



Mild Traumatic Brain Injury: Determinants and Subsequent Quality of Life. A Review of the Literature

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Abstract: In this review, we analyzed literature related to the clinical, theoretical, and empirical determinants of mild traumatic brain injury (MTBI) in adults, with a focus on outcomes. Consequences after MTBI were summarized, patient outcomes were organized following Ferrans and Powers' conceptual model of quality of life, and gaps in knowledge were identified. The following databases were searched for publications related to MTBI: PubMed, PsycINFO, CINAHL, and Digital Dissertation. A total of 44 publications related to MTBI in adults were identified. Neither clinical nor theoretical definitions nor empirical descriptions agreed on the determinants of MTBI in adults. Nine reports included a holistic evaluation of outcomes after MTBI; an additional 35 studies examined health and functioning, psychological, or socioeconomic consequences. Results were mixed regarding how MTBI affects individuals in overall quality of life and which domains of quality of life are affected. With more than one million adults experiencing MTBI annually in the United States, it benefits the healthcare professional to understand the challenges of identifying adults who experience MTBI. Furthermore, the consequences of MTBI may be clinically important. Further research about MTBI using clear definitions and a holistic approach to recovery is warranted.

Mild traumatic brain injury (MTBI) affects more than one million individuals annually in the United States (National Center for Injury Prevention and Control, 2003). Worldwide, estimates of this phenomenon are more difficult to establish because the definitions of MTBI vary extensively in the clinical, theoretical, and empirical literature. Although a consensus panel identified key determinants of MTBI in 1992 (World Health Organization, 1992), this definition is not yet universally accepted. This uncertainty in definitions makes it difficult to capture the outcomes after MTBI. Published studies present conflicting findings that suggest the occurrence of consequences after MTBI may vary from nonexistent to frequently reported. Reported duration of symptoms ranged from a few minutes to prolonged derangement in health.

This article reviews the definitions of MTBI and presents findings related to outcomes after MTBI. The findings are framed from a holistic perspective,

namely, quality of life. When studies did not explicitly examine quality of life, domains of quality of life from Ferrans and Powers' framework (Ferrans, 1996) were used to cluster results. Use of this framework is congruent with nursing's holistic approach to care and links the body of knowledge about recovery from MTBI to information from other healthcare disciplines. This review will help nurses and other healthcare professionals understand possible consequences that patients may experience after MTBI and will suggest future directions for research. Understanding MTBI determinants and outcomes is the necessary first step to developing interventions that target exemplary care for these patients.

Materials and Methods

Four databases were searched for publications related to MTBI: PubMed, PsycINFO, CINAHL, and Digital Dissertation. Studies were included if they were written in English; gave information about determinants of MTBI; described methods sufficiently to permit study replication; and measured outcome variables using accurate, sensitive, reliable, and valid instruments that reflected at least one domain in Ferrans and Powers' framework (Ferrans & Powers, 1985). The following keyword phrases were used in free-text searching: *mild traumatic brain injury*, *mild brain injury*, *closed head injury*, and *concussion*. In addition to

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this search strategy, the bibliographies of all relevant articles were visually searched to retrieve articles not referenced in the electronic databases. The abstracts of the articles were read and the publications that appeared to meet the study criteria were selected. Then the entire articles were reviewed for content.

Initially, all publications that included adult patients with MTBI from 1992 through 2005 were identified. We elected to begin with 1992 because diagnoses related to MTBI were widely disseminated that year in the *International Classification of Diseases (ICD)* (World Health Organization, 1992). This authoritative publication is used across settings and specialties. The *ICD* provides a consistent and reliable code of three to five digits for describing a medical diagnosis or procedure. The *ICD* is now in its 10th revision (*ICD-10*); diagnoses related to MTBI have appeared in every edition. As a result of broad dissemination and use of the *ICD*, it was expected that definitions of MTBI would be more consistent after 1992.

While selecting a starting point was relatively straightforward, defining outcomes was challenging. Traumatic brain injury has a wide range of potential outcomes that include both no change and cognitive, motor, emotional, social, and functional changes. Use of a holistic definition of recovery helps identify outcomes that are meaningful for patients and reflects key values in nursing theory and practice (Roy, 1997, 2005). When a study examines only a single physiological system or neuropsychological domain, reports

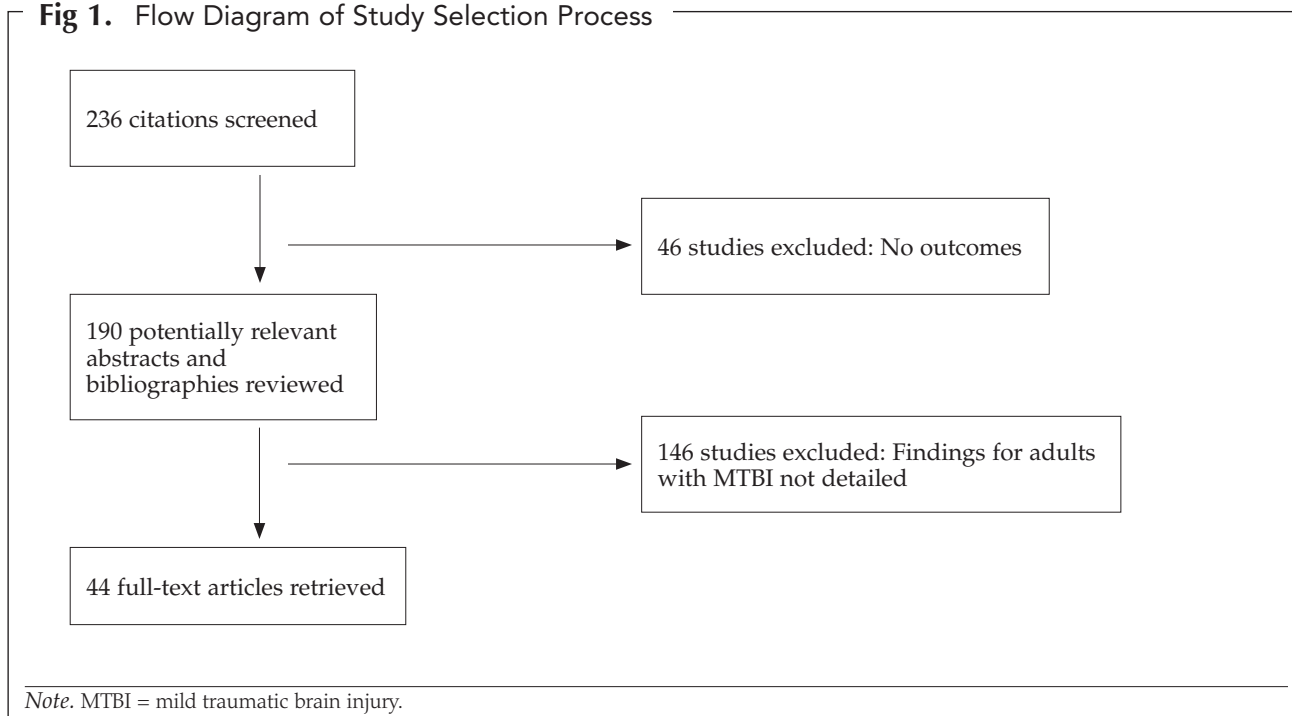
about adults with MTBI may not capture the full range and depth of patient outcomes. Outcomes after MTBI for this review were analyzed and categorized according to Ferrans and Powers' framework, which includes four domains: (1) health and functioning, (2) psychological and spiritual, (3) social and economic, and (4) family (Ferrans, 1990b, 1996; Ferrans & Powers, 1985, 1992). One advantage of this framework is that it has been used in a variety of practice settings and in different cultures (Bolsé et al., 2002; Huang, Lee, Chien, Liu, & Tai, 2004; Petchprapai, 1998); it has the potential to link knowledge about recovery from MTBI internationally.

A total of 236 publications (e.g., journal articles, theses, and dissertations) with constructs related to MTBI were identified. Of these publications, 190 were investigations that included both adults with mild brain injury and their outcomes. However, many of these 190 studies incorporated variable severities of brain injury and findings specific to MTBI were not described; 146 were eliminated as a result. In total, 44 studies were collected and analyzed for this review. The study selection process is illustrated in Figure 1, and the studies are summarized in Table 1 (available at www.AANN.org).

Determinants of MTBI

According to Ruff and Grant (1999), MTBI has been characterized by unclear definitions for more than 30 years. For example, the terms *MTBI* and *concussion* are often used interchangeably (Kibby & Long, 1996), yet concussion can also occur with moderate brain

Fig 1. Flow Diagram of Study Selection Process



injury (Chamelian & Feinstein, 2004; King, Crawford, Wenden, Caldwell, & Wade, 1999; McCauley, Boake, Levin, Contant, & Song, 2001).

