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An Evidence-based Review of Cognitive and Behavioral Rehabilitation Treatment Studies in Children With Acquired Brain Injury

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Objective: The aim of this study was to complete a systematic evidence-based review of published cognitive and behavioral treatment studies with pediatric subjects who have a history of an acquired brain injury (ABI). **Data sources:** We utilized PubMed and EMBASE to search peer-reviewed journals from 1980 to 2006. **Data selection:** Terms such as cognitive rehabilitation, speech therapy, language therapy, and behavior therapy were employed in the search and 28 studies met established criteria. **Data extraction:** The data extracted from each study included specific details about the cognitive or behavioral treatment, subjects, study design, outcome measurements, and treatment effectiveness. **Data synthesis:** The studies, involving 366 children and youth with ABI, were classified as 1 Class I study, 5 Class II studies, 6 Class III studies, and 16 Class IV studies. **Conclusions:** Despite a limited number of studies, 2 treatment recommendations and 1 option were developed from this systematic literature search. **Keywords:** *acquired brain injury*, *adolescents*, *behavior*, *brain injury*, *children*, *cognitive rehabilitation*, *rehabilitation*, *treatment*

CURRENTLY, in the United States, an estimated 1 million children and youth annually experience a brain injury from motor vehicle accidents, sports, falls, brain tumors, and abuse.[1–3] Commensurate with these demographics, there has been increased awareness of the long-standing, global impact of an early brain injury in the life of the child.[4] Acquired brain injury (ABI) is a diverse condition involving occurrence of events that affect brain functioning such as closed, open, and blast traumatic brain injury (TBI), brain infections, tumors and radiation, hypoxia, and stroke.[3,5]

Treatment of ABI generally consists of an acute treatment phase, involving emergency department treatment, possibly inpatient hospitalization, transfer to outpatient treatment, and then return to the school and home environment. There is extreme variability, however, in the type, diversity, and intensity of treatment received by children who have experienced an ABI. Some of the reasons for this include a lack of available trained treatment personnel, gaps in communication between phases of treatment, limited access to medical care for financial reasons, and the child's relatively restricted self-advocacy potential. In addition, after the acute recovery phase, the brain injury often becomes "invisible" to family, friends, educators, and other professionals (as children with such injuries often have no outward physical indications of their underlying condition) and as such children's needs for related interventions are often missed upon returning to home and school. Issues such as these, surrounding treatment of children post-ABI, are complex and have hindered the development of objective, systematic, and accepted treatment protocols.

Limond and Leek[5] report similar challenges and variations in clinical practices in the United Kingdom as found in the United States, and indicate that, in the community setting, a child's significant problems following an ABI are frequently misattributed as non–ABI-related. These authors[5] reviewed published cognitive treatment studies involving children with ABI and found no conclusive evidence for the efficacy of cognitive rehabilitation. Their review was drawn from studies published between 1967 and 2002 and included only studies involving treatment of cognition.[5] Because advances in the field are occurring rapidly, and the need for effective

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interventions is great, the Pediatric-Adolescent Brain Injury Special Interest Group of the American Congress of Rehabilitation Medicine decided to update the Limond and Leeke review to include studies published before March 2006 and enlarge the scope to include both behavioral and cognitive treatment studies with children with a history of ABI. This broadening of the scope of the review is supported by the 1998 NIH Consensus Statement on Rehabilitation of Persons with TBI, which defined cognitive rehabilitation treatment as "cognitive and behavioral rehabilitation."[6]

While the number of identified systematic studies remains somewhat limited, the objectives of this review were to summarize and report what is in existence at this time, understand the limitations of the existing research and illustrate the need for further research, and motivate treatment personnel to design systematic, well-controlled studies according to best practices. Furthermore, it is hoped that this review will help answer the clinical question of what evidence is currently available to define effective, specific cognitive and behavioral treatments in children and adolescents post-ABI. Such a comprehensive review will be important to treatment personnel, families, and school staff.

