Long-Term Behavioral Outcomes after a Randomized, Clinical Trial of Counselor-Assisted Problem Solving for Adolescents with Complicated Mild-to-Severe Traumatic Brain Injury

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Abstract

Family problem-solving therapy (FPST) has been shown to reduce behavior problems after pediatric traumatic brain injury (TBI). It is unclear whether treatment gains are maintained. We sought to evaluate the maintenance of improvements in behavior problems after a Web-based counselor-assisted FPST (CAPS) intervention compared to an Internet resource comparison (IRC) intervention provided to adolescents within the initial year post-TBI. We hypothesized that family socioeconomic status, child educational status, and baseline levels of symptoms would moderate the efficacy of the treatment over time. Participants included 132 adolescents ages 12–17 years who sustained a complicated mild-to-severe TBI 1–6 months before study enrollment. Primary outcomes were the Child Behavior Checklist Internalizing and Externalizing Totals. Mixed-models analyses, using random intercepts and slopes, were conducted to examine group differences over time. There was a significant group $\times$ time $\times$ grade interaction ($F_{(1,304)}=4.42$; $p=0.03$) for internalizing problems, with high school–age participants in CAPS reporting significantly lower symptoms at 18 months postbaseline than those in the IRC. Post-hoc analyses to elucidate the nature of effects on internalizing problems revealed significant group $\times$ time $\times$ grade interactions for the anxious/depressed ($p=0.03$) and somatic complaints subscales ($p=0.04$). Results also indicated significant improvement over time for CAPS participants who reported elevated externalizing behavior problems at baseline ($F_{(1, 310)}=7.17$; $p=0.008$). Findings suggest that CAPS may lead to long-term improvements in behavior problems among older adolescents and those with pretreatment symptoms.

Key words: adolescent; behavior; brain injury; child; online; therapy

Introduction

Behavior problems during the initial 12–18 months after traumatic brain injury

A RECENT REVIEW¹ HIGHLIGHTS the relatively high incidence of both externalizing and internalizing behavior problems after childhood traumatic brain injury (TBI), including attention-deficit/hyperactivity disorder, oppositional behaviors, and depression. Although some problems emerge over time, most studies suggest that new-onset psychiatric disorders emerge during the

initial 6–12 months postinjury with some subsequent recovery.^{2–4} Thus, behavioral interventions delivered during the initial months postinjury may be successful in both ameliorating existing behavior problems and preventing the emergence of additional difficulties.

Problem-solving interventions for pediatric traumatic brain injury

Evidence-based treatments to improve behavioral outcomes after pediatric TBI remain rare.⁵ However, a series of recent studies support the potential efficacy of parent skills training for improving

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behavioral outcomes after acquired brain injuries in young children.⁵⁻⁷ With respect to adolescents, mounting evidence from both the pediatric and adult literature supports the potential utility of problem-solving therapy for remediating deficits post-TBI.⁸⁻¹³ A series of small, randomized, clinical trials (RCTs) comparing family problem-solving therapy (FPST) to treatment as usual or access to Internet resources on brain injury documented significantly greater improvements in both internalizing and externalizing behavior problems in the FPST group immediately post-treatment. However, the benefits of FPST varied as a function of the child's age and the family's income, with older children and those from less economically advantaged backgrounds receiving FPST demonstrating greater improvements in behavioral symptoms post-treatment.^{8,10} These findings support the efficacy of FPST in reducing behavior problems post-TBI in lower-income and older children/adolescents, but fail to shed light on maintenance of treatment effects and whether benefits for younger children may emerge over time.

A recent study¹⁴ reported results from a large, randomized trial comparing the efficacy of counselor-assisted problem solving (CAPS), a form of FPST, versus access to Internet resources (Internet resource comparison; IRC) in improving behavioral outcomes immediately post-treatment in 132 children, ages 12-17 years, with complicated mild-to-severe TBI. Results indicated significant reductions in externalizing behavior problems among high school-age participants in the CAPS intervention, whereas there were no group differences among younger participants. Conversely, parents of high school-age participants in both treatment groups reported significant improvements in internalizing behavior problems from baseline to post-treatment. Again, no improvements were observed among younger participants. The present study extends these findings by examining the maintenance of treatment effects in this cohort during the initial 12 months post-treatment completion and examining the moderating role of family socioeconomic status (SES) on treatment response. We hypothesized that both family SES and the child's educational status (high school vs. middle school) would moderate the efficacy of the CAPS treatment over time. Specifically, we anticipated that adolescents from lower-SES families and those in high school would demonstrate greater improvements in both internalizing and externalizing behavior problems. To our knowledge, this is the largest study of FPST for pediatric TBI to date and the first to examine maintenance of treatment effects for a full year after treatment completion.

