GAVIN PUBLISHERS

Emergency Medicine Investigations

Abourbih D, et al. Emerg Med Inves: EMIG-163

Research Article

DOI: 10.29011/2475-5605. 000063

Concussion Patients in the Emergency Department: Assessing a New Clinical Pathway for Prompt Follow-up and Long-term Management

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Citation: Abourbih D, Bedi S, Hunt C, Michalak A, Ouchterlony D, et al. (2017) Concussion Patients in the Emergency Department: Assessing a New Clinical Pathway for Prompt Follow-up and Long-term Management. Emerg Med Inves: EMIG-163. DOI: 10.29011/2475-5605. 000063

Received Date: 16 October, 2017; **Accepted Date:** 9 November, 2017; **Published Date:** 16 November, 2017

Introduction

Concussion or mild Traumatic Brain Injury (TBI) is a very common Emergency Department (ED) presentation. CDC data shows 1.7 million patients are treated each year for TBI with mild TBI or concussion making up 70-90% those [1]. Significant ED and lifetime costs are associated with these patients depending on the severity of associated injury, the number of times they re-present for treatment, and the outpatient services they may require [2].

The majority of concussions improve in 7-10 days with conservative management; however, a subset of patients may have persistent physical, psychological, and emotional symptoms lasting for months to years described as Post-Concussion Syndrome (PCS) [3]. Risk factors for PCS include previous concussion, history of substance abuse, cognitive impairment, co-morbid depression, and anxiety [3,4]. These are commonly seen conditions in the ED and as such physicians working in this environment have the ability to identify those at potential risk for PCS [4].

Given the risk of prolonged symptomatology, the ED is not ideal environment for ongoing concussion management. A recent survey of American emergency departments showed significant inconsistencies in discharge instructions, time to follow up care, referral to specialists, and return to work/play instructions [5]. Likewise, no evidence-based clinical practice guidelines are currently well accepted in the ED, and those available do not adequately emphasize the close outpatient follow up this population requires [6]. Early mismanagement puts these patients at risk for PCS and multiple return visits to the ED and other healthcare providers [7].

In an effort to address the shortcomings of ED concussion management, an ED/Head Injury Clinic (HIC) clinical pathway has been initiated at St. Michael's Hospital (SMH), a large urban tertiary care trauma center in Toronto, Ontario Canada. The goal of this clinical pathway is to allow "Concussion" patients rapid access to educational information and specialized consultant services with the hope of decreasing the severity of PCS and repeated ED and health care visits.

Our study examines patients who have been through the ED/HIC clinical pathway and triaged to be seen in our head injury clinic, and comparing them to a matched sample of patients referred from the community. Our primary outcome is to assess differences in post-concussion symptoms using the Rivermead PCS questionnaire, a 16-item symptom-based questionnaire. Secondary outcomes include quantifying the number ED repeat visits, specialist consults, and family doctor follow ups. Lastly, patient satisfaction and recommendations for improving the clinical pathway were recorded.

Methods

This study was a single-center prospective observational pilot study of concussion patients seen in the St. Michael's Hospital ED and triaged to the Head Injury Clinic (HIC). Study recruitment occurred between January 2016 and January 2017. This study was reviewed and approved by the St. Michael's Hospital Research Ethics Board.

The ED/HIC clinical pathway begins when the patient is identified by an ED RAZ (Rapid Assessment Zone) coordinator who flags the patient as having a possible head injury. This flagging is done independent of the ED physician, although they can also identify potential missed cases. These patients are given an informational package detailing the symptoms of a concussion, aggravating and alleviating factors, the expected time course of their recovery, and given return to ED instructions for worrisome symptoms. They are also asked to complete a Rivermead post-concussion symptom questionnaire [8]. Patient's contact information is obtained and they all receive telephone follow up from a clinical nurse specialist approximately 7 days following their ED presentation. Those with persistent, worsening, or worrisome symptoms or those with strong risk factors for PCS are given rapid follow up with concussion specialists at the HIC (Figure 1). Independent to all of this interaction, the physician still proceeds with their independent assessment for a head injury (physical exam and history) and order the necessary tests (ie. CT scans) if they are concerned of a more invasive diagnosis, like an intra-cerebral hemorrhage.