Clinical and Theoretical Determinants

Several clinical criteria are used to determine the presence of MTBI. The first criterion is evidence of trauma preceding brain injury. Trauma may be blunt force, contact, acceleration or deceleration, or rotation to the head (Alexander, 1995; American Congress of Rehabilitation Medicine [ACRM], 1993; American Psychiatric Association [APA], 1994; Centers for Disease Control and Prevention, 2004). Any external physical impact can lead to MTBI. In addition, history related to the injury, findings on physical exam, and results of radiographic exams are used to clinically diagnose MTBI (Ruff & Jurica, 1999). Specifically, diagnosis is based on brief loss of consciousness, amnesia surrounding the traumatic event or posttraumatic amnesia, minor and transient focal neurological changes in sensation or movement, and absence of radiographic changes on computed tomography (CT) scans.

The Glasgow Coma Scale (GCS) is commonly used to clinically categorize brain injury. A GCS score of 13–15 is one of the earliest determinants of MTBI and has international acceptance as a valid and reliable approach to identifying the severity of brain injury (Fisher & Mathieson, 2001; Jennett, 2002; Ruff & Grant, 1999). The GCS is a quantitative assessment of decreased consciousness with three subsections: eye opening, verbal ability, and motor movement immediately after the injury. Clinically, it demonstrates adequate interrater reliability or $K = .69 - .71$ (Ruffolo, Friedland, Dawson, Colantonio, & Lindsay, 1999), although the accuracy of assessing with GCS is higher when used by an experienced investigator (Rowley & Fielding, 1991).

In addition to a GCS score of 13 or more, duration of loss of consciousness (LOC) and posttraumatic amnesia (PTA) have been used to determine MTBI in clinical settings. *LOC* is defined as unawareness or inability to respond to the environment. MTBI patients may demonstrate ambiguous, doubtful, or uncertain behavior immediately after the injury (Iverson, Lovell, & Smith, 2000); *LOC* does not include transient confusion or other alterations in mental status (e.g., feeling dazed, disoriented, or confused). *PTA* is further defined as any loss of memory for events immediately before or after the accident until the person returns to continuous memory (Swann & Teasdale, 1999). *LOC* and *PTA* have been reported in a time-sensitive manner, ranging from minutes to hours, days, or weeks.

In the mid-1990s, the American Congress of Rehabilitation Medicine (1993) added duration of *LOC* and duration of *PTA* to the GCS score to

describe MTBI to expand the theoretical definition. In 1994, the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)*, published by the APA, also defined MTBI by using *PTA* and *LOC* with specific cut-points. In these publications, the ACRM set the cut-point for *LOC* at 30 minutes or less, while the *DSM-IV* set it at 5 minutes. The ACRM set the criterion for duration of *PTA* in MTBI at 24 hours or less, while the *DSM-IV* set it at 12 hours or less. Ruff and Grant (1999) noted that the *DSM-IV* definition was purposely created for postconcussion symptoms and may be inadequate to define MTBI.

Concussion has sometimes been used to define MTBI. However, it is not unique to mild brain injury (Parkinson, 2000; Shaw, 2002; Terrell, 2004). Experts suggest that concussion occurs immediately after a variety of traumas and can be graded according to criteria established by the American Academy of Neurology (1997). Concussion is not typically included in the clinical, theoretical, or expert definitions of MTBI today.

Symptoms after concussion have also been used to define MTBI. Postconcussion symptoms (PCS) are described by a reduction in cognitive functioning, accompanied by specific neurobehavioral symptoms that occur as a consequence of closed head injury (Gasquoin, 1997). These symptoms are fatigue; disordered sleep; headache; vertigo or dizziness; irritability or aggression on little or no provocation; anxiety, depression, or affective lability; apathy or lack of spontaneity; and other changes in personality (e.g., social or sexual inappropriateness; Gasquoin, 1998; Ingebrigtsen, Waterloo, Marup-Jensen, Attner, & Romner, 1998; Parkinson, 2000). Other symptoms, such as visual or hearing impairment and anosmia (loss of sense of smell), may also be found (Lees-Haley, Fox, & Courtney, 2001; Suhr & Gunstad, 2002). There are two expert or theoretical definitions of PCS: one from the *DSM-IV* and the other from the *ICD-10*.

In the *DSM-IV*, criteria for PCS are set as three (or more) symptoms that are present for at least 3 months following the mild head injury. The *ICD-10* defines PCS as a set of three or more symptoms that appear for longer than 4 weeks after a history of head trauma with evidence of *LOC* (Mittenberg, Cannyock, Condit, & Patton, 2001; Nguyen & Yablon, 2002). Boake and colleagues (2004) compared the agreement of symptoms using *DSM-IV* and *ICD-10* criteria. The results revealed that five symptoms (i.e., headache, fatigue, sleep disturbance, irritability, and dizziness) present in both criteria had high agreement ($K = .83-.91$). However, the agreement for meeting criteria for diagnosing PCS using both definitions was poor ($K = .13$). The authors concluded that *DSM-IV* had a higher threshold and greater specificity but did not capture participants who had

few or mild PCS complaints. All participants who met *ICD-10* criteria met *DSM-IV* criteria as well (Boake et al., 2004).

The onset and duration of postconcussion symptoms is not well established clinically (Gasquoine, 1997; Jacobson, 1995; Macciocchi, Barth, & Littlefield, 1998; Rees, 2003; Ruff & Grant, 1999; Ruff & Jurica, 1999; Satz et al., 1999). However, PCS is not limited to MTBI—the syndrome can occur with moderate and severe brain injury and has also been associated with trauma unrelated to brain injury (Chan, 2001; Lees-Haley et al., 2001; Machulda, Bergquist, Ito, & Chew, 1998; Smith-Seemiller, Fow, Kant, & Franzen, 2003). This analysis suggests PCS is used in the literature to determine the presence of MTBI. However, PCS does not occur concurrently only with brain trauma. It may occur even in the absence of brain injury. For this reason, clinicians and researchers may find PCS to be more useful if classified as a consequence of MTBI rather than a determinant of MTBI (determinants include duration of posttraumatic amnesia, loss of consciousness, or GCS scores). PCS does not help to diagnose MTBI; rather, it helps frame the type of symptoms experienced by some adults after MTBI.

Empirical Determinants

Because clinical and theoretical definitions for MTBI are inconsistent, the empirical literature was examined for determination of MTBI in the 44 selected studies from 1992–2005 (Table 1, available at www.AANN.org). A total of 31 investigations used a GCS score of 13–15 to define MTBI; 5 of these 31 studies used a GCS score of 13 or more as the sole determinant for MTBI. The publications that used the GCS to determine the presence of MTBI were inconsistent. One group of researchers (De Kruijk et al., 2002) divided participants with MTBI into two groups, one with GCS scores = 13 and one with GCS scores = 14–15, and concluded that these two groups had different outcomes. Another group of researchers (Stranjalis et al., 2004) included only participants with GCS scores of 15 in their study.

The inclusion and duration thresholds of LOC among adults with MTBI are not consistent in the empirical literature. In the 44 studies reviewed, 24 (54.5%) included LOC as a determinant for MTBI. Among those, 18 adopted ACRM's criterion of 30 minutes, while only one used the *DSM-IV* cut-point of 5 minutes. Two studies used LOC duration for up to 60 minutes, and three studies included participants with any period of LOC.

The use of PTA as a determinant of MTBI is also variable in the research literature. Twenty-seven (61%) of the 44 reports about MTBI and outcomes employed PTA. Of these 27 reports, 17 studies used ACRM's cut-point of 24 hours or less and two

adopted the *DSM's* criterion of 12 hours or less. Six studies set the duration of PTA at less than 60 minutes. Two additional studies had multiple values for the duration of PTA.

No studies in this review of outcomes after MTBI included concussion as a determinant of MTBI, but several studies included postconcussion symptoms (PCS). Although the definition of PCS can vary, it is a popular concept in MTBI research. Among these 44 studies from 1992 to 2005, 31 studies (70%) included PCS. In these 31 studies, 7 used a time frame of 3 months, as in the *DSM-IV* (Alves, Macciocchi, & Barth, 1993; Cicerone & Azulay, 2002; Englander, Hall, Stimpson, & Chaffin, 1992; Evered, Ruff, Baldo, & Isomura, 2003; Kay, Newman, Cavallo, Ezrachi, & Resnick, 1992; McCauley et al., 2001; McHugh, 2002). One study reported PCS as three or more symptoms (Ingebrigtsen et al., 1998). The majority of these 31 studies (77%) used a single symptom at less than 3 months as diagnostic of PCS.