Methods

Participants

This clinical trial was registered with clinicaltrials.gov (assigned identifier: NCT00409448). The study was conducted at five major trauma centers in the Central and Western regions of the United States and was approved by the institutional review board of each of institution. Eligibility criteria included age between 12 and 17 years and overnight hospitalization for a complicated mild-to-severe TBI¹⁴ within the previous 1-6 months. Eligibility requirements included documented alteration of neurological functioning as measured by a Glasgow Coma Scale (GCS) score less than 13 or evidence of neurological insult based on imaging findings documenting a TBI-related intracranial lesion (depressed skull fracture, subdural/epidural/subdural/subarachnoid hemorrhage) or intraparenchymal abnormality (contusion, hemorrhage, diffuse abnormality such as edema, or diffuse axonal injury) as observed on magnetic resonance imaging or computerized tomography, English as the primary language spoken in the home, availability of the

adolescent to participate in the intervention, and family residence within a 3-h drive of the hospital. Exclusionary criteria included: 1) insufficient recovery to participate in the intervention (e.g., was in a minimally responsive state); 2) psychiatric hospitalization for child or parent during the year preceding the injury; 3) residence in an area without high-speed Internet access; 4) child residence outside the home (e.g., detention facility); or 5) diagnosis of significant intellectual disability before the injury. As detailed in Figure 1 depicting the CONSORT flow chart, 52 potential participants were excluded after screening owing to failure to meet one or more of the inclusion/exclusion criteria.

Baseline and follow-up assessments

After obtaining informed consent from the parents and assent from the teen, study personnel completed the baseline assessment at the family's home. During this assessment, the primary caregiver provided demographic and background information and completed parent-report measures of child behavior problems. As detailed elsewhere,¹⁴ each family was given a new computer, Web camera, and high-speed Internet access along with the links to TBI resources on the Web. Follow-up assessments were completed immediately post-treatment (6 months postbaseline) and at 6 and 12 months post-treatment, and included the same behavioral assessments that were administered at baseline.

Participating families were randomly assigned to one of two Internet-based interventions: 1) CAPS, a 6-month Web-based, family-centered intervention that focuses on problem solving, communication, and self-regulation, and 2) IRC group, a comparison group that received a self-guided, information-based program. Randomization was stratified on race and gender. Strata were nonwhite females, white females, nonwhite males, and white males within each site. A SAS program was created using permuted block sizes for each of the randomizations. A sealed envelope with the family's group assignment was handed to participants at completion of the baseline visit. In this fashion, group assignment was concealed from the research coordinators completing the assessments.

Treatment groups

Counselor-assisted problem solving intervention. Four clinical psychologists served as the counselors in the CAPS program. A detailed treatment manual (available from the first author) provided detailed session objectives. All therapists participated in weekly supervision calls throughout the course of the project to maintain treatment fidelity. Adherence to session objectives was verified by end-of-session checklists completed by the psychologists and participating parents.

Participants in the CAPS group had an initial face-to-face session with the psychologist in the family's home. This 90-min meeting included a background interview, overview of the program, and identification of child and family goals. The family was also taught to log onto the CAPS website and access available treatment modules and to log onto Skype for the subsequent videoconference sessions.

Subsequent CAPS sessions were completed online and consisted of a self-guided online portion and subsequent synchronous Skype sessions with the therapist. During Skype sessions, the therapist reviewed skills and employed the problem-solving process to develop a plan to address a family-identified goal. The teen with TBI and one parent or caregiver were required to participate in each of the eight core sessions and both parents and school-age siblings, when present in the home, were also encouraged to participate.¹⁴

Internet resource comparison intervention. IRC families received access to a home page with links to online resources, but not access to the CAPS content. Resources included links to local, state, and national brain-injury associations and to sites specific to

FIG. 1. CONSORT flow diagram.

pediatric brain injury, such as the Center on Brain Injury Research and Training, Brain Injury Partners, and the National Database of Educational Resources on Traumatic Brain Injury. IRC families were instructed to spend 1 or more hours per week visiting these online resources and to track the sites that they visited. At follow-up, parents provided information about the TBI-related websites visited and the time spent at each site.

