Conducting Clinical Research Remotely for Individuals with Traumatic Brain Injury (TBI) and Depression during the COVID-19 Pandemic: Transitioning from In-Person to Remote Implementation

Lauren B Fisher, Sylvie Tuchman, Andrew Curreri, Maggie Markgraf, Maren B Nyer, Paolo Cassano, Grant Iverson, Maurizio Fava, Ross Zafonte, Paola Pedrelli

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Lauren B Fisher[1, 2*] PhD; Sylvie Tuchman[1*] BA; Andrew Curreri[3*] MA; Maggie Markgraf[1*]; Maren B Nyer[1, 2*] PhD; Paolo Cassano[1, 2*] MD, PhD; Grant Iverson[4, 5, 6*] PhD; Maurizio Fava[1, 2*] MD; Ross Zafonte[4, 5, 6, 7*] DO; Paola Pedrelli[1, 2*] PhD

[1]Department of Psychiatry Massachusetts General Hospital Boston US
[2]Department of Psychiatry Harvard Medical School Boston US
[3]Center for Anxiety and Related Disorders Boston University Boston US
[4]Department of Physical Medicine and Rehabilitation Harvard Medical School Boston US
[5]Department of Physical Medicine and Rehabilitation Spaulding Rehabilitation Hospital Boston US
[6]Red Sox Foundation and Massachusetts General Hospital Home Base Program Boston US
[7]Department of Physical Medicine and Rehabilitation Massachusetts General Hospital and Brigham and Women's Hospital Boston US
[*]these authors contributed equally

Corresponding Author:
Lauren B Fisher PhD
Department of Psychiatry
Massachusetts General Hospital
1 Bowdoin Square
6th Floor
Boston
US

Abstract

Background: Telehealth provided many researchers, especially those conducting psychosocial research, with the tools necessary to transition in-person clinical trials to remote implementation during the COVID-19 pandemic. A growing body of research supports the effectiveness of telemental health for a variety of psychiatric conditions, but few studies have examined telemental health for individuals with comorbid medical diagnoses. Furthermore, little is known about the remote implementation of clinical trials examining telemental health interventions.

Objective: This paper outlines the procedural modifications used to facilitate conversion of an in-person randomized controlled trial of cognitive behavioral therapy (CBT) for individuals with depression and traumatic brain injury (TBI), CBT-TBI, to a telemental health study that is administered remotely.

Methods: Given the nature of remote implementation and specific challenges experienced by individuals with TBI, considerations related to treatment delivery, remote consent, data management, neuropsychological assessment, safety monitoring, and delivery of supportive material are discussed. Feasibility, acceptability, and safety are evaluated by examining attendance and participant responses on self-report measures of treatment satisfaction and suicidal behavior.

Results: High rates of treatment attendance, assessment completion, study retention, and satisfaction with the intervention and modality are reported by participants who completed at least one telemental health CBT-TBI session.

Conclusions: Study modifications are necessary when conducting a study remotely, and special attention should be paid to comorbidities and population-specific challenges (e.g., cognitive impairment). Preliminary data supports the feasibility, acceptability, and safety of remotely conducting a randomized controlled trial of CBT for depression after TBI. Clinical Trial: NCT03307070
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Keywords: telemental health, clinical trial, traumatic brain injury, depression, cognitive behavioral therapy

The COVID-19 pandemic has had significant implications on the conduct of clinical research. As a result of stay-at-home orders, most in-person clinical trials for non-life saving interventions were suddenly halted, leaving many active research participants and teams in limbo. Many researchers were forced to choose between pausing their research projects, facing a threat to scientific productivity, or modifying procedures to implement remotely[1].

Psychosocial research (e.g. investigation of psychological treatments) is well-positioned to be conducted remotely. Telemental health, the application of telecommunications to provide mental health services from a distance, has grown exponentially during the COVID-19 pandemic [2] and includes the use of a wide range of technologies to deliver synchronous (e.g., live videoconferencing or telephone calls) and asynchronous interventions (e.g., web-based interventions completed without a clinician present)[3]. This paper primarily focuses on the use of synchronous exchanges with telephone and videoconferencing to facilitate the remote implementation of assessment and psychotherapy in the context of a clinical trial for depression that was conducted in-person prior to the pandemic. The transition to remote study implementation was supported by a growing body of research demonstrating the effectiveness of telemental health services across many populations (e.g., adults, pediatric, geriatric) and for a range of psychiatric conditions [4], including depression [5], anxiety [6], and posttraumatic stress disorder [7]. In fact, real-time telemental health (i.e., videoconferencing or telephone) is as effective as face-to-face treatment in reducing depressive symptoms [5,8]. Furthermore, treatment satisfaction and therapeutic alliance are similar among patients engaged in telemental health (videoconferencing and telephone-based interventions) and in-person treatment [9]. Effective implementation of protocols for remotely assessing and managing suicide risk further support the feasibility of conducting clinical trials that examine telemental health interventions for individuals with depression [10].

