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SPECIAL REPORT

SUMMARY OF THE WHO COLLABORATING CENTRE FOR NEUROTRAUMA TASK FORCE ON MILD TRAUMATIC BRAIN INJURY

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This report aims to summarize the key findings of a recent, systematic review of the literature performed by the WHO Collaborating Centre for Neurotrauma Task Force on Mild Traumatic Brain Injury published in a supplement of the *Journal of Rehabilitation Medicine* (1). The Task Force performed a comprehensive search and critical review of the literature published between 1980 and 2002 to assemble the best evidence on the epidemiology, diagnosis, prognosis and treatment of MTBI. The Task Force identified 38,806 citations and 743 relevant studies, of which 313 (42%) were accepted on scientific merit and formed the basis of the best evidence synthesis.

Key words: Mild Traumatic Brain Injury, MTBI, brain concussion, systematic review.

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INTRODUCTION

In order to control the public health problem of mild traumatic brain injuries (MTBI) and aid those clinicians treating this disorder, there is a need to identify the best scientific evidence in support of prevention, diagnosis, prognosis and treatment. Also there is a need to identify the best scientific evidence to identify gaps in knowledge and to build on that scientific base. Therefore, the World Health Organization's Collaborating Center at Karolinska Institute in Sweden initiated the WHO Collaborating Centre for Neurotrauma Task Force on Mild Traumatic Brain Injury to address these issues.

During the years 1998–2003 the Task Force conducted a rigorous evaluation and appraisal of the literature on MTBI. The Task Force Report was published in a supplement of the *Journal of Rehabilitation Medicine* in February 2004 (1–8) and presents a baseline of the relevant and scientifically admissible evidence on this topic. It provides a basis for the understanding of what could and should be done now and in the future to address the human, social and economic ramifications of this health problem. The aim of this summary is to highlight the key points of the full report.

SEARCH STRATEGIES AND CRITICAL REVIEW

The Task Force performed a comprehensive search and critical review of the literature published between 1980 and 2002 to assemble the best evidence on the epidemiology, diagnosis, prognosis and treatment of MTBI. The primary sources of literature were Medline, Cinahl, PsycINFO and Embase. Citations were screened for relevance to MTBI, using *a priori* criteria, and relevant studies were critically reviewed for scientific merit and clinical relevance. The Task Force identified 38,806 citations, of which 671 studies were relevant to the mandate of the Task Force. These, plus 70 studies found by hand-searching reference lists and 2 original research reports performed as part of the Task Force mandate were subjected to critical review to identify fatal biases. After critical review, 313 (42%) were accepted on scientific merit (Fig. 1). Ninety percent of the literature on MTBI was found in Medline, another 5% was found in PsycINFO, with the remainder in Embase and Cinahl.

INCIDENCE, RISK AND PREVENTION

The Task Force critically reviewed 169 studies on incidence, risk and prevention, and accepted 121 (72%). The studies show that 70–90% of all treated brain injuries are mild, and the incidence of hospital-treated MTBI is about 100–300/100,000 population. Population-based surveys of self-reported head injury yield much higher rates, and the Task Force estimated the true MTBI rate to be above 600/100,000. MTBI is more common in males, in teenagers and in young adults. Falls are the most common cause in Sweden and in Denmark. Motor-vehicle collisions are the most common cause in New South Wales, Australia and in France. Strong evidence supports helmet use to prevent MTBI in motorcyclists and bicyclists.

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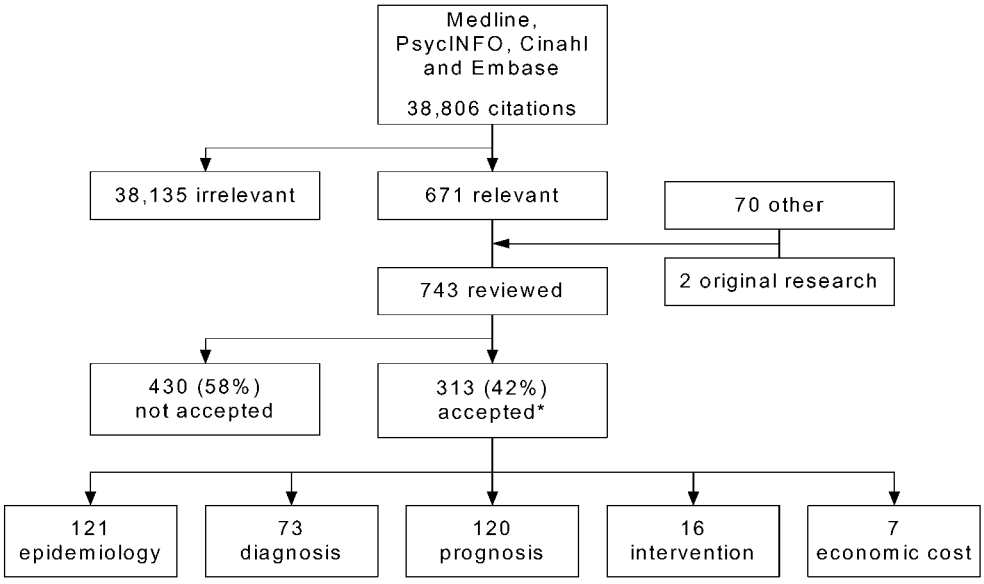