Follow-up assessments

Follow-up assessments were scheduled an average of 6, 12, and 18 months after the baseline assessment and included readministration of the measures that were completed at the baseline assessment. To equate the time between baseline and follow-up assessments between groups and to maintain concealment of group assignment, follow-ups were scheduled without knowledge of whether the participant had completed the treatment protocol.

Measures

Family socioeconomic status. Census tract family income data were obtained from the 2008 census and matched to each participant based on the ZIP code of their home address at baseline. Median census tract family income was a continuous variable that served as a proxy variable of family SES in the analytic models.^{15,16}

Grade level. Grade level at baseline was dichotomized into high school (grades 9–12) or middle school (grades 6–8) for each study participant.

Behavioral outcomes. Parents/primary caregivers completed the Child Behavior Checklist (CBCL), a parental report that focuses on problematic behaviors in everyday settings. The CBCL provides Externalizing, Internalizing, and Total Behavior Problem composites, as well as a number of subscales within each domain. Composites were reported as T scores with a mean of 50 and a standard deviation (SD) of 10, with higher scores indicating more-significant behavior problems. Analyses focused on the Internalizing and Externalizing Scales. Follow-up exploratory analyses of the subscales comprising the internalizing and/or externalizing scales were conducted to elucidate the nature of the effects. Comparisons across groups for subscale scores on specific domains were reported in raw form, controlling for participant age and gender owing to the restricted range of the T scores.¹⁷

Statistical analyses

Summary statistics as well as analysis of variance and chi-square (χ^2) and Fischer's exact tests were used to compare the groups on baseline demographic, injury, and behavioral characteristics. Similar analyses were conducted to examine baseline differences between those who completed the study and those who dropped out. Mixed-models analyses for continuous variables, using random intercepts and slopes, were conducted to examine the maintenance of treatment effects over time. Mixed modeling has the advantage of retaining participants who are missing data for one or more assessments. All participants who completed the baseline assessment, regardless of whether they received the intervention or completed subsequent follow-ups, were included in the analyses. To test the primary hypotheses of the moderating effects of family SES and grade level (high school vs. middle school) on behavior, we initially modeled two separate interactions: treatment group $\times$ income $\times$ time since baseline and then treatment group $\times$ child's grade level $\times$ time since baseline. When a significant interaction was detected, post-hoc analyses were conducted to elucidate the nature of the interaction effects. Secondary analyses were conducted to: 1) test whether participants experiencing higher levels of behavior problems at baseline, as defined by a T score of 60 or above on the CBCL

Internalizing or the Externalizing Problems, showed greater improvement over time in the CAPS group, and 2) examine whether treatment dose, as defined by number of sessions, was associated with treatment response within the CAPS group. Effect sizes (presented as standardized estimates [β]) and the variance of each outcome explained by the model (presented as R^2) are reported. An alpha level of $p < 0.05$ signified significance. All analyses were conducted using SAS software (version 9.3; SAS Institute Inc., Cary, NC).

Results

Participants

A total of 444 potentially eligible participants were identified from the trauma registries at participating hospitals, among which 140 refused, 172 were unable to be contacted within the initial 6 months postinjury (timed out), and 132 completed the informed consent and were enrolled in this study. The three groups did not differ in age of injury, gender, and race; however, enrolled participants had significantly lower GCS scores than those who refused or who timed out.

Sixty-five participants were assigned to CAPS and 67 to the IRC group. Parent- and teen-reported time spent on the websites did not differ significantly by group.¹⁸ Within the CAPS group, 35% of parents were single ($n=23$), 23% ($n=15$) were married with only one parent participating, and 41% ($n=27$) were married with both parents participating. Among participants assigned to CAPS, 32 were attending high school and 33 were attending middle school at baseline. There were 40 IRC participants in high school and 27 in middle school at baseline. As indicated in Table 1, the sample was split into four groups based on treatment assignment and grade levels for descriptive purposes, although these four subsets of participants were combined in the analyses. The four groups did not differ in parent demographics or baseline behavioral problems; however, there were more males in the middle school groups than the high school groups. Not surprisingly, high school participants were older and in a higher grade. Within each grade level, treatment groups were well matched on most demographic and injury characteristics.

