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ORIGINAL ARTICLE

A neuropsychological approach in a paediatric acquired brain injury unit under the public health system



S. Cámara-Barrio^{a,*}, B. Esteso-Orduña^a, M.T. Vara-Arias^b, S. Rodríguez-Palero^b, M.C. Fournier-del Castillo^c

^a Unidad de Daño Cerebral Adquirido, Unidad de Neuropsicología Clínica, Servicio de Psiquiatría y Psicología, Hospital Universitario Niño Jesús, Madrid, Spain

^b Unidad de Daño Cerebral Adquirido, Servicio de Rehabilitación, Hospital Universitario Niño Jesús, Madrid, Spain

^c Unidad de Neuropsicología Clínica, Servicio de Psiquiatría y Psicología, Hospital Universitario Niño Jesús, Madrid, Spain

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KEYWORDS	Abstract
Paediatric acquired	Introduction: Paediatric acquired brain injury (ABI) causes cognitive and behavioural difficul-
brain injury;	ties and alters the course of child development. The ABI unit at Hospital Infantil Universitario
Neuropsychological	Niño Jesús is the first within the public Spanish health system to provide comprehensive coverage
rehabilitation;	to these patients and their families.
Brain tumours;	Objective: This study aims to show the working methodology followed with patients and their
Traumatic brain	families, and to describe the clinical characteristics of the patients treated and the outcomes
injury;	of treatment.
Stroke	Patients: Fifty-three patients aged between 3 months and 16 and a half years received treat-
	ment. The conditions treated were brain tumours, stroke, traumatic brain injury, damage
	secondary to epilepsy surgery, and hypoxia.
	Methods: All patients were evaluated at admission and at discharge. Treatments were adapted
	to each patient's difficulties and their severity, as well as to the patient's age. Families received
	individual and group therapy.
	Results: Older age was associated with better cognitive recovery and shorter duration of treat-
	ment. Different conditions show differential impact on intelligence quotient and developmental
	quotient scores at the beginning of treatment, with hypoxia and encephalitis being associ-
	ated with greatest severity. Intelligence quotient and developmental quotient scores and visual
	memory and attention scores at discharge improved significantly after the faceted neuropsy-
	chological treatment with respect to scores registered at admission.

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E-mail address: silvia.camara@salud.madrid.org (S. Cámara-Barrio).

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Conclusions: The care of patients with ABI should include neuropsychological rehabilitation programmes and provide emotional support to the family so that they may actively participate in the recovery of the child or adolescent.

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PALABRAS CLAVE

Daño cerebral adquirido pediátrico; Rehabilitación neuropsicológica; Tumores cerebrales; Traumatismos craneoencefálicos; Accidentes cerebrovasculares

Abordaje neuropsicológico en una unidad pediátrica de daño cerebral adquirido del sistema público de salud

Resumen

Introducción: El daño cerebral adquirido (DCA) pediátrico provoca dificultades cognitivo/conductuales y altera el curso del desarrollo. La unidad de DCA del Hospital Infantil Universitario Niño Jesús es la primera dentro del sistema público de salud en dar cobertura integral a pacientes y familias.

Objetivo: Se pretende mostrar la metodología de trabajo con los niños y sus familias, describir las características clínicas de los pacientes atendidos y los resultados en cuanto a los tratamientos aplicados.

Sujetos: 53 niños entre los 3 meses y los 16 años y medio recibieron tratamiento. Las patologías atendidas son tumores cerebrales, accidentes cerebrovasculares, traumatismos craneoencefálicos, daño tras cirugía de la epilepsia e hipoxia.

Método: A todos los pacientes se le realizó una evaluación al ingreso y otra al alta. Los tratamientos se modulan en función de las dificultades y su gravedad, así como de la edad del niño. Las familias son atendidas tanto individualmente como en formato grupal.

Resultados: Una mayor edad del niño se asocia con mejor recuperación del nivel cognitivo y menor duración del tratamiento. Las patologías tienen un impacto diferencial en el CI/CD evaluado al inicio de tratamiento, la hipoxia y las encefalitis son las que asocian mayor gravedad. Las puntuaciones al alta del CI/CD, así como las de memoria verbal y atención, mejoraron significativamente respecto a las del ingreso tras el tratamiento neuropsicológico multicomponente. *Conclusiones*: La atención al DCA debe incluir programas de rehabilitación neuropsicológica y proporcionar soporte emocional a la familia para que pueda participar activamente en la recuperación del niño o adolescente.

