

Mild Traumatic Brain Injury: Adapting to Consequences

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Abstract

Mild traumatic brain injury (mTBI) affects more than 28,000 individuals annually in Thailand; however, little information about outcome after mTBI is known. This investigation aimed to explore consequences of mTBI among Thai adults who experienced mTBI in the previous 3-12 months.

A sample of 135 adults was interviewed. Subjects were typically men, middle aged and approximately half were married. All completed the compulsory level of education in Thailand and were in the low income bracket. Subjects had Glasgow Coma Scores 14/15 at 30 minutes after injury and 15/15 (full score) after 3 days. Subjects reported low post-concussion symptoms scores and few depressive symptoms. All subjects worked or studied before the injury and almost of them returned to normal lives at the time of interview. However, 18% did experience moderately severe disability and 1.5% suffered severe disabilities.

Future studies with longitudinal, comparison, or predictive methodology with reduced but relevant variables are suggested. Measures used in this study demonstrated reliability, supporting their use in Thailand. Providing health education and printed information regarding outcomes and disability after mTBI is recommended. Further study of the small but clinically important percentage of subjects who experience ongoing disability after mTBI is needed.

Keywords: *mild brain injury, post-concussion, adaptation, mild head injury, traumatic brain injury*

Introduction

Injuries and deaths from motor vehicle accidents (MVA) have become a major public health and socio-economic concern in Thailand (Suriyawongpaisal & Kanchanasut, 2003). For more than a decade, the incidence of MVAs has ranked among the five leading causes of injuries and deaths of Thai people especially during the traditional Thai New Year holidays (mid-April). The incidence of traffic related injury has been reported at almost 4,000 people per week (Narenthorn Trauma Center, 2014). Head injuries are a major cause of death and disability related to MVAs (Mock, Maier, Bolye, Pilcher, & Rivara, 1995), and 77% of traffic related injuries in Thailand are to the head and brain (Suriyawongpaisal & Kanchanasut, 2003). Despite medical developments and accident prevention campaigns, the number of injured has nearly doubled in the last 10 years. The

majority of adults with head injuries (83.7%) have mild to moderate severity (Phuenpathom, Tiensuwan, Ratanalert, & Saeheng, 2000).

Mild traumatic brain injury (mTBI) is a stressful life event that may impact various dimensions of a person's physical, psychological, social and environmental background. It may cause a person to react by exhibiting complex adverse behaviours (Martelli, Zaster, & Mac-Millan, 1998). Challenges to daily activities after mTBI may produce significant effects on quality of life (QOL), leading to maladaptation. In order to understand the phenomena of mTBI recovery, contribute to a more coherent and comprehensive body of knowledge and to advance the science of nursing, the use of nursing conceptual and theoretical work is recommended (Fawcett, 2000, 2002). The Roy Adaptation Model (RAM) was used to guide this study. According to Roy (2005), a person is an adaptive system, responding to internal and external stimuli (input) through behaviour. The goal of nursing is to promote adaptation for individual(s) in four adaptive modes, thus contributing to health, quality of life, and dying with dignity (Roy, 2005 ; Roy & Roberts, 1981). This is done by assessing

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behaviour and factors that influence adaptive abilities and by intervening to expand those abilities and to enhance environmental interactions (Roy, 2005).

As a practice discipline, the goal of nursing is to promote adaptation by enhancing human system and environment interaction. Using information from this study to build a predictive model will help nurses in assessing adaptive behaviours and the stimuli that influence adaptation behaviour. This information will be useful for nursing interventions, plans to manage stimuli and enhance coping processes of mTBI adults.

Objective

The purpose of this cross-sectional descriptive, predictive study was to explore the extent of post-concussion symptoms after mild traumatic brain injury (mTBI) among Thai adults.

Method

Setting

The setting of this study was the Maharat Nakhon Ratchasima Hospital (MNH), a 1000 bed tertiary hospital in the Nakhon Ratchasima province of Thailand. Mild head injury was the most common inpatient diagnosis in this hospital into which approximately 1,102 mTBI adults were admitted each year (Maharat Nakhon Ratchasima Hospital, 2014).