Three participants completed consent, but failed to complete the CBCL at baseline, and thus were excluded from subsequent analyses. Attrition was 25% at the final assessment and varied by family demographic characteristics. Dropouts had younger parents and lower family incomes and were more likely to be single-parent households. Additionally, dropouts had significantly higher levels of behavior problems at baseline (Table 2). Attrition did not vary significantly by treatment group ($\chi^2(1)=2.27$; $p=0.132$). CAPS participants completed an average of eight sessions (range, 0–13). Within CAPS, the number of sessions completed was unrelated to improvements in internalizing symptoms over time. However, total sessions completed moderated improvements in externalizing symptoms, with those completing more sessions reporting less improvements in externalizing symptoms at visits 3 and 4.

The moderating effect of income by treatment group over time was not significant on either externalizing ($F_{(1,309)}=0.04$; $p=0.84$) or internalizing problems ($F_{(1,312)}=0.13$; $p=0.71$). Results also indicated no significant treatment group by time by grade-level interactions ($F_{(1,302)}=0.67$; $p=0.41$) or group $\times$ time interactions for externalizing symptoms. However, mixed-effect models analyses examining internalizing behavior problems on the CBCL revealed a significant group $\times$ time $\times$ grade interaction ($F_{(1,304)}=4.42$; $p=0.03$). Among high school participants, the CAPS group demonstrated a steady decrease in internalizing problems over time (from a high of

TABLE 1. SAMPLE CHARACTERISTICS BY GROUP AND GRADE LEVEL

Characteristic	High school		Middle school		p value ^a
	CAPS (n = 32)	IRC (n = 40)	CAPS (n = 33)	IRC (n = 27)	
Patient					
Injury severity, <i>N</i> (%)					0.12
Moderate	15 (46.9)	25 (62.5)	25 (75.8)	16 (59.3)	
Severe	17 (53.1)	15 (37.5)	8 (24.2)	11 (40.7)	
Ethnicity, <i>N</i> (%)					0.84
Hispanic or Latino	1 (3.1)	2 (5.0)	1 (3.0)	2 (7.4)	
Not Hispanic or Latino	31 (96.9)	38 (95.0)	32 (97.0)	25 (92.6)	
Race, <i>N</i> (%)					0.79
White	26 (81.2)	32 (80.0)	26 (78.8)	22 (81.5)	
Black or African American	3 (9.4)	7 (17.5)	4 (12.1)	4 (14.8)	
More than one race	3 (9.4)	1 (2.5)	3 (9.1)	1 (3.7)	
Sex, <i>N</i> (%)					< .01
Male	15 (46.9)	21 (52.5)	29 (87.9)	21 (77.8)	
Female	17 (53.1)	19 (47.5)	4 (12.1)	6 (22.2)	
Age, mean (SD)	16.1 (1.2)	16.1 (1.2)	13.4 (0.7)	13.3 (1.0)	< .01
Grade return, mean (SD)	10.0 (1.1)	9.9 (1.4)	7.1 (0.7)	7.3 (0.9)	< .01
Parent					
Ethnicity, <i>N</i> (%)					0.22
Hispanic or Latino	0 (0.0)	2 (5.0)	1 (3.0)	3 (11.1)	
Not Hispanic or Latino	32 (100.0)	38 (95.0)	32 (97.0)	24 (88.9)	
Race, <i>N</i> (%)					0.58
White	27 (84.4)	33 (82.5)	28 (84.9)	23 (85.2)	
Black or African American	4 (12.5)	7 (17.5)	3 (9.1)	4 (14.8)	
More than one race	1 (3.1)	0 (0.0)	2 (6.1)	0 (0.0)	
Relation to child, <i>N</i> (%)					0.26
Biological mother	25 (78.1)	32 (80.0)	29 (87.9)	25 (92.6)	
Not biological mother	7 (21.9)	8 (20.0)	4 (12.1)	2 (7.4)	
Marital status, <i>N</i> (%)					0.29
Married	22 (68.8)	22 (55.0)	20 (60.6)	18 (66.7)	
Not married	10 (31.2)	18 (45.0)	13 (39.4)	9 (33.3)	
Education, <i>N</i> (%)					0.18
Less than 2 years of high school	2 (6.3)	1 (2.5)	0 (0.0)	0 (0.0)	
At least 2 years of high school	1 (3.1)	2 (5.0)	2 (6.1)	0 (0.0)	
High school diploma/GED	10 (31.2)	18 (45.0)	11 (33.3)	12 (44.4)	
Two years of college	11 (34.4)	12 (30.0)	14 (42.4)	4 (14.8)	
Bachelor's degree	5 (15.6)	5 (12.5)	4 (12.1)	6 (22.2)	
Graduate or professional degree	3 (9.4)	2 (5.0)	2 (6.1)	5 (18.5)	
Age, mean (SD)	42.6 (8.4)	43.8 (6.30)	41.2 (6.1)	41.4 (6.5)	0.39
Income, <i>N</i> (%)					0.80
< \$40,000	10 (31.3)	19 (47.5)	12 (36.4)	11 (40.7)	
\$40,000–\$89,999	14 (43.8)	12 (30.0)	11 (33.3)	8 (29.6)	
> \$90,000	8 (25.0)	9 (22.5)	10 (30.3)	8 (29.6)	
Behavioral characteristics					
CBCL Externalizing at baseline, mean (SD)	53.8 (10.8)	54.9 (10.5)	51.7 (9.2)	52.7 (10.9)	0.13
CBCL Internalizing at baseline, mean (SD)	53.9 (10.6)	55.7 (10.0)	49.8 (10.3)	55.2 (13.0)	0.59