DESCRIPTION OF THE ANALYTIC PROCESS

Members of the review committee were self-selected on the basis of their interest and expertise with children who have experienced ABI. A literature search was conducted, identifying English language publications in peer-reviewed journals from 1980 to March 2006, using PubMed and EMBASE databases, and utilizing the following search terms: cognitive rehabilitation, speech therapy, language therapy, behavior therapy, behavioral therapy, cognitive-behavioral therapy, brain injury, acquired brain injury, traumatic brain injury, children, and adolescence. Additional criteria for selection of published studies included direct cognitive and, or behavioral treatment of individuals aged 0–19 and inclusion of subjects with an ABI and no prior identified congenital diagnosis. Forty studies were identified that appeared to meet established criteria. Of these studies, 10 were excluded because they did not involve actual application of a behavioral or cognitive treatment. Another study was excluded because it involved treatment of both children and adults, and the number of individuals younger than 19 was insufficient, at less than 30%.[7] A second treatment study was excluded because of the subject diagnosis not qualifying for this review.[8] The remaining 28 studies were included in this review, and described diverse cognitive and behavioral treatment techniques, as would be expected given the range of services provided to children and adolescents post-ABI. The studies were reviewed using the following strategy: (1) studies were divided into 4 treatment domains: comprehensive, attention and memory, speech and language, and behavior; (2) 2 members of the team reviewed studies in each domain and completed the data extraction form, and the first author reviewed all studies to resolve disagreements; (3) an evidence-based summary table was created using the data extraction form. The data extracted from each study included overall treatment focus, specific characteristics of the treatment, nature of the comparison group, characteristics of subjects in each condition, research setting, identification of the outcome measurements employed, summary of treatment effectiveness, and conclusions of the study.

Studies were classified as Class I to Class IV, utilizing the following criteria. Class I, II, and III studies were controlled trials, while Class IV studies involved no control group and utilized individual case studies or clinical case series. Classification as a Class I study required a prospective, randomized controlled trial, with masked outcome assessment, in a representative population.[9] Class II studies also included prospective, matched group cohort studies, but without a "masked" outcome. In addition, if the study was found to lack a clearly defined primary outcome, exclusion/inclusion criteria, adequate accounting of dropouts, or sufficient matching of subjects, the potential Class I study was downgraded to Class II. Studies involving well-defined natural history controls or patients serving as their own controls were classified as Class III when the outcome was independently assessed and derived from an objective outcome measurement.

The standard proposed in the *Clinical Practice Guideline Process Manual* requiring evidence from 2 Class II studies, or 1 Class I study, to be able to make a specific *treatment recommendation* was used.[9] In addition, the use of evidence from an identical study in a similar population was used to support a *practice option* in 1 Class II study, given the limited number of pediatric studies available.

ANALYSIS OF EVIDENCE

An evidence table was created on the basis of systematic review (Table 1). In addition, studies in each treatment domain are reviewed separately below.

Comprehensive treatment studies

Eight published studies met the characteristics of integrated-comprehensive cognitive rehabilitation studies; 1 Class I, 2 Class II, 1 Class III, and 4 Class IV studies. Many of these studies involved metacognitive training in domains such as memory, attention, and problem solving.[10–12] Given that they were comprehensive in treatment, rather than solely focusing on executive functioning, they were classified as comprehensive treatment studies.