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Introduction

Paediatric acquired brain injury (ABI) results from a sudden brain lesion occurring after birth (ie, it is not congenital, hereditary, or degenerative) and involving a change in neuronal activity that affects the physical integrity, metabolic activity, or functional capacity of brain cells.¹ It may be caused by a wide range of events, including head trauma, infection, brain tumours, stroke, and hypoxia. The sequelae of ABI can present different degrees of severity, may be temporary or permanent, and may cause partial or generalised deficits affecting the physical, cognitive, emotional, and social spheres, resulting in psychosocial adjustment problems for the children and their families.²

The prevalence of ABI in Spain is not precisely known due to the lack of an official registry; furthermore, the studies conducted to date do not follow standardised criteria for data collection. In other countries, rates vary across series, ranging from 110 to 236 cases per 100 000 population.³ Although medical advances have improved survival rates, most children with severe ABI present physical and cognitive difficulties⁴ that negatively impact their quality of life; rehabilitation treatment is needed to achieve the highest possible degree of functional recovery.

The sudden, unexpected nature of ABI constitutes a challenge for the development of adaptive strategies for patients and their families. Physical difficulties can be seen almost from the beginning, while emotional and cognitive problems may appear at later stages, affecting the patient's independence and, consequently, their relationships with their family and in the school setting.⁵ Children with ABI may present developmental problems (or previous difficulties may be exacerbated) and increased risk of learning or behavioural alterations.^{6,7} ABI may have a considerable negative impact on the developing brain since, unlike in adults, the effects of the injury are not static.^{8,9}

The families of children with ABI experience high levels of stress and burden, increasing the likelihood of mood disorders among parents and siblings, as well as marital problems.¹⁰ The main concerns for the families of children and adolescents with ABI are school performance, the child's difficulty controlling such negative emotions as anger, lack of initiative, problems with social integration and the inability to develop close peer relationships, and fear of long-term sequelae.¹¹

The neuropsychological consequences of ABI depend on multiple factors, including the age at which it occurs, whether damage is focal or generalised, and the severity of the injury. ABI occurring within a year of birth is the most severe. ^{12,13} Furthermore, children

Table 1Neuropsychological and psychosocial difficultiesof paediatric patients with acquired brain injury.

