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# Cognitive intervention results in web-based videophone treatment adherence and improved cognitive scores

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**Background:** We report findings from an intervention study using telehealth modalities to determine whether provision of telehealth services can improve access to care and increase adherence to cognitive therapy in veterans with mild traumatic brain injury (TBI) while matching traditional care in terms of outcomes.


**Material/Methods:** Veterans who were initially non-adherent to clinic-based cognitive therapy were offered a newly developed treatment. The control participants were selected from patient records of veterans who had completed cognitive treatment and matched to MOPS-VI participants on the basis of age, marital or relationship status, and composite memory index score. Baseline and post-treatment cognitive functioning as assessed by the Test of Memory and Learning 2<sup>nd</sup> Edition (TOMAL-2) was obtained for all participants. The MOPS-VI modules were designed to increase understanding of TBI and elicit problem-solving skills for attention and memory impairment.

**Results:** Sixty-seven percent of veterans (who were assigned to the MOPS-VI treatment group because they were initially non-adherent with the clinic-based treatment) completed the MOPS-VI telemedicine treatment. Results of a two-way analysis of Variance (ANOVA) comparing baseline and follow-up scores on the TOMAL-2 in the MOPS-VI and control groups revealed there was a significant pre-post assessment effect, indicating that participant's memory and learning improved after treatment for both MOPS-VI and standard treatment groups. There was no significant difference between clinic-based treatment and MOPS-VI therapy.

**Conclusions:** Preliminary evidence supports the efficacy of the treatment, defined as increased compliance in completing the treatment program, and improvements in standardized memory and learning test results comparable to those following clinic-based treatment.

**Key words:** **rehabilitation • traumatic brain injury • veterans • telehealth • cognitive**

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## Background

Traumatic brain injury (TBI) is considered the signature injury of soldiers fighting in Iraq and Afghanistan [1]. Between January 2003 and September 2009, 63,856 service men and women received a diagnosis of TBI [1]. TBI contributes to cognitive impairment, including deficits in planning, problem solving skills, memory, attention, and communication. For some veterans, underlying post-traumatic stress disorder (PTSD) and depressive symptoms also complicate the diagnosis and treatment of TBI and may impede recovery. Thus, rehabilitation following TBI should promote understanding of and therapy for comorbid conditions. Although the 3 diagnoses (TBI, PTSD, and depression) may occur independently in any one patient, the incidence of overlapping diagnoses makes it sensible to combine information about all 3 into 1 intervention. Veterans who need intervention also face special challenges in that many are returning to pre-existing jobs and families, and are unable to take time off from work and time out of family functions to receive treatment in a hospital or clinic. The development of a therapeutic intervention that can be achieved at home or work remains paramount given the high incidence of feelings of isolation, loneliness, and anger following combat.

Telemedicine has begun to play a large part in therapeutic intervention within the U.S. Department of Veterans Affairs (VA) [2]. The Veteran's Health Administration (VHA) began using videoconference phones in 2007 to connect directly into the patient's home. As reported by Darkins [3], the VHA telemedicine programs have reduced hospitalization, length of stay, and emergency room visits while improving the quality of life for veterans.

Evaluation of novel telemedicine practices follow a multi-phase process that involves: (1) identification of a need that warrants treatment provided remotely, (2) comparison of efficacy between the telehealth treatment and clinic-based treatment [4–7], and (3) evaluation of participant satisfaction [8,9]. To date, the majority of studies have found that improvements following intervention via telepractice are approximately equal to those following clinic-based intervention when the results are based on objective measures of progress [4–7]. In some cases, measures of patient satisfaction show larger increases with a telehealth approach. This is presumably due to practical factors: patients can participate in therapy on a schedule that fits their life situation.

An online treatment, the Military On-Line Problem Solving Videophone Intervention (MOPS-VI) was developed to address cognitive symptoms of mild TBI in veterans. The MOPS-VI design adhered to the tenets of traditional cognitive therapy, including duration of treatment, but utilized the Internet and videoconference phones to increase treatment adherence. MOPS-VI taught participants how to compensate for

their deficits through utilizing strategies to improve quality of life. For example, in module 3 – “Getting Organized” – participants were provided with functional strategies to improve attention and memory such as writing things down or taking frequent breaks during a time-consuming task.

Videophones, approved by the Department of Veterans Affairs for use with veterans, were used to provide weekly live support with a speech-language pathologist experienced in treating TBI. The purpose of the present study was 2-fold: 1) to determine if treatment adherence improved with a telemedicine approach, and 2) to test the efficacy of an online cognitive therapy and education program (MOPS-VI) in improving cognitive functioning in veterans with mild TBI. Veterans completed the MOPS-VI treatment in the convenience of their home or workplace.