Fig. 1. Results of the literature search and critical review. Figure taken from ref. 1.

The admissible studies about risk of MTBI in sports were mainly related to rugby, fighting sports, American football and ice hockey. It is difficult to compare the incidence estimates from these studies because they depend on the level of competition, setting (practice vs game, or amateur vs professional), gender, age and other factors.

The Task Force also accepted 1 study on the incidence and risk of second impact syndrome (SIS) during sports. This suggests that the validity of SIS has not been established, and that the incidence of diffuse cerebral swelling and catastrophic deterioration after MTBI is not known. The Task Force recommend surveillance to document deaths after MTBI or concussion.

The Task Force found evidence that MTBI is an important public health problem, but also that more high quality research is needed to precisely document the incidence of MTBI and further delineate risk factors.

DIAGNOSTIC PROCEDURES

The Task Force critically reviewed 228 diagnostic studies and accepted 73 (32%). The estimated prevalence of intracranial computerized tomography (CT) scan abnormalities is 5% in accepted studies of patients presenting to hospitals with a Glasgow Coma Scale (GCS) score of 15 and 30% or higher in patients presenting with a score of 13. About 1% of all hospital-treated patients with MTBI required neurosurgical intervention in these studies. There is strong evidence that clinical factors (Fig. 2) can be used to predict CT scan abnormalities and the need for intervention in adults, but such evidence is lacking for MTBI in children.

Evidence was also found that skull fracture is a risk factor for intracranial lesions, but the diagnostic accuracy of skull fracture on radiological examination as an indicator for intracranial lesion is poor mainly due to very low sensitivity. There was only weak evidence for the diagnostic validity of cognitive testing and other diagnostic tools for MTBI, e.g. biochemical markers such as serum protein S100.

NON-SURGICAL INTERVENTION AND ECONOMIC COSTS

The Task Force reviewed 45 articles on intervention and accepted 16 (36%). With respect to economic costs, 16 articles were reviewed and 7 of these were accepted (44%). There were some, small, controlled trials yielding evidence that early educational information can reduce long-term complaints and that this early intervention need not be intensive. Most cost studies were performed more than 1 decade ago and some of these findings may therefore be outdated. Indirect costs are probably higher than direct costs. Studies comparing costs for routine hospitalization with observation vs the use of CT scan examination for selective hospital admission indicate that the latter policy reduces costs, but comparable clinical outcomes for these policies have not been demonstrated. The sparse scientific literature in these areas reflects both conceptual confusion and limited knowledge of the natural history of MTBI. The complexity of both the causes and the character of persisting symptoms and disability after MTBI offer significant challenges with regard to designing intervention studies and what outcomes to assess.

PROGNOSIS

Of 428 studies related to prognosis after MTBI, 120 (28%) were accepted after critical review. These studies contained consistent