TABLE 1 *Evidence-based classification of 28 studies meeting criteria**

Classification of study	Author names	Year of publication	Total number of subjects	Significance of results, Y/N
Comprehensive treatment				
Class I	Braga	2005	72	Y
Class II	Ponsford	2001	61	Y
	Light	1987	42	Y
Class III	Suzman	1997	4	Y
Class IV	Brett Burke	1998	10	Y
	Crowley	1990	17	Y
	Glang	1991	16	Y
		1992	3	Y
Attention/memory				
Class I	—	—	—	—
Class II	Van't Hooft	2005	38	Y
	Butler	2002	31	Y
Class III	Wilson	2001	12	Y
	Franzen	1996	3	Y
Class IV	Van't Hooft	2003	3	Y
	Kerns	1998	1	Y
	Bulter	1998	1	Y
	Lawson	1989	1	Y
Speech/language/academic				
Class I	—	—	—	—
Class II	Thomas-Stonell	1994	12	Y
Class III	—	—	—	—
Class IV	Chapman	2005	5	Y
	Oberg	1998	2	Y
	Wiseman-Hakes	1998	6	Y
Behavioral treatment				
Class I	—	—	—	—
Class II	—	—	—	—
Class III	Mottram	2004	7	Y
	Selznick	2000	3	Y
	Feeney	1995	3	Y
Class IV	Gardner	2003	2	Y
	Feeney	2003	2	Y
	Slifer	1996	6	Y
	Slifer	1997	3	Y
	Silver	1994	1	Y

*Y indicates clinical or statistic significance in outcome(s); see the text for all details.

The Class I study[13] was conducted on 72 children with moderate to severe TBI, ages 5–12 years, who were 6 to 30 months postinjury. Participants were randomly assigned to either a control group to which rehabilitative interventions were delivered by clinicians or a second group to which rehabilitative interventions were delivered by family members under the supervision of clinicians (SARAH program). Both groups received intensive rehabilitation for 1 year, with cognitive outcomes assessed by the WISC-III and functional outcomes assessed by the SARAH scale. The SARAH approach, utilized in Brazil, is a family-centered ecological treatment modality that emphasizes family participation at every phase of rehabilitation. Inherent within this approach is a 2-week intensive training program, followed by the development of individualized ecologically relevant educational and illustrative intervention manuals. The control group received intensive standard clinic-based rehabilitation provided by clinicians for 2 hours per day, 5 days per week.

The results of this study demonstrate that, although both groups benefited from intervention, only children receiving the family-based SARAH method made statistically significant gains on both the cognitive measure (WISC-III) and the functional SARAH scale, the 2 outcome measures included in the study. This finding was not impacted by the family's level of education. This study offers evidence that families can be trained and

supported in the delivery of rehabilitative interventions for their children with brain injury, using an ecologically valid comprehensive family-centered approach, and that therapies delivered by the family can indeed be effective in developing the desired cognitive and functional improvements. Although the results of this study are compelling, the authors note that it did not assess impairments in social, behavioral, or executive functioning. Also, the level of intensity of the treatment provided and the potential role of Brazilian culture in the study's outcomes are important to investigate through replication studies in other populations.

The emphasis on the early engagement and education of family members regarding the extent and nature of their child's ABI is underscored in a Class II study. Ponsford et al[14] studied the effect of providing information booklets describing symptoms common to mild traumatic brain injury (MTBI) and suggestions and strategies for coping with them, to MTBI patients (ages 6–15 years) and their families. Two MTBI groups were studied and compared with 2 control groups of children who had minor traumatic injuries without a head injury. One MTBI group ($n = 61$) was provided the booklet, while the other MTBI group ($n = 58$) received only emergency department treatment. All participants were assessed on measures of neuropsychological, behavioral, postconcussive symptoms, and adaptive behavior measures 3 months postinjury. But the MTBI group receiving the intervention booklet and one control group were assessed at both 1 week and 3 months postinjury to evaluate testing practice effect. The authors report that, at 3 months postinjury, behavioral symptoms and cognitive difficulties had significantly improved in both MTBI groups overall. Furthermore, the booklet resulted in a statistically meaningful impact on 3 adaptive behavior inventories when compared to the nontreated MTBI group at 3 months postinjury. The researchers concluded that the provision of an information booklet early in treatment can help minimize parental and child stress, and reduce the frequency with which they misattributed MTBI-related symptoms to other causes.