## Material and Methods

### Subjects

Potential subjects for this Phase I study reviewed and signed the informed consent approved by the Institutional Review Board approved by the Cincinnati Veterans Administration Medical Center and the University of Cincinnati before beginning the study. The study was a matched-subject pre/post design, which compared test data collected from 6 veterans who participated in a specialized MOPS-VI intervention for TBI (pre- and post-treatment) vs. test data from 6 veterans who participated in standard clinic-based treatment for TBI (pre- and post-treatment).

### Treatment group (MOPS-VI group)

MOPS-VI participants were enrolled from 3 Cincinnati VA TBI clinics and were referred for speech therapy in the clinic, and either: (1) never came to the initial speech therapy session for a baseline interview, (2) came for an initial speech therapy session and did not return for follow-up, or (3) came for less than 2 sessions and did not continue in treatment.

Initial contact with potential treatment group participants was made by a letter offering participation in the MOPS-VI program. A postage-paid card was sent with a letter that contained a response box for the participant to indicate interest in participating in the MOPS-VI study. A member of the research team made a follow-up phone call to potential participants who had not yet responded.

Inclusion Criteria for Treatment Group (MOPS-VI Group):

1. English as the primary language spoken in the home;
2. Age 20 to 43 years at the time of treatment;
3. Complaints of memory, attention and or concentration deficits on a subjective self-report section of the Neurobehavioral

Symptom Inventory [10] (NSI), defined as self-selecting scores in the range of 2–4 (indicating moderate to severe impairment per participant report) on items 15 m, n, o, and p on the NSI. For example, on item 15 m the patient is asked to rate the degree to which “poor concentration, cannot pay attention” applies along a continuum between 0 (indicating the symptom is rarely if ever present) and 4 (very severe, the symptom is almost always present and the person has been unable to perform at work, school, or home due to this problem) [10].

### Control group

Each participant in the MOPS-VI group was matched to a control participant based on the following factors: age, gender, marital status, and baseline composite scores on the TOMAL-2 test. Control participants were obtained by medical chart review from August 2007 through October 2011 of Operation Enduring Freedom and Operation Iraqi Freedom (OEF/OIF) veterans who were previously treated and discharged from the Speech TBI Clinic following completion of clinic-based cognitive rehabilitation. Following baseline testing, all control participants received education about TBI, memory and attention processes, and compensatory strategies to improve quality of life. This format loosely mirrors the content provided in the MOPS-VI intervention, with the modification of delivery mode. Potential control participants were then matched to intervention participants using the criteria outlined below.

Criteria for Matching Treatment and Control Group Participants:

1. TOMAL-2<sup>nd</sup> edition pretreatment scores
  - a. Participants were matched according to their scores on the Composite Memory Index ( $\pm 10$  out of a possible 100 points) at the start of therapy. The Composite Memory Index consists of 8 core subtests: (1) memory for stories, (2) facial memory, (3) word-selective reminding, (4) abstract visual memory, (5) object recall, (6) visual sequential memory, (7) paired recall, and (8) memory for location.
2. Participants were also matched in pairs on age ( $\pm 3$  years), marital status, (married/partnered), and years of education ( $\pm 2$  years).

Exclusion Criteria for Both Groups:

1. Active treatment for substance abuse, including but not limited to, drugs and alcohol. (Persons receiving treatment in the smoking cessation clinic were not excluded.)
2. Participation in a previous pilot study for cognitive treatment.
3. History of neurologic diseases preceding the head trauma.
4. Psychiatric history prior to the head injury.

### Procedures

MOPS-VI participants came to the Cincinnati Veterans Medical Center (CVAMC) Speech-Language Pathology Department for

preliminary testing. The Peabody Picture Vocabulary Test (PPVT) [11] was administered pre-intervention to obtain verbal intelligence scores because pre-injury IQ scores were not available. The TOMAL-2 [12] was selected as a primary outcome given the ease of use, utilization across control subjects, and endorsement by the American Veterans Association Speech-Language Pathology Network. The TOMAL-2 was administered pre- and post-intervention as an assessment of treatment effects on cognitive functioning. The measures are widely used and have acceptable reliability and validity [13]. In addition, the participants were interviewed to determine highest level of education, number of combat tours, and marital or relationship status. Common cognitive complaints among the control and MOPS-VI participants include deficits in attention, concentration, and memory. Participants specifically noted difficulty with medication management, impaired geographical orientation, inability to establish and adhere to routines, and problems paying attention in a classroom or work environment.