More specifically, in 31 reports of PCS after MTBI, 24 suggested that PCS follows MTBI in 11%–80% of patients. However, the definitions of PCS varied in these studies and included symptoms occurring a few hours after injury (De Kruijk et al., 2002; Echemendia, Putukian, Mackin, Julian, & Shoss, 2001; Emanuelson, Andersson, Bjorklund, & Stalhammar, 2003; Haboubi, Long, Koshy, & Ward, 2001; Ponsford et al., 2000; Sparrow, 2002) to years after injury (Bohnen, Jolles, Twijnstra, Mellink, & Wijnen, 1995). Two studies reported that PCS was not associated with MTBI (Santa Maria, Pinkston, Miller, & Gouvier, 2001; Suhr & Gunstad, 2002). Five studies concluded that PCS among adults after MTBI was not higher than PCS among the normal population or participants with other injuries (Echemendia et al., 2001; Lees-Haley et al., 2001; McCauley et al., 2001; Smith-Seemiller et al., 2003; Suhr & Gunstad, 2002). Thus, with 31 studies of PCS after MTBI, 24 reported the presence of PCS, while 7 reported that PCS was not specifically associated with MTBI.

Outcomes after MTBI

There is evidence that some MTBI patients have cognitive and functional changes that persist for as long as 1 year after injury (Deb, Lyons, & Koutzoukis, 1998; van der Naalt, van Zomeren, Sluiter, & Minderhoud, 1999). Many adults with MTBI do not receive inpatient care or rehabilitative services. Frustration with unrecognized MTBI-related disability and lack of treatment may adversely influence social and physical functioning, disrupt family life, and lead to depression, affecting patient health and well-being or quality of life. Quality of life (QOL) has become a priority in research and clinical practice. To better understand why QOL is a useful frame of reference to measure

outcome after MTBI, a brief review of the meaning and value of QOL as a measure is detailed.

QOL is a broad concept that has been explored among healthcare disciplines for decades (Bowling, 2005). Stewart and King (1994) concluded that there are at least two essential attributes that must be considered when measuring QOL: domain and dimension. Domain, or content area, refers to the aspect of life that is evaluated. Domains of QOL include physical functioning, functioning in daily living, psychological well-being, and social relationships. QOL may be measured as a single domain or in multiple domains. Dimension refers to some level or state of behavior or a feeling (Stewart & King). Dimension may be evaluated as a unidimensional index such as life satisfaction only, or multidimensionally, by including both satisfaction and importance. Multiple domains and more than one dimension should be included in QOL assessment to capture well-being (Bowling).

QOL measurement can be generic or disease specific. Disease-specific QOL measurements emphasize the particular problems unique to the condition for which they are developed (Marra et al., 2005), while generic measurements assess the broad impact of disease and treatment on functioning in everyday life (Ware et al., 1998). Disease-specific measures may be more useful in determining whether treatments (or lack of treatment) have intended specific effects, but they do not permit comparisons across conditions and treatments (Ware et al.).

Another consideration in measuring QOL is subjectivity and objectivity. Although many QOL studies have described life satisfaction as QOL, Meeberg (1993) concludes that life satisfaction is a purely subjective feeling that refers to one's level of happiness regarding one's life. Meeberg states that QOL measures have both subjective and objective aspects. A subjective dimension assesses feelings, perceptions, or opinions of the client, while an objective dimension focuses on demographic variables and socioeconomic status (May & Warren, 2001).

Ferrans (1990b) defined QOL as "a person's sense of well-being that stems from satisfaction or dissatisfaction with the areas of life that are important to him/her" (p. 15). In studies, Ferrans and Powers concluded that a person with high QOL is one who is satisfied in the aspects of life that are important for him or her (Ferrans, 1990a, 1996, 1997; Ferrans & Powers, 1985, 1992). The Ferrans and Powers framework for QOL captures not only multiple domains, by including health and functioning, psychological and spiritual, socioeconomic, and family aspects, but also multiple dimensions, by using a Likert scale to determine satisfaction and importance of various aspects within each of the categories.

Studies Directly Addressing Quality of Life

Among the studies reviewed, only one study explicitly examines QOL among adults with MTBI (Emanuelson et al., 2003). However, if findings from other outcome-based studies are examined from a holistic approach, eight additional studies evaluated multiple domains similar to a framework of QOL. An in-depth review for each of these nine studies gives important information about recovery from MTBI.

Emanuelson and colleagues (2003) examined QOL among adults with MTBI at 3 weeks, 3 months, and 1 year after injury. MTBI was defined as a period of loss of consciousness for 30 minutes or less, with a duration of PTA less than 24 hours and GCS scores 30 minutes after injury at 13–15 (Andersson, Bjorklund, Emanuelson, & Stalhammar, 2003). This definition is congruent with the MTBI definition from the ACRM (1993). A health-related QOL definition used in this study was developed from a framework of the SF-36 (Short Form 36 Health Survey; Sullivan, Karlsson, & Ware, 1995). Although 489 patients enrolled, 173 agreed to participate and only 101 participants completed the study. The total sample was mostly male (65%) with an average age of 32 years. QOL was measured by using the SF-36. Patients with MTBI reported lower QOL than control participants (Emanuelson et al., 2003), and scores remained lower at 1 year after injury. In addition, data about PCS were collected at each time point. Headache was the most frequently reported health and functioning symptom at all time points (reported by 30%–35% of participants), while depression was the most frequently reported psychological and spiritual symptom at 3 months after the injury (reported by 36% of participants). The relationships between QOL and PCS were reported ($r = -.68$ to $.85$), but it was not clear which aspects of QOL had negative relationships with the PCS. The SF-36 is a generic and unidimensional measure that consists of two subscales: physical health and mental health. However, a generic scale may miss the disease-specific aspects of MTBI, such as changes of daily living related to sequelae after the injury or the effects of MTBI on family functioning. An attrition rate of 43% (62 of the 173 enrollees did not complete the study) also may have affected results; those participants who did not complete the study may have had significantly more or less derangements after MTBI than the participants who provided complete data.

Eight other studies included all four QOL domains in their investigation of outcomes after MTBI. In 1992, Alexander pioneered a holistic approach. He interviewed 35 participants after closed head injury between 6 months and 5 years after their injury; 23 participants experienced MTBI. All participants

were from an outpatient head injury clinic and had an average age of 37 years; 60% were male. Although he did not use a specific measure of QOL, Alexander measured health and functioning by using the Glasgow Outcome Scale, open-ended questions, and physical and neurological examination. Psychological and spiritual responses were assessed by a mental status exam and psychiatric symptoms interview. An interview about the ability to return to work and the participant's social network was used for evaluation of the social/economic and family domains. He reported on several determinants of MTBI of interest to this review: The average LOC was less than 15 minutes; PTA was less than 1 hour and radiographic results were negative for focal contusion. In terms of health and functioning, PCS was experienced by 43%–87% of participants (commonly headaches and dizziness). In terms of outcomes, depression was present in almost 90% of the participants, and nearly half of the participants needed workers' compensation after brain injury. Even though the study had a holistic approach, the findings were limited by the small sample size; power was not reported. The wide variation in time after injury, from 6 months to 5 years, was another limitation of this study, because different periods of time after injury could influence the presence of symptoms. Moreover, results from open-ended questions were varied and the method of interpretation was not clear, making it difficult to reproduce this aspect of the study.

In the same year, Kay and colleagues (1992) collected data from 808 participants with mild head injury. Participants were interviewed at 1 week, 1 month, 3 months, 6 months, and 1 year after injury. Sample characteristics were not reported. The NYU Head Injury Family Interview was used to describe outcomes after brain injury. This group used clear definitions for MTBI and PCS. However, they also included participants with mild head injury (MHI); MHI was defined as injury to the head and face area with or without injury to the brain, while MTBI was a subset of these patients who also had injury to their head or brain. Typical determinants of depth of coma (i.e., GCS score) and duration of PTA or LOC were not reported. Headaches were the most common physical symptom reported after injury for all time points, with an incidence of 23%–69%. Health and functioning gradually improved, but headache, fatigue, forgetfulness, and sleep disturbance were reported by 8%–23% of participants at 1 year after injury. Over 80% of the participants returned to work or school within 3 months after injury; another 5% returned after 1 year, and 11% failed to return to work more than a year after injury. Because this study applied a unique definition of MTBI (i.e., including MHI and not including GCS score, PTA, or LOC), the findings are not comparable to those for patients diagnosed with MTBI today.