^ap values are based on chi-square tests for discrete characteristics and analysis of variance for continuous characteristics.

CAPS, counselor-assisted problem solving; IRC, Internet resource comparison; GED, General Educational Development; SD, standard deviation; CBCL, Child Behavior Checklist.

53.4 at baseline to a low of 49.0 at visit 4), whereas the average for the IRC group remained relatively flat (baseline score = 55.4 to visit 4 score = 54.6). As depicted in Figure 2, CAPS high school participants were significantly better at visit 4 than their IRC counterparts ($t = -2.06$; $p = 0.04$). Treatment differences for middle school participants were not significant. Both groups reported a decrease in internalizing problems over time.

Post-hoc analyses examining the subscales comprising the internalizing total revealed significant interactions of group $\times$ grade $\times$ visit for both the anxious/depressed ($F_{(1, 308)} = 4.60$; $p = 0.03$) and somatic complaints ($F_{(1, 306)} = 4.40$; $p = 0.04$) subscales, but not for withdrawn/depressed ($F_{(1, 309)} = 0.72$; $p = 0.40$). Whereas there was a moderating effect of grade level on the anxious/depressed subscale, contrasts of CAPS and IRC participants in high school and middle

TABLE 2. COMPARISON OF COMPLETERS VERSUS DROPOUTS

	<i>Dropped out (n = 33)</i>	<i>Completed (n = 99)</i>	<i>p value</i>
Patient			
Treatment group, <i>N (%)</i>			0.13
CAPS	20 (30.8)	45 (69.2)	
IRC	13 (19.4)	54 (80.6)	
Injury severity, <i>N (%)</i>			0.12
Moderate	24 (29.6)	57 (70.4)	
Severe	9 (17.7)	42 (82.3)	
Ethnicity, <i>N (%)</i>			0.63
Hispanic or Latino	1 (16.7)	5 (83.3)	
Not Hispanic or Latino	32 (25.4)	94 (74.6)	
Race, <i>N (%)</i>			0.12
White	23 (21.7)	83 (78.3)	
Black or African American	8 (44.4)	10 (55.6)	
More than one race	2 (25.0)	6 (75.0)	
Sex, <i>N (%)</i>			0.83
Male	21 (24.4)	65 (75.6)	
Female	12 (26.1)	34 (73.9)	
Grade level			1.00
Middle school	15 (25.00)	45 (75.00)	
High school	18 (25.00)	54 (75.00)	
Age, mean (SD)	15.1 (1.16)	14.8 (1.18)	0.36
Grade return to school postinjury, mean (SD)	8.7 (1.6)	8.6 (1.7)	0.97
Parent			
Relation to child, <i>N (%)</i>			0.22
Biological mother	30 (27.0)	81 (73.0)	
Not biological mother	3 (14.3)	18 (85.7)	
Marital status, <i>N (%)</i>			0.009
Married	15 (17.7)	70 (82.3)	
Not married	18 (38.3)	29 (61.7)	
Education, <i>N (%)</i>			0.19
High school or less	18 (30.5)	41 (69.5)	
>High school	15 (20.6)	58 (79.4)	
Age, mean (SD)	40.4 (6.6)	43.0 (6.9)	0.06
Household income, <i>N (%)</i>			0.01
<\$40,000	20 (38.5)	32 (61.5)	
\$40,000–\$90,000	8 (17.8)	37 (82.2)	
>\$90,000	5 (14.3)	30 (85.7)	
CBCL Internalizing at baseline, mean (SD)	56.2 (10.2)	52.8 (11.3)	0.15
CBCL Externalizing at baseline, mean (SD)	57.7 (7.8)	52.0 (10.6)	0.007