Difficulties with problem-solving Slow information processing speed Memory alterations Impaired language skills, delayed language development Attention and working memory problems <i>Executive function</i> Poor judgement and concept formation for age and school level Planning difficulties Self-monitoring difficulties Difficulty starting and inhibiting behaviours <i>Emotional and psychosocial aspects</i> Difficulty showing empathy or remorse Low frustration tolerance, with frequent mood swings Loss of friends Poor social skills Poor school performance Social isolation within the school setting	Cognitive function
Slow information processing speed Memory alterations Impaired language skills, delayed language development Attention and working memory problems <i>Executive function</i> Poor judgement and concept formation for age and school level Planning difficulties Self-monitoring difficulties Difficulty starting and inhibiting behaviours <i>Emotional and psychosocial aspects</i> Difficulty showing empathy or remorse Low frustration tolerance, with frequent mood swings Loss of friends Poor social skills Poor school performance Social isolation within the school setting	Difficulties with problem-solving
Memory alterations Impaired language skills, delayed language development Attention and working memory problems <i>Executive function</i> Poor judgement and concept formation for age and school level Planning difficulties Self-monitoring difficulties Difficulty starting and inhibiting behaviours <i>Emotional and psychosocial aspects</i> Difficulty showing empathy or remorse Low frustration tolerance, with frequent mood swings Loss of friends Poor social skills Poor school performance Social isolation within the school setting	Slow information processing speed
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Executive function Poor judgement and concept formation for age and school level Planning difficulties Self-monitoring difficulties Difficulty starting and inhibiting behaviours Emotional and psychosocial aspects Difficulty showing empathy or remorse Low frustration tolerance, with frequent mood swings Loss of friends Poor social skills Poor school performance Social isolation within the school setting	Attention and working memory problems
Poor judgement and concept formation for age and school level Planning difficulties Self-monitoring difficulties Difficulty starting and inhibiting behaviours <i>Emotional and psychosocial aspects</i> Difficulty showing empathy or remorse Low frustration tolerance, with frequent mood swings Loss of friends Poor social skills Poor school performance Social isolation within the school setting	Executive function
Planning difficulties Self-monitoring difficulties Difficulty starting and inhibiting behaviours <i>Emotional and psychosocial aspects</i> Difficulty showing empathy or remorse Low frustration tolerance, with frequent mood swings Loss of friends Poor social skills Poor school performance Social isolation within the school setting	Poor judgement and concept formation for age and school level
Self-monitoring difficulties Difficulty starting and inhibiting behaviours Emotional and psychosocial aspects Difficulty showing empathy or remorse Low frustration tolerance, with frequent mood swings Loss of friends Poor social skills Poor school performance Social isolation within the school setting	Planning difficulties
Difficulty starting and inhibiting behaviours Emotional and psychosocial aspects Difficulty showing empathy or remorse Low frustration tolerance, with frequent mood swings Loss of friends Poor social skills Poor school performance Social isolation within the school setting	Self-monitoring difficulties
Emotional and psychosocial aspects Difficulty showing empathy or remorse Low frustration tolerance, with frequent mood swings Loss of friends Poor social skills Poor school performance Social isolation within the school setting	Difficulty starting and inhibiting behaviours
Difficulty showing empathy or remorse Low frustration tolerance, with frequent mood swings Loss of friends Poor social skills Poor school performance Social isolation within the school setting	Emotional and psychosocial aspects
Low frustration tolerance, with frequent mood swings Loss of friends Poor social skills Poor school performance Social isolation within the school setting	Difficulty showing empathy or remorse
Loss of friends Poor social skills Poor school performance Social isolation within the school setting	Low frustration tolerance, with frequent mood swings
Poor social skills Poor school performance Social isolation within the school setting	Loss of friends
Poor school performance Social isolation within the school setting	Poor social skills
Social isolation within the school setting	Poor school performance
	Social isolation within the school setting

with severe ABI are at increased risk of presenting cognitive impairment at later stages. ABI halts or slows cognitive, social, or motor development beyond a year after the injury, even in spite of successful rehabilitation.¹⁴ Attention problems, memory problems, and executive dysfunction are the most frequently reported issues.^{15–18} These cognitive alterations may in turn have a negative impact on patients' psychosocial function, affecting social interactions and family life.^{19–22}

Patients with more severe ABI frequently present greater developmental problems. This is relevant both for managing family expectations and for treatment planning.⁴ A meta-analysis of 28 studies conducted between 1988 and 2007 into the cognitive status of children with ABI found that children with moderate (baseline Glasgow Coma Scale score of 9-12) or severe traumatic brain injury (baseline score of 3-8) presented more severe intellectual deficits, executive dysfunction, and memory problems than children with mild traumatic brain injury. In the latter group, symptoms resolved over time, whereas children with more severe damage continued to present neurocognitive alterations 24 months after the injury.¹⁶

ABI causes multiple neuropsychological and social difficulties (Table 1); these should be considered on a case-by-case basis during rehabilitation planning.²³ Although some studies suggest that more intensive training achieves better outcomes in children with ABI,²⁴ we are yet to determine the optimal duration or frequency of treatments. In any case, the benefits of rehabilitation as compared to spontaneous recovery are well known.

Neuropsychological rehabilitation is a systematic intervention aimed at restoring cognitive function or compensating for the impact of the impairment caused by ABI.²⁵ Neuropsychological interventions may be categorised into different types, and may be used alone or in combination depending on the cognitive domain requiring rehabilitation:

- 1 Exercise training: repetition of hierarchical exercises focused on a given cognitive function.
- 2 Metacognitive strategy training: this approach teaches patients to reflect and provides general instructions for performing tasks, with the aim of improving generalisation. This type of intervention improves adaptation, cognition, memory, and executive function; however, its application depends on the patient's age and the severity of cognitive alterations.