Ingebrigtsen and colleagues (1998) studied PCS among 100 adults with MTBI 3 months after injury. The average age in this sample was 30 years; 70% were male. Almost all of the participants (90%) had a GCS score of 15. Duration of PTA less than 15 minutes was reported among 42% of the participants, and 85% reported PTA at less than 5 minutes. The authors examined severity of PCS by using the Rivermead Postconcussion Symptoms Questionnaire. The authors described headaches as the most frequent health symptom, reported by more than 60% of the participants, and 40% met *ICD-10* PCS criteria (i.e., three symptoms or more at 3 months after injury). Poor memory, fatigue, irritability, and dizziness were the next most common symptoms. Even though this study appeared to have an appropriate number of participants, it did not report socioeconomic and family responses that contributed to a holistic recovery, so it is difficult to generalize the findings to other settings. A multidimensional approach to outcome measurement was not used.

Quality of life is a broad concept that has been explored among healthcare disciplines for decades.

In the same year, Deb and colleagues (1998) interviewed 134 MTBI participants with GCS scores of 13–15 who might or might not have had LOC and abnormality in radiographic results. Most of the participants (67%) were male, and more than half (51%) were 18–40 years old. Participants were contacted at 6–12 weeks and interviewed at 1 year after brain injury using the Glasgow Outcome Scale (GOS), the Edinburgh Rehabilitation Status Outcome (ERSS), the National Adult Reading Test, the Barthel Index, the Clinical Interview Schedule Revised, and the Psychosis Screening Questionnaire. The results revealed that 29%–33% of the participants had evidence of moderate to severe disability assessed by the GOS and the ERSS, and 15%–20% of the participants reported at least one behavioral problem lasting longer than 1 year after injury. Even though this study used a holistic approach to evaluate outcomes, only objective data were measured; subjective responses were missing. In addition, inclusion of patients with abnormal CT results may mean that some participants had moderate rather than mild TBI.

Levin and colleagues (2001) compared depression and stress between traumatic brain injury (TBI) and

general trauma patients. In the TBI group, there were 60 adults with MTBI and 9 adults with moderate TBI. MTBI was defined as those with a GCS score of 13–15 with LOC less than 20 minutes and presence of normal radiographic results within 24 hours after brain injury. Since the majority of participants had MTBI (85%) and the measures provided unique and important information about social aspects of recovery as well as the potential influence of alcohol in MTBI adults, the study was included in this review. In this study, participants were interviewed at 3 and 6 months after injury; the average age was 35 years and 71% were male. Face-to-face interviews were used to complete 12 measures: the Structured Clinical Interview for *DSM-IV*, the Center for Epidemiologic Studies Depression Scale (CES-D), the Posttraumatic Stress Disorder (PTSD) Checklist, the Extended Glasgow Outcome Scale (GOSE), the

These findings imply that immediately after MTBI there were adverse mood and social-economic outcomes in this sample compared to the general trauma population.

Community Integration Questionnaire, the 6-trial Verbal Selective Reminding Test, the Rey-Osterrieth Complex Figure, the Symbol Digit Modalities Test, the Paced Auditory Serial Addition Test, the Grooved Pegboard, the Wisconsin Card Sorting Test, and the Social Support Questionnaire. Eighteen percent of participants reported depression, 13% met criteria of PTSD, and 58% encountered moderate disability. Incidence of social support, a measure for the family domain, was not reported, but presence of social support was negatively correlated with stress. As a result of the mixed severity of injury among the participants, the findings for MTBI are somewhat limited. This study also excluded participants with blood alcohol levels higher than 200 mg/dl. Alcohol can be an influential factor in recovery from brain injury (Altura & Altura, 1999; Bazarian, Hartman, & Delahunta, 2000). Failure to include participants with high blood alcohol levels may not capture all outcomes after MTBI.

Among 115 participants with mixed mild ($n = 95$) and moderate ($n = 20$) TBI, McCauley and colleagues (2001) defined those with MTBI as having GCS scores of 13–15 with LOC less than 20 minutes and normal radiographic results. They categorized participants with GCS scores of 13–15 with presence of abnormal radiographic results within 24

hours after brain injury as moderate brain injury. They also included participants with GCS scores of 9–12 in the moderate brain injury group. The majority of participants (83%) fit the typical MTBI determinants. Unlike other studies of MTBI, in this study, most of the participants were women (79%), with a mean age of 33 years. Participants were interviewed at 1 and 3 months after injury with measures that included the GOSE, an evaluation of PCS which included a brief structured interview based on *DSM-IV* criteria, the Visual Analogue Scale for Depression, the CES-D, the Structured Clinical Interview for the *DSM-IV*, the Posttraumatic Stress Checklist–Civilian Form, the 6-item version of the Social Support Questionnaire, the Social Integration Tool, the Paced Auditory Serial Addition Test, the Symbol Digit Modalities Test, the 6-trial version of the Verbal Selective Reminding Test, and the Osterrieth Complex Figure. Three or more post-concussion symptoms were reported by 24% of the participants, while high stress levels were found in 10% of the participants and depression was reported in 17%. The values for social support and social integration measures were not reported. These findings imply that immediately after MTBI there were adverse mood and social-economic outcomes in this sample compared to the general trauma population. Findings from this study were limited by a sample with mixed severity of TBI and exclusion of participants with high blood alcohol level (>200 mg/dl). Persistence of adverse outcomes after 3 months was not examined.

In the same year, Haboubi and colleagues (2001) collected data from 639 participants with MTBI who were 16–65 years old and had GCS scores of 13–15. Participants were interviewed at 2 weeks after brain injury, and a subsample of 179 with PCS were interviewed again at 6 weeks after brain injury. Most of the participants were male (75%) and averaged 33 years of age. Forty-two percent of the participants admitted to alcohol intake within 6 hours prior to brain injury. The majority (70%) experienced LOC for less than 15 minutes, and 65% of participants reported PTA. Responding to a unique PCS checklist, more than half of the participants reported at least one health and functioning symptom 6 weeks after injury. More than half (56%) were unable to return to work at 2 weeks after injury, while 27% were still off work at 6 weeks. Even though this study was conducted with a large number of participants, it did not employ a standard definition of PCS and did not examine all participants at 6 weeks. Six weeks may be too brief a period to uncover clinically important MTBI outcomes.

In 2004, Kashluba and colleagues used the ACRM definition of MTBI in their study. One hundred and ten patients with MTBI were interviewed at 30 and

100 days after brain injury. Participants endorsed the frequency and severity of 43 symptoms included in the Problem Checklist (PCL) after brain injury. Symptoms in the PCL as reported in this study covered health, function, psychological, and socioeconomic concerns. Fatigue (59%) was the most frequently reported symptom, followed by headaches (58%), irritability (56%), distractibility (55%), and anxiety (51%). Headaches were reported as the most severe symptom, followed in order of decreasing severity by fatigue, irritability, sleep disturbance, and forgetfulness. This study used multidimensional measures. However, the unique assessment of PCS makes it difficult to compare findings with other studies. Measures of family function were not included in this study.

Studies Indirectly Addressing Quality of Life

Each of the 35 remaining studies reporting on outcomes after MTBI was reviewed to identify any findings related to at least one domain of QOL: health and functioning, psychological and spiritual, social and economic, or family aspects. These four domains reflect Ferrans and Powers' framework for QOL; they also have been accepted worldwide for many disease-specific populations.

Health and Functioning. The health and functioning domain emphasizes response to needs associated with body systems, including the senses and neurological functions. However, because MTBI patients do not typically have visible oxygenation, nutrition, elimination, or protection deficits, studies related to health and functioning response among MTBI adults emphasize sensory and neurological functions. Thirty-four of the 35 remaining studies included health and functioning responses. In these 34 studies, 80% used a measure of postconcussion symptoms. However, timing and incidence of health and functioning responses among these studies varied. Overall, 29% of the studies reported the incidence of PCS at 3 months or less; 25% reported PCS at 3–12 months; and 32% reported symptoms at more than a year after brain injury. Since the timing of assessment was inconsistent, the range of the incidence of health and functioning derangements was broad, at 10%–80%. All of the health and functioning responses documented in these studies were subjective reports. Some studies used generic measures such as the Mini Mental State Examination (Rapoport, McCullagh, Streiner, & Feinstein, 2003b) and the Sickness Impact Profile (SIP; Levine, Dawson, Boutet, Schwartz, & Stuss, 2000) to capture health and functioning responses. Two studies also used unique physical or physiological markers: the level of S-100B in the blood (Stranjalis et al., 2004) and ventricular size (Bigler & Snyder, 1995). One study did not find a derangement in health and

functioning from baseline at more than 3 months after MTBI (Santa Maria et al., 2001). Another study found that health and functioning responses were at the same level as in normal, noninjured controls, indicating that any derangements were not specific to MTBI (Echemendia et al., 2001).