CAPS, counselor-assisted problem solving; IRC, Internet resource comparison; SD, standard deviation; CBCL, Child Behavior Checklist.

school revealed no significant differences at any time point. Treatment group differences by grade level over time may be owing to somatic complaints. As seen in Figure 4, CAPS high school participants were rated as having significantly lower levels of somatic complaints than those in the IRC high school group at visit 4 ($t = -2.08$; $p = 0.04$), controlling for age and gender.

Although proportionally more IRC participants (32%) scored above the clinical cutoff of 63 on internalizing problems, compared to CAPS participants (17%) at baseline, these results were not statistically significant ($\chi^2 = 3.47$; $p = 0.06$). Additionally, elevated internalizing problems at baseline ($T \geq 60$) did not moderate the efficacy of

CAPS in improving internalizing symptoms. Slightly less than one quarter of the IRC group (22%) reported externalizing scores above the clinical cutoff of 63 at baseline, compared to 17% of the CAPS group. These results were not statistically significant ($\chi^2 = 0.44$; $p = 0.50$). However, results from the secondary analysis indicated a significant improvement over time for treatment CAPS participants who reported elevated externalizing behavior problems at baseline ($F_{(1, 310)} = 7.17$; $p = 0.008$). As seen in Figure 5, post-hoc contrasts revealed significant treatment group differences at 12 and 18 months for those in CAPS with elevated externalizing behavior problems at baseline. At 12 months, CAPS participants reported a mean score of 57.8, whereas the mean score for the IRC group was 64.7 ($t = -2.56$; $p = 0.01$). There were similar findings at 18 months (CAPS mean score = 55.0; IRC mean score = 64.1; $t = -3.01$; $p = 0.003$).

Discussion

This is among the first studies to examine the maintenance of treatment effects post-FPST for adolescents with TBI. The results provide support that online FPST has beneficial effects on the internalizing behavior of older adolescents with TBI and on the externalizing behavior of those with initial subclinical elevations in symptoms that are maintained for 1 full year post-treatment. Importantly, results suggest that the full benefits of the program may not be evident immediately post-treatment, but may emerge over time. We speculate that older participants in the CAPS intervention may incorporate the problem-solving process and self-regulation skills into their repertoire of coping behaviors, thereby enabling them to respond more effectively to life challenges over time. Improvements over time among the CAPS high school participants ranged from one-thirds to two-thirds SDs, suggesting moderate treatment effects. Taken together, these findings support the utility of FPST in reducing internalizing behavior problems post-TBI among older adolescents and suggest that older adolescents may be continuing to use the strategies they learned in their daily lives. Findings also support the utility of CAPS for adolescents with initially elevated levels of externalizing symptoms.

Within high school-age participants, CAPS demonstrated trends for greater improvements on both anxious/depressed and somatic complaints subscales. Both anxious and nonanxious depression are common consequences of pediatric TBI,¹⁹ with depressive symptoms contributing to poorer school functioning²⁰ and quality of life.²¹ Considerable evidence supports the efficacy of problem-solving therapy in reducing depressive symptoms.²² Thus, interventions such as CAPS may equip older adolescents with the skills that they need to more effectively cope with the consequences of their injury. Somatic complaints and depressive symptoms are correlated and overlapping (e.g., sleep problems and fatigue). Thus, it is also possible that improvements in somatic and depressive symptoms post-CAPS also reflect improved coping and problem solving regarding the persistent somatic consequences of TBI.

