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ORIGINAL ARTICLE

Feasibility of group telerehabilitation for individuals with chronic acquired brain injury: integrating clinical care and research

Mary E. Boulos[a,b], Brenda Colella[a], Liesel-Ann Meusel[a], Bhanu Sharma[a,c], Marika K. Peter[a], Thomas Worthington[a] and Robin E. A. Green[a,d,e]

[a]Cognitive Neurorehabilitation Sciences Lab, KITE-Toronto Rehabilitation Institute, University Health Network, Toronto, Canada; [b]Michael G. DeGroote School of Medicine, McMaster University, Hamilton, Canada; [c]Department of Medical Sciences, McMaster University, Hamilton, Canada; [d]Rehabilitation Sciences Institute, University of Toronto, Toronto, Canada; [e]Department of Psychiatry, University of Toronto, Toronto, Canada

ABSTRACT

Background: Acquired brain injury (ABI) is a leading cause of lifelong disability, but access to treatment in the chronic stages has significant barriers. Group-based, remotely delivered neurorehabilitation reduces costs, travel barriers, and infection risk; however, its feasibility for patients with ABI is not well-established.

Objectives: To investigate the feasibility of remotely group-based cognitive and mood therapies for persons with chronic ABI.

Methods: Three hundred and eighty-eight adults with chronic ABI participated in group tele-neurorehabilitation modules comprising Cognitive Behavioral Therapy, Goal Management Training®, Relaxation and Mindfulness Skills Training, and/or a novel Concussion Education & Symptom Management program. Assessments comprised quantitative metrics, surveys, as well as qualitative semi-structured interviews in a subset of participants.

Results: High retention, adherence, and satisfaction were observed. Facilitators of treatment included accessibility, cost-effectiveness, and convenience. Adoption of technology was high, but other people's technological interruptions were a barrier. Self-reported benefits specific to group-based format included improved mood, stress management, coping, interpersonal relationships, cognitive functioning, and present-mindedness.

Conclusions: The present study examined chronic ABI patients' perceptions of telerehabilitation. Patients found remotely delivered, group-based mood, and cognitive interventions feasible with easy technology adoption. Group format was considered a benefit. Recommendations are provided to inform design of remotely delivered ABI programs.

➤ IMPLICATIONS FOR REHABILITATION

- Group-based mood and cognitive telerehabilitation is feasible for persons with chronic acquired brain injury, with high reported satisfaction.
- Screening for technical proficiency and providing ongoing technical support improves therapy adherence and retention.
- Integration of clinical care and research is feasible for delivering remote therapies to persons with brain injury.

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Introduction

Acquired brain injury (ABI) is a leading cause of disability worldwide, affecting an estimated 100–156 people per 100 000 [1]. Chronic cognitive and psychiatric disorders can be debilitating [2–6],impeding return to work, school, and leisure activities; these impairments also compromise personal relationships, which has been shown to lead to social isolation and increased suicide risk [7–13]. Of additional concern is the growing evidence for progressive deterioration in the chronic stages of ABI, both of cognition and brain structure (e.g., brain volume; white matter integrity) [14–17]. Given this enormous toll, neurorehabilitation care and research are critically needed to minimize disability and improve outcomes for people with ABI and their families.

Despite the need, patients with ABI face barriers to accessing neurorehabilitation. Barriers include: (1) a dearth of available, evidence-based resources in the *chronic* stages of injury [18,19]; (2) geographic distance between patients and treatment sites; (3) cognitive and physical impairments that impose mobility restrictions, even for local travel; (4) costs of travel for both patients and therapists [20–22]; and (4) infection risk (e.g., the COVID-19 pandemic).

Remote delivery of treatment (i.e., telerehabilitation) can help to mitigate these barriers, obviating logistical barriers related to

CONTACT Robin E. A. Green Robin.Green@uhn.ca Toronto Rehabilitation Institute, University Health Network, 550 University Ave, Toronto, ON, M5G 2A2, Canada

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distance, travel and travel costs, and infection risk. Telemedicine has increasingly become integrated in clinical care since the COVID-19 pandemic [23,24] and there is a growing evidence base supporting its feasibility for ABI in the context of one-on-one therapy sessions [25–28], as well as for self-administered cognitive interventions [29]. *Group-based treatment* can also help to mitigate access barriers by considerably reducing overall treatment costs, and group treatment has known clinical advantages, offering understanding, affiliation, and validation of experiences through peer support [30–32]. Group-based cognitive and mood interventions have moreover been successfully employed for ABI patients in a handful of studies [33–35].

