

An evaluation of anti-social behaviour in children after traumatic brain injury – prospects for improving the quality of life in rehabilitation

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Tomaszewski W, Buliński L, Mirski A, Rasmus A, Kowalczyk J, Bazan M, Pąchalska M. An evaluation of anti-social behaviour in children after traumatic brain injury – prospects for improving the quality of life in rehabilitation. *Ann Agric Environ Med*. 2014; 21(4): 649–653. doi: 10.5604/12321966.1120620

Abstract

Introduction and objective. The aim of the article is to present the consequences of traumatic brain injury in children, associated with general cognition and behavioural disorders, mainly of the anti-social type.

Materials and method. A total of 20 school-age children took part in the study – 6 girls and 14 boys; average age of the children – 13.35 years (standard deviation SD = 1.95). The research instruments included an analysis of documentation, a structured clinical interview, MMSE and Frontal Behavioral Inventory (FBI_{nv}) with an additional set of 5 supplementary questions directed at the detection of anti-social behaviour.

Results. The functioning of the children with traumatic brain injury is severely disrupted because of the presence of cognitive impairment; however, dementia was not manifested. In a significant number of the children with traumatic brain injury, not only frontal syndrome was found, but also the occurrence of anti-social behaviour. The most commonly reported behavioural problems were: disorganization, commonly referred to as laziness, hypersensitivity, and anxiety. The most common types of anti-social behaviours were: impulsivity, physical and verbal aggression, as well as outbursts of anger.

Conclusions. The children with traumatic brain injury suffer from cognitive disorders and behavioural problems, especially impulsivity, physical and verbal aggression, increased anxiety, and disorganization. The occurrence of frontal syndrome is related to the development of anti-social behaviour.

Key words

brain damage, anti-social behaviour, cognitive functions, microgenetic theory

INTRODUCTION

Data are critical for understanding traumatic brain injuries (TBI) as an important public health problem of our time [1]. Every year, at least 1.7 million TBIs occur, either as an isolated injury or together with other injuries [2], an important reason being the rise in the number of traffic accidents [1, 3, 4, 5]. An estimated 10 million people will be affected annually by TBI, and by the year 2020, it will surpass many diseases as the major cause of death and disability [5]. Unfortunately, despite new, innovative safeguards offered by car manufacturers (airbags, controlled crumple zones), the increase in the number of cars on the road has inevitably resulted in a higher number of car accidents, and pedestrian injuries [4, 5]. This makes TBI a pressing public health and medical problem [5]. The World Health Organization has predicted that road accidents, which account for many instances of TBI, will constitute the third largest contributor to the global burden of disease and disability (after heart disease and depression) [5]. A recent study of nearly 3000 serious head trauma cases found that 52% of survivors (154/100,000 population) were moderate to

severely disabled at first year. Many patients never recover full social independence, even though they may have no physical disabilities and a normal life expectancy [4, 5].

Pąchalska [4] in 2007 reports that the direct medical costs associated with such a situation, affecting, for example, the US government in 2000, are estimated at \$25 billion, and indirect cost, such as loss of productivity of TBI patients, are estimated at \$76.5 billion. The situation in recent years is even worse, however not very well recognized, as it was stated by the Humphreys et al. [5]. These authors studied the nine online journal databases, including MEDLINE, CINAHL, PsychINFO, and PUBMED) queried for studies between July 2010 and May 2012 pertaining to the economic burden of head injuries. One hundred and eight potentially relevant abstracts were identified from the journal databases. The studies included a cost-benefit analysis of the implementation of treatment guidelines from the US Brain Trauma Foundation and a cost-effectiveness analysis of post-acute traumatic brain injury rehabilitation. The authors concluded that very little research has been published on the economic burden that mild and moderate traumatic brain injury patients pose to their families, careers, and society as a whole [5].

The USA studies revealed that the children aged 0 – 4 years, older adolescents aged 15 – 19 years, and adults aged 65 years and over, are most likely to sustain a TBI [1,2,6,7]. More

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Received: 09 September 2013; accepted: 10 October 2013

persons have been killed as a result of traffic accidents, than in all the wars conducted by the country since its inception. In other countries, the situation worldwide is not much different from the data originating from the USA (6). About 50% of the causes of brain injuries are car accidents, another 30% by falls. Accidents, sports injuries, assaults, and gunshot wounds to the head account for the remaining 20% [5]. The situation in Poland, on a proportional basis, on the number of accidents and the size of the population, seems to be similar, with the possible exception of gunshot wounds to the head, which is connected with the much more difficult access to firearms than in the USA [3, 4, 5, 6].