Contrary to expectations, the group differences in externalizing behaviors among high school participants noted immediately post-treatment were not maintained over time.¹⁴ However, participants with subclinical elevations in externalizing behavior at baseline had significantly fewer externalizing symptoms at both 12 and 18 months postbaseline post-CAPS than those in the IRC group with initial symptom elevations. These findings suggest that CAPS may be particularly beneficial for youth who are experiencing behavioral issues shortly after injury, whereas the effects may be attenuated among youth who are coping well.

FIG. 2. Significant group $\times$ time $\times$ grade interaction ($p=0.03$). CAPS high school-age participants scored significantly lower than IRC high school-age participants at 18 months postbaseline ($p<0.05$). CAPS, counselor-assisted problem solving; IRC, Internet resource comparison; HS, high school.

Treatment dose was inversely associated with treatment response within the CAPS group, indicating that participants who were continuing to experience difficulties completed more supplemental sessions. These findings are not surprising given that overall adherence was high, with all but 5 participants completing the seven core sessions. In this context, families with unresolved issues were more likely to complete supplemental sessions, which was their intended purpose.

Consistent with previous findings,¹⁴ but contrary to current hypotheses, there were no treatment differences over time among middle school participants. It is likely that high school participants had more well-developed cognitive skills before injury that enabled them to more readily integrate the problem-solving heuristic into their behavioral repertoire. Planning skills and future orientation continue to develop into early adulthood. As a consequence, older adolescents may be better able to identify salient goals and pursue them using the skills provided via the program. Thus, the FPST

FIG. 3. Significant group $\times$ time $\times$ grade interaction ($p=0.03$). Symptom scores did not differ between the CAPS and IRC groups in high school or middle school at any time point. CAPS, counselor-assisted problem solving; IRC, Internet resource comparison; HS, high school.

FIG. 4. Significant group $\times$ time grade interaction ($p=0.04$). High school-age CAPS participants had significantly lower internalizing symptoms at 18 months postbaseline than IRC high school-age participants, after controlling for age and gender. CAPS, counselor-assisted problem solving; IRC, Internet resource comparison; HS, high school.

treatment may be better suited to supporting their autonomous decision making. However, it is worth noting that baseline levels of externalizing and internalizing behavior problems were comparable to the population means for healthy youth, suggesting relatively few problems at treatment initiation. Because attrition was higher among participants with greater baseline behavior problems, it is possible that differential attrition in the middle school participants resulted in artificially low levels of behavior problems. These floor effects may have limited our ability to demonstrate treatment effects in this age range.

We also failed to find hypothesized moderation effects of family SES on treatment efficacy on externalizing behaviors over time. This failure to find greater improvements among lower-income

FIG. 5. Significant group $\times$ time $\times$ baseline externalizing symptoms ($T>60$; $p=0.008$). CAPS participants with elevated baseline externalizing symptoms had significantly lower levels of externalizing symptoms than IRC participants with elevated baseline externalizing symptoms at both 12 and 18 months postbaseline. CAPS, counselor-assisted problem solving; IRC, Internet resource comparison; HS, high school.