Psychological and Spiritual. The psychological and spiritual domain focuses on the ability of a person to feel or to experience and to maintain his or her self-organization after MTBI. Concepts such as depression, stress, psychological or spiritual distress, neuropsychological changes, and neurobehavioral changes are reflections of outcomes in this domain.

Among 35 studies that used a QOL domain in measuring outcomes of adults with MTBI, 34 studies (97%) probed for psychological symptoms. Twenty-four of the 34 studies used a tool that measured PCS to report psychological and spiritual responses, and one used the Rivermead Head Injury Follow-up Questionnaire–Psychological Distress (McCullagh, Oucherlony, Protzner, Blair, & Feinstein, 2001). The PCS tools typically included at least one question asking whether an individual felt depressed. Nine studies used generic depression measures, such as the CES-D (Levin et al., 2001), the SIP–Psychological part (Levine et al., 2000), the Clinician Administered Posttraumatic Stress Disorder Scale–Form 2 (Bryant, Moulds, Guthrie, & Nixon, 2003), the Beck Depression Inventory (Bell, Primeau, Sweet, & Lofland, 1999), the Structured Interview for the *DSM-IV* (Rapoport, McCullagh, Streiner, & Feinstein, 2003a), the Minnesota Multiphasic Personality Inventory (Ruttan & Heinrichs, 2003), or other psychological outcomes (Arcia & Gualtieri, 1993; Bigler & Snyder, 1995; Ruffolo et al., 1999). Depressive symptoms have been found to occur in 12% (Levin et al.) to 30% (Alexander, 1995) of participants, with the average score for the CES-D being 22.14, indicating a high level of depression (Levin et al.). The CES-D has more detail for capturing depression, but it was created to screen for depressive symptoms only. Individuals with MTBI who are depressed often report more frequent and more severe PCS symptoms than those who are not depressed (Trahan, Ross, & Trahan, 2001). However, there was also no way of knowing the participants' depression level before their injury.

Social and Economic. The social and economic domain focuses on one's ability to maintain one's role in society and to maintain one's relationships with others. For some people with MTBI, going back to work or school is one of the most difficult things they experience. Short-term memory problems can make it hard to learn new material. Fatigue or other physical symptoms may mean individuals with MTBI have limited energy for work or school. Returning to work or school

assumes that people really want to fit in with their peers (Johnson, 2000). Only seven studies included social and economic outcomes, and all focused on the ability to return to work or school after MTBI (Cicerone et al., 1996; Englander et al., 1992; Kay et al., 1992; McCullagh et al., 2001; Rapoport et al., 2003b; Ruffolo et al., 1999; Stranjalis et al., 2004). The results from these studies are inconsistent. Three studies reported that almost all patients with MTBI (84%–88%) returned to work at 1 week to 3 months after brain injury (Englander et al.; Kay et al.; Stranjalis et al.), while another study concluded that less than half (42%) of MTBI patients returned to work at 6 months after brain injury (Ruffolo et al.). The authors also found that one-third of the people (30%) who returned to work needed to modify their jobs. Likewise, Cicerone and colleagues found that at 1 year after the injury, 40% of MTBI adults with good recovery had to work in a position with less responsibility. In one study, the rate of return to work at 6 months after injury related to the severity of the brain injury (McCullagh & Feinstein, 2003). The authors concluded that the rate of return to work among MTBI adults with GCS scores of 13–14 was lower than the rate among those with GCS scores of 15 (38% versus 60%). Successful return to work was found to have inverse relationship with level of blood S-100B, an investigational marker of neuronal injury (Stranjalis et al.). However, rate of return to work was not correlated with depressive symptoms in one study (Rapoport et al., 2003b).

Family. The family domain involves interaction with others to fulfill a person's affection needs. The responses in this domain are often seen as giving and receiving of love, respect, and value. With the exception of the nine holistic studies, no other study included variables that could be considered family-related outcomes.

Each of the 35 studies included at least one QOL domain. The majority reported disturbances in the health and function or psychological domains; however, none included family response. Most of these studies (74%) were done among the U.S. population, 9% were done in Canada, and 16% were done in Europe (i.e., Italy, the Netherlands, England, Sweden, and Greece). In general, it should be noted that mechanisms of injury and medical treatment vary in different regions of the world, and the importance and satisfaction with the four domains in QOL may vary across cultures.

Identifying Knowledge Gaps

MTBI has been defined various ways. Classification of TBI severity usually depends on depth of coma, LOC, and PTA. Depth of coma has commonly been defined and quantified by the GCS score (Fisher &

Mathieson, 2001; Jennett, 2002). In the 44 studies considered here, 31 defined MTBI by GCS score. Even among studies using GCS scoring, there is some controversy about the cut-point. One group of researchers (De Kruijk et al., 2002) separated participants with GCS scores of 13 from those with GCS scores of 14–15, while another group (Stranjalis et al., 2004) included only participants with GCS scores of 15 in the study. Typically a GCS score of 13–15 defines MTBI clinically, theoretically, and empirically in reported studies.

This review indicates that both LOC and PTA are often determinants for MTBI but are not consistently used. Duration of LOC and PTA may affect outcomes. For example, LOC with PTA and LOC alone have been reported as predictors of PCS (Savola & Hillbom, 2003). However, the duration for LOC or PTA is not well established, and even experts do not have a single recommendation (ACRM, 1993; APA, 1994). The defining features of PTA and LOC in MTBI are less clear in the empirical literature. In these 44 studies related to MTBI, 24 included LOC as a criterion for MTBI. Among those, 18 adopted ACRM's criteria, while only one used the *DSM-IV* cut-point. Two studies used LOC duration for up to 60 minutes, and three studies included participants with any period of LOC. Among the 44 studies, more than half (27 studies, 61%) identified the duration of PTA. Of those 27, 17 studies used ACRM's cut-point; only two adopted the *DSM-IV* criteria. Two studies had more than one category of duration of PTA, and six studies set duration of PTA at less than 60 minutes. Because of the lack of congruence between cut-points for LOC and PTA, the presence of any duration of PTA and LOC may need to be included in future studies. Consistent determinants of MTBI will allow comparison of findings across settings and populations.

Another consideration for research is the timing of data collection. It is recommended that outcomes after MTBI be evaluated 3–12 months after injury (Bullinger & The TBI Consensus Group, 2002). Results from studies in this review suggest that the incidence of symptoms is highest in the first 3 months after injury and that most adverse outcomes disappear after 1 year. However, some patients experience important disturbances in at least one domain as long as 1 year after MTBI. Some experts suggest that symptoms or conditions present 3–12 months after injury should be labeled as "persistent" and symptoms or conditions that are still present after 1 year should be labeled "chronic" (Ruff & Grant, 1999). Evidence exists that both persistent and chronic symptoms occur after MTBI, but factors that influence the occurrence and resolution of these symptoms are not clear. Only three studies in this review studied participants over a 1-year period

(Emanuelson et al., 2003; Kay et al., 1992; Levin et al., 2001). Most studies were cross-sectional and included participants injured less than 6 months earlier. Longitudinal studies may help us better understand the trajectory of recovery and whether interventions besides “tincture of time” can be useful in preventing persistent and chronic symptoms or conditions.

The prevalence and severity of consequences after MTBI remain controversial. Most studies focus on health, functioning, and mood. Often these outcomes are reported as postconcussion symptoms. Findings indicated that PCS followed MTBI in 24 studies. However, seven studies reported that PCS was either not present or not specific to MTBI. Conflicting findings may be the result of varied definitions of PCS or the length of time after injury during which participants were studied. As clearer definitions of PCS evolve in the literature, it will become important to reexamine this phenomenon. Socioeconomic and relational (family) outcomes after MTBI are rarely reported but have great potential to affect recovery and need further investigation.

Subjective and multicomponent concepts are also recommended for future evaluations, especially when evaluating quality of life (Power, Harper, & Bullinger, 1999; WHOQOL Group, 1998). In the only explicit examination of QOL, patients with MTBI reported lower QOL during the year following injury when compared with a normal control population (Emanuelson et al., 2003). Use of multidomain, multidimensional measures and both objective and subjective tools, as suggested by Ferrans and Powers' QOL framework, is one approach to link knowledge across disciplines and cultures regarding the health, function, mood, social, economic, and familial outcomes after MTBI. This framework uses language that is shared among nursing, medicine, social work, psychology, and related practice professions. In addition, it has been widely translated, and related psychometric properties have been tested in many settings (Belec, 1992; Franks, 2004; Lobentanz et al., 2004; May & Warren, 2001; Petchprapai, 1998; Sharp et al., 1999). This framework was useful to us in categorizing and analyzing empirical data reported in a variety of publications for this review.