Despite the benefits of group therapy, what remains a gap in our understanding is the feasibility of treatments for patients with ABI that *combine* remote delivery with group-based format. Here, the physical absence of a therapist, the requirement for social interaction with other patients, and the use of technology may pose separate or joint challenges. For example, such a setting requires: navigation of video-conferencing technology; troubleshooting technology glitches when they arise; managing the reduced availability of social communication information (e.g., body language); remaining engaged and comfortable in a group setting without the in-person support of a facilitator; and, retaining focus and continuity of treatment through disruptions (e.g., other people's technology glitches) without in-person support. An optimal response to treatment depends upon the ability of patients to successfully negotiate these issues. A further gap is the *patient perspective* regarding these issues, particularly the use of technology in the context of treatment.

At the time of writing, there were only four published studies on remotely delivered, group-based telerehabilitation programs for adults with ABI [36,37]. In $n = 13$ patients with ABI, Johansson et al. [36] found decreased anxiety and depression, as well as improved attention and processing speed following an online, group-based Mindfulness-Based Stress Reduction (MBSR) program, compared to face-to-face MBSR [36]. This study had a moderate retention rate for the virtual group (76.9%). The second study, which focused exclusively on TBI ($n = 7$), found that online, group CBT had high attendance (93.8%), adherence (93.8%), and satisfaction [37]. Finally, Pitt et al. [38] examined the feasibility of remotely delivered, group-based aphasia therapy for two participants and found high participant satisfaction, therapy adherence, and technical feasibility. A follow-up study ($n = 19$) by the same research group demonstrated improvements in psychosocial wellbeing and quality of life following virtual group-based aphasia therapy [39].

The current study examined the feasibility of remotely delivered, group-based therapies in $n = 388$ patients in the setting of a teleneurorehabilitation centre for ABI that integrates clinical care and research. The first objective of the study was to measure recruitment, retention, and adherence for three evidence-based cognitive and mental health treatments – Cognitive Behavior Therapy (CBT [40,41]), Goal Management Training (GMT [42]), and Relaxation-Based Mindfulness Strategies (RMS [43–45]) – plus a fourth intervention we developed for patients with prolonged symptoms of concussion, the *Concussion Education and Symptom Management* (CESM) program [46,47]. To better understand the ability to integrate research into a telerehabilitation clinical context, we measured rate of patient consent for use of data for research. As well, our adherence measure included rate of completion of the pre- and post-treatment online outcomes. The second objective of the study was to evaluate patient perceptions of telerehabilitation, including technology acceptance; here, we employed a quantitative survey and a semi-structured clinical interview.

Methods

Participants

Participants for this study were referred to the Telerehab Centre for ABI ("the Centre") at the University Health Network/KITE Research Institute in Toronto, Canada from January 2018 to December 2020. Referrals came from outpatient rehabilitation programs, community organizations, and private clinics across the province of Ontario, Canada. Patients were asked during the intake process if they could be approached for research participation. Participants were notified that their decision to participate or not participate would not impact their access to care and the results would be anonymized for quality improvement of the program. If they agreed, a research assistant contacted them via telephone after completion of their first group. Verbal consent was obtained over the telephone and then a hard copy consent form was mailed to participants with a postage paid envelope included for written consent.

Admission criteria to the *Telerehab Centre for ABI* were: (1) at least 18 years of age, (2) clinical diagnosis of ABI, (3) greater than 6-months post-injury, (4) basic computer literacy, and (5) fluency in English. People with the following symptoms: (1) aphasia, dysarthria, or another communication disorder, (2) cognitive impairments (e.g., impaired insight/awareness, amnesia), (3) active psychosis or mania, and (4) substance use were evaluated on a case-by-case basis to determine if the severity of their symptoms would preclude active participation in online, group therapies. Inclusion and exclusion criteria for the current study were the same as for admission to the Centre.