Each MOPS-VI participant was provided a laptop computer, wireless Internet, and a videoconference phone for the duration of the intervention. The treatment intervention was not intended to meet patient need for psychotherapy. Behavioral issues targeted were related to pragmatics or social communication and were within the scope and practice for licensed speech-language pathologists. For both MOPS-VI and the control group, intervention followed a conventional approach in that it had dual foci: (1) education about TBI and PTSD with the aim of improving knowledge about the conditions, and (2) a therapeutic cognitive intervention focused on memory and attention. The MOPS-VI portion of the study was designed to be as similar as possible to the control treatment, with the difference that the control treatment was conducted face-to-face in a clinic setting, but the MOPS-VI was designed to deliver treatment online. The MOPS-VI incorporated military themes and didactic video clips of veterans discussing how their everyday life had changed since their injury, and how particular strategies helped them. Weekly homework assignments were presented to reinforce information learned. The modules included 6 sessions. Module number 1, titled “Getting Started”, described the purpose of the intervention and provided general information about TBI. Module number 2, “Staying Positive”, highlighted common concerns and problems that veterans may face following a brain injury and provided strategies to improve attitude and communication with others. Module number 3, titled “Getting Organized”, focused on organizational strategies to reduce extraneous stress and minimize problems at work, home, or school. Specific strategies to improve attention and memory were discussed. Module number 4, “Staying in Control”, outlined ways to control emotions and behavior. Topics discussed included the identification of PTSD and strategies for its management. The content focused on planning for success using a self-monitoring mnemonic, SMART (Stop Monitor Appraise Reflect Try). Module number 5,



**Figure 1.** Picture of videoconference phone used in MOPS-VI.

“Controlling your Behavior”, placed emphasis on participants monitoring and changing their behavior. Module number 6 provided a review of content learned.

MOPS-VI participants were issued a TeleVyou 500SP videophone (Figure 1) for use during simulated face-to-face therapy and were required to sign a waiver agreeing to return the videophone upon completion of the study. The use of telephone technology has the advantage of familiarity within veterans. A more commonly used communication method such as Skype would have been the preferred method of simulated face-to-face therapy; however, VA regulations prohibited the use of Skype or anything similar. The authors acknowledged the videophones as an inferior technology to what was commercially available at the time. The TeleVyou 500SP utilizes POTS (plain old telephone service) and is VA – approved for encryption purposes. All treatment group participants were trained in how to plug the standard telephone wire into the videophone, in addition to making simulated videophone calls while in the presence of the PI to ensure sufficient participation usability. All videophone contact with treatment participants was therapist-generated at a pre-determined appointment time. During the first videophone conference, the therapist reviewed module use and provided instruction on troubleshooting.

Participants were asked to view 1 module per week for 6 weeks. Each module took approximately 60 minutes to complete. The PI contacted each participant weekly via videophone to review the session materials and provided a reminder follow-up call to complete the modules if indicated. These videophone sessions lasted approximately 60 minutes, for a total treatment time of 60 minutes per week. Additional time was allotted to complete the intervention to take into account unanticipated events such as family illness/death or vacations. Thus, the time to complete the intervention varied between participants (range, 3–5 months; average, 3.8 months).

Following completion of all modules, participants were asked to return to the VAMC Speech-Language Pathology department, at which time the TOMAL-2<sup>nd</sup> was re-administered.

## Data analysis

Descriptive data were obtained for the treatment and the control groups (means and standard deviations or frequencies and percentages, as appropriate.) Both parametric and nonparametric analyses were used, given the small sample size. In addition, t-tests were used to ensure that the treatment and the control groups were equivalent in age, education, and vocabulary scores as an estimate of IQ (i.e., PPVT). Next, the pre-post TOMAL 2 scores were compared for both groups at 2 points in time (pre-post test results) using Analysis of Variance (ANOVA) and the Wilcoxon Signed Ranks Test. All data management and analyses were conducted using SPSS version 18.0 [14].

## Results

One of the aims of this study was to test the effect of MOPS-VI on patient compliance. Participants were selected from a group of veterans initially non-adherent with clinic-based cognitive rehabilitative services. Non-adherence was defined by the following criteria: 1) failure to schedule a follow-up appointment after referral for cognitive rehabilitation therapy; or, 2) failure to attend more than 2 therapy sessions. It was hypothesized that the MOPS-VI therapeutic approach would increase adherence because of decreased travel time and increased scheduling convenience.

Among the veterans identified as non-adherent with speech therapy for cognitive rehabilitation services using these criteria, 9 signed the informed consent, 8 participated in pre-intervention testing, and 6 (67%) completed the intervention. The 3 who did not complete the intervention included 1 participant who signed the informed consent and was unable to be contacted for baseline testing, a second participant who dropped out after being diagnosed with cancer, and a third participant who was unable to complete the intervention due to redeployment shortly after completing baseline testing.

