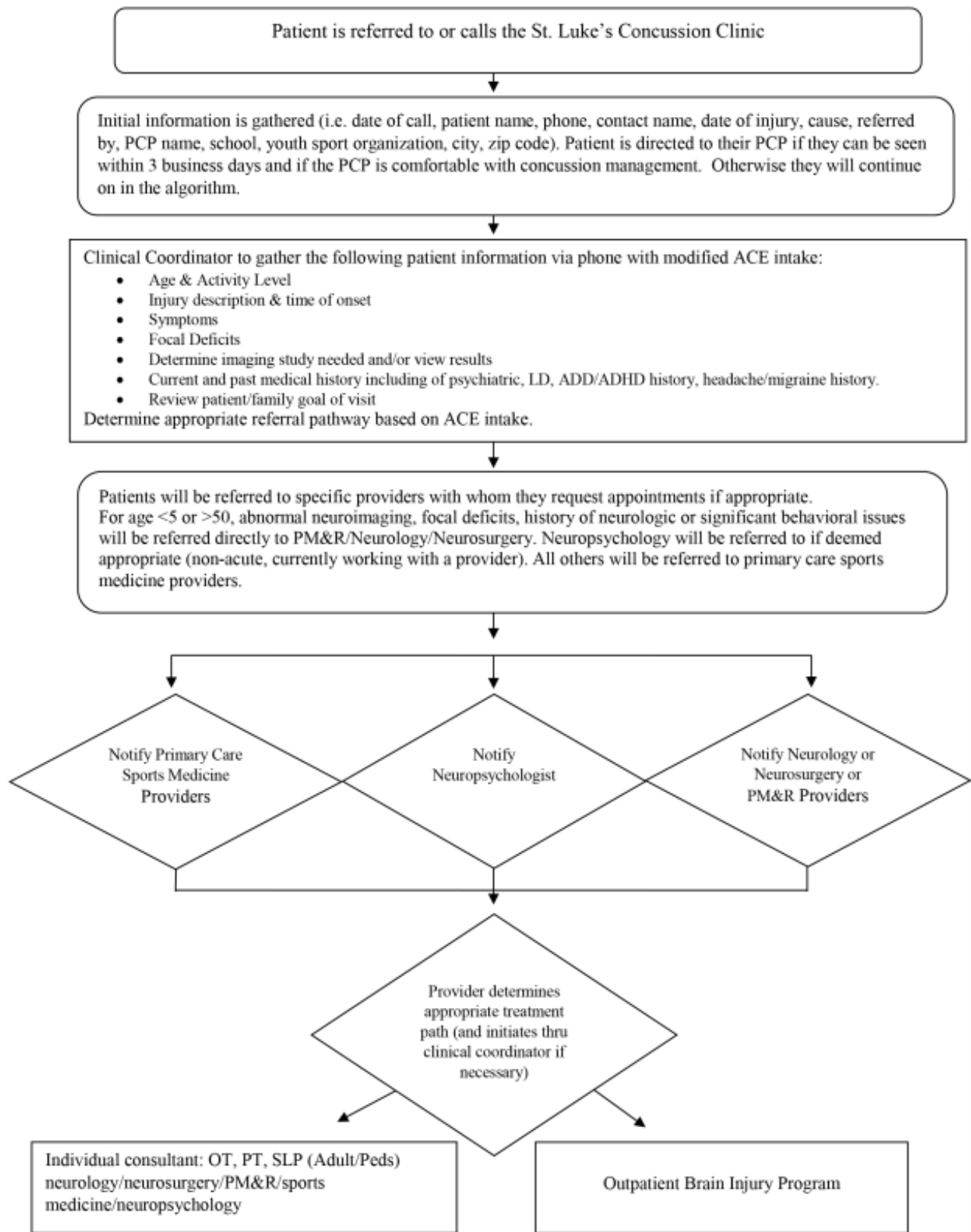
Over approximately ten months, a Medical Director for the Concussion Clinic was identified and stakeholders consisting of health care providers from several medical specialties (e.g. primary care sports medicine, pediatric and adult neuropsychology, neurology, neurosurgery, emergency medicine, physiatry, physical/occupational therapy and speech and language pathology) reviewed existing concussion management protocols and moved forward with the goal of developing and serving patients of a virtual clinic. These stakeholders will hereafter be referred to as Concussion Clinic providers. Established concussion clinics throughout the U.S. were contacted to better understand how these clinics operated, including their clinics' "medical home" concept; the patient relationship with his/her primary care physician; what each specialty brought to management of patients with concussion; criteria suggesting immediate specialty referral; and perceived needs of each specialty in managing patients with concussion. Research further included inquiring at what age patients moved from pediatric to adult providers; initial intake parameters needed to effectively coordinate care for patients; and types of patient education information required for dissemination at the patient's visit.