Despite the significant promise of telemental health for many individuals with depression, individuals with various comorbid medical diagnoses may experience distinct challenges that serve

as barriers to effectively utilizing telemental health interventions and participating in clinical research implemented remotely. In our work with individuals who have sustained traumatic brain injuries (TBI), the impact of TBI sequelae, including cognitive difficulties (e.g., impaired focus and attention, executive dysfunction) and sensitivity to light/screens, present unique challenges to participation in telemental health. Nevertheless, preliminary evidence suggests that individuals with major depressive disorder (MDD) and complicated mild to severe TBI experience similar reductions in depressive symptoms after 16 weeks of in-person and telephone-delivered CBT and report similarly high rates of treatment satisfaction and strong therapeutic alliance [11]. Although we have been unable to identify studies examining the use of videoconferencing for the delivery of individual psychotherapy for adults with depression and TBI, there is support for the feasibility of using videoconferencing for group CBT to improve emotion regulation after TBI [12] and problem-solving based telemental health for improving behavior and family functioning in children with TBI [13]. Furthermore, support for the feasibility of video-based telerehabilitation in adults with TBI [14] suggests that telemental health interventions adapted for this population may also be feasible.

Given the mounting evidence for telemental health research as a feasible alternative to face-to-face participation in clinical trials and the public health restrictions during the COVID-19 pandemic, in March 2020, we transitioned our National Institutes of Health (NIH)-funded, in-person randomized controlled trial (RCT) of CBT for depression for individuals with TBI (CBT-TBI) to a remotely-delivered telemental health study. In this paper, we discuss study modifications that were implemented to maximize feasibility, acceptability, and safety of remote study participation for individuals with depression and TBI. Preliminary evidence of feasibility, acceptability, and safety is examined among individuals who began the study in-person and transitioned to remote procedures, as well as participants who completed all procedures remotely.

Method

Participants

Study participants were enrolled in an ongoing randomized, waitlist-controlled trial (target N=40) piloting a 12-week, individual cognitive behavioral treatment for depression that was adapted for individuals with TBI (CBT-TBI). Aims of the parent trial are to evaluate the feasibility and acceptability of the intervention (primary), as well as the potential efficacy in reducing depressive severity (secondary). As of August 27, 2021, the ongoing RCT enrolled (consented) a total of 33 participants, of which 18 participants were enrolled in-person and 15 participants were enrolled remotely. The clinical trial began in-person recruitment in April 2019 and transitioned to remote procedures on March 16, 2020, which remains ongoing at the time of writing. Of the 33 enrolled participants, 8 completed all study visits in-person, 6 completed a combination of in-person and telemental health sessions, 2 enrolled in-person but completed all CBT-TBI sessions remotely, 7 completed all study visits remotely, 3 were deemed ineligible at the screening session (1 in-person and 2 remote), 2 discontinued (during remote CBT-TBI), 1 was lost to follow up and 3 determined they did not have time to participate (immediately after remote enrollment). One participant remains active at the time of writing. The feasibility and safety analyses presented below include participants who completed one or more CBT-TBI sessions remotely. Acceptability data includes participants who completed one or more CBT-TBI sessions remotely and completed the study (defined as attending all 12 intervention sessions; n = 12), as well as one participant who terminated CBT-TBI early but completed end of study assessments. Participants in this subsample of the ongoing RCT were between the ages of 21 and 69 years old (M = 39.2, SD = 16.3), and the majority were white (78%), Non-Hispanic or Latino (83%), and highly educated (56% with at least 4 years of college). Just over half of the sample was female (56%) while less than half the sample was married or in a relationship (44%).

Procedures

All study procedures, including pandemic-related modifications, were approved by the Massachusetts General Hospital Institutional Review Board. Adults with clinically significant

depressive symptoms and history of moderate to severe TBI were included in the study (see Supplemental Material for full study criteria).

An initial screening visit includes informed consent, diagnostic and symptom evaluation with a study clinician, and a neuropsychological battery that was completed in-person prior to March 2020 and remotely since April 2020. Participants also complete a series of baseline self-report measures of mood; suicidality; and cognitive, social, and emotional functioning, using a secure web-based platform (REDCap). Eligible participants are then randomized to 12 weeks of a newly developed, manualized cognitive behavioral treatment for depression adapted for individuals with TBI (CBT-TBI) or a 12-week waitlist. The intervention includes psychoeducation, behavioral activation, goal setting, cognitive restructuring, and relapse prevention. CBT-TBI was adapted for individuals with TBI by incorporating the following strategies: repetition; patient workbook with session summaries and forced choice worksheets; modified thought records; therapeutic use of neuropsychological testing results; individually tailored text messages/between session reminders; and daily use of an activity monitoring device (Fitbit Charge 3). Individuals in both conditions complete bimonthly phone assessments of depressive symptoms with an independent evaluator. Weekly 50-60 minute individual CBT-TBI sessions were delivered by a master's or doctoral level clinician in-person until March 16, 2020 and via Zoom videoconferencing (or telephone, when needed) thereafter. At the end of 12 weeks, all participants complete a post-assessment, which includes clinician-rated and self-rated measures, as well as repeat neuropsychological testing. Individuals randomized to the waitlist condition can receive CBT-TBI upon completion of 12 weeks of assessment. All study procedures are outlined in Figure 1 and a detailed breakdown of CBT-TBI visits are shown in Figure 2.