Materials

Primary study outcomes

Quantitative outcomes. *Recruitment (objective 1)*. Recruitment was operationalized as the total number of referred patients who completed the intake process and were eligible for online group therapy.

Therapy retention (objective 1). Retention was defined as the total number of patients who completed each therapy module.

Adherence (objective 1). (i) Therapy adherence: The percentage of therapy sessions attended by each patient averaged across all patients for each therapy module. *(ii) Outcome measure adherence:* Mean percentage of patients who completed at least 75% of both pre- and post-treatment efficacy outcome measures for each treatment module. Clients who started treatment but dropped out some time after the first session were included in these adherence calculations; however, those who accepted a spot in a group but dropped out before the group started or who did not attend any sessions were not included. (*Note*: While homework was assigned to patients, completion of the homework was not monitored and therefore not included as an outcome measure.)

Note that for all subsequent analyses, only those who consented to use of their data for research were included. This is because calculation of these metrics required access to individual data.

Telerehabilitation Satisfaction Survey (objective 2). This 18-item online, patient-reported outcome was adapted from surveys designed by Tsai et al. [48] and Larsen et al. [49] for the current program to assess technology adoption and experience of online group therapy. Each participant completed the survey once, after the first module in which they participated. Survey items are rated on a three-point Likert scale (e.g., Always, Usually, Rarely). The survey queries patient satisfaction with online group therapy,

technology uptake, and conveniences of online therapy (see Appendix 1 for items).

Qualitative outcomes. *Semi-structured interview (objective 2).* A subset of participants who consented to use of their data for research was asked to participate in a 30-minute, semi-structured interview to ascertain their subjective experience with group telerehabilitation (see Appendix 2 for interview questions). The interviewees had to have completed at least one therapy module. This interview was adapted from previously published structured interviews [48–52] and explored: (a) general impression of the program; (b) targets for optimization and enhancement; (c) barriers to adherence; (d) barriers to retention; (e) technology acceptance; and (f) additional suggestions and comments. After completion of the Telerehabilitation Satisfaction Survey, participants were asked if they would consent to participating in the qualitative interview. Participants were consecutively recruited to participate in the interview using convenience sampling until content saturation was reached. Interviews were conducted by a graduate student who was not involved in the clinical operations of the Centre.

Treatment protocols

General information

All therapy groups followed the same format: there were 5–9 participants per group participating in weekly therapy sessions which lasted 120 minutes including a 10-minute break at the midway point. The interventions followed the content outlines described below, with *ad hoc* customizations for cognitive and mood symptoms based on clinical judgment. Prior to the start of intervention groups, participants met with the clinician one-on-one. During this meeting, participants were provided with an overview of the content to be covered in the module, group rules, and expectations of participants. In addition, participants were asked to identify at least one challenge they were experiencing in their day-to-day lives that was related to the content of the intervention (e.g., for GMT: difficulty with meal preparation because ingredients or steps are missed). They were then encouraged to set at least one goal related to the challenge that they could work on during the course of the intervention (e.g., "Use strategies I learn in GMT to decrease errors during cooking.").

Cognitive Behavior Therapy (CBT). A 10-week program that aimed to help clients identify and change unhelpful thoughts and thinking patterns. The intervention loosely follows the book *Mind over Mood,* by Greenberger and Padesky [41] and between sessions participants were asked to complete homework using the Mind Over Mood workbook [41]. We previously demonstrated the efficacy of an adapted version of this program, delivered in-person via groups and one-to-one over the phone, for alleviating emotional distress and improving community integration in patients with moderate-severe brain injury [40,53].

Goal Management Training® (GMT). An intervention directed at rehabilitation of attention, planning, and goal attainment. The GMT intervention followed published protocols by Levine et al. [33,54]. Prior to the start of the group sessions, participants met with the therapist. Participants received nine weekly GMT sessions, or seven weekly sessions if they were in the GMT module adapted for those with concussion. Between sessions, clients were assigned homework based on the week's therapy content. For this intervention, participants were also offered make-up appointments if they missed any of the group sessions.