Referral guidelines were then drafted for implementation among the 18 initial participating clinical practices (Concussion Clinic providers) and the three emergency departments within the St. Luke's health system. The definition of concussion issued by the 4th International Consensus Conference(9) on concussion in sport was used to define concussion to ensure proper referral and treatment diagnosis. Through review of the literature and consensus, triage intake sheets were developed based on the Centers for Disease Control (CDC) Acute Concussion Evaluation (ACE)(4) form, with modifications to include added domains for care coordination and referral determination. For this study, the four total ACE domain symptom scores for Cognitive, Emotional, Physical and Sleep domains plus the overall ACE score were analyzed with a Univariate General Linear Model with gender and cause of concussion at time

of intake as fixed variables using the Statistical Package for the Social Sciences (SPSS) Ed. 22.(7,15) The scores for the ACE symptoms are divided into four separate domains based on presence of symptoms: Physical (0= No, 1= Yes; 10 questions), Cognitive (0= No, 1= Yes; 4 questions), Emotional (0= No, 1= Yes; 4 questions), and Sleep (0= No, 1=Yes; 4 questions). Each Total ACE score is determined by the sum of the Physical, Cognitive, Emotional, and Sleep domains. Cause of concussion is denoted on the ACE by a checklist and includes the following variables: motor vehicle crash (MVC), pedestrian motor vehicle crash (Pedestrian-MVC), Fall, Assault, Sports (specify), and Other (specify). Patients mark the scenario that best fits their cause of concussion, and these results were entered into a database for comparison to ACE domain scores and gender.

Figure 1 summarizes the intake protocol used for the Clinic (Figure 1). Patient education handouts from the CDC were utilized, and other concussion clinics throughout the U.S. were contacted to obtain permission to utilize and adapt their academic recovery plans. Because of the virtual nature of the Clinic and multiple physical locations of Concussion Clinic providers, patient education materials and above forms were all consistently branded with the St. Luke's Concussion Clinic logo, website, and phone number.

Figure 1: Algorithm for Care Coordination



Critical to the functioning of our virtual Concussion Clinic was the full time Clinical Coordinator, who assessed, referred, and tracked patients. The model utilized highly matched care coordination protocols, where an individual with clinical experience and training in brain injury coordinated the multiple facets of care between providers and therapeutic services. Tasks of the Coordinator included performing patient intakes, arranging appropriate specialty

evaluation, requesting and/or attending school meetings as necessary to advocate for school accommodations, and following up with patients to ensure proper management. This person also oversees the collection of patient data to help better steer services and evaluate outcomes (e.g. ability of the Clinic to connect patients to providers within three business days).

