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Telephone Follow-Up of Mild Traumatic Brain Injury; A Feasibility Study

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Abstract

Background & Objective
This study investigates the prevalence of Post-Concussion Syndrome (PCS) one-year post-injury in patients that were treated for Mild Traumatic Brain Injury (mTBI) in the Clinical Decision Unit (CDU) of Cork University Hospital's (CUH) Emergency Department.

Methods
Adults treated for mTBI in 2013 completed a telephone questionnaire comprising the Rivermead Post Concussion Symptoms Questionnaire (RPQ), the Short Form 12 (SF-12), and the EuroQol Health Outcome Assessment Tool (EQ5D5L).

Results
There were 112 patients identified. Of these, 57 (51%) were successfully contacted. The median age was 40 (IQR 27.5 – 57.5) and 58% were male. The most common mechanism of injury was a mechanical fall (28%). PCS of at least mild severity was present in 12 (21%). Overall, females tended to have worse outcomes (mean Physical Function score; males: females, 97.7: 76; $p < 0.004$).

Conclusions
mTBI patients continue to suffer from PCS at one-year post-injury and females had a worse physical function outcome.

Key Words & Glossary

mTBI	Mild Traumatic Brain Injury
PCS	Post-Concussion Syndrome
RPQ	Rivermead Post-Concussion Symptoms Questionnaire
SF-12	Short Form 12 (General Health Questionnaire)
EQ5D5LEuroQol	Health Outcome Assessment Tool
CDU	Clinical Decisions Unit
ED	Emergency Department
CUH	Cork University hospital

Introduction

Mild Traumatic Brain Injury (mTBI), commonly referred to as concussion, has recently emerged as a significant public health concern. **It accounts for 1% to 2% of emergency department visits in the U.S.A.** [1] and it makes up 70-90% of all hospital-treated TBI worldwide[2]. An mTBI is defined as a traumatically induced physiological disruption of brain function, manifested by at least one of the following: loss of consciousness for less than 30 minutes, amnesia for less

than 24 hours, or any alteration in mental state at the time of injury, but with a Glasgow Coma Scale of no less than 13.
Post-concussion symptoms are common acute sequelae of mTBI, and include headaches, dizziness, neuropsychiatric symptoms, and cognitive impairments. The natural course after mTBI is usually favourable with resolution of symptoms within three months for the majority of patients[3], however a considerable proportion of patients (≈ 7-45%) experience post-concussion symptoms for a prolonged period after the injury[4]. The literature on mTBI outcomes varies significantly, both in terms of the incidence of PCS and the symptom severity, as well as the length of recovery.

The lack of consensus in the literature on the topic of PCS after mTBI presents an under-appreciated problem for patients for whom additional services may be beneficial. We conducted a cross-sectional study on mTBI patients presenting to the ED at Cork University Hospital to assess the incidence of PCS at 1 year post discharge.

Methods

This is a descriptive, quantitative cross-sectional study that was set in the ED of the CUH. The subject sample was derived from adult patients treated for mTBI in the CDU in the year 2013 (January 1st – December 31st inclusive). The definition of mTBI used was that created by the American Congress of Rehabilitation Medicine, which is endorsed by the WHO. The RPQ tool used in this study is the only validated and reliable PCS assessment tool. It has been backed by expert consensus groups and clinical practice guidelines[5].

CUH ED has a yearly census of 60,000 patients. The CDU, which is run by the consultants in emergency medicine, admits 2,368 patients per year constituting 7% of total hospital admissions.

There are four broad categories of patients who attend the ED at CUH having sustained a head injury:
Firstly, those who sustain mTBI and are discharged directly from the ED post neurological and cognitive assessment with or without CT brain scan having been performed, in the presence of a responsible adult who is provided with head injury advice.
Secondly, those, who, owing to time of day, concomitant intoxication, social reasons or severity of mTBI symptoms are admitted to CDU. The admission criteria to the CDU are broad but fundamentally these are patients who, it is envisaged, will be discharged within 24 hours.
Thirdly, frail elderly and patients with more complex needs who sustain a head injury where, it is anticipated, will require >24 hours of in-hospital care, are usually admitted under the general medical service.
Fourthly, those patients whose brain injuries are more severe and likely to require neurosurgical intervention are admitted under the neurosurgical service.