Figure 1 Variables with an impact on the neuropsychological rehabilitation needs of paediatric patients with acquired brain injury.

PTBI: paediatric traumatic brain injury.

- 3 External memory aids: diaries, notes, and reminders to compensate for cognitive and memory difficulties and help in daily life. This strategy can only be used with older children without severe cognitive impairment.
- 4 Family counselling: families need to develop strategies to cope with the new situation. These sessions provide advice on behaviour management and cognitive stimulation at home. Counselling focuses on cognitive problems and their management, and helps to develop an appropriate system of communication with the child, setting rules and limits, to identify risk situations, and to develop problem-solving techniques.

Several authors have underscored the importance of multicomponent interventions, particularly if they are introduced sequentially, from the most simple (eg, exercises) to more complex interventions, such as strategy training, establishing priorities. Interventions must initially aim to improve attention and oppositional behaviours; the child's developmental stage should be considered during intervention planning.²⁶ Fig. 1 lists the variables that must be considered in designing a neuropsychological rehabilitation intervention.

A recent meta-analysis examined the types of neuropsychological interventions and the factors determining their effectiveness in children and adolescents.²⁷ Interventions that focus on training specific cognitive functions improve performance in those functions. The use of metacognition strategy training, combined with other strategies whenever possible, improves psychosocial function; metacognitive skills are essential for social and behavioural function.²⁸ In adolescents with ABI, an intervention programme based on social mediation, cooperative learning, and metacognition was found to be more effective when performed among peers than in the family setting.²⁹

Our study aims to analyse the function and methodology of the ABI unit at Hospital Universitario Niño Jesús, in Madrid. Created in 2015, this is the first unit for paediatric patients with ABI to be created in a Spanish public hospital, and provides individualised rehabilitation for children with ABI during the months following the injury. We analyse a series of patients attended between 2015 and 2018. The care model includes neuropsychological rehabilitation for the child or adolescent with ABI, emotional support for families to actively participate in patient rehabilitation, orientation regarding patient needs after discharge, and follow-up. As a secondary objective, we aimed to analyse the clinical characteristics of paediatric patients with ABI and the neuropsychological changes observed at discharge after intensive multicomponent neuropsychological rehabilitation.

Patients and methods

Patients may be referred to the ABI unit of Hospital Universitario Niño Jesús from any hospital in the region of Madrid. Eligibility criteria for admission to the ABI unit are as follows:

- < 8 months since the injury
- Recovered from minimally conscious state
- Presenting functional deficits with potential for recovery
- Not requiring continued medical or nursing care (families are responsible for the patient's care)
- Registered with the Spanish Social Security System or entitled to receive healthcare according to international law or agreement.

In patients not meeting the admission criteria, we evaluate the need for follow-up or referral to another centre. Patients eligible for admission to the ABI unit are assessed by the rehabilitation, clinical neuropsychology, and social work departments, and the treatment programme is designed on an individual basis.

A total of 75 patients were referred to the ABI unit and underwent neuropsychological assessment; 22 did not meet the admission criteria. in most cases due to the interval between injury and assessment being longer than 8 months. All patients received treatment counselling. Fifty-three patients received integral care, including neuropsychological treatment. Our series includes more boys than girls (69.8% vs 30.2%). The most frequent cause of ABI in our sample was brain tumour (19 patients; 35.8%), located in the posterior fossa in most cases. The second most frequent cause was head trauma (11; 20.8%), occurring mostly in boys. The most frequent causes of head trauma were domestic accidents, falls, and traffic accidents. The third most frequent cause of ABI in our unit was stroke (9; 17%), also more frequent among boys. Less frequent causes of ABI included encephalitis (6; 11.3%), hypoxia (4; 7.5%), and damage due to epilepsy surgery or complications of the procedure (4; 7.5%). Cognitive sequelae were classified as mild, moderate, severe, or very severe according to the child's cognitive status (Table 2). The type of neuropsychological intervention provided is also specified in Table 2. Table 3 presents the distribution of diseases causing ABI by age and sex.

The ABI unit is a multidisciplinary unit including rehabilitation physicians, clinical psychologists specialising in clinical neuropsychology, social workers, speech therapists, physiotherapists, occupational therapists, and therapeutic pedagogy teachers. The unit also works in cooperation with such other medical specialties as the paediatric neurology department.