Measures

Acceptability. The 12-item, self-rated Satisfaction with Therapy and Therapist Scale-Revised (STTS-R) [19] is used to assess satisfaction in two domains of treatment. Current analyses include

the satisfaction with therapy subscale scores which range from 6 to 30, with higher scores indicating greater satisfaction. In March 2020, five questions were composed by the study team to gather feedback on remote CBT-TBI visits, including satisfaction with remote CBT-TBI sessions on a 5-point Likert scale, where 1 = very satisfied and 5 = very dissatisfied. Participants are also asked to share what they liked and did not like about virtual treatment. Participants who completed some CBT-TBI sessions in-person and some remotely were asked to indicate the degree of their preference for one modality over the other on a 5-point Likert scale, where 1 = strongly preferred telemental health sessions and 5 = strongly preferred in-person sessions. Finally, participants are asked to select the modality they would choose if given the option for treatment after the pandemic (e.g., in-person, over the telephone, videoconferencing, combination of in-person and virtual).

Safety. Suicidal ideation is monitored weekly during CBT-TBI with the suicide item from the Beck Depression Inventory-II [20], a 21-item self-report scale designed to measure the presence and severity of depressive symptoms. The BDI-II suicide item is associated with risk of repeat suicide attempts and death by suicide and is recommended as a screener for suicide risk in routine clinical care [21]. Adverse events are also assessed during bimonthly phone assessments.

Study Modifications with Transition to Remote Implementation of Research

Several protocol modifications (see Table 1) were instituted after all clinical trials for non-life saving interventions were halted in our institution due to the pandemic. Modifications aim to facilitate feasibility and adherence to the original procedures as much as possible.

Videoconferencing platform. All procedures (except for neuropsychological testing, discussed below) that were previously conducted face-to-face are now completed remotely using videoconferencing. Secure Zoom videoconferencing (Zoom Enterprise) was adopted after working with our institution's Research Information Security Office to optimize privacy and security settings, including enabling the waiting room, locking meetings once sessions begin, and generating meeting IDs with a password. Individuals who are unfamiliar with the videoconferencing platform receive

step-by-step instructions for Zoom account set-up and may conduct a “trial-run” and orientation to the platform with the study coordinator.

Remote consent. Since the study transitioned to remote implementation, the informed consent process has been embedded into a live telehealth session, also referred to as teleconsent [22]. An institution-specific REDCap electronic informed consent template is utilized. The study clinician meets with the participant over Zoom to review the consent form and instruct the participant to digitally sign consent. A signed copy is then securely emailed directly to the participant from REDCap. Participants are given the option to receive a mailed paper copy and/or a brief summary of key study information to make the process less overwhelming. Overall, teleconsent provides a feasible alternative to in-person paper consent and facilitates research continuity when face-to-face interactions are not possible [23].

Data management. Prior to the pandemic, study participants were given the option of completing self-report questionnaires directly in REDCap using a computer or tablet, either in our office or at home. Individuals participating remotely are provided an electronic link to complete questionnaires at home directly on REDCap. Given that it can be cognitively taxing to sit at a screen for an extended duration of time, participants are encouraged to complete a few questionnaires at a time. Participants are offered the option of being mailed paper questionnaires with a self-addressed envelope that is returned to the research team.

Neuropsychological testing. The original, in-person battery included a series of traditional, paper and pencil neuropsychological measures and the iPad-administered NIH Toolbox Cognition battery [24]. Following review of the available tele-neuropsychology literature [25] and guidelines for remote assessments [26], it was determined that certain subtests from the original battery could be administered via videoconferencing without significant impact on reliability and validity, although some tests could not (see Table 1). CNS Vital Signs [27], a brief computerized neurocognitive test battery, replaced the NIH Toolbox Cognition battery and is administered remotely in accordance with

guidelines to maximize validity. Participants are instructed to watch a preparatory video that emphasizes the importance of creating an optimal, standardized testing environment (e.g., limit distractions and interruptions, set aside sufficient time to complete) which in turn maximizes reliability of test results. CNS Vital Signs reports include a validity indicator for each subtest, allowing the clinician to determine if a test was not valid.

Suicide risk assessment. On the day of CBT-TBI sessions, the study coordinator emails or texts the REDCap link for the Beck Depression Inventory-II (BDI-II) [20] to the participant, instructs them to complete the measure prior to meeting with the study therapist, and reviews their response to the BDI-II suicide item in real-time. If the participant does not complete the measure, the study therapist is notified to remind the participant to do so and to review the suicide item response before starting the session. In the event that a participant endorses a score of 2 or higher, the therapist is immediately alerted to conduct a detailed suicide risk assessment in session and to determine the need for a higher level of care, which could involve voluntary or involuntary hospitalization and/or contacting the individual's previously identified emergency contact. The participant's physical location is identified after signing consent and confirmed before starting every CBT-TBI session. All efforts would be made for the study therapist to remain connected to the participant (on Zoom or telephone) until emergency personnel arrive at their location.