The second Class II study reviewed[15] investigates the effectiveness of a cognitive reeducation program, the Neurocognitive Education Program (NEP), on neuropsychological, academic, and adaptive/behavioral functioning post-ABI. The program is specifically geared toward assisting children with acquired brain injuries in adjusting to, and compensating for, their learning deficits, as they transition back to schools. The NEP was designed to supplement the academic curriculum by facilitating the child's level of motivation and ability to learn. Problem-solving, metacognitive strategies, and tutoring were built into the NEP to facilitate transfer of learning into the classroom setting. Forty-two children who were at least 1-year post-ABI participated in this study. Following an initial evaluation, educational specialists met with each tutor to review the testing data and, with the assistance of a neuropsychologist, developed intervention strategies tailored to each child's unique needs. A total of 15 children with ABI who received the NEP interventions were compared with 6 children with ABI who did not participate in the NEP, and 21 normal controls. Levels of cognitive, behavioral, academic, and adaptive functioning were assessed. At the time of follow-up assessment, both ABI groups had improved on most neuropsychological measures, relative to their respective baseline scores; however, the improvements observed were not significant. Statistically significant differences, found in both groups, were on measures of simultaneous processing and expressive vocabulary. Adaptive behavior and functional communication measures also improved in both groups with greater improvements in the intervention group than in the comparison group. The authors acknowledge that analyses should be interpreted as preliminary, as the study is confounded by the potential impact of unblinded evaluators, small sample sizes, lack of randomization, and the possibility of spontaneous recovery in the subjects.

The Class III study reviewed[10] consisted of using a multicomponent cognitive-behavioral training program to rehabilitate 5 children with a history of moderate to severe ABI with subsequent deficits in problem-solving skills. The cognitive rehabilitation program consisted of metacognitive training, self-instruction, self-reinforcement, self-regulation, and attribution training. Students were taught to use these skills while doing computerized programs involving problem solving. At the end of the training program, improvement on standardized neuropsychological measures of problem solving was seen. The authors cautiously reported evidence of generalization of metacognitive skills to new and challenging problem-solving tasks.

In a Class IV study, Crowley and Miles[11] customized interventions to train mathematical computation skills in a 16-year-old male. Through the use of dynamic ongoing assessment while the participant engaged in the cognitive task, strategies were modified to improve self-awareness, maturation, and error detection. A second Class IV study[16] tailored interventions to meet the unique needs and underlying component skills or cognitive deficits of an academic task with elementary school children with ABI, using direct instruction techniques (consisting of a task analysis and the application of cognitive-behavioral techniques, such as modeling, shaping, and positive reinforcement of accurate responses). Results indicated that a tailored direct education approach was successful in assisting children with ABI to acquire academic and behavioral skills such as self-management. A third Class IV study[12] involved the provision of cognitive rehabilitation, within

the school environment, to 10 high school students who were 1 to 16 years post-ABI. The students received an individualized program of cognitive rehabilitation on a biweekly basis for 20 weeks by school teachers who were trained and supervised by cognitive rehabilitation psychologists, using a developmental rehabilitation model with a focus on metacognitive strategies. Postintervention results of neuropsychological testing demonstrated a small but statistically significant improvement in verbal memory. This study suggests that cognitive rehabilitation can be brought into the natural setting (ie, school), underscoring the utility of "training the trainers" (ie, teachers) in the delivery of context-specific cognitive rehabilitation, and the potential of dramatically increasing accessibility of services to children with ABI. The final Class IV study by Burke et al[17] investigated the effectiveness of an integrated comprehensive program of cognitive rehabilitation for 17 children with moderate to severe brain injuries who demonstrated behavioral and cognitive problems. Following an initial assessment, participants received a range of therapies during their inpatient stay, including cognitive therapy, applied behavior analysis, special education, social skills, and problem-solving training. The program also addressed issues related to community reentry. Outcome data revealed that most participants (53%) were discharged to home and were attending a public school.