TABLE 3. MULTI-VARIABLE MODELS FOR CBCL: INTERNALIZING AND EXTERNALIZING PROBLEM SCALE SCORES

Effect	Internalizing problems				Externalizing problems			
	Estimate	Standard error	t value	p value	Estimate	Standard error	t value	p value
Intercept	48.9	2.7	18.1	<0.0001	50.2	2.7	18.6	<0.0001
Grade level (middle vs. high)	−0.1	2.6	−0.02	0.98	−2.4	2.6	−0.9	0.35
Time since baseline	−2.0	1.2	−1.6	0.11	−4.2	1.1	−3.8	0.0002
Group (CAPS vs. IRC)	6.5	3.8	1.7	0.09	2.1	3.8	0.6	0.58
Income (<\$40,000 vs. >\$90,000)	8.9	3.0	2.9	0.003	8.0	3.0	2.6	0.01
Income (\$40,000–\$90,000 vs. >\$90,000)	8.2	3.3	2.5	0.01	5.0	3.3	1.5	0.13
Time since baseline *group (CAPS vs. IRC)	−2.3	1.4	−1.7	0.09	−0.8	1.2	−0.6	0.53
Group*grade level	−3.8	3.7	−1.0	0.30	1.4	3.6	0.4	0.70
Group*income (CAPS [<\$40,000] vs. IRC [>\$90,000])	−6.1	4.2	−1.4	0.16	−5.0	4.3	−1.2	0.24
Group*income (CAPS [\$40,000–\$90,000] vs. IRC [>\$90,000])	−14.7	4.3	−3.4	0.0009	−6.2	4.4	−1.4	0.16
Time since baseline * grade level (middle vs. high)	−2.5	1.4	−1.8	0.07	0.1	1.3	0.1	0.92
Time since baseline * income (<\$40,000 vs. >\$90,000)	1.5	1.3	1.2	0.23	3.4	1.2	2.9	0.004
Time since baseline * income (\$40,000–\$90,000 vs. >\$90,000)	2.1	1.2	1.7	0.08	3.1	1.1	2.8	0.005
Time since baseline * group*grade level	4.2	2.0	2.1	0.04	1.6	1.8	0.9	0.39

CAPS, counselor-assisted problem solving; IRC, Internet resource comparison.

participants in the CAPS group may be, in part, owing to baseline differences in behavior problems between low-income participants in the CAPS and IRC groups. Only the lower-income IRC participants were reported as having elevated behavior problems before treatment (mean=58.66 vs. mean=52.08 among lower-income CAPS participants). Thus, although there were significant reductions in behavior problems in both the lower-income CAPS and IRC groups, it was not possible to detect a moderation effect owing to the relatively low pretreatment scores (lack of problems) in the low-income CAPS group.

Although this was a large RCT with multiple follow-up assessments over the initial 12 months post-treatment, a number of limitations should be noted. First, assessment of behavioral improvements was based solely on parent report. Teen self-report, teacher report, or diagnostic interview regarding behavior problems/psychiatric symptoms would provide valuable additional information. Parents may be less aware of internalizing symptoms, such as anxiety and depression, and thus their ratings may represent an underestimation of the true level of internalizing problems. Given the study design, it is impossible to distinguish whether maintenance of group differences was attributable to the components of FPST (problem-solving and self-regulation training) or group differences in therapist involvement. Subsequent studies equating the treatment groups on therapist contact are needed to address this question. A strength of the study was the homogeneity of the sample with respect to time postinjury. However, further research is needed to determine whether similar maintenance of treatment effects would be observed among adolescents in the chronic phase of recovery. Finally, differential attrition among lower-income participants may limit the generalizability of the findings. Because attrition was greater among participants with higher levels of baseline behavior problems, it is possible that the current findings underestimate the efficacy of CAPS. This is particularly likely given that previous studies^{8,13} have demonstrated greater efficacy of FPST among families of lower SES and among youth with higher levels of problems at treatment entry.

Taken together, the findings suggest that FPST continues to have beneficial effects on the behavior of older adolescents and those with pretreatment externalizing symptoms across the initial year post-treatment, with emerging improvements up to 18-months postbaseline. Given the paucity of evidence-based treatments and high risk of behavioral morbidity,^{2,23,24} FPST may be a useful treatment during the early, postacute phases of recovery. Given that many treatment centers are incorporating telehealth services as part of their standard of care, it will be increasingly feasible to offer programs such as CAPS as part of standard psychosocial follow-up after adolescent TBI. Future research should seek to identify alternative treatments for younger adolescents who may be less able to benefit from an intervention focused on problem solving.

Acknowledgments

This work was supported, in part, by National Institutes of Health grant R01-MH073764 from the National Institute of Mental Health; a grant from the Colorado Traumatic Brain Injury Trust Fund Research Program, Colorado Department of Human Services, Division of Vocational Rehabilitation, Traumatic Brain Injury Program; and the Department of Education's National Institute on Disability and Rehabilitation Research (Center on Interventions for Children and Youth with Traumatic Brain Injury; grant no.: H133B090010-10). This material does not necessarily represent the policy of these agencies, nor is the material necessarily endorsed by the federal government. Clinical Trial Registration: NCT00409448.

Author Disclosure Statement

No competing financial interests exist.

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