Preparing for CBT-TBI telehealth visits. Given that individuals with TBI can be sensitive to changes in routine due to deficits in mental flexibility and problem solving [28], it is encouraged that telemental health visits mirror in-person CBT-TBI visits as much as possible. A predictable environment that parallels the in-person setting (i.e., consistent office space/background) may be beneficial [29]. In order to compensate for a patient's reduced ability to read their therapist's non-verbal cues over video, clinicians configure their camera to ensure that the patient can see as much of their body language as is feasible [29]. Clear and consistent expectations about virtual visits are directly communicated in a "Welcome Letter" that emphasizes how best to ensure security and

privacy and provides tips for limiting distractions during the session (see Table 1). For participants who have more than one internet and video-enabled device, they are encouraged to consider which device will best suit their needs based on factors such as strength of internet connection or device portability. Additionally, the active, hands-on nature of the study intervention, which uses worksheets and encourages notetaking, warrants an appropriate workspace, such as sitting at a desk or table.

Delivery and setup of wearable technology. Participants are mailed a Fitbit Charge 3 activity tracker prior to starting the intervention. The study coordinator schedules individual videoconferencing meetings with participants prior to the first CBT-TBI session where they provide instruction on setup and use and provide a handout reiterating this information.

Minimize reliance on screens. For some individuals with TBI, screen time can contribute to the exacerbation of neurocognitive sequelae of TBI, including headaches due to photosensitivity [30]. To minimize the degree to which participants are engaged with material in electronic format, all participants are mailed a physical copy of the CBT-TBI Workbook, which contains copies of weekly agendas, handouts, and worksheets. Participants who report greater difficulty with photosensitivity are encouraged to turn away from the computer or turn off video.

Importance of tailoring delivery and being flexible. Given the importance of clear, direct communication for individuals experiencing cognitive difficulties, the therapist speaks with the participant in the first session to understand their comfort with technology and preferences for ways of engaging in the collaborative treatment (e.g., physical vs. electronic worksheets, therapist vs. participant typing responses into worksheets, use of videoconferencing screen share feature to provide visual cues and allow the therapist to model skill use). Consistent with procedures utilized during in-person delivery of the intervention, participants continue to receive between session reminders via text, email, or phone call to carry out collaboratively identified activities or goals (e.g., behavioral activation).

Troubleshooting challenges with technology. It is inevitable that technological challenges will

arise both prior to and during virtual sessions. It is important that clinicians do not get visibly frustrated in the face of technological difficulties, as the patient may interpret this as the clinician being upset with them [31]. Additionally, shared insecurities over technology may, in fact, aid therapeutic alliance [32]. However, it is worth recognizing that technological issues can be disruptive, and clinicians may want to identify a cutoff point at which they switch from videoconferencing to a telephone session. In the first CBT-TBI session, the clinician and participant develop an individualized plan for navigating potential technological difficulties, such as losing a connection mid-session.

Data Analyses

To assess preliminary feasibility and acceptability of remote study implementation, descriptive statistics were used to report the number of CBT-TBI intervention sessions attended, number of assessment sessions attended, number of participants who completed the study, and rate of satisfaction with treatment (STTS-R and supplemental questions). Study retention (number of study completers/number randomized) was also calculated. Finally, number of elevated responses to the BDI-II suicide item (≥ 2) are described to demonstrate maintenance of safety protocols.

Results

Feasibility

At the time of the transition to remote procedures (March 2020), there were nine active study participants, including three participants on the waitlist (i.e., had not started CBT-TBI) and six participants who were mid-treatment. The six participants who started CBT-TBI in-person prior to March 2020 were at different points in treatment at the time of the transition (weeks 3, 7, 9, 10 11, and 12) and all went on to complete the remainder of their 12 weeks of CBT-TBI remotely using telemental health sessions. Two out of three waitlist participants who enrolled in the study before March 2020 with the expectation of attending CBT-TBI sessions in-person completed the entire 12 weeks of CBT-TBI via videoconferencing. One participant discontinued participation after four CBT-

TBI sessions due to a demanding work schedule but completed post assessments. Finally, of all randomized participants who enrolled in the study remotely (n = 9), 7 (78%) completed the study, 1 (11%) was withdrawn due to worsening depression, and 1 (11%) remains active in CBT-TBI. Study retention rate prior to March 2020 was 100% (8 CBT-TBI completers), and completion from March through January 2021 is about 93% (13 out of 14 possible randomized CBT-TBI completers). Approximately 91% of clinician-rated assessments (102 out of 112 possible assessments) were completed throughout the period in which the study has been conducted remotely.

Acceptability

Satisfaction with therapy (STTS-R therapy subscale) was high (M = 27.1 , SD = 2.8) among participants who completed at least one session of CBT-TBI remotely (n=16). Overall satisfaction with telemental health sessions (videoconferencing, telephone, or combination of the two) was high (n=14): 9 participants reported being “very satisfied” (64%), 4 participants were “satisfied” (29%), and one participant reported being “neither satisfied nor dissatisfied” (7%). If given the choice of modality in the future, 3 participants indicated that they would choose in-person treatment (21%), 4 participants would choose telemental health treatment (videoconferencing or telephone; 29%), and 7 participants would choose a combination of in-person and telemental health treatment (50%) (Figure 3). Among the participants who completed a combination of in-person and telemental health treatment and provided feedback (n=4), there was no clear pattern in preferred modality, ranging from strongly preferring telemental health (n=1, 25%), somewhat preferring telemental health (n=1, 25%), strongly preferring in-person (n=1, 25%), and no indication of preference (n=1, 25%).