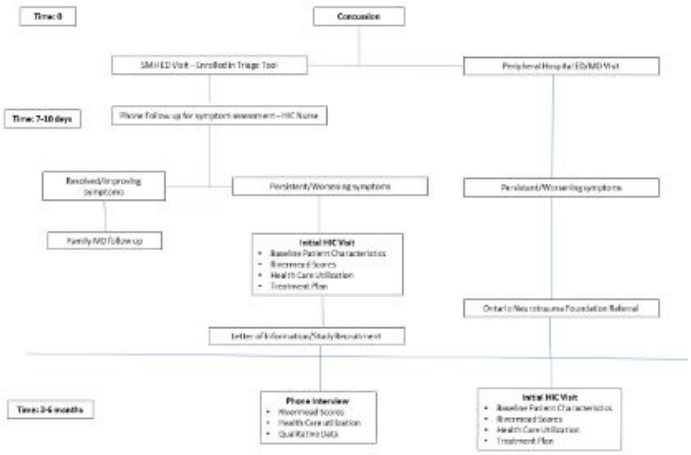

Figure 1: Referral Pathway to the ED/HIC Clinic.

Two groups of patients were compared. The first group acted as the comparison arm of the study. This group comprised patients referred to the HIC through the Ontario Neurotrauma Foundation. Patients selected in this group had a diagnosis of concussion made in community by their family doctor or a community ED physician with their initial HIC clinic visit occurring 3-6 months following their concussion (Figure 1). These patients had essentially failed community concussion management and were referred to HIC for ongoing care.

The intervention group entailed patients who were diagnosed with a concussion in the SMH ED and referred to the ED/HIC. These patients were seen in the concussion clinic 7-14 days following their injury. Once seen in clinic they are offered multiple services including access to specialized neurologists, psychiatrists, physiatrists and concussion specialists. Treatments offered include education, counseling, and pharmacotherapy for persistent headache, sleep disturbances, or depression. These patients were contacted by phone between 3-6 months following their concussion with assessment of their ongoing symptoms, healthcare utilization, and satisfaction with their overall care.

The intervention group all received a letter of information outlining the study two weeks prior to being contacted by a trained research staff from the concussion clinic. Verbal consent for participation was obtained and documented at the start of the phone interview.

Several outcome measures were recorded in this study. The Rivermead Post-Concussive Symptoms Questionnaire is a 16-item symptom based questionnaire [8]. This questionnaire captures post-concussion symptoms experienced in the past 24 hours and subjectively rates their intensity on a 0-4 likert scale (0 = not a problem, 1 = no more of a problem, 2 = mild problem, 3 = moderate problem, 4 = severe problem). It is widely used to measure symptomatology in mild/moderate TBI and is recommended by the Ontario Neurotrauma Foundation [9]. Patients were also surveyed on their healthcare utilization by recording the number of repeat visits to the ED, family physician, walk-in clinic, other specialists and allied health professionals. Lastly, patients were also asked a series of subjective questions to determine their perceived improvement of PCS symptoms, the relative contribution if any of the ED/HIC referral pathway to their improved symptomatology and what areas of the referral pathway could be improved.

Inclusion criteria for both comparison and intervention arms included patients diagnosed with a concussion in the St. Michael's ED or community setting greater than 16 years old who have been seen in follow-up in the ED/HIC 3-6 months following their concussion. Exclusion criteria included patients <16 years of age, those with moderate to severe TBI, if their injury required surgery or a prolonged hospital admission, concussions occurring under the influence of alcohol or drug intoxication, non-English speaking patients, and those without access to a telephone for follow up interview.