A final gap in this literature review is also apparent. Cultural influences on determinants and outcomes related to MTBI in adults have not been explored. The data in this review are limited to reports in the English language. Several interesting international abstracts related to outcomes among adults with MTBI were available in the PubMed database; however, the full text was not available in English. International studies may have unique perspectives but were not included in this appraisal. The majority of data about MTBI focuses on the

United States, limiting applicability of findings in countries where the causes of trauma, determinants of TBI severity, and sociocultural outcomes may be different.

Nursing Implications

This review has implications for nursing practice, education, and research. For example, nurses who care for adults with MTBI may want to provide follow-up information regarding their consequences after the injury. A person or department should be available for patients to contact if the symptoms persist for more than 3 months. Educators can include PCS and social or emotional dysfunctions as potential adverse outcomes after MTBI. Researchers will want to apply consistent, thoughtful definitions of MTBI and QOL to provide high-quality findings. Clinicians, educators, and researchers can use this summary to detail the common determinants of MTBI, such as GCS, LOC, and PTA. Because findings related to outcomes after MTBI are sometimes conflicting or have been limited by the design and measures used, nurses should anticipate that patients may not share a “typical” pattern of recovery. For example, some patients may need medical intervention for headaches, others may need social interventions for revised work tasks, and still others may need no interventions. Philosophically, the nurse must assess all aspects of recovery. The health and functioning, psychological and spiritual, socio-economic, and family domains must all be considered to promote a return to health and function with an acceptable quality of life as defined by the patient.

Case Study

JD was a 29-year-old right-handed male who sustained an MTBI in a car accident. He lost consciousness for an undetermined period of time and could not recall anything after the accident. He was in the intensive care unit for 3 days and in the acute care unit for 4 more days. His initial GCS score was 13; it was 15 at 6 hours after the injury. His CT scan was negative. JD reported that he could remember that he was in the hospital after the accident. However, his relatives noticed that he could not remember who came to visit him after they left for a few hours. After discharge, JD was told his symptoms would be better after 1 year and no further intervention was needed for full recovery.

Health and Functioning

At discharge, JD complained that his right toe was numb. He demanded to see a chiropractor and a traditional Thai massage therapist. He complained that he could not remember anything from his

graduate coursework from the previous 5 years. The last academic memory that he could recall was what he had learned in his undergraduate studies. After 4 months, he had no change and began to reread the textbooks from his recent courses.

Psychological and Spiritual

JD reported feeling dependent and anxious for months after his injury, relying on family members to help with household tasks, such as shopping and laundry. His anxiety concerned memory loss and his ability to continue working and to complete his master's degree while feeling that he was not able to remember and process information quickly and clearly. He was not evaluated for depression.

Socioeconomic

Prior to his injury, JD was a full-time police officer and a part-time student in a master's degree program. After the injury, he used sick leave for 1 month. Although he subsequently returned to work, he reported that he could only sit in his office at first, unable to complete even simple paperwork for almost 3 months; he then modified his job to a lower level. Four months after his injury, JD returned to school, relying on assistance from his classmates and instructors.

Family

JD reported physical and emotional support from his family, friends, coworkers, classmates, and instructors. However, he broke up with his girlfriend of 1 year (a mutual decision) because "too many things had changed."

Even though JD was diagnosed with "only" mild TBI and had no visible disability, he was unable to return to his normal life after the injury. He needed to modify his job and his approach to learning in graduate school. He had to relearn all academic material from the previous 5 years. One year after the injury, JD continued his job in the same position and graduated with his master's degree. However, both JD and his family indicated he had a different personality after the injury. For example, he took longer to make decisions and was more irritable. One year after his injury, he appeared recovered but reported feeling frustrated that his hospital and healthcare providers did not assist or inform him during his struggles with memory impairment or mood changes.

Summary

Research about adults with MTBI and their outcomes has resulted in a wide range of findings regarding the type and incidence of derangements in health and functioning after injury. Conflicting

findings may be the result of different time points for data collection, small sample sizes, and inclusion of patients with different severities of brain injury in the sample. Research among adults with MTBI has not consistently used the same determinants of MTBI, so findings are difficult to compare across studies. As a practice discipline, the goal of nursing is to promote well-being. Few studies about adults with MTBI reflect the holistic perspective of nursing. Consequences of MTBI for at least some patients are clinically important. Further research into MTBI using clear determinants and a holistic approach to examining recovery is warranted.

References

- Alexander, M. P. (1992). Neuropsychiatric correlates of persistent postconcussive syndrome. *Journal of Head Trauma Rehabilitation*, 7(2), 60-69.
- Alexander, M. P. (1995). Mild traumatic brain injury: Pathophysiology, natural history, and clinical management. *Neurology*, 45(7), 1253-1260.
- Altura, B. M., & Altura, B. T. (1999). Association of alcohol in brain injury, headaches, and stroke with brain-tissue and serum levels of ionized magnesium: A review of recent findings and mechanisms of action. *Alcohol*, 19(2), 119-130.
- Alves, W. M., Macciocchi, S. N., & Barth, J. T. (1993). Postconcussive symptoms after uncomplicated mild head injury. *Journal of Head Trauma Rehabilitation*, 8(3), 48-59.
- American Academy of Neurology (Quality Standards Subcommittee). (1997). Practice parameter: The management of concussion in sports [Summary statement]. Retrieved June 29, 2006, from http://aan.com/professionals/practice/pdfs/pdf_1995_thru_1998/1997.48.581.pdf.
- American Congress of Rehabilitation Medicine. (1993). Definition of mild traumatic brain injury. *Journal of Head Trauma Rehabilitation*, 8(3), 86-87.
- American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.
- Andersson, E. H., Bjorklund, R., Emanuelson, I., & Stalhammar, D. (2003). Epidemiology of traumatic brain injury: A population based study in western Sweden. *Acta Neurologica Scandinavica*, 107(4), 256-259.
- Arcia, E., & Gualtieri, C. T. (1993). Association between patient report of symptoms after mild head injury and neurobehavioral performance. *Brain Injury*, 7(6), 481-489.
- Bazarian, J., Hartman, M., & Delahunta, E. (2000). Minor head injury: Predicting follow-up after discharge from the emergency department. *Brain Injury*, 14(3), 285-294.
- Belec, R. H. (1992). Quality of life: Perceptions of long-term survivors of bone marrow transplantation. *Oncology Nursing Forum*, 19(1), 31-37.
- Bell, B. D., Primeau, M., Sweet, J. J., & Lofland, K. R. (1999). Neuropsychological functioning in migraine headache, nonheadache chronic pain, and mild traumatic brain injury patients. *Archives of Clinical Neuropsychology*, 14(4), 389-399.
- Bigler, E. D., & Snyder, J. L. (1995). Neuropsychological outcome and quantitative neuroimaging in mild head injury. *Archives of Clinical Neuropsychology*, 10(2), 159-174.
- Boake, C., McCauley, S. R., Levin, H. S., Contant, C. F., Song, J. X., Brown, S. A., et al. (2004). Limited agreement between criteria-based diagnoses of postconcussional syndrome. *Journal of Neuropsychiatry and Clinical Neurosciences*, 16(4), 493-499.
- Bohnen, N. I., Jolles, J., Twijnstra, A., Mellink, R., & Wijnen, G. (1995). Late neurobehavioural symptoms after mild head injury. *Brain Injury*, 9(1), 27-33.
- Bolse, K., Flemme, I., Ivarsson, A., Jinhage, B. M., Carroll, D., Edvardsson, N., et al. (2002). Life situation related to the ICD implantation: Self-reported uncertainty and satisfaction in Swedish and US samples. *European Journal of Cardiovascular Nursing*, 1(4), 243-251.