TBI in children account for 30% of all injuries [5], a number which is constantly increasing. Almost every second child in Poland experiences TBI and requires medical intervention, and 1 in 10 is hospitalized for this reason and requires further rehabilitation. TBI in patients aged 0–19 years is the cause of more than 50% of deaths and disability. Mortality due to such injuries in traffic accidents among children and adolescents is up to 30%. Such assumptions concerning the epidemiology of brain injury [6] confirm, for example, the results of the test by the Pąchalska [4] in a group of 256 people (167 men and 89 women) affected by TBI. These data indicate that the cause of brain injury in 95 men (56.9%) and 36 women (40.4%) are traffic accidents, accidents at work – 21% and 30.3%, respectively, of this type of injury. On a smaller scale, the cause of injuries are falls from a height (9.6% of males, 5.6% females), assaults (in the order of 3%, 4.5%), and finally, gunshot wounds to the head (1.2% of males).

Pathomechanism of brain injuries. TBI occurs as a result of a large mechanical energy with a power greater than the adaptability of the skull [6]. TBI can be classified, based on severity, mechanism (closed or penetrating head injury), or other features (e.g., occurring in a specific location or over a widespread area). Head injury usually refers to TBI, but is a broader category because it can involve damage to structures other than the brain, such as the scalp and skull bones [7,8].

A large percentage of the children killed by brain trauma do not die immediately, but days or weeks after the event [8] rather than improving, after being hospitalized. The condition of around 40% of TBI patients deteriorate [9,10]. Primary brain injury (damage that occurs at the moment of trauma, when tissues and blood vessels are stretched, compressed and torn) does not adequately explain this deterioration; it is usually caused by secondary brain injury, a complex set of cellular processes and biochemical cascades that occur within the minutes to days following the trauma, such as vasospasm, intracranial haematoma, cerebral oedema (swelling), and meningitis. As a consequence of subsequent brain injury, severe brain atrophy, traumatic hydrocephalus, and traumatic porencefalia may occur. These secondary processes can dramatically deteriorate the damage caused by primary brain injury [2, 4, 10].

The brain injury can be classified as focal and multifocal damage [8]. Focal brain damage occurs when the damage is located directly below the point of impact (coup), but also in a straight line on the opposite side of the brain, because of impact on the inner wall of the skull (contra-coup). However, failure of this type is rare in children, and its presence may not be related to the accident; it may also occur as a result of caregiver abuse and ill-treatment. In the deeper structures of the brain, below the point at which the

impact came, bleeding into the brain may cause impaired consciousness, complicated, cognitive disorders, including both emotional and linguistic [4, 9, 11]. Focal brain damage can also occur when the patient's head is damaged, resulting from acceleration combined with deceleration. This type of rapid movement of the brain inside the skull results in bruises and cuts in the frontal and occipital lobes [8].

Multifocal brain damage, also known as extensive damage, can occur within the frontal, temporal and parietal lobe. The problems caused by this type of damage can include, for example, post-traumatic aphasia, cognitive and behavioural problems [4, 9, 12], as well as characteristic frontal and temporal syndrome [13]. Within all the diversity of the complex consequences of brain injuries, a special role is played by post-traumatic characteropathies, caused by permanent, irreversible organic changes. Most appear in the case of damage occurring in the area of the frontal lobe and the temporal lobe. These parts of the brain control the inhibition of unwanted behaviour that may be contrary to our cultural or moral values. Traumatic brain injury can lead to the development of frontal syndrome [4, 10], as well as to impulsive, aggressive, and anti-social actions [14] in which even the most mild-mannered person can act like a hostile, aggressive sociopath [10, 14]. The criminal justice system needs to be aware of the link between aggressive behaviour and traumatic brain injury, in order to make sure that victims of TBI obtain medical and rehabilitation services they need, rather than spending time in a prison cell [4, 15].

More detailed knowledge and an understanding of the issues relating to the functioning of patients following TBI is important for clinical practice, and may allow the implementation of appropriate therapeutic activities in the later life of the patient.

Objective. The aim of this research was to evaluate anti-social behaviour caused by traumatic brain injury in children under the age of 17. It was hypothesized that the functioning of children with traumatic brain injury is severely disrupted because of anti-social behaviour. The occurrence of anti-social behaviour is related to the development of frontal syndrome.