Qualitative feedback highlighted that all 14 study completers noted at least one benefit of telemental health sessions, including ease of conducting sessions from home and not having to travel for appointments. Conversely, technological challenges, reduced focus, limited privacy, and difficulty feeling connected with the therapist were noted as factors that participants disliked about telemental health sessions. Five participants reported that there was nothing they disliked about

telemental health treatment.

Safety

Since March 2020, one participant endorsed a score of 3 on the BDI-II [20] suicide item on two consecutive weeks. Per protocol, the study coordinator alerted the CBT-TBI therapist and the Principal Investigator immediately after having identified the safety concern, and the therapist started the CBT-TBI session with a thorough assessment of suicide risk. After several weeks of worsening depression and increasing suicidal ideation, the participant was eventually referred for a higher level of care (partial hospitalization program), withdrawn from the study, and was ultimately hospitalized voluntarily for worsening of symptoms. No serious adverse events were reported throughout the duration of remote procedures.

Discussion

Using several procedural modifications described in this paper, an in-person randomized controlled trial of CBT for depression after TBI was converted to remote implementation and demonstrated preliminary evidence of feasibility, acceptability, and safety. Specific modifications to study implementation and the treatment protocol are outlined in Table 1. Given the range of neurocognitive effects that can arise after TBI (e.g., photosensitivity, impaired attentional capacity), all modifications were made with consideration of their potential impact on participants and to enhance feasibility.

Preliminary data support the feasibility, acceptability, and safety of conducting a randomized controlled trial for depression among individuals with TBI exclusively utilizing remote procedures. Specifically, preliminary results demonstrate high rate of completion for clinician-rated assessments (91%) and high study retention (93%). Procedures that were designed to monitor safety have been effective in identifying individuals at high risk for suicide, triggering clinician suicide risk assessments via videoconferencing. Feedback from participants suggests a high degree of satisfaction with the CBT-TBI treatment and telemental health modality, providing initial evidence of

acceptability of the remotely delivered study intervention. Findings are consistent with previous studies that have examined telephone-delivered cognitive behavioral interventions among individuals with TBI [11,33].

Feedback from our small sample highlighted a range of preferences when participants were asked to consider their ideal treatment modality (in-person treatment, telemental health treatment, or a hybrid model), which has significant implications for study participation and potentially for treatment outcomes. Research has demonstrated better treatment outcomes among individuals whose preferences about psychological treatment (e.g., appointment times, venue, type of treatment) are accommodated compared to individuals whose preferences are not met [34]. Previous research among depressed individuals with TBI utilized a choice-stratified randomization, in which participants could assert a preference for CBT that was delivered in-person or over the telephone prior to randomization, in order to enhance ecological validity [11]. Qualitative feedback from our study suggested that participants may appreciate a mix of in-person and telemental health visits, which is consistent with the evidence for high feasibility and acceptability of "blended" models of delivery (combination of face-to-face and web-based sessions) of CBT for depression [35]. Although the efficacy of our study intervention is unknown at this time, tailoring the intervention modality according to preferences may lead to greater attendance at treatment sessions and engagement in treatment.

It is important to acknowledge several limitations. Although several steps were taken to optimize the testing environment, neuropsychological assessment is ideally suited to in-person administration. Challenges with technology and sub-optimal conditions in the participant's environment have the potential to impact engagement and data collection. Behavioral observations can be restricted by videoconferencing and rapport can sometimes be limited without in-person interactions, which may impact participant responses or commitment to participation, especially prior to randomization. It is also important to note that our sample was heavily comprised of

individuals who received specialized, acute inpatient rehabilitation (61.5%) and specialized outpatient treatment (58%) for their TBIs in a single academic medical center in the Northeast. Individuals who receive inpatient rehabilitation represent 7% of all persons hospitalized with moderate-to-severe TBI, are less likely to be a member of a racial/ethnic minority group, and more likely to have health insurance compared to individuals who are hospitalized and do not receive inpatient rehabilitation after moderate-to-severe TBI[36]. Thus, our sample may not be representative of all individuals with moderate-to-severe TBI in the US.

Conclusion

Remote study participation has been a feasible alternative when in-person research was halted during the COVID-19 pandemic. Strategic procedural modifications outlined in this paper have been instrumental to the continued feasibility of recruitment and retainment of individuals with depression and TBI in the context of our ongoing RCT. Furthermore, telemental health offers significant advantages in eliminating common barriers to study participation, including transportation, time needed to travel to appointments, distance to the hospital, limited mobility, and inclement weather. Conversely, some individuals may struggle to secure private space for their sessions and a visit to a traditional office space may be preferred. Further, many individuals do not have internet access and a camera-enabled device for videoconferencing. Some individuals may find it easier and less intimidating to be vulnerable about the challenges they face over a computer screen rather than in-person [37] while others may have difficulty connecting with a therapist through a screen. For some individuals, the flexibility of utilizing both types of modalities within the course of treatment may be an ideal balance, thus future research designs should consider the role of patient preference. For individuals with TBI who frequently struggle with physical, cognitive, and emotional impairments, flexibly tailored treatments that utilize telemental health and in-person modalities are likely to be critical in both research and clinical settings. Future research should directly compare the feasibility and efficacy of CBT delivered via telemental health, in-person, and hybrid models for individuals

with TBI, as well as the validity and reliability of remote neuropsychological assessment and strategies to facilitate remote engagement. The COVID-19 pandemic abruptly presented researchers with unique challenges that have required flexibility and innovation. The advantages presented by the ability to conduct clinical research using remote methods are likely to persist long after the pandemic ends.