Braga et al[13] presented Class I evidence of a comprehensive, family-centered rehabilitation program, allowing a *Practice Guideline* involving family members as treatment providers (Table 2). In addition, a *Practice Option* concerning the use of informational booklets in the acute phase of TBI rehabilitation (Table 2) is supported by 2 studies by Ponsford et al. The Ponsford study reviewed here[14] explored the use of such an intervention with children with MTBI, and is supported by their study of the same intervention used with adult survivors of MTBI.[20]

Attention/memory studies

Eight studies that involved the evaluation of cognitive interventions for attention and memory were reviewed and classified. There were no Class I studies, 2 Class II studies, 2 Class III studies, and 4 Class IV studies.

The first Class II study, performed by van't Hooft et al,[19] studied children status after the brain tumor treatment. Eighteen experimental subjects were given the Amsterdam Memory and Training Program for children (Amat-c) 30 minutes per day, over a 17-week period. The experimental group was compared on measures of memory and attention with a group of 20 control subjects who were involved in interactive activity with supportive adults of equal length and intensity, but no directed remediation. The subjects were randomly assigned to the groups, but a blind masked outcome evaluation procedure was not described. Statistically significant improvement within the experimental group was demonstrated on sustained and short-term attention tests and a delayed word memory test, compared to no changes in the control group. Significant changes were not seen in both groups on a measure of reaction time and immediate recall of words. A second Class II study by Butler and Copeland[18] looked at an experimental group of 21 child and adolescent postradiation cancer survivors, including 10 subjects with status post brain tumor treatment, who participated in a Cognitive Remediation Program (CRP) consisting of approximately 50 hours of treatment, over the course of 6 months, utilizing attention process training, metacognitive strategies, and cognitive-behavioral therapy. The control group consisted of a nonrandomized cohort group of

TABLE 2 *Evidence-based recommendations for treatment of children and adolescents post-ABI*

Domain	Practice guideline	Reference
Attention and memory	Service providers of children and adolescents with acquired brain injury (ABI) should consider providing attention remediation to assist recovery	Bulter and Copeland[18] van't Hooft et al[19]
Comprehensive	Providers of comprehensive rehabilitation serving children and adolescents with ABI should consider the involving family members as active treatment providers in the rehabilitation treatment plan.	Braga et al[13]
	Practice option	
Comprehensive treatment	Parents or guardians of children who are seen in an emergency department would most likely benefit from an information booklet concerning the effects and symptoms of traumatic brain injury	Ponsford et al[14] Ponsford et al[20]

10 post-radiation cancer survivors, including 6 subjects with status post brain tumor treatment who were on a waiting list for CRP training or lived too far away to participate as a control. Following treatment there was statistically significant higher performance within the CRP training group on the Digit Span Test, Sentence Memory, and Continuous Performance Test, but an arithmetic computational measure was equivalent between the 2 groups. Given that the subjects were a mean of 4.0 years posttreatment, spontaneous recovery is not expected to be a significant factor in the demonstrated improvement but the study is limited by lack of randomization of subjects into treatment and control groups.

One of the Class III studies involved a subgroup of 12 pediatric and adolescent subjects within a larger study of persons across a wide age range. A randomized control crossover design was used to look at reducing everyday memory and planning problems using a compensatory paging system.[21] Some subjects received 7 weeks of training in the use of a pager system after a 2-week baseline, while others were required to wait 7 weeks after baseline and served as controls during their wait period. Outcome was based on subjects either rating themselves or being rated by care givers on accuracy of achieving their target goals. All subjects made significant gains in reported target accuracy after receiving training in use of the pager. Sustained accuracy of performance was also reported in 75% of the cases while using the pager overtime. In the other Class III study,[22] an evaluation was conducted of 2 cognitive training strategies for reading comprehension (the PQRST method and a metacognitive reading comprehension technique) with 2 students with brain injury. The 2 subjects with ABI received both methods of training, while a control nonimpaired subject also received training in both methods. The 2 students with ABI performed significantly better using the PQRST method, approaching the level of performance of the nonimpaired student, but not when the metacognitive strategy was employed.