Relaxation and Mindfulness Skills (RMS). An 8-week program focused on introduction and practice of basic relaxation and mindfulness techniques. The module incorporated principles and practices from three evidence-based programs: Mindfulness-Based Stress Reduction (MSBR) [43], Mindfulness-Based Cognitive Therapy (MBCT) [44], and Acceptance and Commitment Therapy [45]. The intervention was designed to be less intensive than MBSR and MBCT in order to improve accessibility for individuals with ABI. Patients enrolled in RMS begin the program by learning relaxation techniques including diaphragmatic breathing and progressive muscle relaxation. Then, patients were introduced to mindfulness techniques with an emphasis on present-moment awareness. Between sessions, patients were provided resources to practice the skills learned (e.g., breath focus, body scans).

Concussion Education and Symptom Management (Table 1). Patients participated in a 6-week psychoeducational program, roughly two hours per week, comprising both didactic and group discussions. Participants are provided strategies to manage prolonged somatic, cognitive, and emotional symptoms of concussion. Sessions incorporated some of the principles of mindfulness and CBT, as well as self-compassion and energy conservation. The content drew in large part from the Ontario Neurotrauma Foundation Guidelines for persisting symptoms of concussion, and sessions focused on education about both medical treatments and self-care strategies [46,47].

Intervention facilitators

The interventions were administered by clinicians with at least 5 years of experience working with individuals with ABI, including clinical neuropsychologists, social workers, occupational therapists, speech language pathologists, and post-doctoral psychology fellows under the supervision of a licensed psychologist. All clinicians hired at the Centre had experience running group therapy, however to ensure consistency of intervention delivery, the following training procedure was followed: (1) facilitators were provided with a PowerPoint slide deck and accompanying notes for all sessions of a given intervention, (2) before running a group independently, new clinicians were required to observe a senior Centre clinician delivering the group intervention, and (3) after observing one full group, the new clinician went on to run a group with a senior Centre clinician observing them (*n.b.* this step might be repeated, as necessary). Once the new clinician was comfortable running the group intervention and the senior clinician was satisfied that the delivery was consistent with the

Table 1. Concussion Education and Symptom Management protocol.

Week	General content
1	General information about concussion; acute effects
2	Prolonged symptoms: why symptoms persist, the importance of treating symptoms, risk factors for prolonged symptoms, synergistic amplification of symptoms. Introduction to self-care/self-management, and to mindfulness principles.
3	Prolonged physical/somatic symptoms (e.g., post-traumatic headache, sleep–wake disturbances, vestibular symptoms, vision issues, deconditioning) including tools and self-management strategies (e.g., headache diary, sleep hygiene, exercise as medicine). Introduction to gratitude journaling.
4	Prolonged cognitive symptoms, including strategies for maximizing cognitive function in the context of ongoing physical and mental health symptoms (e.g., energy conservation). The causal role of reduced attentional resources for other cognitive symptoms.
5 and 6	Management of mental health symptoms, including self-care and activity planning (e.g., nourishing vs. depleting activities), concepts and tools from CBT (e.g., the role of thoughts in contributing to mood; coping plans for dealing with anxiety). Introduction to acceptance and self-compassion.

Centre protocol, the new clinician would be able to run groups independently. Some clinicians had the background and experience to run all groups, while other clinicians ran only one or two types of group based on their training. As there are only a few clinicians at the Centre who are able to run different groups, typically participants had a different facilitator for each intervention.

Study design

This is a mixed-methods feasibility study which used retrospective analysis of quantitative and qualitative clinical data collected from participants at the Telerehab Centre for ABI over a 4-year period. Study ethics approval was obtained from the University Health Network Research Ethics Board.

Procedures

Following referral to the Centre, patients were contacted via telephone to confirm their referral and went on to complete a brief telephone screening interview to verify they met basic admission criteria. Then, all patients completed an intake interview and brief cognitive testing with a clinician. This was done over the telephone until June 2020 and then over videoconferencing after that. In order to streamline the process and decrease burden, in July 2018 the intake interview was shortened to focus on details of the index injury (i.e., the injury for which they were referred to the Centre), past and current rehabilitation supports, self-reported cognitive symptoms, current complaints/challenges, and impact of injury on daily life and additional information was collected via a background questionnaire self-administered by the patient on a secure website. This questionnaire focused on past medical and psychiatric history, educational attainment, occupational history, social/family status, and technology proficiency. After completion of this intake process, determination of appropriateness for online group therapy and clinical need/eligibility for specific modules was made by the clinical team and a treatment plan is determined. Patients could potentially participate in any or all of the four modules of the program, which were delivered free of charge.