Six veterans who initially did not follow through with clinic-based cognitive treatment completed the MOPS-VI telemedicine treatment. Results from these 6 participants were thus the main focus of the study. These 6 MOPS-VI participants ranged in age from 23 to 38 years, with a mean age of 30.17 years. The control group consisted of participants seen face-to-face (clinic-based) who were selected according to inclusion/exclusion data and were similar to the treatment group participants. Of the 6 participants who completed the intervention, most of the sessions were completed sequentially and according to schedule. The few exceptions included 1 participant who re-scheduled his initial videophone session 2 times because he had not yet completed the self-guided module

**Table 1.** Descriptive statistics for MOPS-VI and control group.

	Treatment group (n=6)		Control group (n=6)	
	Mean	SD	Mean	SD
Age	30.17	5.27	30.67	6.77
Months in treatment	3.83	0.98	9.33	4.32
Years of education	14.00	1.67	13.00	1.67
Pre-TOMAL composite score	86.67	8.06	80.83	6.69

preceding the session and required 2 sessions for post-intervention testing. An additional participant called to re-schedule his third videophone session because of traffic. All other participants kept their originally scheduled appointments. Detailed compliance data was not available for control group participants due to the study design.

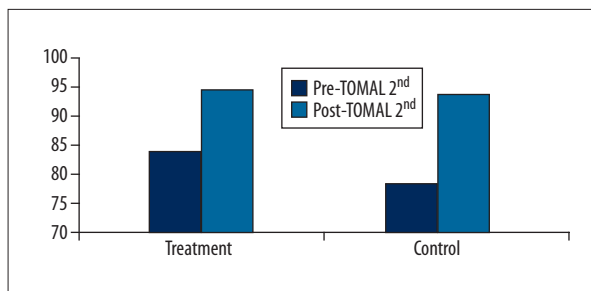
There were no significant differences between the groups in mean age, marital status, years of education, and TOMAL-2nd pre-test composite score, indicating that the matching procedure was successful. Table 1 shows group demographic data.

Results of a 2-way (pre- vs. post- assessments) × (standard vs. MOPS-VI) Analysis of Variance (ANOVA) revealed a significant pre-post assessment effect,  $F(1,10)=50.38, p<0.001$ , indicating that participants' memory improved after treatment for both MOPS-VI and standard treatment groups (Table 2). There was no significant interaction between treatment groups and pre-post assessment,  $F(1,10)=3.43, p=0.09$ . There was no significant difference between face-to-face therapy and MOPS-VI therapy ( $F(1, 10)=0.39, p=0.55$ ) suggesting that MOPS-VI therapy is as effective as clinic-based treatment and therefore is a viable alternative.

Because of the small n of the MOPS-VI Treatment Group, the nonparametric test, the Wilcoxon Signed Ranks Test was also

**Table 2.** Analysis of variance of pre-treatment and post-treatment scores (composite TOMAL2<sup>nd</sup>) for two groups (MOPS-VI and standard treatment).

Source		SS	df	MS	F	p	Partial Eta Squared
Test of between-subjects effects	Treatment groups	48.17	1	48.17	0.39	0.55	0.037
	Error	1236.83	10	123.68			
Test of within-subjects effects	Pre vs. post	793.5	1	793.5	50.38	0.001	0.83
	Pre vs. post treatment groups	54	1	54	3.43	0.09	0.26
	Error	157.50	10	15.75			



**Figure 2.** Pre-Post Mean composite scores. Pre-TOMAL 2<sup>nd</sup> – Pre-Intervention Test of Memory and Learning 2<sup>nd</sup> Edition Composite Memory Index Score, Post-TOMAL – Post-Intervention Test of Memory and Learning 2<sup>nd</sup> Edition Composite Memory Index Score. An increase in test scores indicates improvement.

conducted to compare the Composite Memory Index score pre- and post-intervention. The Z score was  $-2.21$  with a  $p=0.027$ . Therefore, both the parametric and nonparametric statistical analyses indicated a significant improvement in pre- and post-treatment performance on the TOMAL-2.

Partial eta-squared was used to provide an estimate of the magnitude of the effects of treatment as assessed by changes over time. The change in TOMAL-2nd scores from the pre- to post-treatment contributed 0.83, which indicates a strong effect of treatment on composite test scores regardless of whether the treatment was clinic-based or MOPS-VI (Figure 2). Although both therapy groups experienced a positive change in TOMAL-2<sup>nd</sup> test scores, the MOPS-VI group spent approximately 6 months less time in treatment (mean=3.87) compared to the control group (mean=9.33).