Along with baseline patient characteristics (age, gender, history of prior TBI, psychiatric history, education level, and socioeconomic status), patients consented to the recording of Rivermead scores and healthcare utilization on their initial clinic. All concussion related healthcare visits including general practitioner, emergency department, consultant, physiotherapist and allied health visits were also recorded on initial contact with the ED/HIC.

Convenience sampling was used for patient recruitment with two researchers calling patients in the experimental arm from 9am to 5pm seven days a week. Patients who did not respond following three phone call attempts were considered lost to follow-up. Given the nature of this study, no power analysis was undertaken and a total of 74 patients were recruited (32 in the experimental

group, and 42 in the comparison group). Detailed patient characteristics and Rivermead were only available on 36/42 patients in the comparison group. Means and standard deviations were used to describe the patients in both arms of the study. Given the relative infrequence of this diagnosis, data was expected to be non-normally distributed, and outcome measures were analyzed using Mann Whitney U scores and Chi Square Analysis. P values <0.05 being deemed statistically significant.

Results

Forty-two comparison patients and 32 patients seen in the ED/HIC 3-6 months following their injury were enrolled. The study population is described in Table 1. Both groups were comparable in terms of age distribution. The experimental population had a high but not significantly different proportion of female participants, 66% vs. 58%. A slightly higher proportion of patients in the intervention arm also had a prior history of TBI (13% vs. 5%). Importantly, the intervention population had a statistically significant higher rate of psychiatric disorders (32% vs. 8%, X2 = 4.79, p = 0.03) such as depression and anxiety. Other potential confounding variables such as co-morbid substance abuse (17% vs. 13%), cognitive impairment (6% vs. 0%), secondary school level of education (14% vs. 6%), and low socioeconomic status (8% vs. 9%) were similar between groups.

	Control, n=36	Experimental, n=32	X^2	p value
Age (yr)	40 (±16.3)	46 (±15.1)		
Gender, %Female	21 (58%)	21 (66%)	1.81	p = 0.179
History of Prior TBI/patient	2 (6%)	4 (13%)	1.27	p = 0.260
Psychiatric History (Depression, Anxiety, PTSD) - Self reported	3 (8%)	9 (32%)	4.79	p = 0.033
Substance Abuse Hx – Self Reported	6 (17%)	4 (13%)	0.23	p = 0.628
Cognitive Impairment/Learning Disorder	2 (6%)	0 (0%)	0.26	p = 0.607
Low Socio-Economic Status (0-20,000$)	3 (8%)	3 (9%)	0.03	p = 0.88
High School Education or Equivalent	5 (14%)	2 (6%)	1.075	p = 0.30

Table 1: Demographic information for control and experimental groups.

Post-concussion symptoms scores, as measured by the Rivermead questionnaire differed subtly between groups with a general trend for the ED/HIC group having lower self-reported symptoms. Patients seen in the ED/HIC clinic pathway had an average Rivermead score of 28 compared to 33 in the comparison arm. The largest observable difference was seen in the Headache subcategory. Patients seen in the ED/HIC had a significantly lower reported headache score compared to the comparison population, 1.75 vs. 2.64, z = 2.83 (p=0.005). The remaining Rivermead subcategories were similar between groups and a full breakdown can be found in Table 2.

	Control	Experimental	Z-Score	p value
Rivermead Score (Max 64)	32.6 (±12)	27.96 (±14.67)	1.26	p = 0.20
Headache Score (Max 4)	2.64 (±1.27)	1.75 (±1.21)	2.83	p = 0.0047
Fatigue Score	3.00 (±0.95)	2.43 (±1.37)	1.55	p = 0.12
Depression Score	2.11 (±1.38)	1.68 (±1.26)	1.28	p = 0.20
Frustration Score	2.43 (±1.34)	2.13 (±1.39)	0.72	P = 0.472
Memory Score	2.28 (±1.34)	2.22 (±1.24)	0.3	p = 0.76

Table 2: Selected Rivermead Score Breakdown.