Once assigned to a first therapy module, patients completed the pre-intervention outcome measures associated with each treatment module. Initially these were completed over the telephone, but as of July 2018 patients completed them independently on a secure website. The outcomes assessed mood (Depression, Anxiety and Stress Scale-21 [55]), quality of life (Quality of Life Enjoyment and Satisfaction Questionnaire [56]), coping (Brief COPE [57]); community integration (Community Integration Questionnaire [58]), executive function (Goal Management Training Questionnaire [42]; Dysexecutive Questionnaire [59]; Cognitive Failures Questionnaire [60]), and mental fatigue [61]. (Note that the *completion rate* of these outcomes, but not survey scores, is presented in section *Results*).

All therapies were delivered online to patients in their homes using the patient's own computer or tablet device via a hospital approved, fully encrypted, privacy legislation compliant videoconferencing platform. Patients without a computer or high-speed internet were provided either/both for the duration of the study, free of charge. For groups that ran between January 2018 and June 2020 ($n = 37$ groups), a hospital-secured telecommunications bridge that connected to an internal, existing phone infrastructure with conferencing facility was used. For all subsequent groups that ran between July 2020 and December 2021 ($n = 42$ groups), we transitioned to a third-party provided video-conferencing platform (i.e., *Microsoft Teams*). Both were free to use for patients. Prior to the intervention, all patients received support from the program's technical coordinator for assistance with setup and testing of the application. During therapy sessions, technical support was available as needed. Reminder phone calls and emails were sent to patients to alert them of upcoming therapy sessions and homework.

Following completion of each therapy module, the above mood, quality of life, and cognitive outcomes were completed again, along with the *Telerehabilitation Satisfaction Survey*. A subset of patients at this time also underwent the semi-structured telephone-based interview ($N = 12$).

Data processing and analyses

Data were entered in Microsoft Excel (Redmond, WA) and analyzed using R (R Foundation for Statistical Computing, Vienna) [62]. Descriptive statistics were used to calculate totals and proportions for categorical variables (i.e., recruitment rate, retention, and adherence); and means, and standard deviations were reported for continuous variables. For the qualitative, semi-structured interview data, responses were recorded and transcribed verbatim into Microsoft Word (Redmond, WA). Thematic and descriptive qualitative analyses [63] were completed by a trained researcher not involved in treating patients. Following immersion in the data by the researcher, an inductive approach using NVivo 10 [64] was employed to organize the interview content into initial codes. After coding, overarching themes were developed based on common patterns observed. The themes were analyzed again to generate subthemes.

Results

Participants

Of the 368 people referred and eligible for treatment at the *Telerehab Centre for ABI*, from 1 January 2018 through 31 December 2021, 61 people (16.6%) declined to provide consent, 34 (9.2%) could not be reached for consent, 215 (58.4%) consented to use of their clinical data for research purposes, and consent for research is still in progress for 15.7% of patients. Table 2 summarizes demographic, injury characteristics of these participants. On average, the participants were middle aged (average age 46.3 ± 13.3 years old), predominantly female (65.5%), with a college education (mean education 14.9 ± 2.02 years) and had sustained their index brain injury just over 3 years prior to admission to the Telerehab Centre program. Participants' location in Ontario,

Table 2. Participant demographic and injury characteristics of the sample who consented to use of their data for research ($N = 215$).

Variable	Mean (SD)
Mean age at time of admission (years)	46.3 (13.3) (range = 18–83)
Mean level of education (years)	14.9 (2.02)
Mean time post-injury/diagnosis at time of admission (months)	41.9 (64.8)
	% of total *N*
Sex at birth	
Female ($n = 141$)	65.5
Male ($n = 74$)	34.4
Type of injury	
TBI – concussion ($n = 113$)	52.6
TBI – complicated mild, mod, or severe ($n = 31$)	14.4
Stroke, aneurysm, AVM bleed ($n = 30$)	14.0
Brain tumor ($n = 11$)	5.0
MS ($n = 17$)	8.0
Other ($n = 13$)	6.0

SD: standard deviation.

the Canadian province in which the Telerehab Centre is located, varied with some living in the local vicinity of the treatment centre and others further away, with the furthest participant 650 km north of the treatment centre. Ninety-eight percent of patients who consented to research explicitly reported ongoing cognitive symptoms during the clinical intake interview.

