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CHAPTER 12

Follow-up and community integration of mild traumatic brain injury

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Traumatic brain injury (TBI) is an important cause of disability and death in young adults [1, 2]. The majority (80–90%) of patients admitted to the emergency department are classified as mild TBI [3]. The definition of mild TBI according to the Task Force on mild TBI of the WHO Collaborating Center for Neurotrauma [4] comprises the following criteria:

1 Glasgow Coma Scale on admission 13–15

2 Loss of consciousness less than 30 min

3 Posttraumatic amnesia less than 24 h

Most of these patients recover within weeks to months without specific therapy. However, a subgroup of 15–25% patients continues to experience disabling postconcussive symptoms (PCS) that interfere with their return to work or resumption of social activities [5, 6]. These symptoms cause a social economical burden, since TBI often affects young patients in their twenties and thirties with full occupational status. The financial costs associated with unemployment after TBI are substantial, given that TBI disproportionally affects young people of working age [7]. Lost work productivity after mild TBI may be the largest component of economic costs of brain trauma in the USA [8]. In the USA, costs associated with care and management of TBI are estimated to be $22 billion annually [9]. In health care, indirect costs are much higher than direct costs. Admission and radiological policies are determining factors for the level of direct costs, whereas loss of productivity is the main expense for indirect costs. As minimal data are available regarding the lost work productivity in the majority of patients who are not hospitalized, economic costs of brain injury are substantially underestimated. Given the economic consequences, it is of paramount importance to identify those patients who are prone to develop chronic postconcussive problems in order to institute early rehabilitation focusing on resumption of previous activities [10, 11].

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Care as usual

Several protocols are applied to optimize patient care and management. According to international guidelines, a brain computed tomography (CT) scan is performed at the Emergency Department (ER) on all patients with a GCS of 15 or less and in the presence of certain risk factors (see Chapter 4) [12, 13].

Only patients with documented brain injury are admitted to the neurological or surgical ward. In general, follow-up of patients after sustaining a mild TBI is only done in patients with abnormalities on admission CT. When a CT scan reveals no abnormalities in the acute phase after injury, the patient is regarded as having sustained no relevant TBI and is not seen for follow-up. However, routine CT imaging appears rather insensitive for detecting structural brain changes which may account for persistent symptoms as 20% of the patients with a normal CT scan on admission will develop cognitive complaints. On the other hand, 22% of patients with CT abnormalities showed good outcome [14]. Especially in mild TBI, CT abnormalities are rather nonspecific, and therefore, clinical variables and age are found to be stronger predictions for outcome than CT abnormalities [15]. Only when a patient experiences residual deficits does a referral to a neurologist or rehabilitation specialist occur, and eventually, a neuropsychological examination and magnetic resonance imaging (MRI) are performed. In general, referral occurs within several months after injury due to late recognition of residual impairments and because no practice-based guidelines for a multidisciplinary approach are available [6].

Follow-up

Routine follow-up or interventions are not useful for most patients with mild TBI as the vast majority of improvement occurs between the time of injury and 3 months following the injury. For those patients admitted to the hospital, one regular follow-up either at the hospital or with the general practitioner is advised in most recent guidelines [14]. Mostly, patients are admitted to the outpatient clinic within 4–6 weeks after injury. In those patients with complaints that interfere with resumption of work, additional diagnostic procedures (MRI, neuropsychological assessment) are performed to evaluate whether these impairments are related to the injury or to concomitant anxiety or depression. With the acquired information of these diagnostic procedures, individual targeted rehabilitation therapy can be instituted (Figure 12.1).

Some studies reveal that early targeted educational intervention that includes reassuring information can reduce long-term complaints [16]. A single-session educational intervention within 3 weeks after injury was found to be as effective as a more elaborate assessment. However, many patients had returned to

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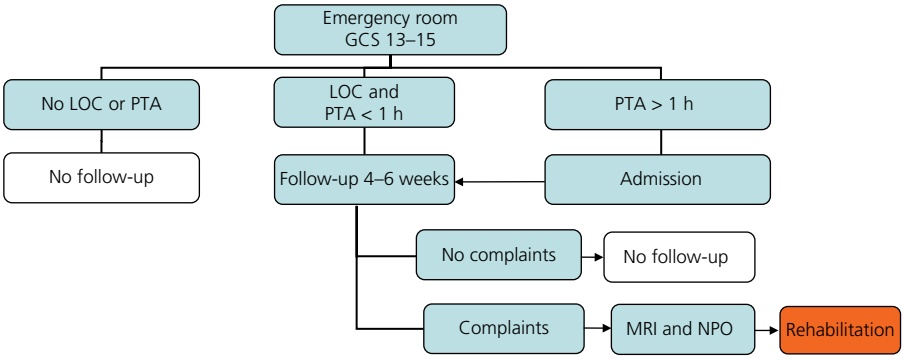