All adults who suffered an mTBI and were admitted to CDU were included in this study. Patients were excluded if no contact details were available or if they were deceased at the time of follow up.
All subjects were then contacted in writing to explain the study and offer opt out consent. Telephone calls were completed four weeks later. Subjects were excluded from the study if they failed to answer four attempted telephone calls. Each of these four attempts were made at different times of the day, on different days of the week, and with at least one being made outside of normal working hours.

Three validated questionnaires were administered during the telephone calls. These were the Rivermead Post-Concussion Symptoms Questionnaire (RPQ); the Short Form-12 Health Survey (SF-12); and the EuroQol, 5 Level, 5 Dimension Health Outcome Assessment Tool (EQ5D5L).

The RPQ is a self-report symptom questionnaire consisting of 16 common symptoms following mTBI. The patients rate symptoms by degree of severity on a Likert scale of 0–4.

It is a validated measure used in PCS research [6, 7] and can be effectively administered via telephone call[8].
The SF-12 Health Survey is a 12-item, multipurpose, short-form health survey that is a brief, broad measure of eight domains of health status that are considered important in describing and monitoring individuals suffering from illness. The SF-12 includes one favourably scored scale measuring each of eight health domains: physical functioning, role

participation with physical health, bodily pain, general health, vitality, social functioning, role participation with emotional health problems, and mental health.
The EQ5D5L is a standardised instrument for use as a measure of health outcome. The EQ-VAS element of the tool was used in this study: the patient's own global rating of their overall health, on a scale from 0 (worst possible health) to 100 (best possible health).
There is no validated general health outcome measure specific for use in PCS[9]. With this in mind it was decided to use both the SF-12 and the EQ5D5L because of their strong presence in the literature and their ability to be implemented via telephone call.
Where performed, CT scans of subjects who completed the questionnaires were reviewed. Subjects were stratified in a binary fashion, into "complicated" or "uncomplicated" mTBI on the basis of day-of-injury CT brain results. Complicated mTBIs were considered those that demonstrated intracranial pathology resulting from the head injury (e.g. haemorrhage).

A script outlining specifically how each telephone conversation would take place was formulated. The data collected in the questionnaires was recorded in a Microsoft Excel® worksheet before being exported to SPSS® statistics version 20.
As sample sizes were small and/or not normally distributed, statistical evaluations were performed with non-parametric tests. The Mann-Whitnney *U* test was used to make gender comparisons and to compare age groups against the various assessment tools. The Kruskal-Wallis test was used to analyse the distribution of VAS across different categories of age.
Statistical significance was set at $p < 0.05$.
Results of the SF-12 were entered into a separate scoring software platform, as per the guidance of the producers. This scoring software, in line with standard practice, derives the PCS and MCS components of the SF-12 by using a principal components analysis, specifying orthogonal varimax rotation.

Ethical approval for the study was provided by the Cork Research Ethics Committee.

Results

Population Characteristics
There were 127 patients treated in 2013 in the CDU for mTBI; telephone contact was attempted in 112 of these cases, of which 57 successfully completed the questionnaires (51%) (Fig 1). Table 1 contains a breakdown of the demographic details of the participants.

Characteristics	
Gender, *n* (%)	
Male	33 (57.9)
Female	24 (42.1)
Age, years, median (IQR)	40 (27.5 – 57.5)
Date of Admission, *n* (%)	
Jan - March	11 (19.3)
April - June	21 (36.8)
July - Sept	11 (19.3)
Oct - Dec	14 (24.6)
Mechanism of Injury, *n* (%)	
Sports Related	15 (26)
Assault	8 (14)
Alcohol Related	6 (11)
Mechanical Fall	16 (28)
RTC	8 (14)
Other	4 (7)
Total Participants	57