Sample Selection

Sample selection was purposive. The potential subjects were defined through the MNH's database. Subjects included patients who had mTBI between three and twelve months.

Inclusion criteria

Medical records of subjects discharged from the hospital with ICD-10 code S.00 (superficial wound), S.01 (head wound), S.02 (skull fracture), S.06 (intracranial injury), S.07 (compression injury), and S.09 (other head injury) were accessed. Subjects discharged from the hospital with those codes and diagnoses who met other inclusion criteria (i.e., age of 18 years or older; able to communicate by speaking or writing; initial mTBI only; and absence of psychiatric or other neurological disease), were able to provide informed consent and were willing to participate in the interview were invited to participate this study.

Exclusion Criteria

Participants were excluded if they had a his-

tory of multiple head injuries, congenital or organic learning disorders, premorbid psychiatric disorders or neurological disorders unrelated to mTBI such as Alzheimer's, multiple sclerosis, Parkinson's disease, stroke or other central nervous system diseases. Patients who had a documented GCS score < 13 during first 72 hours after admission were excluded. Patients who had mTBI for less than three months or more than one year, or patients with multiple head injuries were also excluded.

Measures

Translation was originally performed by a medical-surgical nurse fluent in English/Thai. Another bilingual medical-surgical nurse reviewed both the completed Thai and English versions to determine the appropriateness of their meaning and the equivalence between the Thai and English versions. Finally, a bilingual person checked the original and back-translated versions for the equivalence of the translations. All Thai version measures were piloted with five Thai adults, 18 years of age or older. Adjustments were done as needed, mostly adding clarification of the instruction and repeated instructions for at least three times throughout the interview.

Post-concussion symptoms were measured by the Post-concussion Symptoms Checklist (PCSC) (Gouvier, Cubic, Jones, Brantley & Cutlip, 1992; Gouvier, Uddo-Crane & Brown, 1988). The PCSC is a self-reporting questionnaire that allows subjects to rate the frequency, intensity and duration of ten symptoms by using a Likert-type scale (1 = not at all, 5 = constant or crippling). Four sets of scores were derived for each subject: frequency, intensity, duration and total. Range of PCS total scores and each subscale scores were 10-50. The PSCS has high concurrent validity with other post-concussion symptoms checklists ($r = .77$) (Gouvier et al., 1992). The accuracy rate of discrimination between persons with and without PCS is 70% in a normal healthy population and 56% in head-injured persons (Sawchyn, Brulot & Strauss, 2000).

Depressive symptoms were assessed using the Thai version of the Center for Epidemiological Studies Depression Scale (CES-D Thai-version) (Trangkasombat, & Likapichitkul, 1997). The CES-D Thai version, a modification of the CES-D, is a frequently used depressive symptoms screening measure among several Thai populations such as spinal cord injury (Kuptniratsaikul, Chulakadab-

ba, & Ratanavijitrasil 2002) and teenagers (Trangkasombat, & Likapichitkul, 1997). It is a self-reporting 20-item questionnaire used for evaluating perceived mood and level of functioning in the past 7 days. Scores range from 0-60, Scores of 22 or higher are considered indicative of depressive symptoms (Trangkasombat, & Likapichitkul, 1997). The CES-D yields high internal consistency when tested among Thai teenagers ($\alpha = .86$) and spinal cord injured ($\alpha = .92$). The sensitivity of this measure is 72-93%, its specificity is 85-94%, and the predictive value is 82%.

The Extended Glasgow Outcome Scale (GOS-E) was developed from the traditional Glasgow Outcome Scale to address limitations, to be more sensitive, and reliable. Jennett, Snoek, Bond & Brooks (1981) extended the GOS-E from five categories to eight categories which are: dead, vegetative state, lower severe disability, upper severe disability, lower moderate disability, upper moderate disability, lower good recovery and upper good recovery (Sander, 2002).