Figure 12.1 Flow diagram with follow-up scheme of mild TBI. LOC, loss of consciousness; MRI, magnetic resonance imaging; NPO, neuropsychological assessment; PTA, posttraumatic amnesia.

work before the intervention and as such the lack of treatment effect may be due to lack of persistent symptoms in the participants [17]. Early follow-up within 7 days after injury was only found to be effective in hospitalized patients with PTA durations of more than 1 h, resulting in significantly fewer difficulties with everyday activities and lower ratings of PCS at 6 months after injury [18]. In a systematic review [19], it was recommended to apply cognitive behavioral therapy (CBT) in those patients with symptoms not responding to information and education alone as this treatment may not be as beneficial as previously thought. Future research on effective treatments can probably focus more on developing early brief treatments targeted to a specific problem group than studying potentially more extensive and expensive rehabilitation models for all mild TBI survivors.

Imaging

In the acute phase after injury, CT is the standard imaging technique because of more accurate detection of intracranial blood to determine eligibility for eventual neurosurgical intervention (see Chapter 4) [20]. For mild TBI, the incidence of abnormalities is about 15% increasing to 50% when a CT scan is done only in those with neurological symptoms [21]. Conventional CT has limited ability to detect structural and functional abnormalities as suggested by the fact that 20% of patients with a normal CT scan on admission show unfavorable outcome [14]. MRI is the preferred imaging technique in the subacute phase and during follow-up of mild TBI as MRI is more sensitive in detecting diffuse axonal injury and nonhemorragic contusions (see Chapter 2) [22]. For years, T1- and T2-weighted spin echo and FLAIR-weighted sequences were the most commonly used MRI modalities in TBI. Nowadays, T2*-weighted gradient

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echo is used instead of these conventional sequences because of better detection of diffuse axonal injury, with visualization of hemosiderin deposits as a result of hemorrhage [23, 24]. The number of T2*-weighted abnormalities are found to correlate with outcome and with neuropsychological deficits [23, 25, 26]. Susceptibility-weighted imaging is the most recently developed structural MRI technique with high sensitivity for hemosiderin. The first studies are promising as they show high sensitivity but a rather inconsistent relation with outcome [27, 28] (Figure 12.2).