## Discussion

MOPS-VI participants were recruited from the 36% of veteran's non-adherent to standard face-to-face treatment. These numbers suggest that of 100 randomly chosen patients, 64 would complete treatment if offered clinic-based therapy, and

36 would drop out, but 27 (67%) would complete treatment if offered MOPS-VI. This suggests that if both clinic-based therapy and MOPS-VI were offered as alternative treatments to veterans, a 91% compliance rate could be achieved with no diminution in the quality of results. This would be a major advance in the effort to maximize these veterans' ability to transition to normal lives.

A Consensus Conference sponsored by the National Institutes of Health [14] outlined the characteristics thought to define effective cognitive interventions in TBI. Their recommendations included the following optimal characteristics of cognitive therapy: structured, systematic, goal-directed, individualized, and involving learning, practice, social contact, and a relevant context. The MOPS-VI intervention was structured to include modules that were delivered sequentially in a systematic fashion; participants completed the program at their own pace. A speech-language pathologist called the participants on a weekly basis to provide clarification and support and to encourage use of the strategies in social contexts. These follow-up videophone sessions also facilitated generalization of the content learned in the web-based modules. The Cognitive Rehabilitation Task Force (ACRM, BI-ISIG) conducted a systematic review of cognitive rehabilitation after TBI, and provided updated evidence-based practice recommendations [15]. The report addressed the full spectrum of TBI severity and recommended the use of attention, problem solving, and memory training during post-acute rehabilitation of individuals with TBI. Emphasis is placed on the use in training of metacognitive strategies that increase awareness of anticipated difficulties and help develop online monitoring and self-regulation skills. Such skills are thought to be necessary to promote the generalization of newly acquired compensatory strategies to real-world tasks [15]. The MOPS-VI intervention placed considerable emphasis on metacognitive strategies and generalization and yielded results similar to standard therapy, even though the MOPS-VI was conducted independently in the veterans' homes or workplaces with weekly videophone support over a shorter time period. Results of the MOPS-VI intervention are consistent with the findings of Cicerone [16], who reported that cognitive therapies directed at multiple domains of impairment can significantly improve neuropsychological performance in particular skill areas (e.g., attention, memory, and problem solving).

The MOPS-VI is an example of a cognitive intervention that addresses the constellation of neurobehavioral deficits commonly encountered in veterans [17]. The results of the current study suggest that veterans recovering from mild TBI might benefit from an online treatment program with videophone support to improve memory and learning.

The current findings contrast in some respects with those of other investigators. For example, Schoenberg et al. [18] compared the effectiveness of a commercially available computer-based cognitive rehabilitative teletherapy program and traditional outpatient speech therapy, finding that the teletherapy group spent significantly more time in therapy compared to the face-to-face group. However, MOPS-VI participants spent less time in treatment (3.87 months) than the clinic-based control group (9.33 months), yet both groups had similar outcomes, suggesting that effective telehealth therapies can be briefer than standard office-based treatments.

The restricted time frame of the current study prohibited a randomized control group. The control group was meant to emulate a microcosm of the traditional population. Fluctuating numbers of participants from which to recruit hinders optimal structuring of methodology. In the current study, logistical restraints due to limited funding prohibited an extended time for recruitment, contributing to a small sample size. The researchers evaluated whether or not this intervention improved compliance with cognitive therapy for those who initially did not comply. Comparisons were made to those who complied with traditional face-to-face cognitive therapy. Although matched groups are not ideal given the baseline variability between the populations (initially compliant vs. not initially compliant), the researchers acknowledge these limitations a priori. The purpose of this study was to test the efficacy of cognitive therapy and education using a telemedicine treatment for veterans with mild TBI in the convenience of their homes or workplaces. There was also a practical advantage to MOPS-VI; many individuals requiring therapeutic intervention are unable to take time off from work and time out of family functions to receive treatment in a hospital or clinic.

Because, because all participants had a diagnosis of a mild TBI, findings may not generalize to a more severely injured sample. Nevertheless, we were able to demonstrate improvement in treatment compliance and cognitive test scores following participation in an online program with phone support (MOPS-VI). The MOPS-VI resulted in better compliance and a similar degree of improvement in cognitive test scores within a shorter time period than standard clinic-based treatment.

## Conclusions

Overall, these results support the feasibility of the MOPS-VI approach and provide evidence of efficacy, defined as increased compliance in a group of veterans who were not compliant with traditional face-to-face therapy. Furthermore, improvement in standardized cognitive test performance was comparable to clinic-based treatment.

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