The GOS-E was originally developed for assessment of severe brain injuries; therefore, some categories such as dead or vegetative state might not be appropriate to use with mild traumatic brain injury people. In this study, only six of eight categories were included, and the structured interview from Wilson, Pettigrew & Teasdale (2000) was used to guide the assessment. Those structures were:

- 0 = Upper good recovery
- 1 = Lower good recovery
- 2 = Upper moderately disabled
- 3 = Lower moderately disabled
- 4 = Upper severely disabled
- 5 = Lower severely disabled

The GOS-E consists of two domains: independence and difficulty. For an independent domain, the questions consist of ability to be independent in the home and ability to be independent outside the home (including shopping and travelling). If the mTBI person could not do at least one of these independent tasks, he/ she was considered as in the severely disabled group. For the mTBI person who could not stay home alone for at least eight hours, he/ she was also be considered as in the lower severely disabled group. For a difficulty domain, the questions consist of ability to work (or study), social and leisure activities, and family and friendships. The mTBI person who reported at least one difficulty in these questions was considered

as in the moderately disabled group. The mTBI person who could not return to work or study at the same level as before brain injury was considered as in the lower moderately disabled. The last question in the GOS-E was about return to normal life after brain injury. This question referred to the symptoms that might occur after mTBI that might bother mTBI people and made them feel that their lives were changed. The mTBI person who did not have independence or difficulty issues but could not return to normal life was considered as in the lower good recovery group while mTBI person who did not have any issue and returned to his or her normal life was in the upper good recovery group (Wilson, 1998 ; Wilson, Pettigrew & Teasdale, 2000). Questions for the GOS-E were integrated in demographic data worksheet.

Procedures

Invitation Procedures

After the human subjects review board at the Maharat Nakhonratchasima Hospital (MNH) approved the study, the principal investigator (PI) identified potential subjects from the hospital database. The PI determined inclusion criteria from each medical record and mailed the consent form package to all potential subjects. The PI waited for two weeks for the subjects to review and consider participating in this study. If the subject mailed the opt-in postcard, the PI made a call to the subject to introduce herself, explain the study and confirm the subject's willingness to be part of the study. After two weeks, a reminder postcard was sent to subjects who did not return the initial postcard or informed consent. The PI waited for another two weeks for the subjects to make decision. If the informed consent was not returned within seven days, the PI made one last phone call to again invite participation and provide instructions.

Interview Procedures

All subjects were interviewed by telephone at a time and place of the subject's choosing. After receiving the signed consent, the PI scheduled a time for the interview either by —1) the subject provided the date and time in an opt-in postcard or 2) the PI called the subject, using the telephone number shared by the subject during the follow-up phone call. The interview consisted of 100 questions and lasted approximately 30 minutes. The interview questions were the same for each subject (same order, same words), specifically; demographic form, the PCSC, the GOS-E (questions were included in the demographic data worksheet) and the CES-D.

Medical Record Reviewing Procedures

Chart data was collected after the interview by a research assistant (RA) who was trained by the PI. After the interview, hospital number and study number were assigned and given to the RA by landline (secure) telephone initiated by the PI. The RA used the hospital number to obtain each subject's medical record and completed data collection, returning the forms to the PI by registered mail with signature required.

Data Analysis

To explore the consequences after mTBI, frequencies, percentage, means, standard deviation, median, and tests that provide inferential statistics on normality: skewness, kurtosis, P-P plots, outliers, histogram and Kolmogorov-Smirnov tests were computed to describe the extent of stimuli, coping process and quality of life among Thai mTBI patients.

Protection of Human Subjects

This study underwent review by the institutional committee from the Maharaj Nakharachasima Hospital. All subjects were informed about the purpose of this study. Participation in this study was voluntary and each subject could withdraw from the study at any time. There were no direct benefits to participating in this study. There were no substantial risks involved in this study, although subjects may become uncomfortable by the type or quantity of questions. Subjects could participate even if they do not wish to answer specific questions. No subject declined to answer isolated questions. No forms had subjects' name or other information that could be used to link responses to one individual. Results were reported as aggregates only. If there was any information specific to an individual in a report on the study, an alias was used.