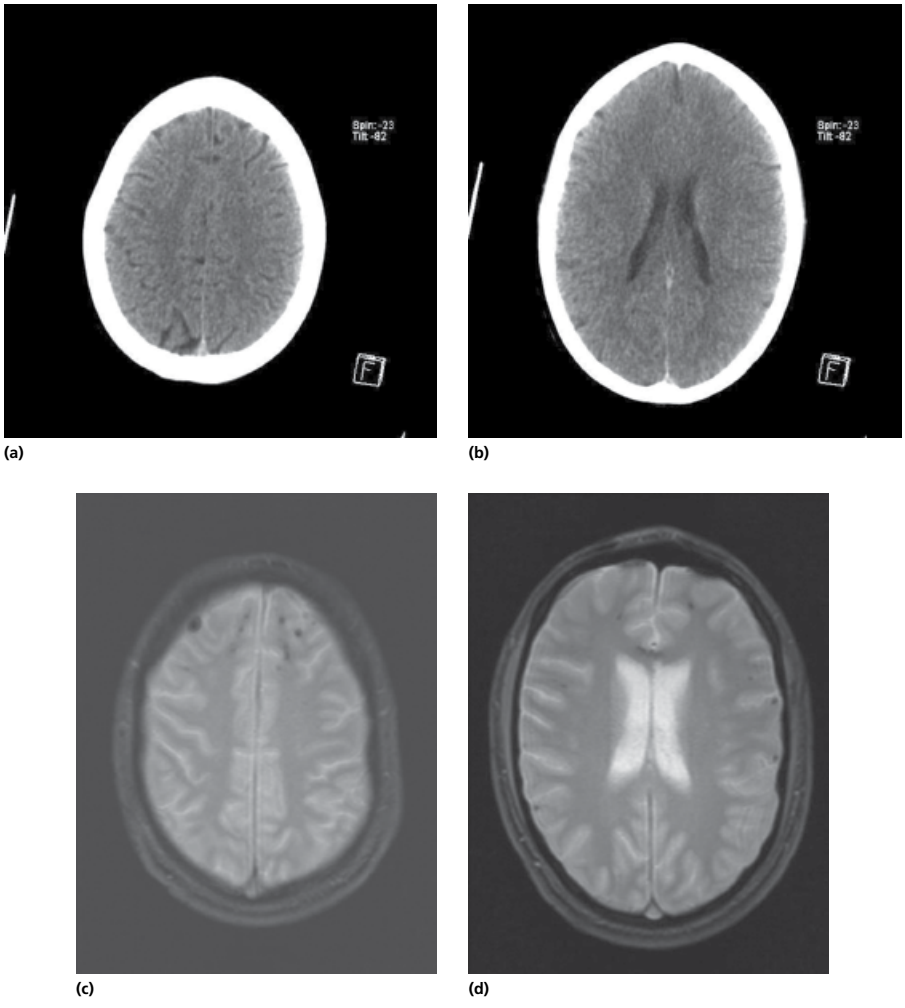

Figure 12.2 Patient with mild TBI, GCS 14 on admission, after a bicycle accident. CT on admission reveals no abnormalities (a and b). MRI performed 3 months after injury due to persisting cognitive complaints reveals microhemorrhages corresponding with diffuse axonal injury in the frontal regions bilaterally (c) and in the corpus callosum and in the cortex (d).

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Outcome of mild TBI

Postconcussive symptoms

The outcome after mild TBI in general is favorable with 75–90% of patients achieving good outcome 1 year after injury [29] measured with the Glasgow Outcome Scale. Although the majority of symptoms are present in the first 3 months after injury, still, 25–50% of patients will have persistent complaints interfering with resumption of work and social activities. The most frequent complaints after mild TBI are forgetfulness, concentration problems, and increased fatigue [30–32]. In one of the first studies on outcome of mild TBI, moderate disability was found in one out of four patients [33]. For determination of outcome and return to work, timing of follow-up is important. One month after injury, physical limitations play a role in resuming work [34] with considerable improvement noted over the first 6 months postinjury, whereas some of the reported limitations in communication and emotional domains remain constant over time [35].

Cognitive impairment

Deficits in cognitive functioning are not consistently demonstrated with standard neuropsychological tests despite the often reported attention and memory complaints. Some studies report cognitive deficits in the early stage postinjury. For instance, Kwok *et al*. [36] found mild TBI patients to be impaired on tests for speed of information processing, attention, and memory at 1 month postinjury. However, at 3 months postinjury, patients were reassessed, and most test performances had returned to a normal level or were only present in those patients with CT abnormalities on admission [37]. A meta-analysis by Binder *et al*. [38] showed evidence for subtle neuropsychological deficits in mild TBI patients assessed more than 3 months postinjury, but more recent meta-analyses fail to detect significant long-term neuropsychological impairments [39–41]. Furthermore, poor test performances of mild TBI might be the consequence of poor effort [42]. More than 25% of a sample of mild TBI patients failed a symptom validity test, indicating poor effort. Strikingly, this was not related to litigation, but to lower educational levels as well as reported high levels of distress. It is also demonstrated that the mere expectation that an individual will experience cognitive symptoms influences the extent to which they are actually experienced. Studies investigating mild TBI patients under a condition of *diagnosis threat* (in which they were told that they may be experiencing cognitive problems due to the injury) versus a neutral condition found lower performances on cognitive tests as well as higher complaint ratings for the first group, even on a long term [43–45].

Return to work

The majority of patients with mild TBI will have returned to work by 3 months after injury [30, 46]. In most studies, only the first day of working is noted without defining the level of work that the patient could achieve or the

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percentage of the total working hours. One recent study showed that the majority of patients with mild TBI (56%) started working until 1 and 3 months after injury. Ultimately, 91% of the patients were working in a full-time job at 6 months postinjury [47]. However, this does not imply that patients resuming work are without complaints. Work-related problems were reported by up to half of employed patients. Even patients who have resumed work completely report temporary increase of postconcussive complaints in the first months after regaining full activities, suggesting that patients who are resuming activities show suboptimal performance [32]. Given the long-term consequences, lost work productivity should not only be measured by work absence but also by estimation of reduced performance on the job.