Management of uncomplicated concussions is well within the purview of the primary care physician. Considering the need to reinforce the medical home, patients were required to call the clinic directly to complete an initial intake with the Clinical Coordinator, including gathering the following information: patient name, date of call, date of birth, date of injury, cause, primary care provider (PCP), and school name. Patients were then referred to their PCP unless they were unable to be seen within three business days or if the PCP desired patient referral to a Concussion Clinic provider for management. If the patient had no PCP, or was referred directly from the PCP, the modified ACE was completed to determine the most appropriate provider within the Concussion Clinic. Ninety-five percent of patients without significant comorbidities and who were two weeks or less from date of injury, were seen by primary care sports medicine physicians within the Concussion Clinic within three business days. Those with outstanding comorbidities or who were two weeks or more from date of injury, were seen by adult or pediatric physical medicine and rehabilitation (PM&R) or neurology or neurosurgery, also within three business days. At these appointments, resources are provided to the patient as needed, including academic and/or work accommodations, activity guidance prescriptions, consultant or therapeutic referral (such as referral to individual physical therapy, occupational therapy, speech therapy, a comprehensive outpatient brain injury program or neuropsychological testing), and pharmacological management of symptoms, if appropriate. All patients, whether seen by Concussion Clinic providers or not, received a three week follow up call to ensure they were receiving care and recovering based on reporting of on-going symptoms.

Parallel with defining the Concussion Clinic patient care functions, St. Luke's committed a second full time staff position for a Community Outreach and Education Coordinator. This position helps standardize and present concussion education across multiple communities. The health system's outreach athletic trainers assist with reinforcing this education. A special focus of this position, therefore, is on youth sports. During the first year and a half, an estimated 50,000 people and approximately 50 organizations were served by annual educational events for coaches, medical providers, school administrators, nurses, parents, and many community organizations. These educational programs included one-on-one meetings with community organizations, facilitating collaborations between Concussion Clinic providers and community medical providers. Educational outreach also included provision of and training in, the baseline neurocognitive testing program in the community, using ImPACT.(9) This testing was delivered to multiple middle and high schools in the region, in addition to offering testing twice monthly at St. Luke's. Neurocognitive testing has shown to be effective in identifying the presence of concussion and as such can be utilized to help make determinations about returning timeframes for high risk activities.(16)

RESULTS

For ease of description, we have chosen to limit our discussion of the Concussion Clinic to the first year and a half after opening the Clinic. Although the absolute numbers of patients entering the Concussion Clinic continues to rise in a linear fashion, the demographic descriptions have remained consistent.

During this period, the Concussion Clinic coordinated care for 623 patients between 18 Concussion Clinic providers. During this period, over 900 calls to the Clinic were received and 320 interactions were facilitated between PCPs and their patients, directing patients to their medical home. Patients contacting the clinic were referred by the following sources: emergency departments (368); urgent care (29); PCP (237); athletic trainers both employed by the health system as well as others in the community (119); orthopedic surgery (5); neurosurgery (20); physical medicine/neurology (12); occupational health (8); other (113), which includes Clinic website, school registered nurses, former patients, community education events, coaches, and patients served in our baseline ImPACT testing program.

Patients calling the Concussion Clinic were initially seen by the following providers: primary care sports medicine (405), physical medicine and rehab (194), neurosurgery (1), neurology (17), neuropsychology (8), and emergency department (122). The remaining patients either cancelled or were not scheduled due to no returned phone call. These descriptions reflect only the initial referral from the Concussion Clinic Coordinator, as patients were often seen by more than one Concussion Clinic provider in cases where multiple areas of expertise were necessary.

Six hundred and twenty three individuals were assessed with the ACE. This sample was approximately equal between women (43%) and men (57%), and the average age was 21.8 years (SD= 14.27). Cause of concussion at the initial intake phone call by the Clinic Coordinator was categorized into seven groupings: assault, fall, motor vehicle accident (MVA), MVA vs pedestrian, MVA vs bicycle, other, and sport. As shown in Table 1, sport was the most common cause of concussion for both men and women (40% F, 60% M) followed by accidents involving a motor vehicles, with 51 women (19%) and 45 men (13%) meeting the latter.