MATERIALS AND METHOD

The study group consisted of 20 school-age children (6 girls and 14 boys) with traumatic brain injury confirmed by magnetic resonance imaging (MRI). The children were diagnosed and treated in the Reintegrative-Training Centre of the Polish Neuropsychological Society. The exclusion criteria were birth complication, low birth weight, prenatal brain damage, more than one accident, and post-traumatic dementia, which may cause symptoms such as long-term memory problems [13]. The average age of the patients was 13.35 years (standard deviation SD = 1.95). Screening was carried out in order to assess the depth of post-traumatic dementia with the short version of Mini-Mental State Examination (MMSE), which is a 30-point scale to examine cognitive impairment and determine its severity [16]. Behaviour was evaluated with structured clinical interview [17] and a Polish version of the Frontal Behavioral Inventory (FBIInv). The final version of the FBIInv consists of 24 questions which enable an evaluation of frontal syndrome [17, 18], as well as the AB-Test consisting

of 5 additional questions which enable an evaluation of anti-social behaviour [4]. The inventory questions include both correct as well as incorrect, negative aspects of behaviour – from which the caregiver selects those, he thinks, describes the patient correctly. Particular questions can be rephrased if the carer has problems with understanding them. The particular items are grouped into 2 types of behaviour:

1. *negative behaviours*: such as apathy, asponaneity, indifference, thinking rigidity, concreteness, personal neglect, distractibility, inattention, loss of insight, logopenia, verbal apraxia, and alien hand syndrome [the last 3 items were included to evaluate the specific motor and linguistic behaviours that might occur in TBI children].
2. *positive behaviours*: connected with disinhibition, such as perseveration, irritability, excessive jocularity, unpredictability, irresponsibility, inappropriateness, impulsivity, restlessness, aggression, hyperorality, hypersexuality, utilization behaviour, and incontinence.

For calculating the results of the Frontal Behavioral Inventory, the following scale was applied: 0 – lack of behavioural disorders, 1 – mild impairment, 2 – moderate impairment, 3 – abnormal (deep). The scale total score represents the sum of: 0–18 – no behavioural disorders 19–36 – mild impairment, 33–54 – moderate disorders, 55–72 – severe problems.

Procedure. The structured clinical interview as well as FBIInv was conducted with a patient caregiver, and the examiner provided explanations of the meaning of particular questions whenever necessary.

RESULTS

The average result obtained by the subjects in the general mental activity tested in the MMSE score was 24.30 points (SD 51.92). This result is within the lower limit for the occurrence of cognitive impairment. None of the subjects showed signs of severe post-traumatic dementia, although a considerable proportion of cognitive disorders appeared, including those that were mild and medium (Fig. 1).

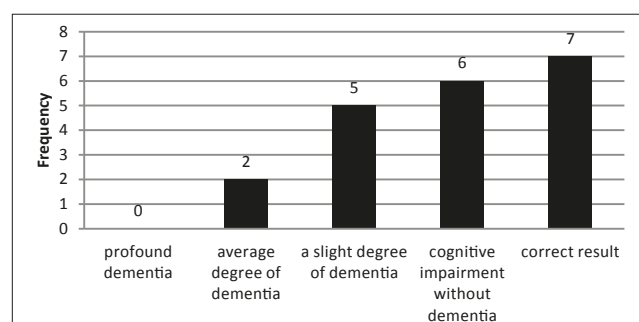


Figure 1. Frequency of dementia in the children with traumatic brain injury

The results obtained in the presented study using the Frontal Behavioral Inventory (FBIInv) are characterized by great diversity. The maximum number of points that can be obtained in the questionnaire FBIInv, is 72, the result being the deepest level of behavioural disorders. The average score for all subjects was 21 points. The lowest result obtained at the level of 5 indicates a definitely good functioning of the

subject and a lack of symptoms associated with abnormalities characteristic of 'frontal lobe syndrome'. The highest observed score was 48 points, which gives rise to the inference that an individual with a result of disorders associated with traumatic brain injury, experience moderate or severe disorders which may persist for a long period of time (Tab. 1).