Health care utilization, as measured by self-reported visits to concussion specialists and allied health professionals was assessed. Similarities were once again found in the percentage of patients visiting their generalist, walk-in clinics, neurologists, and psychiatrist, table 3. A significant difference was found in the number of patients returning to the ED for a repeat visit for concussion management. Only 16% of patients seen in the ED/HIC clinic returned to the ED for concussion symptoms vs. 70% of patients in our comparison population, (X^2 = 13.82, p = Table 3).

	Control (n=42)	Experimental (n=32)	X2	p value
ED Repeat Visits	30 (71%)	5 (16%)	13.82	p = 0.0002
Family MD	35 (83%)	22 (69%)	2.18	p = 0.14
Walk-in Clinic	9 (21%)	3 (10%)	1.94	p = 0.163
Psychiatrist	10 (24%)	13 (41%)	2.81	p = 0.094
Neurologist	16 (39%)	10 (31%)	0.37	p = 0.541

Table 3: Selected Healthcare Utilization.

Our qualitative assessment showed that the majority of patients (28/32) described significant improvement in their post-

concussion symptoms at the 3-6-month mark post-injury. 30/32 patients found the concussion clinic treatment program to be very helpful and beneficial for their recovery. Areas of improvement suggested on qualitative analysis included continued emphasis on ED physician/patient counselling and reassurance. Other suggestions included limiting the cognitive load on patients seen in the concussion clinic by decreasing paper based assessments and decreasing the lighting of the clinic (symptomatic photophobia). Table 4 lists representative quotes of the personal accounts of patients seen in the ED/HIC and their suggestions for improvement.

Patient Responses to suggestions for improvement to clinic
"Helped in my recovery by providing me access to a team of specialists"
"Very compassionate"
"Very patient, impressed with care"
"More time to explain diagnosis, felt rushed in the ED"
"Overall care was helpful but long wait to be seen in clinic"
"More clinic dates to decrease wait times"
"Helpful follow up calls from nurses"

Table 4: ED/HIC Patient Experiences and Suggestions for Improvement.

Discussion

The purpose of this study was to determine the efficacy of our center's ED/HIC referral system in reducing the severity of PCS and healthcare utilization following concussion. We were able to recruit a sample size of 74 patients seen between 3-6 months following their concussion. Within the limitations of our small cohort, patients who present to the ED with concussion have trend towards lower, but not statistically significant overall symptoms of PCS.

The experimental arm of the study had a slightly higher proportion of female participants than the comparison group. Studies in the pediatric setting have identified the female gender as an independent risk factor for PCS [10]. Possible theories include differences in stress responses to TBI and self-reporting between genders. Interestingly, our experimental arm also had a higher proportion of patients with co-morbid psychiatric disorders, which is also a strong risk factor for PCS [11]. Even with these relative biases, the ED/HIC arm had lower Rivermead scores which may suggest a signal in favor of our intervention plan. Other potential confounding factors such as prior TBI and low socioeconomic status were relatively equal in each group. Given the nature of our study we were not powered to do sub-group analysis controlling for these variables which may have affected the severity of Rivermead scores.

While our study was underpowered these results may still have clinical importance. A recent pilot study in pediatric patients discharged from the ED with concussion examined the efficacy of early telephone follow-up and patient education on self-reported PCS symptoms [12]. No significant difference was found in this small population at 3 months follow up and authors reported that a more multi-disciplinary team approach may be better suited. The head injury clinic in our study allowed patients early access to a physiatrist, psychiatrist, ENT, and multiple allied health professionals including a head injury nurse specialist, a social worker, and an occupational therapist. This multi-disciplinary approach has been effective in the pediatric setting where more consistent care has been documented to be given [13].

The multi-modal treatment approach may be beneficial for patient care but poses significant challenges in treatment effect determination given the heterogenous interventions offered to patient. As an example, certain patients in our comparison arm may have been started on selective serotonin reuptake inhibitors for treatment their depressive symptoms. Others who had predominantly vertiginous symptoms might have been referred to physiotherapists and ENT physicians specializing in vestibular retraining. Given our small sample size subgroup analysis for treatments received was impossible. It is thus challenging to determine which of the interventions offered in the head injury clinical pathway may have resulted in the decrease post-concussion symptoms. As such we can only comment on the efficacy of our program as a whole.