	<i>ACE Cognitive</i>	<i>ACE Emotional</i>	<i>ACE Physical</i>	<i>ACE Sleep</i>	<i>ACE Total</i>
Cause of Concussion	Female (N= 269)				
Assault (12)	3.67 (0.49)	2.58 (1.08)	7.00 (1.86)	2.08 (0.52)	15.33 (2.23)
Fall (44)	2.52 (1.58)	1.66 (1.80)	5.30 (2.51)	1.86 (1.01)	11.51 (5.06)
MVA_Ped (47)	3.26 (1.11)	1.98 (1.54)	7.00 (1.87)	2.23 (0.89)	14.47 (3.99)
MVA_Bike (4)	2.25 (2.06)	2.50 (1.92)	7.00 (2.45)	2.50 (0.58)	14.25 (6.13)
Other (51)	2.94 (1.59)	1.33 (1.41)	5.67 (2.43)	1.78 (1.06)	11.73 (4.96)
Sport (107)	2.50 (1.51)	1.23 (1.59)	5.06 (2.17)	1.52 (1.04)	10.30 (4.79)
Cause of Concussion	Male (N= 354)				
Assault (9)	2.44 (1.94)	0.89 (1.36)	4.33 (3.04)	1.44 (1.24)	9.11 (5.71)
Fall (38)	2.37 (1.98)	1.00 (1.20)	5.26 (2.61)	1.61 (1.08)	10.19 (5.03)
MVA_Ped (41)	2.63 (1.70)	1.46 (1.29)	4.71 (2.57)	1.88 (1.10)	10.68 (5.32)
MVA_Bike (4)	1.50 (2.12)	0.50 (0.71)	3.00 (2.83)	0.50 (0.71)	5.50 (4.95)
Other (45)	4.00 (0.00)	0.50 (0.71)	3.50 (2.12)	1.50 (0.71)	9.50 (0.71)
Sport (213)	2.44 (1.78)	1.18 (1.35)	5.18 (2.25)	1.70 (1.11)	10.53 (5.17)

Table 2 presents the results of the four ACE domains and total scores and standard deviations by gender and cause of concussion. Across all ACE domains and cause of concussion, women on average had higher ACE scores. Statistically significant effects for gender ($p < 0.02$) were observed for all ACE scores except for the cognitive domain, and statistically significant effects were also observed for cause of concussion ($p < .001$ across all ace domains. there was a statistically significant interaction between gender and cause of concussion on the physical domain. comparisons male versus female total scores found that women exceeded men by at least points for assault mva with bicycle.

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Descriptive profiles were generated for males and females identified as having sport as the cause of their concussions. For this analysis, the sample was divided according to 4 age categories (7-12 years, 13-18 years, 19-25 years, and 26 and older). Sixteen unique sports were reported for women and 17 unique sports were reported for men. Women in this sample had no concussion reported for wrestling, mountain biking, rodeo or rugby. Men had no concussion reported for track & field or dance. The most frequently occurring sport causing concussion for women was soccer (47), with 39 (83% of all soccer concussions) in the 13-18 year age group. Basketball (21) and cheerleading (21), were tied for second most frequent sport causing a concussion for women. The majority of these cases occurred within the 13-18 year old group (18 or 86% for all basketball injuries and 20 or 95% for all cheerleading injuries).

Football was the most common cause of concussions for men, representing 212 of 327 sport related concussions (65%). The players' ages with concussion symptoms were skewed towards the younger groups (92 or 57% of all 7-12 year olds and 114 or 47% of all 13-18 year olds). Other cited sports causes of concussion represented the 22% remaining cases, including wrestling (17), basketball (16), lacrosse (14), cycling (14), and soccer (12). With the exception of cycling, the majority of incidents occurred within the 13-18 year old group: 14 (82%) of all wrestling concussions, 12 (75%) of all basketball concussions, 12 (86%) of all lacrosse concussions and 12 (75%) of all soccer concussions.