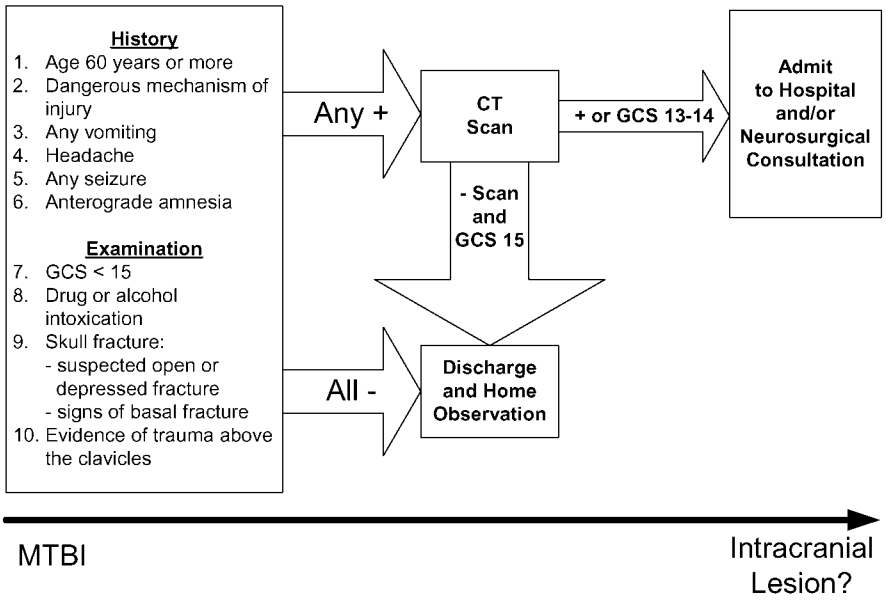

Fig. 2. Evidence-based approach to the acute diagnostic management of mild traumatic brain injury (MTBI) in adults. Figure taken from ref. 3. CT: Computerized Tomography; GCS: Glasgow Coma Scale.

and methodologically sound evidence that children's prognosis after MTBI is good, with resolution of MTBI-specific symptoms within 2 or 3 months after MTBI and little evidence of residual cognitive, behavioural or academic deficits. A number of studies point out the similarities between children sustaining a MTBI and those sustaining other kinds of injuries, suggesting that where deficits are observed, it is likely due to pre-morbid characteristics and/or the experience and aftermath of sustaining any injury.

Some of the same symptoms have been noted in both adults and children, such as headache, dizziness and fatigue. These appear to resolve quite rapidly in children. For adults, cognitive deficits and symptoms are common in the acute stage, and the majority of studies report recovery for most within 3–12 months. Where symptoms persist, compensation/litigation was identified as a factor, but there is little consistent evidence for other predictors.

In the literature on prognosis there is variability in how adequately selection and information bias are controlled and whether confounding is considered. Causal inferences are often mistakenly drawn from cross-sectional studies. In general, the studies examining prognosis of MTBI in adults make less use of control groups than the studies of MTBI in children. Where controls are used, they are usually uninjured controls, often volunteers, who may be matched on sociodemographic factors, but may be dissimilar on pre-injury symptoms or personality characteristics. Injured controls are rarely used, and the possible contributions of psychological distress or pain associated with other (non-brain) injuries have not been adequately considered. Many measures of post-concussion symptoms ask subjects to identify symptoms that are either new or more intense since the injury, and thus may be seriously affected by failures of recall and/or reporting bias. This is especially true when subjects are asked weeks, months or even years after the injury to recall pre-injury symptoms, injury-related events or acute post-injury symptoms.

The best evidence consistently suggests there are no objectively measured cognitive deficits attributable to MTBI beyond 1–3 months' post-injury in the majority of cases. Self-reported symptoms are common after MTBI; however there is little consistency in findings about how long such symptoms persist. On the other hand, symptoms usually resolve rapidly in athletes after a sports concussion, although it could be argued that athletes may under-report symptoms in order to resume play. With respect to other populations, the stronger studies of MTBI that use appropriate control groups and consider the effects of other non-MTBI factors generally show resolution of symptoms within weeks or a few months. There is also evidence that some of the observed long-standing post-concussion symptoms may be attributable to factors other than the MTBI. However, there is a great need for well-designed, prospective, confirmatory studies in this area.

No study reported that severity of the MTBI was an independent predictor of persistent post-concussion symptoms. However, those sustaining more serious MTBI (e.g. GCS 13 or 14, focal brain lesions, depressed skull fractures) appear to have increased rates of disability, as assessed by the Glasgow Outcome Scale or awarding of disability pensions. Most studies examining this issue, however, do not distinguish MTBI-related disabilities from those associated with injuries to other parts of the body. Thus, the independent role of severity of MTBI in long-term disability cannot be confirmed.

The best evidence suggests that MTBI increases the risk of seizures during the first 4 years post-injury, although the absolute risk is still low; but there is little or no increased risk

of brain tumours following MTBI. No conclusions could be reached on the role of MTBI as a risk factor for dementia.

There is an ongoing debate as to whether or not whiplash injuries to the head and neck can commonly result in MTBI, and the Task Force reviewed the available evidence. This evidence shows that mild cognitive complaints do occur after whiplash, but are not specific to MTBI, and are not likely due to a brain injury *per se*. These same cognitive complaints are also reported in patients with chronic pain, depression, anxiety, post-traumatic stress disorder, chronic fatigue syndrome, malingering and in patients involved in non-personal injury litigation.