Table 1. Total score in FBIInv in the children with traumatic brain injury

Total score in FBIInv	N	Min	Max	Maximum possible score	Mean	SD
	20	5	48	72	21.00	12.732

In terms of the additional questions for investigating anti-social behaviour in FBIInv, a total of 15 points could be attained. Analysis of the additional questions about specific anti-social behaviours showed that the average score observed for those diagnosed with trauma was 2.55 ± 2.11 , the highest recorded was 7 points, with a low of 0 (Tab. 2)

Table 2. Overall result for any questions investigating anti-social behaviour in the children with traumatic brain injury

Overall result for any questions investigating anti-social behaviour	N	Min	Max	Maximum possible score	Mean	SD
	20	0	7	15	2.55	2.114

The result of anti-social behaviour average for an individual patient showed that there were about 7.2 anti-social traits (Tab. 3). A person with severe frontal syndrome manifested 13 anti-social traits, but the person who least reflected this type of anti-social behaviour had only 3.

Table 3. Antisocial behaviour average for the children with traumatic brain injury

Result of antisocial behaviour average for an individual	N	Min	Max	Mean	SD
	20	3	13	7.20	2.876

The number of anti-social symptoms in the children with traumatic brain injury is presented in Table 4. A large group of the patients (14 patients, 70%) manifested from 5–10 anti-social symptoms. A much smaller group manifested 5 symptoms (4 patients, 20%), while the remaining group (2 patients, 10%) showed 10–15 anti-social symptoms.

Table 4. Number of anti-social symptoms in the children with traumatic brain injury

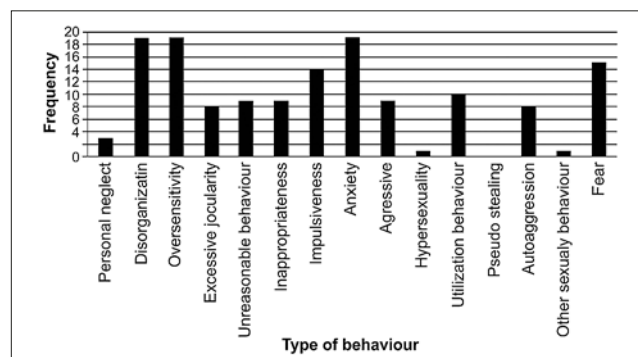
Number of anti-social symptoms	N	%
1–5	4	20
5–10	14	70
10–15	2	10

Further analysis was conducted into the frequency of anti-social behaviour (Tab. 5). Mean values in the appearance of anti-social behaviour were 9.89 (SD=6.6). This means that approximately 10 persons manifested frontal syndrome with anti-social behaviour. However, in the case of a few patients, the symptoms of frontal syndrome and anti-social behaviour did not appear at all.

Table 5. Frequency of antisocial behaviour in the children with traumatic brain injury

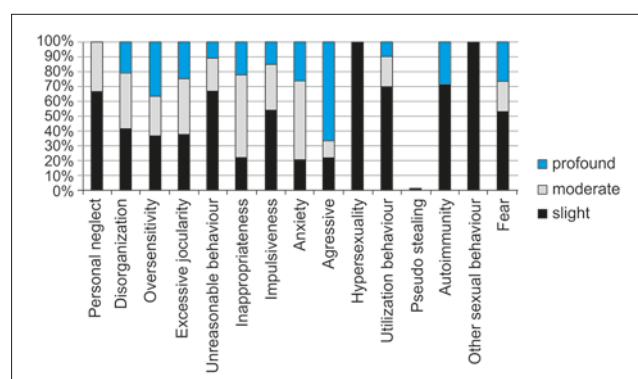
Frequency of antisocial behaviour	N	Min	Max	Mean	SD
TOTAL	15	0	19	9.89	6.6

The analysis shows 3 most commonly occurring types of anti-social behaviour: disorganization, hypersensitivity, and anxiety, which occurred in case of 19 patients (Fig. 2).

**Figure 2.** Frequency of antisocial behaviour in the children with traumatic brain injury

The frequency of disorganization, hypersensitivity and anxiety can be caused by a sudden change in lifestyle as a result of traumatic brain injury, and awareness of the changes and lack of ability to function as was the case in the period prior to the injury. An interesting phenomenon is the frequent occurrence of disorganization (19 out of 20 cases), but with a slight intensification of about 40%. However, low scores on scales related to child sexual misbehaviours give rise to the inference that such problems could not be developed, or the parents responding to the questions in FBIInv and additional questions were ashamed to talk about them. It also appears that a low score on the scale related to neglect of appearance may be determined by the young age of the respondents. Most of them were accompanied by an adult who took care of the appearance of the child, rather than the child taking care of itself. In view of the varying intensity of the abnormality, on a scale of 1 – 3, where 1 denotes a slight disturbance, 2 moderate, and 3 is profound, the intensity by which a particular disorder appears can be determined (Fig. 3).