Treatment is concluded in any of the following situations:

- Referral to another centre
- End of the period of care
- Patient achieving functional stability or meeting functional objectives enabling return to social, family, or school life
- Intercurrent processes that prevent rehabilitation from being continued; death.

The maximum duration of treatment at the unit is 18 months; after that period, families are informed about the available resources for continued care, and patients attend periodic follow-up consultations. The unit has a maximum capacity of 20 patients.

The clinical neuropsychology intervention includes the following stages:

1 Initial clinical interview with the family: the clinical history must include information on the patient's motor, language, social, and emotional development before ABI. It should also gather any clinical data that are relevant for establishing the impact of ABI, physical sequelae, and medical complications, including test results (eg, neuroimaging studies, EEG). The patient's school records are also reviewed, as they provide relevant information about premorbid school performance and presence of learning difficulties. Lastly, we investigate the child's behaviour before ABI and any changes occurring thereafter, paying special attention to the development of psychopathological or behavioural alterations.

- 2 Initial neuropsychological assessment: we perform a thorough cognitive assessment evaluating intellectual function, perception, non-verbal skills, abstract reasoning, receptive/expressive language, verbal/visual memory, attention, and executive cognitive function; the assessment is adapted to the patient's age, ABI severity, and the presence of sequelae. The neuropsychological assessment includes a psychopathological assessment and an evaluation of executive functions involved in behavioural and emotional regulation.
- 3 Neuropsychological treatment programme: after identifying strengths and limitations in the patient's cognitive profile, we design a multicomponent neuropsychological treatment programme for each patient. The most frequently used techniques are those based on exercise training. The use of metacognitive strategies depends on the patient's age and level of cognitive impairment. External memory aids are more frequently used in patients with severe memory alterations.
- 4 Guidance for families and schools: from the beginning of the intervention, the rehabilitation team should maintain constant communication with all parties involved in caring for the child. The needs of patients and their families change over the course of the functional rehabilitation intervention. The rehabilitation team should inform about the patient's needs at all times, establishing communication channels and providing advice on the most appropriate behavioural management, with particular attention to emotional aspects.
- 5 Follow-up: follow-up consultations are essential for identifying any problems that may arise after rehabilitation.

At the ABI unit, families are attended on an individual basis, but are also invited to participate in family group sessions. This is intended to provide a safe space where families can share their thoughts and experiences, and offer support and be supported by other parents who have gone through a similar experience. These groups also provide psychoeducational information about the sequelae of ABI and their impact on families. Table 4 summarises the working dynamic of family group sessions. Parents can also suggest topics for discussion during the sessions.

Statistical analysis was performed with IBM SPSS statistical software, version 25.0.³⁰ We performed a descriptive analysis of the sample (mean and standard deviation, frequency and percentage). The Spearman correlation coefficient was calculated to analyse the association between age at the time of ABI, treatment duration, and changes in intelligence quotient (IQ) or development quotient (DQ) and in specific cognitive domains after completing the rehabilitation intervention at the ABI unit. The Kruskal-Wallis H test was used to analyse the impact of each type of disease on overall cognitive function and specific cognitive domains at admission, as well as the effects of treatment, the disease, and treatment duration on IQ and DQ scores and cognitive function at discharge.

Results

Age at the time of ABI was found to be positively correlated with the cognitive change observed between baseline and the end of the intervention (r = 0.368; P = .023), with older patients showing more marked improvements in overall cognitive function (IQ/DQ). We found a negative correlation between age at the time of ABI and treatment duration (r = -0.320; P = .020); thus, younger patients stayed for longer at the unit (normally the maximum duration of treatment, 18 months).