DISCUSSION

Concussion as a diagnosis encompasses heterogeneous symptoms and a myriad of manifestations in personal, scholastic and/or professional, recreational, and athletic settings, and thereby requires extensive and comprehensive treatment modalities. As such, major medical organizations have recommended that optimal management of the patient with concussion involve a broad range of professional specialties.(5,6) Our research suggests that the causes of concussion in our patient population are multiple, differ by gender and age, and through analysis of ACE subject scores, manifest themselves in multiple ways. Therefore, our results match previous literature that concussion standard of care and optimal treatment plans require further investigation to enhance the short and long-term health outcomes of patients with concussion. There is scant research beyond consensus and case series on immediate treatment approaches to concussion, highlighting the need to further explore standard of care

avenues and short and long-term outcomes for patients with concussion. While Concussion Clinic providers have reached consensus on current standards of care for concussion patients, the determination of optimal care for patients with concussion continues to evolve and remains unclear.

One such way to address this gap is the virtual clinic, as our virtual Concussion Clinic linked together a consortium of medical providers through care coordination. Over the observed 20 months of operation, this model demonstrated the feasibility of the approach with the time and effort required to sustain the initial Concussion Clinic provider network. By linking together multiple medical and therapeutic specialties, barriers to timely and appropriate care can be lessened. Given that Clinic volumes are not large enough to have a dedicated location to house all specialty services full time, the virtual nature enables the clinic to provide broad services in a coordinated manner that would not otherwise be possible. In terms of patient access, the clinic was often able to schedule the patient in a location close to his or her home, thus lessening the burden on the patient and his/her family. These patients were typically seen by a health care provider within three business days, minimizing impact on work and school.

Additionally, our process provides early education on concussion symptoms, activity and school restriction, and safe return to sport. This efficient process allows for the timely initiation of cognitive restructuring, as few other interventions have demonstrated decreased risk of chronic post-concussion symptoms in mTBI patients.⁽⁵⁾ Thus, the virtual Concussion Clinic may yield important information in further describing the impact of timely and accessible care on concussion outcomes.

A year and a half of operational experience has underscored the importance of maintaining standardization of concussion management across diverse provider groups. Weekly meetings among medical directing staff, bimonthly meetings with primary care sports medicine staff, biannual meetings with the larger group of Concussion Clinic providers, and intermittent meetings with individual specialty groups and primary care practices have proven invaluable at ensuring uniform care of the highest standard. These meetings provide integral insights and further development of the Concussion Clinic, for discourse and future applications are updated as the research on concussion evolves.

With our health care system moving to an Accountable Care model, and with the development of computer and wireless based applications such as electronic health records, we are positioned well to increase efforts in researching the short and long-term impact of a virtual clinic. Our Clinic has the opportunity to initiate long term studies, such as a patient registry, that can provide longitudinal information on quality of life and lifetime risk. By review of demographic data, we can identify populations uniquely served by the Clinic and investigate if treatment paradigms may vary based on population. This additional research in turn improves clinical practice. Through our outreach and education program we can prospectively target at risk populations and provide educational and research opportunities. We also have the infrastructure to access a broader demographic of patients with concussion for developing smaller scale RCTs, which many concussion clinics are incapable of achieving. Finally, a crucial area for exploration is determining the financial impact of the virtual Concussion Clinic

and its potential effect on outcomes, including health related quality of life.

CONCLUSION

The Clinic's experience establishes the operational feasibility of establishing the Clinic within our health care system. Although feedback from families suggests the concept of a virtual clinic may be alien at first and requires explanation, based on a patient satisfaction survey completed three weeks after initial contact with the Clinic, patients held a very favorable opinion of the clinic and its approach to streamlining care, demonstrating future promise. Ninety percent of patients said they would recommend the St. Luke's Concussion Clinic to others. By performing a comprehensive intake on each patient calling the clinic, we have successfully matched the patient and his/her individual health care needs to the appropriate provider(s) and his/her health care expertise in a timely fashion. We believe this coordination of care is critical for ensuring good patient outcomes.

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