The subjects' decisions regarding participation did not affect services that they received from the MNH. Only the PI and members of her committee could access the original questionnaires.

Results

Approximately 461 invitation letters and consent forms were sent to eligible subjects. From the hospital's database, most patients had been involved in motor vehicle crashes, falls, or physical assaults. There were 363 men (78.7%) and 98 (21.3%) women. The overall age ranged from 18 to 82 years. The majority were younger than 29 years (41.4%) and the average age was 36 years. Over a

period of four months, 135 consent forms were returned yielding return rate of 29%. All of the 135 subjects who were willing to participate, were interviewed. The proportion of men to women among 135 participants was 84% to 16%, the median age was 36 years and the mean age was 38 years. Even though only 29% of the eligible subjects were included in this study, their age and gender were not different from the original 461 eligible subjects.

Among 135 subjects enrolled, 40% had mTBI without other injuries. Another 60% had other injuries, such as extremity fracture, maxilla or mandible fracture, blunt trauma to the abdomen, or lacerated wound, with mTBI. The presence of multiple injuries was not exclusionary for this study. Length of stay in the hospital was between 3 and 90 days, with a mean of 8 days. Time post-injury was between 4 and 12 months, with the average being 8 months. Subjects spent between 3 and 180 days recovering at home, averaging about 50 days. The average duration of post-traumatic amnesia (PTA) was five minutes and the duration of loss of consciousness (LOC) was close to two minutes. The average Glasgow Coma Scores (GCS) at 30 minutes after injury was 14, and 15 at 72 hours post-injury. Post-concussion symptoms (PCS) were reported for the total scale and three subscales: frequency, intensity, and duration. The total PCS scores were between 30 and 120 and the average was 50. The average scores for three subscales were 17, 17, and 16, respectively. Depressive symptoms, as measured by the CES-D, were between 0 and 42 and the average was 21.26 (see Table 1).

Internal consistency reliabilities were tested in all questionnaires. The Cronbach's alpha coefficients were high; all were more than 0.7 (see Table 2). These Cronbach's alpha coefficients indicated that the questionnaires were of high quality and were free from measurement errors.

In the GOS-E, this finding is categorised in the upper good recovery category. Thirteen percent of all subjects could not live their normal lives, although no issues were reported. This finding is considered to be in the lower good recovery category of the GOS-E. Sixteen per cent of all subjects reported one or more problems and could not return to their normal lives. They were categorised in the upper moderately disabled category. Three percent of all subjects were categorised as

Variables	Mean (SD)	Median	Range	95% of CI Mean Lower	95% of CI Mean Upper
Length of Stay (days)	8.24 (10.62)	5.0	3—90	6.44	10.05
Time post injury (months)	8.36 (2.15)	8.0	4—12	8.00	8.73
Recovery period (days)	48.67 (45.96)	30.0	3—180	40.85	56.50
Duration of PTA	5.74 (14.55)	0	0—60	3.26	8.22
Duration of loss of consciousness	1.53 (4.42)	0	0—30	0.59	2.48
Glasgow Coma Scores					
- At 30 minutes	14.04 (0.77)	14	13—15	13.91	14.18
- At 72 hours	14.86 (0.35)	15	14—15	14.80	14.92
Post Concussion Symptoms					
- Frequency	17.30 (6.11)	16.0	10—40	16.26	18.34
- Intensity	16.61 (5.89)	15.0	10—40	15.61	17.62
- Duration	16.34 (6.04)	15.0	10—40	15.31	17.37
- Total	50.25 (17.92)	47.0	30—120	47.20	53.30
Depressive Symptoms	21.26 (9.31)	18.0	0—42	19.67	22.84

Table 1 (Above): Severity of Mild Traumatic Brain Injury for all subjects (N=135)

Measures	Cronbach's Alpha	Cronbach's Alpha based on Standardised items	Number of items
Post Concussion Symptoms Checklist	0.952	0.961	30
CESD Thai Version	0.789	0.808	20
Extended Glasgow Coma Outcome Scale	0.750	0.785	5

Table 2 (Above): Reliability statistics of the measurements.