Table 1: Demographic and Injury Characteristics
IQR = Interquartile Range

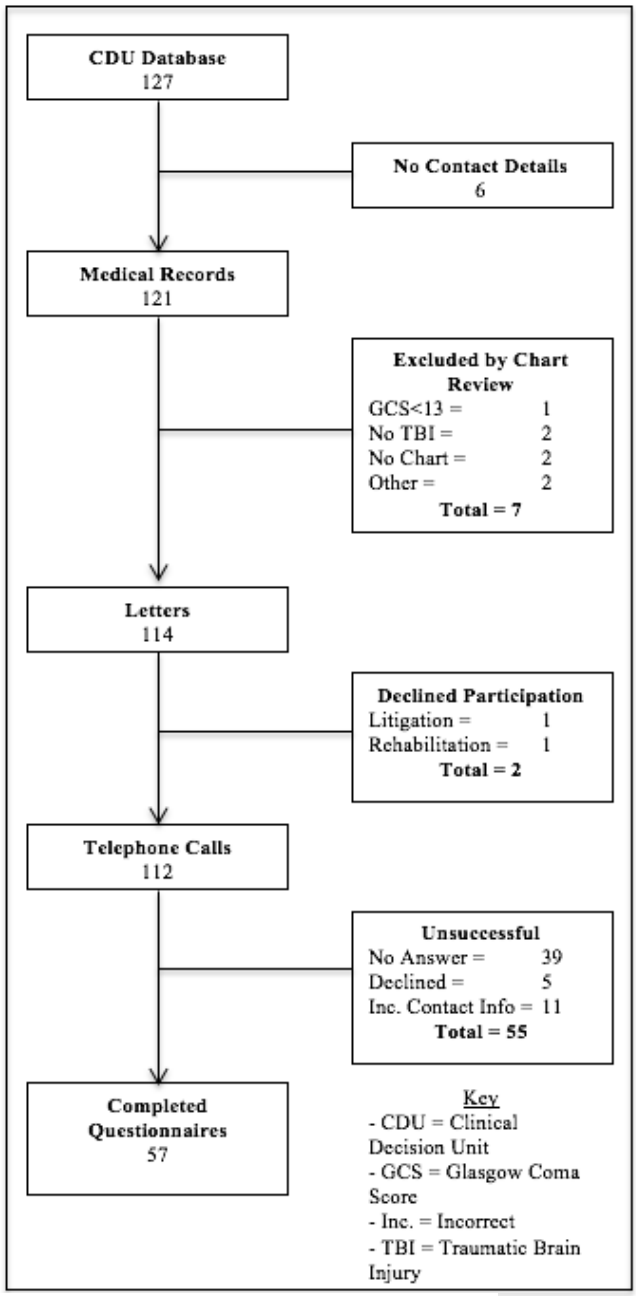


Figure 1: *Flow of Participation*

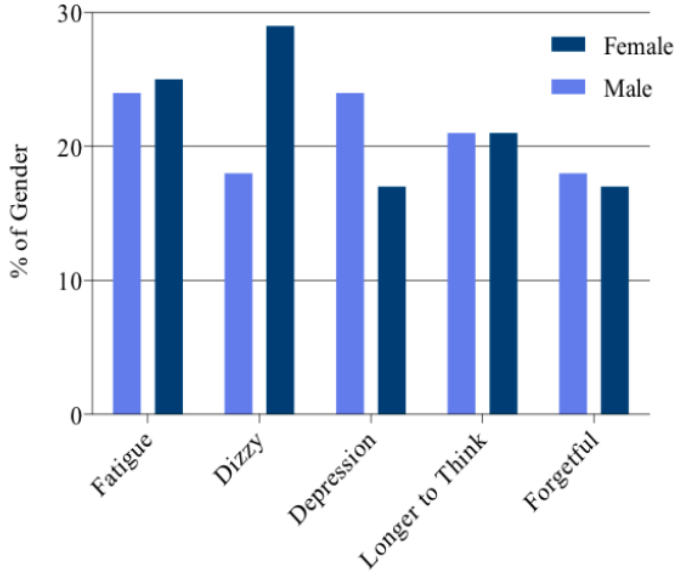
RPQ

The median total RPQ score was 5 (IQR 1-12), classified as mild PCS. There was no difference between genders (males: females = 3(1-13): 6.5(1.25-11.5); median (IQR), p=0.62).

When examining for gender differences, the RPQ symptom dizziness was found to have a greater severity in women than men (males: females = 0(0-0.5): 1(0-2); median(IQR), p = 0.035).

The most commonly reported symptoms (fatigue, dizziness, depression, taking longer to think, and forgetfulness), according to gender, are represented in Figure 2.

Figure 2: *The most commonly reported symptoms on the Rivermead Post-concussion Symptoms Questionnaire (RPQ), according to gender*



SF-12

There was a significant difference in the reporting of the Physical Function (PF) component of SF12 (the respondents' reported level of difficulty in carrying out a range of physical tasks from low exertion to high exertion) across gender (males: females = 97.7(9.8): 76(35.8); mean(SD), p = 0.004).