Objective 1

Recruitment rate

As indicated in Figure 1, 739 individuals with ABI were referred to the Telerehab Centre for ABI; of these, 368 (52%) were admitted into the program and eligible for treatment, 21.7% ($n = 161$) could not be contacted, 10% ($n = 74$) declined to participate after hearing more about the Centre services. Only 4.7% of referrals ($n = 35$) were deemed ineligible for admission.

Retention and adherence

Table 3 illustrates overall retention rates were over 80%. The highest attrition was observed for RMS (16.9%) and the lowest for CESM (2.9%). Reasons for attrition overlapped across modules and included school and work commitments, scheduling conflicts, family demands, health issues, lack of interest, or patients were removed for repeated absences.

Overall weekly therapy adherence was 87%. GMT (which offered make-up sessions) had the highest therapy adherence rate (94.6%), and CBT had the lowest therapy adherence rate (82.4%).

For all therapies, mean outcome measure adherence was 77.6% for those that completed both pre- and post-outcome measures, and ranged from 71.8% to 89.9%.

Objective 2

Telerehabilitation Satisfaction Survey

A total of 128 patients completed the Satisfaction Survey. This represents a completion rate of 59.5% of the consented sample ($n = 215$). The completion rate for this questionnaire is lower than for the other outcome measures because the questionnaire was not administered as part of the post-intervention questionnaire package until January 2019. Although efforts were made to