Table 3 (Below): Description of the Extended Glasgow Outcome Scale.

lower moderately disabled or could not return to work/study (see Table 3).

Discussion

Post-concussion symptoms (PCS): Possible range of each of the three PCS subscales was 10-50, and total score was 30-150 with the higher scores indicating more problems. In this study, PCS scores were relatively low; the average of the frequency was 17.30 (SD = 6.11), the intensity was 16.61 (SD = 5.89), the duration was 16.34 (SD = 6.04). The total score was 50.25 (SD = 17.92). These scores were lower than the lowest PCS scores reported in other studies (Hanna-Pladdy, Berry, Bennett, Phillips & Gouvier, 2001; Sparrow, 2002), in which PCS scores were reported at 57 and 58, respectively. The findings of low PCS in this study may result from the length

Domain/Category	All Subjects (N=135) N	All Subjects (N=135) %
Problem in the independence domain	2	1.5
Problem in the difficulty domain	25	18.6
Categories:-		
- Upper good recovery	91	67.4
- Lower good recovery	17	12.6
- Upper moderately disabled	21	15.6
- Lower moderately disabled	4	3.0
- Upper severely disabled	2	1.5

of time post injury in this study, an average of 8 months. The results of PCS from the post-concussion checklist (PCSC) used in this study were difficult to compare to other studies for several reasons. Firstly, other studies used different measures such as absence of symptoms or only the frequency of symptoms. Therefore, findings from other studies, with the exception of the frequency scores, are not comparable. Secondly, for the frequency subscale, the PCSC combined the answer for "none" and "few" in the same category (1). Therefore, it is impossible to distinguish nil symptoms from few symptoms from the PCSC. In addition, other authors have suggested that PCSC scores are not specific to mTBI (Sawchyn, Brulot & Strauss, 2000). If this suggestion is true, then other factors, such as few depressive symptoms or few stress life events in this sample, may contribute to the relatively low PCS scores.

Depressive symptoms: Few depressive symptoms were reported among the subjects with mTBI in this study (average = 21, range = 0-42). The average scores were lower than the normative scores for Thai teenagers (22) (Trangkasombat & Likanapichitkul 1997) but higher than scores reported by subjects with postpartum depression (16) (Srisaeng, 2003). As in the United States, mental health disorders are stigmatised and subjects may be unwilling to report depressive symptoms.

The finding of low depressive symptoms in this study is consistent with McCauley, Boake, Levin, Contant & Song (2001) who reported depressive symptoms among mTBI subjects at 23. Depressive symptom scores among subjects with general trauma were lower at 19. In their study, subjects rated their depressive symptoms at one month post injury and the additional passage of time in this study may help explain the differences in results. The findings in this study was in contrast with findings from Bell, Primeau, Sweet & Lofland (1999) who concluded that subjects with mTBI had depressive symptoms of 15, higher than a score of 9 among subjects with headaches. However, in their study, the use of a different depressive symptom measure and a data collection period at one month after injury, may explain the different results.

Glasgow Outcome Scale: A total of 27 subjects were categorised as moderately or severely disabled and could not return to work or school in this study. This finding contrasts with one study which reported that only 42% of adults with mTBI could return to work/

study (Ruffolo, Friedland, Dawson, Colantonio & Lindsay, 1999). However, other studies have findings similar to this one, reporting that 84-88% of their subjects returned to work or study (Englander, Hall, Stimpson & Chaffin, 1992; Kay, Newman, Cavallo, Ezrachi & Resnick, 1992). The finding of unable to return to work or study after the averaged time post injury of eight months was unexpected. Subjects in this study had a low severity of brain injury as measured by a combined high GCS, short duration of PTA and short duration of LOC. With this type of mild injury, all of the subjects were expected to return to work or study 3 months after injury.