Cognitive performance (IQ/DQ) at the first assessment post-ABI was positively correlated with cognitive performance at discharge (r = 0.824; P = .000) and negatively correlated with deficits in specific cognitive domains at the end of treatment: children with better cognitive performance at baseline presented less marked deficits in receptive language (r = -0.831; P = .000), expressive language

	Mean (SD)
Age at onset of disease (months)	93.30 (59.957)
Duration of neuropsychological treatment	13.73 (5.498)
IQ/DQ before treatment	71.79 (30.074)
	N (%)
Sex (boys)	37 (69.8)
Disease	
Tumour	19 (35.8)
Head trauma	11 (20.8)
Stroke	12 (22.7)
Encephalitis	7 (13.2)
Нурохіа	4 (7.5)
Severity of cognitive sequelae (IQ at treatment onset)	
Mild (IQ > 85)	18 (34.0)
Moderate (IQ 70-85)	17 (32.1)
Severe (IQ 50-70)	7 (13.2)
Very severe (IQ < 50)	11 (20.8)
Neuropsychological intervention	
Exercise training and family counselling	12 (22.6)
External memory aids, exercise training, and family counselling	3 (5.7)
External memory aids, metacognition, and family counselling	2 (3.8)
Exercise training, external memory aids, metacognition, and family counselling	13 (24.5)
Family counselling	23 (43.4)

 Table 2
 Descriptive statistics of our sample of patients with acquired brain injury receiving neuropsychological rehabilitation.

DQ: development quotient; IQ: intelligence quotient; SD: standard deviation.

	Tumour	Head trauma	Stroke	Encephalitis	Hypoxia
Age					
0-6 years	6 (11.32)	5 (9.25)	5 (9.25)	5 (9.25)	2 (3.77)
6-12 years	10 (18.86)	2 (3.77)	4 (7.54)	0 (0.00)	0 (0.00)
12-18 years	3 (5.66)	4 (7.54)	3 (5.66)	2 (3.77)	2 (3.77)
Sex	. ,	. ,			
Boys	14 (26.41)	9 (16.98)	8 (15.09)	3 (5.66)	3 (5.66)
Girls	5 (9.25)	2 (3.77)	4 (7.54)	4 (7.54)	1 (1.88)

 Table 3
 Frequencies and percentages of diseases causing acquired brain injury, by age and sex.

 Table 4
 Structure of family group sessions at our acquired brain injury unit.

Introduction: during the first session, parents are informed about the objective of the group sessions, introduce themselves, and express their concerns and expectations.

What is ABI?: definition of ABI, description of its impact on the developing brain, and analysis of the concepts of plasticity and vulnerability.

Consequences of ABI: impact of ABI on the cognitive, emotional, and behavioural spheres.

Emotional impact on the family: emotional consequences, changes in family roles, social impact, impact on the parents' working life, marital problems.

Impact on siblings: frequent reactions of the patient's siblings to the new situation, differences between siblings, strategies for managing behavioural problems, and interventions aimed at improving the emotional well-being of the siblings.

Returning home: how to approach the patient's return home, recommendations.

Coping strategies: definition of the main coping strategies (active/passive/avoidance coping) and their advantages and disadvantages.

Parenting styles: analysis of different parenting styles (permissive, authoritarian, authoritative, overprotective, etc) and their impact on the behaviour of children or adolescents with ABI.

Parent counselling: basic guidance on reinforcement, punishment, limits, and rules.

ABI: acquired brain injury.

Table 5Intelligence quotient/development quotient ofparticipants at admission and at discharge, by aetiology ofacquired brain injury.

Aetiology	IQ/DQ at admission	IQ/DQ at discharge
Tumour	86.63 (13.88)	90.58 (13.60)
Head trauma	74.81 (31.07)	82.52 (20.26)
Stroke	72.91 (28.47)	78 (27.44)
Encephalitis	51.28 (36.74)	54.42 (36.33)
Hypoxia	25.5 (18.91)	40 (26.83)

Data are presented as mean (standard deviation).

DQ: development quotient; IQ: intelligence quotient.

(r = -0.803; P = .00), verbal memory (r = -0.793; P = .000), visual memory (r = -0.850; P = .000), visuospatial processing (r = -0.843; P = .00), and attention (r = -0.833; P = .000).