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Table 1

Study Modifications with Transition to Remote Implementation

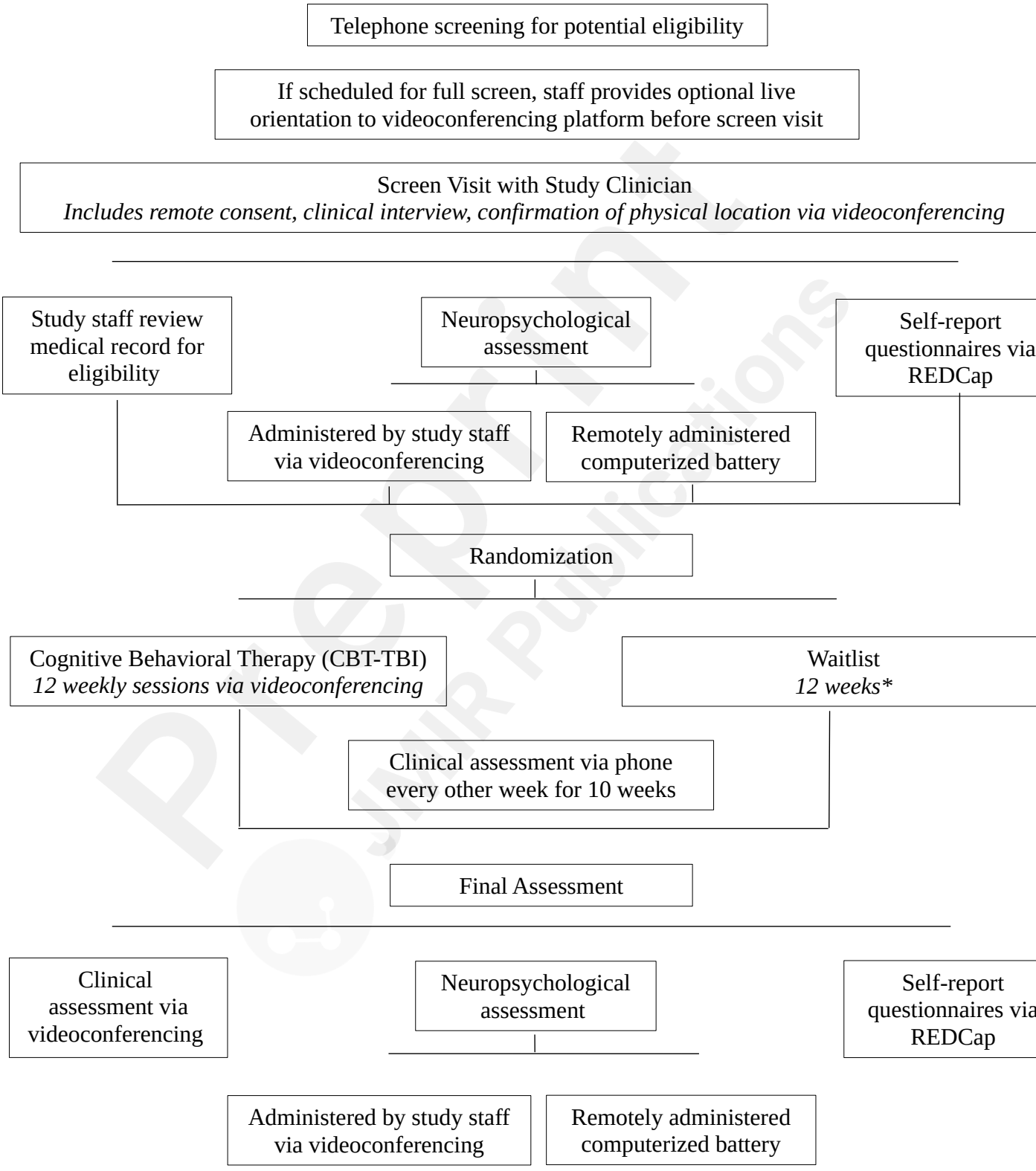
Protocol Element	**In-Person**	**Remote**
Treatment Modality	Individual, face-to-face sessions in-office	Individual sessions via secure videoconferencing
Consent	Clinician and participant review paper consent and sign in office	Clinician and participant utilize teleconsent with REDCap eConsent template during videoconference
Data Management	• Participants complete questionnaires directly on REDCap using in-office computer (preferred method) o REDCap links are emailed to participants who are unable to complete questionnaires during office visit o Paper copies are completed in office or at home for participants unable to complete electronically • Clinicians complete pencil and paper assessments (requires data entry)	• Via text or email, send participants REDCap link to complete questionnaires independently (preferred method) o Paper copies are mailed with self-addressed return envelope for participants unable to complete electronically • Clinicians enter clinical data directly into REDCap
Neuropsychological Assessment	• Administered by study staff in-office (traditional measures): o TOPF [38] o WAIS-IV Coding, Digit Span and Similarities [39] o D-KEFS Color Word and Trails [40] o CVLT-II [41] • Administered on iPad in-office: o NIH Toolbox Cognition Battery [24]	• Administered by study staff via videoconferencing (traditional measures): o TOPF [38] o WAIS-IV Digit Span and Similarities o WMS-IV Logical Memory I and II [42] • Computerized battery, completed by participants at home: o CNS Vital Signs [27]