The 4 Class IV studies were subject to interpretation limitations of single-case studies or group-case studies without control groups, that is experimental bias, selection bias, and lack of generalization. The 4 studies did demonstrate, however, that in these selected subjects or small groups, gains were possible on measures of functionality[23,24] and measures of attention and memory.[23–26]

In similar Class II treatment studies, Butler and Copeland[20] described a treatment involving Attention Process Training (APT) developed by Solberg and Mateer,[27] and van't Hooft et al[19] described AMAT-c as developed from the same source. Butler and Copeland[18] combined APT with metacognitive strategies from the education field and AMAT-c was described as a "modified" APT approach. This provides sufficient evidence to develop a *Practice Guideline* involving attention remediation for children and adolescents with ABI (Table 2).

Speech and language studies

Of the 4 studies identified in this review as addressing a range of speech, language, and academic impairments, one was a Class II study and three were Class IV studies. The Class II study[28] involved 12 TBI adolescents who were randomized into a standard educational environment, supplemented by conventional rehabilitation, or a computer-assisted cognitive remediation program designed to enhance cognitive-communication skills with clinician support. After 8 weeks of treatment, only the group that received computerized rehabilitation experienced significant improvements on a broad, standardized battery of cognition and speech and on anecdotal teacher reports. The study involved unmasked outcome measures, but supports the use of a computerized program to enhance language skills. Three speech and language studies were classified as Class IV.[29–31] In these studies, the subjects were all adolescents between the ages of 13 and 19 years. Oberg and Turkstra[29] evaluated the effects of encoding to facilitate verbal learning in 2 adolescent subjects with severe memory impairment following a TBI. They found significant improvement in expressed word knowledge at the conclusion of the therapy and 1 month later, suggesting that this technique may be effective for teaching specific information required in schools. Chapman et al[30] investigated precision teaching and fluency training across academic, communicative, physical, and academic tasks in 5 children with TBI. All 5 subjects achieved significant improvement from fluency training intervention. In addition to skill acquisition, all subjects also demonstrated increased self-esteem and satisfaction by the immediate feedback that they received. Wiseman-Hakes et al[31] evaluated the effectiveness of peer group training to improve pragmatic communication skills for 6 subjects (14–17 years) with ABI, with Rancho Los Amigos Scale scores of IV or more.[32] Findings from this study suggest that a group setting or peer group may be beneficial for treating adolescents with these difficulties.

Behavioral treatment studies

Eight studies, 3 Class III and 5 Class IV studies, were reviewed, which addressed interventions for behavioral targets post-ABI. All of the studies reviewed utilized the single-subject design (SSD) methodology, standard in the field of applied behavior analysis.

One of the Class III studies[33] utilized an A-B-C-A study design to assess the effectiveness of interventions at the antecedent level and the resulting outcome of behavior with 3 severely TBI male adolescents. The goals of the interventions were to reduce the number and

intensity of challenging or aggressive behaviors displayed, and to increase the percentage of completed assigned work. Interventions included task analyses conducted with the subjects, the provision of photographic and written cues for desired behaviors, verbal rehearsal of plans, and a review of their performance. Improvements in frequency counts of target behaviors were reported during the interventions phases, but gains were lost when the treatment (picture/verbal routine) was withdrawn. The study provides support for the use of antecedent cueing interventions in managing problematic behaviors in adolescents with TBI to facilitate behavior change.

Another class III study[34] explored the use of a package of operant techniques, including classroom rules and a token economy, in targeting disruptive behaviors in 3 male children with ABI in comparison with 5 children with congenital disabilities, using a multiple baseline approach. Results demonstrated that the package intervention worked quickly and convincingly, and was maintained at follow-up. Effect sizes for the control groups suggested no change. Nevertheless, Mottram and Berger-Gross provided 3 additional disruptive children, and 2 control children, in comparison groups to further the power of their findings. While their findings suggest the efficacy of the behavioral package, it is impossible to determine the effectiveness of separate elements of the package and the effects were confined to the classroom.