Long-term outcome and community integration

Outcome studies beyond 10 years after injury contain patients with varying severity of injury hampering the precise estimation of long-term outcome. Furthermore, the response rate is often low in mild TBI probably due to relative favorable outcome of this patient category. However, the few studies on long-term follow-up on mild TBI ultimately show good recovery varying from 50 to 88 % of patients [48, 49]. Approximately 95% of patients found their life as a whole at follow-up good or at least acceptable. An important factor influencing survival seemed to be whether relations with family and friends could be maintained at preinjury levels [50]. Up to 30% reported distressed family relations 1 year after injury. Emotional and behavioral impairments are also noted 1 year after injury [51]. Even though patients are found to live and work independently several years postinjury, they still may have difficulties in social interactions due to personality disturbances [52]. Over the years, changes in adjustment show improvement of emotional stability but increased difficulties with anger management and self-monitoring [53]. In those with milder injuries, adverse psychosocial factors are associated with deterioration [54]. At follow-up 5–7 years after injury, as many had deteriorated (12%) as had improved (13%). Those who deteriorated were more depressed and anxious and had more alcohol-related problems [55]. When comparing a mild to a moderate–severe TBI group in a cohort study beyond 10 years after injury, no substantial difference was found between injury severity groups in case of living arrangements, marital status, education, or quality of life. In addition, cognitive impairment and emotional problems were more commonly reported than physical impairment in the long term with 10–25% of patients reporting some degree of feelings of depression or anxiety [56, 57]. Approximately 1 in 10 patients was found to have lost their jobs because of persistent complaints [58]. Long-term outcome surveys in mild TBI indicate that self-reported outcomes and adaptation to impairment-related limitations improve as the time since injury increase, especially in the mild TBI group [59] (Table 12.1).

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Table 12.1 Long-term outcome studies of mild TBI. Studies with 100 or more patients are selected.

Author	Severity	Follow-up	Impairments	Outcome (for mild TBI)	Return to previous work	
Engberg [50]	Register-based questionnaire survey	2–5 years *n* = 240 mild TBI	42%, behavioral disturbances	65%, good recovery* 25%, less social contacts	42%	Response 76%
Kashluba [37]	Prospective outcome study	1 year *n* = 102 mild TBI with abnormal CT	29%, cognitive problems	Not specified	61%	
Huang [52]	Level 1 trauma center	1–10 years *n* = 327 75% mild TBI	Not assessed	Good recovery† 49%, 1 year 41%, 3 years	50%, 1 year 75%, 3 years	Response 33%
Brown [59]	Prospective cohort study	10–30 years *n* = 1623 79% mild TBI	24%, depression or anxiety	75%, satisfied with quality of life	62%	Response 37%
vanderPloeg [54]	Cross-sectional cohort study	10–30 years *n* = 254 mild TBI	14%, depression 16%, anxiety disorder	22%, concentration 28%, memory	75%	
Asikainen [48]	Retrospective cohort study	*n* = 508 TBI 115 mild TBI 5–20 years	Not assessed	73%, good recovery†	68%	
Masson [49]	Prospective cohort study	*n* = 176 TBI 114 mild TBI 5 years	Not assessed	88%‡, good recovery	77%	

TBI, traumatic brain injury.
Outcome defined by the Glasgow Outcome Scale—Extended (GOSE) with * = 8 or † = 7 and 8, ‡ = recovered from brain and initial injury.

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Prediction of outcome

The factors predictive for outcome have to be defined, both in the acute and chronic phases in order to facilitate treatment strategies for TBI.

Acute injury characteristics such as mechanism of injury [60], extracranial injuries [34, 61], duration of PTA [32], and clinical findings [62] have been related to outcome. Furthermore, preinjury characteristics such as personality traits, vocational status, and education level are related to residual impairments [42, 63, 64]. Few studies have examined which symptoms in the immediate postinjury period best predict subsequent development of PCS [65–68]. Postural instability and dizziness have been related to PCS at 3 months postinjury but not with specific outcome measures. Vomiting and headache at the ER together with noise intolerance and pain assessed within days to weeks after injury have been found to be predictive for PCS [62, 69–71]. However, in the setting of acute trauma care it is not always possible to obtain information on all these variables and therefore early identification of patients who are likely to develop residual complaints is difficult.