Within these limitations, the most striking difference found favoring our experimental arm was a reduction in headache scores. Post-concussion headaches can be amongst the most debilitating symptoms following a head injury [14]. Treatment of this particular symptom can be challenging given its chronicity and poor characterization displaying features of both tension and migraine headaches. Patient's seen in the ED/HIC are given expert guidance in the form of pharmacologic and non-pharmacologic treatment options aimed at limiting current analgesic use. A potential explanation for this finding may be that medication overuse headaches make up a significant proportion of PCS headaches [15]. Our clinic provides expert guidance on the judicious use of analgesia for PCS may have contributed to lower headache score seen in the experimental arm. Those with a more "Migraine" nature to their PCS can be offered preventative or abortive agents though the evidence for this practice in TBI patients is weak [16].

Our secondary outcome was to compare health care utilization following referral to the ED/HIC. Patients in the experimental arm had significantly fewer return visits to the ED at 16% vs. 70% of those in the comparison group. A number of factors have been suggested to account for return visits including poor identification of populations at risk for return, lack of primary care available for follow up, and inconsistent discharge instructions [17]. The value of an ED/HIC referral tool thus significantly decreases the risk of return visits and provides an avenue for definitive care required for this populations. With an average cost of 181$ per ED visit in Ontario, 54% decrease in ED visits as shown in our study may represent substantial cost savings [18]. Access to definitive care

will also likely cut down on the frequency of health care visits to primary care physicians and specialists, representing a significant economic savings [19,20].

Our group has chosen to determine those requiring follow up based on PCS risk factors and the results of short term follow up phone calls to all concussion patients seen in the ED. Novel methods of identifying those at risk for PCS requiring follow-up from the ED may include plasma biomarkers, serum microRNA (miRNA) and neurocognitive testing [21-23]. These risk stratifying techniques may supplant traditional risk assessment but further study in larger cohorts are needed.

Utilization of other consultant services varied little between our groups. The experimental arm had a slightly higher proportion of patients seeing a psychiatrist. This result is not unexpected given that our program frequently refers those with patients with neuropsychiatric complaints to a psychiatrist with a focused training in TBI. We feel this to be appropriate and beneficial to our patients. Both groups had high proportions of visits to family doctors. While this may put a strain on the primary health practitioners, this is essential given the ongoing follow ups and potential referrals required for this complex population.

Our last objective was to determine patients' satisfaction with the ED/HIC tool and to identify any patient-centered shortcomings in our care model. Over 90% of patient's enrolled in the experimental arm felt the ED/HIC referral tool positively affected their recovery. Areas of strength patients identified included providing counselling and education surround their diagnosis and providing an avenue for access to specialized consultant services including neurology, psychiatry, psychiatry, ENT and allied health workers such as physical and occupational therapist and social workers.

Multiple limitations are inherent to this study and must be discussed. Great efforts were made to contact these patients including sending a letter of information describing the study and calling the patient at multiple times in the day and evening. Those who did not respond within 3 phone calls were considered lost to follow up. Unfortunately, only 30% of patient's initially contacted (107 total) responded to the telephone survey. While this rate of patients lost to follow up is high it remains comparable to other studies [24]. Given the nature of our institution and its high population of indigent and lower socioeconomic status patients, these rates of patient lost to follow up may be somewhat explainable. Patients improving medically may also not seek out further follow up. It is thus challenging to determine how these lost to follow ups may have influenced results. This study was also inherently biased given that it was based out of a single site with a specific population base. Such findings may not be generalizable to all emergency departments. Likewise, not all hospitals have the resources to devote to a head injury clinic. Despite these limitations, we feel that our study demonstrates that an ED/HIC may decrease PCS and significantly reduces return visits to the ED. Further studies are needed to determine if this strategy of concussion management is effective across multiple different EDs and with larger cohort sizes.

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