In a third Class III study,[35] the researchers provided intervention at the process level, using antecedent cueing. A concurrent multiple baseline design was used, where each subject served as his or her own control. The authors explore the efficacy of providing training in self-monitoring techniques to 3 subjects with ABI to increase on-task behaviors, productivity, and accuracy while completing math problems in a private school setting. The intervention involved skill training and audio cues to self-monitor. Improvements were reported in on-task behaviors with the institution of the self-monitoring techniques, and improvements were maintained after fading and later at follow-up. The study provides preliminary evidence to suggest that training brain-injured individuals in self-monitoring can be done successfully and may be productive in improving on-task behavior.

Five Class IV studies explored the utility of interventions at the antecedent and/or consequence level of behavior in children with ABI. One[36] explored operant conditioning techniques (eg, differential reinforcement of appropriate behaviors, verbal praise, token economy, extinction, and response costs) to manage disruptive behavior in 6 children (5 post-TBI and 1 diabetic coma) who were still in PTA. Another[37] was a case study of a severely brain-injured 12-year-old female, postanoxic injury, utilizing positive reinforcement techniques for the completion of ADLs including toileting, dressing, and undressing. A third Class IV study[38] utilized a nonconcurrent multiple baseline design to assess the effects of an antecedent environmental manipulation and an operant conditioning-based compliance training intervention with 3 adolescent females with PTA. The goals of the intervention were to increase therapy attendance and decrease disruptive behaviors in therapies. The fourth Class IV study[39] explored the use of a "multicomponent" approach, including functional assessment, antecedent control procedures, functional communication training, and positive reinforcement in decreasing aggressive behaviors, incidents of property destruction, and "other problematic behaviors" in 2 adolescent males attending a residential school. A reduction in the frequency counts of the targeted behaviors, increased use of alternative communicative responses, and decreased need for the use of physical restraints was seen in this study. The final Class IV study[40] also explored a multicomponent approach utilizing environmental supports in the classroom to manage disruptive behaviors arising from escape behaviors secondary to poor performance and low reinforcement rates. Interestingly, they also used an intervention (Goal-Plan-Do-Review method) to increase subject input and control over environmental demands. Overall, it appears that multicomponent interventions are effective in reducing disruptive behaviors and improving social functioning.

CONCLUSIONS

While 3 practice recommendations were developed in this review (Table 2), there remains a great need for experimentally derived, prospective studies with randomly assigned experimental-control groups and masked outcome measures in this domain of study. Furthermore, development of psychometrically sound cognitive and behavioral assessment tools for children and adolescents will facilitate accurate measurement of functional gains. Studies also need to make an effort to define and categorize treatment methods relative to the type and nature of the brain injury. Studies should try to consider how developmental factors impact the nature of rehabilitation treatment and recovery. Still, in all domains of this evidence-based review, methodological inadequacies were found. Most surprising was the lack of verifiable masked outcome evaluations. In addition, in the behavior treatment studies, there is a significant need for independent observers and outcomes measures, more consistency in patient samples, and better control of potential confounding variables.

Single-case studies, case series, and SSD studies are extremely valuable in defining the details of the treatment, effects on specific populations, duration and intensity of a treatment, and appropriate outcome measurement tools. While randomized controlled studies are generally

dependent on public and private funding, this review has highlighted very promising, effective techniques within the classification of Class II, III, and IV studies. To more quickly move forward the field of study regarding post-ABI treatment in children and adolescents, larger multisite studies of systematic treatment are recommended. Further work is needed, however, to prepare for larger multisite studies, and should include duplication and further exploration of treatments outlined in the effective Class II–IV studies reviewed.

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