It is estimated that 15–25% of patients having sustained mild TBI are at increased risk of developing chronic symptoms, but there is controversy on the actual rate of poor outcome as many studies focus on symptom manifestation rather than on actual level of functioning. The predictive power of most commonly reported complaints after mild TBI is poor because of nonspecificity of complaints that may be reported by those with other injuries [72, 73] and the fact that patients seem to underestimate the prevalence of their preinjury complaints compared to controls.

Furthermore, several factors are associated with the development of chronic postconcussive impairments comprising coping strategies that subjects use, premorbid anxiety, and depression levels, as well as having social support of relatives and close others [63, 67, 74–77]. Mild TBI patients with many complaints have a significantly higher risk on a negative vocational outcome than those with lesser or no complaints [40, 76]. Having postconcussion complaints is significantly related to higher levels of stress and depression which in turn can be conceived as the result of an inadequate coping style [76, 78]. Patients with inadequate coping styles showed a worse psychosocial outcome than patients with adequate coping styles [79, 80].

Treatment strategies

Postconcussive complaints

Because anxiety in the acute phase after injury has been found to be related to persistent PCS [71, 73], interventions aimed at reducing anxiety would be expected to decrease prolonged symptomatology. This is consistent with

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Mittenberg's work that reported a beneficial effect of a brief, early cognitive behavioral intervention in reducing the incidence of PCS [72]. In one of the first studies on CBT in mild TBI, reduced anxiety and depression were found although no changes were noted in cognitive measures [81]. However, in this study over half of patients were involved in litigation and were seen several years after injury. One nonrandomized study suggests that the treatment of depression in patients with mild TBI may improve cognitive function [82].

Inadequate coping skills have been found to be a major factor in the development of residual impairments in TBI patients. Inadequate coping pertains to the inability to regulate emotions and adapt responses to a distressing situation and is related to frontal network dysfunction. It manifests itself as unrealistic illness perception, leading to increased feelings of anxiety or depression. This results in persisting residual complaints and impairments and eventually unfavorable outcome. Psychotherapeutic intervention by means of CBT aimed at improving coping skills in order to reduce stress- and anxiety-related responses has proven to be effective in the chronic stage [83, 84] in patients with varying severity of injury.

Whitaker [75] demonstrated that in mild TBI patients, illness perception is decisive for the eventual outcome with higher risk for those who tend to catastrophize on long-term postconcussion complaints interfering with their social and vocational reintegration. Hence, coping style and specifically early illness perception seem plausible targets for psychotherapeutic intervention. In a range of studies, the effectivity of CBT in reducing stress-, depression- and anxiety-related complaints and improving coping skills and adaptive behavior in TBI patients in the chronic stage (6 months or longer postinjury) was proved [83, 85–88].

Return to work

Return to work is another important outcome measure in rehabilitation after TBI. There is little evidence to suggest what should be considered the best approach for vocational rehabilitation [7] although Mateer and Sira [89] argue that CBT is very effective for improving coping styles in TBI patients. Three main categories of vocational rehabilitation for TBI patients are identified based on program-based vocational rehabilitation, supported employment, and case-coordinated care. A postintervention study of mild TBI patients within a rehabilitation setting showed 60% resumption of work, with two-thirds of patients being full-time employed. Age and a high symptom load were found to be negative predictors [90]. After long-term follow-up, approximately 80% of patients fully employed before the injury were found to have resumed full-time work [32]. As a clinical implication, early identification of patients with mild TBI at risk of prolonged time off work is mandatory. Available predictors such as preinjury job status are not sufficient to select suitable patients for intervention. An alternative approach to identify high-risk TBI patients would be a brief screening interview or questionnaire used during the first weeks after injury.

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Summary

Most patients with mild TBI recover without specific therapy with a subgroup experiencing residual impairments that interfere with resumption of work and social activities. Routine follow-up may not be needed, but given the consequences of late referral when residual impairments interfere with return to work, it is mandatory to identify those patients at risk for developing persistent symptoms in an early stage. Such knowledge would facilitate risk stratification directly at the emergency department, to help decide which patients need specialized follow-up care focused on return to work and social activities.

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