- Bowling, A. (2005). *Measuring health: A review of quality of life measurement scales* (3rd ed.). Buckingham, England: Open University Press.
- Bryant, R. A., Moulds, M., Guthrie, R., & Nixon, R. D. (2003). Treating acute stress disorder following mild traumatic brain injury. *American Journal of Psychiatry*, *160*(3), 585–587.
- Bullinger, M., & The TBI Consensus Group. (2002). Quality of life in patients with traumatic brain injury—Basic issues, assessment and recommendations. *Restorative Neurology and Neuroscience*, *20*, 111–124.
- Centers for Disease Control and Prevention. (2004). Traumatic brain injury facts. Retrieved August 8, 2007, from www.cdc.gov/ncipc/factsheets/tbi.htm.
- Chamelian, L., & Feinstein, A. (2004). Outcome after mild to moderate traumatic brain injury: The role of dizziness. *Archives of Physical Medicine and Rehabilitation*, *85*(10), 1662–1666.
- Chan, R. C. (2001). Base rate of post-concussion symptoms among normal people and its neuropsychological correlates. *Clinical Rehabilitation*, *15*(3), 266–273.
- Cicerone, K. D., & Azulay, J. (2002). Diagnostic utility of attention measures in postconcussion syndrome. *Clinical Neuropsychology*, *16*(3), 280–289.
- Cicerone, K. D., Smith, L. C., Ellmo, W., Mangel, H. R., Nelson, P., Chase, R. F., et al. (1996). Neuropsychological rehabilitation of mild traumatic brain injury. *Brain Injury*, *10*(4), 277–286.
- De Kruijk, J. R., Leffers, P., Menheere, P. P., Meerhoff, S., Rutten, J., & Twijnstra, A. (2002). Prediction of post-traumatic complaints after mild traumatic brain injury: Early symptoms and biochemical markers. *Journal of Neurology, Neurosurgery, and Psychiatry*, *73*(6), 727–732.
- Deb, S., Lyons, L., & Koutzoukis, C. (1998). Neuropsychiatric sequelae one year after a minor head injury. *Journal of Neurology, Neurosurgery, and Psychiatry*, *65*(6), 899–902.
- Echemendia, R. J., Putukian, M., Mackin, R. S., Julian, L., & Shoss, N. (2001). Neuropsychological test performance prior to and following sports-related mild traumatic brain injury. *Clinical Journal of Sport Medicine*, *11*(1), 23–31.
- Emanuelson, I., Andersson H. E., Bjorklund, R., & Stalhammar, D. (2003). Quality of life and post-concussion symptoms in adults after mild traumatic brain injury: A population-based study in western Sweden. *Acta Neurologica Scandinavica*, *108*, 332–338.
- Englander, J., Hall, K., Stimpson, T., & Chaffin, S. (1992). Mild traumatic brain injury in an insured population: Subjective complaints and return to employment. *Brain Injury*, *6*(2), 161–166.
- Evered, L., Ruff, R., Baldo, J., & Isomura, A. (2003). Emotional risk factors and postconcussional disorder. *Assessment*, *10*(4), 420–427.
- Ferrans, C. E. (1990a). Development of a quality of life index for patients with cancer. *Oncology Nursing Forum*, *17*(Suppl. 3), 15–19; discussion 20–11.
- Ferrans, C. E. (1990b). Quality of life: Conceptual issues. *Seminars in Oncology Nursing*, *6*(4), 248–254.
- Ferrans, C. E. (1996). Development of a conceptual model of quality of life. *Scholarly Inquiry for Nursing Practice: An International Journal*, *10*(3), 293–304.
- Ferrans, C. E. (1997). Development of a conceptual model of quality of life. In A. G. Gift (Ed.), *Clarifying concepts in nursing research* (pp. 110–122). New York: Springer.
- Ferrans, C. E., & Powers, M. J. (1985). Quality of life index: Development and psychometric properties. *Advances in Nursing Science*, *8*(1), 15–24.
- Ferrans, C. E., & Powers, M. J. (1992). Psychometric assessment of the Quality of Life Index. *Research in Nursing & Health*, *15*(1), 29–38.
- Fisher, J., & Mathieson, C. (2001). The history of the Glasgow Coma Scale: Implications for practice. *Critical Care Nursing Quarterly*, *23*(4), 52–58.
- Franks, J. S. (2004). Comparing perceived quality of life in nursing homes and assisted living facilities. *Journal of Gerontological Social Work*, *42*(1), 119–130.
- Gasquoin, P. G. (1997). Postconcussion symptoms. *Neuropsychology Review*, *7*(2), 77–85.
- Gasquoin, P. G. (1998). Historical perspective on postconcussion symptoms. *The Clinical Neuropsychologist*, *12*(3), 315–324.
- Haboubi, N. H., Long, J., Koshy, M., & Ward, A. B. (2001). Short-term sequelae of minor head injury (6 years experience of minor head injury clinic). *Disability and Rehabilitation*, *23*(14), 635–638.
- Huang, S. M., Lee, C. H., Chien, L. Y., Liu, H. E., & Tai, C. J. (2004). Postoperative quality of life among patients with thyroid cancer. *Journal of Advanced Nursing*, *47*(5), 492–499.
- Ingebrigtsen, T., Waterloo, K., Marup-Jensen, S., Attner, E., & Romner, B. (1998). Quantification of post-concussion symptoms 3 months after minor head injury in 100 consecutive patients. *Journal of Neurology*, *245*(9), 609–612.
- Iverson, G. L., Lovell, M. R., & Smith, S. S. (2000). Does brief loss of consciousness affect cognitive functioning after mild head injury? *Archives of Clinical Neuropsychology*, *15*(7), 643–648.
- Jacobson, R. R. (1995). The post-concussional syndrome: Physiogenesis, psychogenesis and malingering. An integrative model. *Journal of Psychosomatic Research*, *39*(6), 675–693.
- Jennett, B. (2002). The Glasgow Coma Scale: History and current practice. *Trauma*, *4*, 91–103.
- Johnson, G. (2000). Traumatic brain injury survival guide. Retrieved May 5, 2005, from www.tbiguide.com.
- Kashluba, S., Paniak, C., Blake, T., Reynolds, S., Toller-Lobe, G., & Nagy, J. (2004). A longitudinal, controlled study of patient complaints following treated mild traumatic brain injury. *Archives of Clinical Neuropsychology*, *19*(6), 805–816.
- Kay, T., Newman, B., Cavallo, M., Ezrachi, O., & Resnick, M. (1992). Toward a neuropsychological model of functional disability after mild traumatic brain injury. *Neuropsychology*, *6*(4), 371–384.
- Kibby, M. Y., & Long, C. J. (1996). Minor head injury: Attempts at clarifying the confusion. *Brain Injury*, *10*(3), 159–186.
- King, N. S., Crawford, S., Wenden, F. J., Caldwell, F. E., & Wade, D. T. (1999). Early prediction of persisting post-concussion symptoms following mild and moderate head injuries. *British Journal of Clinical Psychology*, *38* (Pt 1), 15–25.
- Lees-Haley, P. R., Fox, D. D., & Courtney, J. C. (2001). A comparison of complaints by mild brain injury claimants and other claimants describing subjective experiences immediately following their injury. *Archives of Clinical Neuropsychology*, *16*(7), 689–695.
- Levin, H. S., Brown, S. A., Song, J. X., McCauley, S. R., Boake, C., Contant, C. F., et al. (2001). Depression and posttraumatic stress disorder at three months after mild to moderate traumatic brain injury. *Journal of Clinical and Experimental Neuropsychology*, *23*(6), 754–769.
- Levine, B., Dawson, D., Boutet, I., Schwartz, M. L., & Stuss, D. T. (2000). Assessment of strategic self-regulation in traumatic brain injury: Its relationship to injury severity and psychosocial outcome. *Neuropsychology*, *14*(4), 491–500.
- Lobentanz, I. S., Asenbaum, S., Vass, K., Sauter, C., Klosch, G., Kollegger, H., et al. (2004). Factors influencing quality of life in multiple sclerosis patients: Disability, depressive mood, fatigue and sleep quality. *Acta Neurologica Scandinavica*, *110*(1), 6–13.
- Maccocchi, S. N., Barth, J. T., & Littlefield, L. M. (1998). Outcome after mild head injury. *Clinics in Sports Medicine*, *17*(1), 27–36.
- Machulda, M. M., Bergquist, T. F., Ito, V., & Chew, S. (1998). Relationship between stress, coping, and postconcussion symptoms in a healthy adult population. *Archives of Clinical Neuropsychology*, *13*(5), 415–424.
- Marra, C. A., Woolcott, J. C., Kopec, J. A., Shojania, K., Offer, R., Brazier, J. E., et al. (2005). A comparison of generic, indirect utility measures (the HUI2, HUI3, SF-6D, and the EQ-5D) and disease-specific instruments (the RAQoL and the HAQ) in rheumatoid arthritis. *Social Science & Medicine*, *60*(7), 1571–1582.
- May, L. A., & Warren, S. (2001). Measuring quality of life of persons with spinal cord injury: Substantive and structural validation. *Quality of Life Research*, *10*(6), 503–515.
- McCauley, S. R., Boake, C., Levin, H. S., Contant, C. F., & Song, J. X. (2001). Postconcussional disorder following mild to moderate traumatic brain injury: Anxiety, depression, and social support as risk factors and comorbidities. *Journal of Clinical and Experimental Neuropsychology*, *23*(6), 792–808.
- McCullagh, S., & Feinstein, A. (2003). Outcome after mild traumatic brain injury: An examination of recruitment bias. *Journal of Neurology, Neurosurgery, and Psychiatry*, *74*(1), 39–43.
- McCullagh, S., Oucherlony, D., Protzner, A., Blair, N., & Feinstein, A. (2001). Prediction of neuropsychiatric outcome following mild trauma brain injury: An examination of the Glasgow Coma Scale. *Brain Injury*, *15*(6), 489–497.
- McHugh, T. S. (2002). Natural history of cognitive, affective, and physical symptoms of postconcussion syndrome following mild traumatic brain injury. *Masters Abstracts International*, *42*(02), 687. (UMI No. MQ82543)