GUIDELINES ON MTBI

The purpose of guidelines is to reduce practice variability, but they need to be evidence-based. The Task Force examined current MTBI guidelines, critiqued their basis in evidence and examined their variability in recommendations. In all, 41 guidelines were found. There were 18 sports-related guidelines, 13 related to hospital admission policies, 12 to diagnostic imaging and 5 to neuropsychological assessment. Some guidelines addressed several areas. Only 5 guidelines reported a methodology for the assembly of evidence used to develop the guideline. After appraising the guidelines against a validated index, we found that only 3 of the 41 guidelines could be categorized as evidence-based. Two of these focused on paediatric patients and 1 on adult patients. The limited methodological quality in the current guidelines results in conflicting recommendations amongst them.

FUTURE RESEARCH

Of 743 relevant studies, 313 were accepted on scientific merit and comprise the best-evidence synthesis. The current literature on MTBI is of varying quality and in the supplement the most common methodological flaws are reported, e.g. the use of cross-sectional designs to assess recovery or the use of sub-optimal reference groups to identify MTBI specific sequelae. Recommendations are also given for avoiding the shortcomings evident in much of the current literature and identify topic areas in urgent need of further research. There are some important gaps in the literature concerning the risk of MTBI in certain sports, such as professional football (American), hockey and boxing. There is also a need for large, well-designed studies to support evidence-based guidelines for emergency room triage of children with MTBI and to more fully explore the issue of course of recovery and factors associated with poor outcome after MTBI in both adults and children. We also recommend that intervention trials give more consideration to the optimal target population and timing of an intervention. This necessitates consideration of the findings of studies on prognosis after MTBI in order to identify those at risk of difficulties for recovery and what factors to target for intervention. Studies targeting interventions with those most likely to benefit from such intervention are more efficient. Identification of factors associated with poor prognosis, especially when those factors are modifiable, provide a useful target for an intervention study. Some of these factors may be unrelated to the MTBI itself, such as somatic pain from associated injuries, or depression and other emotional reactions to the injury.

One major issue is the wide range of conditions considered to comprise MTBI and the heterogeneity in case definitions of MTBI. In a number of studies, the relevant injuries were described only as concussion, with no further definition. In sports studies, MTBI was frequently described as a head blow causing cessation of play, missed games or requiring assessment and treatment. Other studies provided specific information on a wide spectrum of brain injury severity, including those usually considered mild, without explicitly defining these as MTBI. This problem has a negative impact on the interpretation and comparison of findings on MTBI.

An in-depth discussion of the strengths and weaknesses of the existing criteria for classifying a traumatic brain injury as mild was beyond the scope of the Task Force. However, the literature would greatly benefit by common criteria. The Task Force recommends the following operational definition of MTBI:

> MTBI is an acute brain injury resulting from mechanical energy to the head from external physical forces. Operational criteria for clinical identification include: (i) 1 or more of the following: confusion or disorientation, loss of consciousness for 30 minutes or less, post-traumatic amnesia for less than 24 hours, and/or other transient neurological abnormalities such as focal signs, seizure, and intracranial lesion not requiring surgery; (ii) Glasgow Coma Scale score of 13–15 after 30 minutes post-injury or later upon presentation for health care. These manifestations of MTBI must not be due to drugs, alcohol, medications, caused by other injuries or treatment for other injuries (e.g. systemic injuries, facial injuries or intubation), caused by other problems (e.g. psychological trauma, language barrier or coexisting medical conditions) or caused by penetrating craniocerebral injury.

This definition is derived from the definition developed by the Mild Traumatic Brain Injury Committee of the Head Injury Interdisciplinary Special Interest Group of the American Congress of Rehabilitation Medicine and has similarities with the conceptual definition of MTBI produced by a panel of experts from the US Centers for Disease Control and Prevention's (CDC) MTBI Working Group. We agree with the American Congress of Rehabilitation Medicine definition, which specifies that the GCS score of 13–15 be assessed after 30 minutes post-injury. However, we recognize the practical concern that individuals with MTBI will rarely be assessed at an emergency department within this time frame. Therefore, although an assessment of GCS score just after 30 minutes post-injury remains the ideal, our proposed definition permits diagnostic use of a GCS score assessed by a qualified healthcare provider at the first opportunity.

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