Suicide Risk Monitoring	Clinician reviews paper copy response to BDI-II suicide item at start of CBT-TBI visit with participant in room	Study coordinator reviews REDCap response to BDI-II suicide item at start of CBT-TBI visit and alerts clinician to scores of 2 or higher
Preparation for CBT Visits	Routine scheduling, study coordinator answers questions from participants	Send "Welcome Letter" to establish expectations: • Ensure security (e.g., close other applications while Zoom is open) • Ensure privacy (e.g., conduct sessions in a private room with the door closed, use headphones and/or noise blocker) • Provides tips for limiting distractions (e.g., silence cell phone, avoid eating, ensure device is fully charged, let others in their home/space know you are unavailable) • Consider feasibility of your device (e.g., a computer allows for typing notes in electronic handouts, hardwired ethernet connections can be more reliable than Wi-Fi)
Delivery and Setup of Wearable Technology	Study coordinator sets up Fitbit with participant on day of first in-office CBT-TBI session	Study coordinator mails device to participant and guides them through device setup via videoconferencing
CBT Delivery Modification	Provide handouts in session that are added to CBT Workbook, week-by-week	• Mail CBT Workbook with handouts and worksheets prior to start of treatment • Minimize reliance on screens (e.g., turn away from computer, turn off video) • Tailor delivery to individual needs/preferences and be flexible (e.g., utilize 'screen share', provide electronic handouts)

Note. TOPF = Test of Premorbid Functioning, WAIS-IV = Wechsler Adult Intelligence Scale – Fourth Edition, D-KEFS = Delis-Kaplan Executive Function System, CVLT-II = California Verbal Learning Test – Second Edition, WMS-IV = Wechsler Memory Scale – Fourth Edition

Figure 1

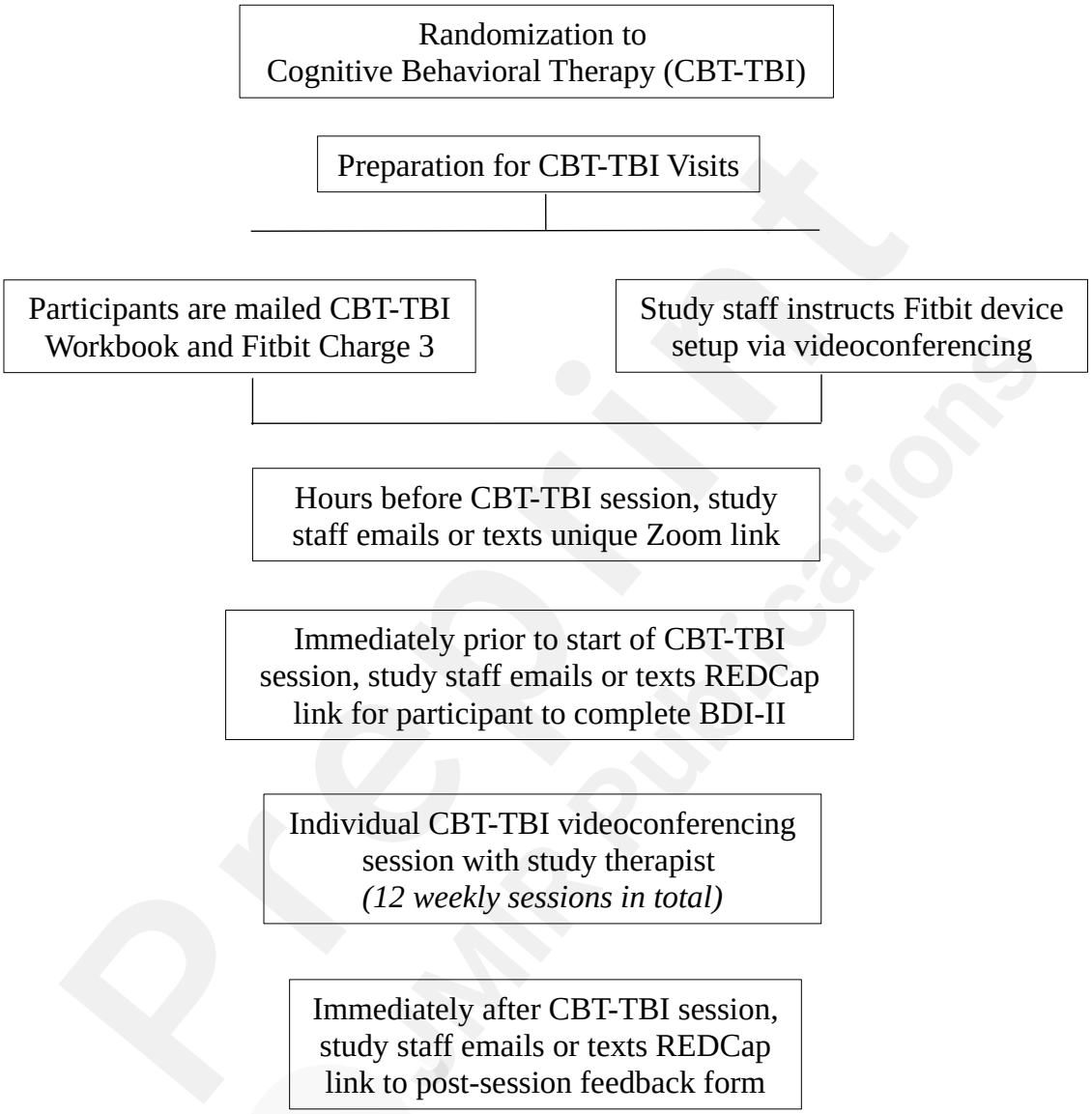
Flowchart of Study Procedures for Eligible Participants