The inability of return to work or study for subjects in this study may be a result of multiple concurrent injuries at the time of mTBI. However, even among subjects with only mTBI, 18% could not return to work or study. This is a small figure but important clinically. The results were similar with one study that was conducted in Thailand in 1985. The authors found that 84% of subjects with mTBI were in the good recovery categories. However, the same authors replicated the same study in 1995 and found that there were only 3% of subjects with mTBI were still in the disability categories at six months post injury (Phuenpathom et al., 2000). Several reasons may explain for the differences of incidence of disability following mTBI. Firstly, many injuries occurred in the municipal area in which the helmet rule is successfully enforced for all riders. Helmets may alter the mechanism of injury in the brain and subsequent disability may not occur (Lam et al, 2015) Secondly, the treatment settings may have different standards of care; this study was conducted among patients who received care at a tertiary public hospital. In the other study completed in Thailand, their sample size was large (3,194 in 1985 and 4,217 in 1995); they collected data from all subjects who came to their hospital and all subjects at this University-based medical centre followed a common standard of hospital care and follow-up that evaluated function with the GOS-E at six months. In this study, GOS-E was self-reported rather than the result of a physical exam. It may be that this study under-reported disability since only volunteer participants were included. In addition, disability may vary over time and this study did not examine immediate responses to mTBI. It is recommended that the GOS-E be used at structured time intervals for all subjects with the same condition (either with or without multiple injuries but not both), to better under-

stand the incidence and prevalence of disability after mTBI.

Recommendations

Education

There were a small number of patients with mTBI that could not live their normal lives after the injury. Including information about severity of brain injury and outcomes to help students anticipate the possible recovery pathway of an individual can be incorporated when teaching about brain injury. Teaching recognition of disability in patients with mTBI is suggested as one of the assignments for students who are training in surgical or neurological departments, so that intervention is not unduly delayed.

Practice

The findings from this study revealed that there were at least 18% of the subjects with mTBI who could not return to their normal lives, even though the GOS-E is not a sensitive tool to capture outcome after mTBI, despite being easy to use and can be finished in a few minutes. Health care professionals should develop or provide an information pamphlet covering "What to expect after an mTBI". Health care assessment on admission after mTBI should include social support networks to aid in recovery. Patients should be educated to evaluate their outcomes after 3, 6, 9 and 12 months. Patients should be advised that if their symptoms or disabilities persist that they should re-contact the health care facility or health care provider.

Several measures used in this study were translated into Thai, tested and yielded high reliability coefficients. These tools can be implemented among Thai adults with mTBI to assess their outcomes.

Research

Findings from this study provided descriptive information regarding adults with mTBI. For future studies, it is recommended that concurrent data collection with a matching normal population be included to provide baseline information. Replication studies could extend the science. For example, stratifying subjects with different categories of time post injury, applying longitudinal methodology, recruiting subjects from multi-settings for a variation of demographic data and increasing sample size to gain more variations.

Some future studies that compare outcomes between different groups such as between genders, age categories, diagnosis (with and

without multiple injuries), time post injury and those with low social support should be conducted. In addition, the role of spirituality or religion could be added as a potential variable. Future studies that explore the same concepts but use different measures may provide different points of view.

Multiple regression models used in this study may not be the best way to examine the data. One strategy for this study is to re-examine the statistical models with transformation of data points that did not demonstrate optimal linearity. Another strategy is to enter variables into the statistical model only if there are demonstrated relationships.

Health policy

There was at least one standard of care that was different between this setting and other hospitals. It is recommended that subjects with mTBI should have follow-up appointments at least six months after the injury to identify those patients with maladaptation as measured by independence, lack of disability and quality of life. Health education regarding outcomes after mTBI should be routine prior to discharge. Printed information regarding symptoms and outcomes after mTBI should be available.

Conclusion

The findings from this study provide a basis for future studies. Several measures used in this study were reliable and can be used within the Thai context. Health education and printed information about outcomes after mTBI is recommended for both health care students and victims of mTBI. Further study to better understand why a small, but clinically important percentage of subjects, experience ongoing disability after mTBI is needed.

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