EQ5D

The total mean EQVAS score (a self-rated general health scale from 0 to 100, where 0 is worst health and 100 is best health imaginable) was 77.2 (SD 21.9). This is lower than the European mean total EQVAS score of 82.3[2], the U.K. score of 82.8[10], the U.S. score of 82.5[3], and the Japanese score of 92.7[11]. When cross-matching for age, the mTBI population studied here scored lower than the European average EQVAS across age groupings.

CT

Of the 57 participants who successfully completed the questionnaires, 44 (77.2%) had a CT brain performed on the day of injury. Of those undergoing CT brain, 10 (22.7 %) were found to have an mTBI related intracranial pathology thus being classified as "complicated mTBI" cases. Interestingly, those who suffered a complicated mTBI had significantly fewer PCS symptoms as measured by the median RPQ at the time of follow-up 1.5 vs 7.5, (p = 0.019). Complicated mTBI cases also reported better overall health status as measured by the EQVAS ((median EQVAS 90 vs 85 (p = 0.046)).

There was no significant difference in the age of complicated mTBI patients compared with that of uncomplicated - 39(25.2 – 52.8): 48(24-72); median(IQR); p = 0.396.

Discussion

In this feasibility study we show that achieving high rates of follow up for this cohort of patients is challenging, that females suffer worse concussion symptoms as measured by RPQ at 1 year after mTBI, and that CT findings are poor predictors of PCS severity.

The most commonly reported RPQ symptoms were analogous to those reported in the literature, with fatigue being the single most common[6,7]. Even though there was a trend towards increased symptom reporting in females, which is in accordance with the literature, the trend did not reach statistical significance (with the exception of the symptom of dizziness). Female sex is suggested as one of several risk factors for prolonged symptoms after mTBI[12] and our

findings of significantly worse dizziness and physical functioning are consistent with this. Other aspects of health that may impact on this finding, such as BMI and baseline fitness status were not collected.

Interestingly, patients with complicated mTBI (as evidenced by intracranial pathology on CT e.g. haemorrhage) outperformed those with uncomplicated mTBI in both the RPQ (assessing PCS symptoms) and the EQVAS (assessing health in general). This is counterintuitive and at odds with evidence in the literature[13,14]. The reasons behind this unexpected outcome are unknown and may just be an aberrancy due to small numbers with intracranial abnormalities treated in the CDU. The younger age of the complicated mTBI cases, although not reaching significance, may in part explain some of the difference– as was noted in the evaluation of EQVAS scores there is increased symptom burden with progressing age. It is also possible that there was a treatment bias in favour of those diagnosed with intracranial pathology on CT

This study reinforces the evidence that PCS is real and burdensome. However, clinical implications of these findings are somewhat limited by the lack of effective therapies. Emerging evidence is suggesting that exercise and cognitive activity in a prescribed and graded manner may benefit recovery, but on the most part current mTBI rehabilitation policies are largely consensus, rather than evidence based. With the results of this study, we can however, better educate patients on expected trajectories of recovery.

Limitations of the current study include the low numbers and moderate response rate. This raises questions about the representativeness of the mTBI population as well as questions about recruitment bias, whereby individuals with more significant symptoms are more likely to enrol in follow-up[15]. A recruitment bias may also be at play in the inclusion of only those patients that were treated in the CDU.

The questions posed in mTBI questionnaires are relatively non-specific and positive answers can be drawn from the general population who have not sustained an injury . The use of a control group in future research would serve well to somewhat account for this limitation[16]. Symptom free patients made up 21% of the respondents. The mode used to administer the questionnaire may be a factor at play here; it has been shown that when more 'intimate' means of administering self-reported outcome measures are used (e.g. by face-to-face interview or telephone interview) instead of less intimate means (questionnaires anonymously returned by post) that health is generally rated better[17]. It may be that telephone follow-up methods approximate to face to face methods[18], however this has not been validated.

In conclusion, mTBI patients treated in an ED short stay facility continue to suffer from PCS at approximately one-year post-injury, with 21% of the study population classified with at least mild PCS. They also suffer from a reduced quality of life as compared to age-matched populations. Larger studies are required to identify prognostic factors and treatment interventions that will reduce the burden of this under-recognised condition.

Conflicts of Interest Statement:
The authors have not conflicts of interest to declare.

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