Note. *All participants randomized to waitlist can complete CBT-TBI following the final assessment.

Figure 2

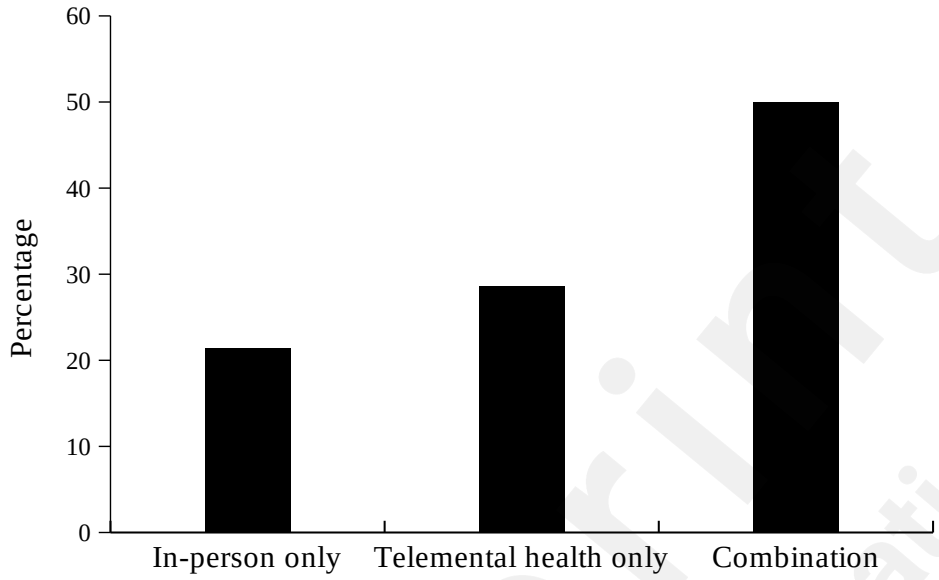
Flowchart of Study Procedures for CBT-TBI



Note. BDI-II = Beck Depression Inventory-II

Figure 3

Preferred Modality of Treatment for Cognitive Behavioral Therapy (n = 14)



Note. Combination refers to a mix of in-person and telemental health sessions.

Supplemental Material

Inclusion/Exclusion Criteria for Randomized Controlled Trial

Eligibility criteria include: 1) age 18 or older; 2) having been treated for complicated mild to severe TBI that occurred at least 3 months prior to study entry; 3) clinically significant depressive symptoms [meets criteria for Major Depressive Episode on the MINI [15] or has a total score ≥ 23 on the clinician-rated Inventory of Depressive Symptomatology (IDS-C)] [16]; 4) out of post-traumatic amnesia (PTA) at time of enrollment; 5) English language proficiency; 6) ability to attend in-person, outpatient sessions (April 2019-March 2020) or access a smartphone/tablet/computer with internet and video capabilities for virtual sessions (April 2020-present); 7) ability to see and hear (hearing or visual loss cannot impair ADLs or in-room conversation); and 8) possesses capacity for consent (University of California San Diego Brief Assessment of Capacity to Consent [17]). TBI severity criteria were defined such that participants have to meet one of the following criteria in order to qualify for the study: a) Glasgow Coma Score (GCS) [18] 3–12 with GCS motor score ≤ 5 within 4 hours after injury; b) GCS 3–12 with GCS motor score = 6 within 4 hours after injury AND documented intracranial abnormalities on imaging; c) GCS 13–15 within 4 hours after injury AND documented intracranial abnormalities on imaging; d) loss of consciousness (LOC) > 30 min; or e) post-traumatic amnesia (PTA) > 24 hours. Participants are not included in the study if any of the following exclusionary criteria are met: 1) presence of uncontrolled medical illness; 2) presence of behavioral dyscontrol; 3) evidence of acute PTSD as the primary diagnosis; 4) evidence of substance use disorder, moderate or severe, within the past six months; 5) history of bipolar disorder, a primary psychotic disorder or current psychotic symptoms, or acute suicidality or homicidality; 5) currently receiving regular (≥ 2 times/mo.) psychosocial treatment for

depression; 6) participated in CBT for depression within the past 6 months, and 7) history of dementia or severe cognitive impairment that is not related to TBI.

Supplementary Files

Figures