Aetiology of ABI was found to have an impact on IQ/DQ at admission, that is, before treatment onset (H = 13.528; P = .001; $\sum^2 = 0.25$). Likewise, when analysing the severity of alterations by aetiology, we observed significant differences in receptive language (H = 37.981; P = .000; $\sum^2 = 0.73$), expressive language (H = 34.94; P = .000; $\sum^2 = 0.671$), verbal memory (H = 25.954; P = .000; $\sum^2 = 0.499$), visual memory (H = 25.916; P = .000; $\sum^2 = 0.498$), visuospatial processing (H = 26.755; P = .000; $\sum^2 = 0.514$), and attention (H = 30.267; P = .000; $\sum^2 = 0.582$). The cause of ABI with the greatest impact on IQ/DQ was tumours, followed in decreasing order by brain trauma, stroke, encephalitis, and hypoxia. Table 5 shows IQ/DQ at admission and at discharge in our sample, by aetiology of ABI.

We observed significant differences between discharge and admission IQ/DQ scores; these may be attributed to the neuropsychological treatment (H = 7.888; *P*.019; $\sum^2 = 0.151$). However, no significant differences in IQ/DQ scores were observed between different aetiologies (H = 4.243; *P* = .374) or treatment duration (H = 3.256; *P* = .196). Verbal memory (H = 13.347; *P* = .008; $\sum^2 = 0.256$) and attention (H = 12.660; *P* = .013; $\sum^2 = 0.243$) improved significantly after the intervention with respect to baseline scores.

Discussion

Like other articles in the literature, our results show that injury occurring at earlier developmental stages is associated with poorer prognosis than injury occurring at older ages; patients in the latter group present milder cognitive impairment and achieve more marked improvements.^{12,13} Younger children need longer interventions, requiring treatment for the maximum time allowed at our unit. After discharge, families need guidance to continue care, with the collaboration of schools.

As previously reported, ^{12,13} the cause of ABI is relevant for prognosis. The more severe and generalised the lesion, as is the case with hypoxia or encephalitis, the greater the cognitive sequelae and the poorer the prognosis.⁴ In our series, overall cognitive status at treatment onset showed a significant correlation with cognitive performance at discharge in such domains as language expression, language comprehension, verbal memory, visual memory, visuospatial processing, and attention.

Based on a previous study showing that multicomponent interventions achieve better results,²⁶ all patients in our unit received individualised treatment with task training and family counselling, combined with metacognition strategy training and external memory aids where necessary or possible, according to the patient's age or the severity of injury. We did not include a control group for ethical reasons, as ABI cannot be left untreated and treatment cannot be delayed. Better outcomes after ABI depend on early onset of rehabilitation; rehabilitation always achieves better outcomes than spontaneous recovery. At discharge, patients presented improvements in overall cognition and in specific cognitive domains, such as attention and memory, with no significant differences between patients receiving different types of intervention. This may be explained by the fact that treatment was individualised, taking into account not only each patient's cognitive deficits but also their cognitive resources with regards to age and severity of ABI, as other authors have suggested.²³

Conclusions

Paediatric ABI may be caused by a wide range of disorders and is associated with multiple sequelae. Due to the shortage of longitudinal studies with large, representative samples, little information is available on patient progression and treatment effectiveness. The creation of multidisciplinary units for paediatric ABI within the public healthcare system, like our own, represents a huge step forward in the management of children with this condition.

Immediate neuropsychological care of children and adolescents with ABI at specialised units and long-term follow-up not only achieves clinical improvements but also promotes adaptation, as patients return gradually to normal life. Furthermore, families need emotional support to actively participate in their child's recovery and have realistic expectations around the cognitive and behavioural outcomes of ABI. Information about the consequences of ABI should also be provided to school teachers, who play a major role in the child's successful readjustment to the school setting. The ultimate goal of these interventions is to achieve the best possible long-term outcomes, with a view to enabling patients to meet the challenges of normal life.⁸

Improving cognitive function after paediatric ABI is essential to the recovery and psychosocial rehabilitation of these children and adolescents.²⁷ Multidisciplinary management of ABI is essential due to the complexity and variability of physical, cognitive, and emotional sequelae and should be maintained throughout the patient's life; in childhood and adolescence, care should be provided by specialised paediatricians.³¹ Our results underscore the importance of neuropsychological rehabilitation in children with ABI and the need for studies into the efficacy of treatment programmes.³²

Conflicts of interest

The authors have received no public or private funding for this study and have no conflicts of interest to declare.

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