It can be observed that the most common disorders that occur to a mild degree are: disorganization, anxiety and impulsivity. These behaviours occur in 40% of subjects. To

**Figure 3.** Intensity of antisocial behaviour in the children with traumatic brain injury

a smaller extent, but also on the same level, is the apparent severity of the hypersensitive type of disorders, as well as user symptom occurring in 7 patients, and auto-immunity in 6. The least visible symptoms, that occur in case of only 1 – 2 people, were – in addition to negligence or the appearance of impropriety – behaviours associated with a child's sexual sphere, i.e., hypersexuality and other sexual forms of behaviour (such as indecent exposure or masturbation).

Taking into account the types of anti-social behaviour disorders which manifest themselves in a moderate to extremely rare form, belong the following: negligent design and aggressiveness, both occur only once, and in 2 patients unreasonable behaviour, utilization behaviour and auto-aggression. On the other hand, the most severe anxiety behaviour was seen in 50% of the patients, also significantly less severe, but also seen in 35% of disorganization behaviour. In the case of disorders which manifest themselves to a profound degree, the most visible and maintained are auto-aggressive behaviour and hypersensitivity, which occur sequentially in 30% and 35% of the study population. At the other extreme are: unreasonable behaviour that disturbed the functioning of only one case in the presented research.

It is also worth noting that in the structured clinical interview, 11 patient caregivers (55%) declared an occurrence of various types of behavioural and educational problems in their children with traumatic brain injury. The most commonly reported behavioural problems that parents highlighted were: an outburst of anger, impulsivity, physical and verbal aggression, increased anxiety, and disorganization, commonly referred to as laziness. Nine patient caregivers (45%) did not note behavioural problems in their answers, although these problems were highlighted in the FBIInv questionnaire and in additional questions about specific anti-social disorders of all the children. The reason for this may be generally limited knowledge about the disorder caused by a brain injury, and that caregivers can mistakenly judge this behaviour, attributing it to being a characteristic of puberty.

DISCUSSION

Analysis of the results confirms the assumption that the functioning of children with traumatic brain injury is severely disrupted. It confirms the authors' hypotheses that the overall mental ability tested in the MMSE proved that the children with traumatic brain injury are characterized by a cognitive disorder, causing an inability to return to the complete skills acquired before the injury, including behavioural problems that emerged during the learning process, especially impulsivity and aggression. More than a half the group of examined children developed frontal syndrome and anti-social behaviour. The most common behavioural problems are organization of activity, sensitivity, fear and anxiety, and the most severe symptoms in the subjects turned out to be aggression, both verbal and physical, which often appears to be impulsive. The occurrence of anti-social behaviour in children with traumatic brain injury is related to the development of frontal syndrome, as noted in the scientific literature [19, 20]. This means that actually it was the TBI that caused the emergence of the anti-social behaviour identified in the FBIInv. On the one hand, the anti-social behaviour disorders which appeared least common, were negligent appearance (3 times), behaviour associated with sexuality

(hypersexuality – once; other sexual behaviour – once). The low level of the negligent appearance also seems to be due to the young age of the respondents, as the study subjects were still in the period in which the parents had a lot of control over the child and decide on a number of issues. However, in the case of hypersexual behaviour in which questions related to behaviour, including issues such as public masturbation or indecent exposure, these matters may have been simply too embarrassing for the parents to discuss, and they probably did not want to reveal such behaviour of their children, as is pointed out in the scientific literature [4]. On the other hand, when children with TBI return to school, their educational and emotional needs are often very different from those before the injury. Their disability happened suddenly and traumatically, but they can often remember what they were like before the brain injury. This can bring on many emotional and social changes. The child's family, friends and teachers also recall what the child was like before the injury, and may have adjusted their expectations of the child. This situation is related to the quality of life of the children with traumatic brain injury [4, 21, 22, 23]. It seems that the mere appearance of the presented group with an anti-social disorder gives rise to the inference that in this population the symptoms are more extreme. The results therefore suggest the need for studies of a broader scope, to cover a larger number of children who have experienced TBI.

CONCLUSIONS

The children with traumatic brain injury suffer from cognitive disorders and behavioural problems, especially impulsivity, physical and verbal aggression, increased anxiety, and disorganization. The occurrence of frontal syndrome is related to the development of anti-social behaviour.

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