- Meeberg, G. A. (1993). Quality of life: A concept analysis. *Journal of Advanced Nursing*, 18(1), 32–38.
- Mittenberg, W., Canary, E. M., Condit, D., & Patton, C. (2001). Treatment of post-concussion syndrome following mild head injury. *Journal of Clinical and Experimental Neuropsychology*, 23(6), 829–836.
- National Center for Injury Prevention and Control. (2003). Report to Congress on mild traumatic brain injury in the United States: Steps to prevent a serious public health problem. Retrieved July 12, 2007, from www.cdc.gov/ncipc/tbi/mtbi/mtbireport.pdf.
- Nguyen, B. N., & Yablon, S. A. (2002). Mild traumatic brain injury and postconcussion syndrome. In G. A. Malanga & S. F. Nadler (Eds.), *Whiplash* (pp. 199–218). Philadelphia: Hanley & Belfus.
- Parkinson, D. (2000). Concussion confusion. *Critical Reviews in Neurosurgery*, 9, 335–339.
- Petchprapai, N. (1998). *Factors effecting on quality of life of valvular heart disease patients*. Unpublished master's thesis, Khon Kaen University, Khon Kaen, Thailand.
- Ponsford, J., Willmott, C., Rothwell, A., Cameron, P., Kelly, A. M., Nelms, R., et al. (2000). Factors influencing outcome following mild traumatic brain injury in adults. *Journal of International Neuropsychological Society*, 6(5), 568–579.
- Power, M., Harper, A., & Bullinger, M. (1999). The World Health Organization WHOQOL-100: Tests of the universality of quality of life in 15 different cultural groups worldwide. *Health Psychology*, 18(5), 495–505.
- Rapoport, M. J., McCullagh, S., Streiner, D., & Feinstein, A. (2003a). Age and major depression after mild traumatic brain injury. *American Journal of Geriatric Psychiatry*, 11(3), 365–369.
- Rapoport, M. J., McCullagh, S., Streiner, D., & Feinstein, A. (2003b). The clinical significance of major depression following mild traumatic brain injury. *Psychosomatics*, 44(1), 31–37.
- Rees, P. M. (2003). Contemporary issues in mild traumatic brain injury. *Archives of Physical Medicine and Rehabilitation*, 84(12), 1885–1894.
- Rowley, G., & Fielding, K. (1991). Reliability and accuracy of the Glasgow Coma Scale with experienced and inexperienced nurses. *Lancet*, 337, 537–538.
- Roy, C. (1997). Future of the Roy model: Challenge to redefine adaptation. *Nursing Science Quarterly*, 10(1), 42–48.
- Roy, C. (2005, April). *The Roy Adaptation Model: Application of theory to evidence-based practice in nursing*, Lecture presented at University of Akron College of Nursing, Akron, OH.
- Ruff, R. M., & Grant, I. (1999). Postconcussional disorder: Background to DSM-IV and future considerations. In N. R. Varney & R. J. Roberts (Eds.), *The evaluation and treatment of mild traumatic brain injury* (pp. 315–325). Mahwah, NJ: Lawrence Erlbaum Associates.
- Ruff, R. M., & Jurica, P. (1999). In search of a unified definition for mild traumatic brain injury. *Brain Injury*, 13(12), 943–952.
- Ruffolo, C. F., Friedland, J. F., Dawson, D. R., Colantonio, A., & Lindsay, P. H. (1999). Mild traumatic brain injury from motor vehicle accidents: Factors associated with return to work. *Archives of Physical Medicine and Rehabilitation*, 80(4), 392–398.
- Ruttan, L. A., & Heinrichs, R. W. (2003). Depression and neurocognitive functioning in mild traumatic brain injury patients referred for assessment. *Journal of Clinical and Experimental Neuropsychology*, 25(3), 407–419.
- Santa Maria, M. P., Pinkston, J. B., Miller, S. R., & Gouvier, W. D. (2001). Stability of postconcussion symptomatology differs between high and low responders and by gender but not by mild head injury status. *Archives of Clinical Neuropsychology*, 16(2), 133–140.
- Satz, P. S., Alfano, M. S., Light, R. F., Morgenstern, H. F., Zaucha, K. F., Asarnow, R. F., et al. (1999). Persistent post-concussive syndrome: A proposed methodology and literature review to determine the effects, if any, of mild head and other bodily injury. *Journal of Clinical and Experimental Neuropsychology*, 21(5), 620–628.
- Savola, O., & Hillbom, M. (2003). Early predictors of post-concussion symptoms in patients with mild head injury. *European Journal of Neurology*, 10(2), 175–181.
- Sharp, L. K., Knight, S. J., Nadler, R., Albers, M., Moran, E., Kuzel, T., et al. (1999). Quality of life in low-income patients with metastatic prostate cancer: Divergent and convergent validity of three instruments. *Quality of Life Research*, 8(5), 461–470.
- Shaw, N. A. (2002). The neurophysiology of concussion. *Progress in Neurobiology*, 67(4), 281–344.
- Smith-Seemiller, L., Fow, N. R., Kant, R., & Franzen, M. D. (2003). Presence of post-concussion syndrome symptoms in patients with chronic pain vs. mild traumatic brain injury. *Brain Injury*, 17(3), 199–206.
- Sparrow, B. J. (2002). Coping resources and the development of persistent postconcussional syndrome after a mild traumatic brain injury. *Dissertation Abstracts International*, 64(09), 4669. (UMI No. 3106598)
- Stewart, A. L., & King, A. C. (1994). Conceptualizing and measuring quality of life in older populations. In R. P. Abeles, H. C. Gift, & M. G. Ory (Eds.), *Aging and quality of life* (pp. 27–54). New York: Springer.
- Stranjalis, G., Korfiatis, S., Papapetrou, C., Kouyialis, A., Boviatisis, E., Psachoulia, C., et al. (2004). Elevated serum S-100B protein as a predictor of failure to short-term return to work or activities after mild head injury. *Journal of Neurotrauma*, 21(8), 1070–1075.
- Suhr, J. A., & Gunstad, J. (2002). Postconcussive symptom report: The relative influence of head injury and depression. *Journal of Clinical and Experimental Neuropsychology*, 24(8), 981–993.
- Sullivan, M., Karlsson, J., & Ware, J. E., Jr. (1995). The Swedish SF-36 Health Survey–I. Evaluation of data quality, scaling assumptions, reliability and construct validity across general populations in Sweden. *Social Science Medicine*, 41(10), 1349–1358.
- Swann, I. J., & Teasdale, G. M. (1999). Current concepts in the management of patients with so-called 'minor' or 'mild' head injury. *Trauma*, 1, 143–155.
- Terrell, T. R. (2004). Concussion in athletes. *Southern Medical Journal*, 97(9), 837–842.
- Trahan, D. E., Ross, C. E., & Trahan, S. L. (2001). Relationships among postconcussional-type symptoms, depression, and anxiety in neurologically normal young adults and victims of mild brain injury. *Archives of Clinical Neuropsychology*, 16(5), 435–445.
- van der Naalt, J., van Zomeren, A. H., Sluiter, W. J., & Minderhoud, J. M. (1999). One year outcome in mild to moderate head injury: The predictive value of acute injury characteristics related to complaints and return to work. *Journal of Neurology, Neurosurgery & Psychiatry*, 66(2), 207–213.
- Ware, J. E., Jr., Kemp, J. P., Buchner, D. A., Singer, A. E., Nolop, K. B., & Goss, T. F. (1998). The responsiveness of disease-specific and generic health measures to changes in the severity of asthma among adults. *Quality of Life Research*, 7(3), 235–244.
- World Health Organization. (1992). *International statistical classification of diseases and related health problems* (10th ed.). Geneva: Author.
- WHOQOL Group. (1998). The World Health Organization Quality of Life Assessment (WHOQOL): Development and general psychometric properties. *Social Science Medicine*, 46, 1569–1585.

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