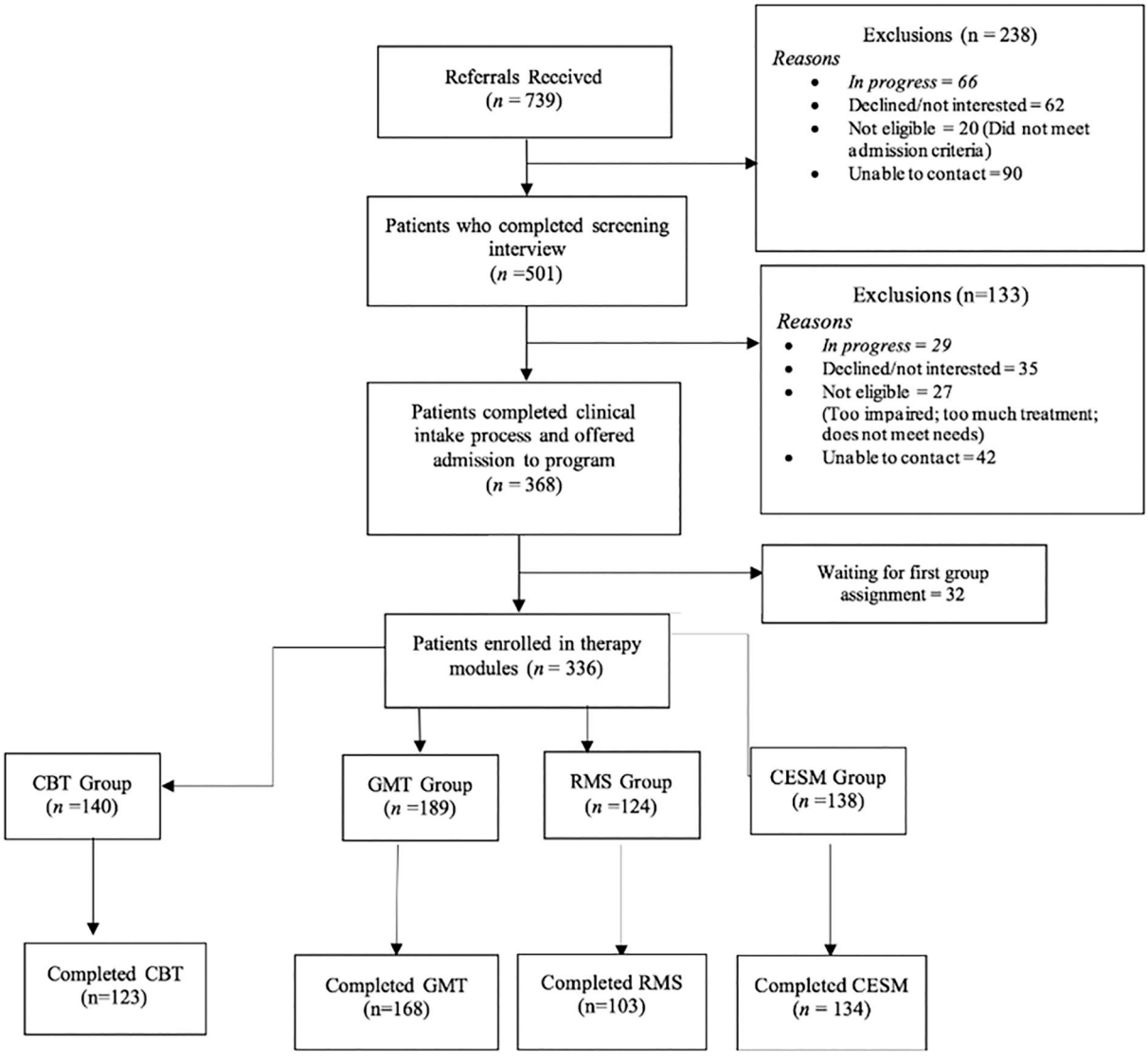

Figure 1. CONSORT participant flowchart. Summary of participants' progress through the program between August 2017 and December 2021 is presented in accordance with the CONSORT 2010 standard [65]. Of 739 participants referred to the program, 368 were enrolled in the program. n.b., participants may have enrolled in ≥1 therapy module and will be represented in all enrolled modules; hence, total patients across treatment groups are greater than the total number of patients eligible for therapy.

Table 3. Retention and adherence rates.

Group	Therapy retention	Weekly therapy adherence	Outcome adherence
CBT	87.9% (123/140)	82.4%	72.9%
GMT	88.9% (168/189)	94.6%[a]	75.7%
RMS	83.1% (103/124)	83.8%	71.8%
CESM	97.1% (134/138)	87.2%	89.9%
Overall	89.3%	87%	77.6%

[a]Has make-up sessions.

contact participants who had already been discharged from the Centre to complete the questionnaire retrospectively, not everyone could be reached and of those contacted not everyone completed the questionnaire.

Participants reported high satisfaction of online therapy, with 94.5% of respondents reporting they were glad they participated and 91.4% reporting they would participate in online therapy again. Limited technical issues were identified with 97.7% of participants reporting they could always see the therapist and group members during therapy sessions. The majority of participants noted their own technical issues (82.8%) and/or the technical issues of their peers (66.4%) only rarely disrupted their therapy experience. All participants were able to ensure adequate privacy during the therapy sessions.

When comparing group versus individual therapy, 78.1% of participants either preferred group therapy or were neutral regarding group versus individual therapy. Furthermore, 28.9% of participants preferred online therapy to in person therapy, while 50.8% of participants were neutral when comparing online and in person therapy (Table 4).

Semi-structured qualitative interview findings

A subset of 13 participants were invited to participate in the semi-structured interview. All consented to participate, but one individual could not participate due to scheduling, therefore, 12 interviews were completed. Interviews took place between March and April 2019. The majority of participants were female (58.3%), and the average age of interview participants was 56.2 ± 11.9 years old. The majority of participants had sustained a traumatic brain injury in the past (58.3%). At the time of the interview, all participants completed at least one session of RMS, 75% completed at least one session of GMT, and 50% completed at least one session of CBT (Table 5).

Five themes were identified: (1) the telerehabilitation experience, (2) future of telerehabilitation, (3) group therapy, (4) perceived functional benefits, and (5) perceptions of the program. Subthemes from each of the themes are organized based on their frequency and saliency.

(1) *The telerehabilitation experience*

(i) *Technology interactions*. The majority of participants identified videoconferencing as a user-friendly therapy platform. Individuals that self-identified as *less* competent with computers remarked that set-up was straightforward. Equipment provision (e.g., webcam and laptop) facilitated participation. Availability of a technician to support participants was a notable benefit, with participants remarking that technical support was provided in a timely fashion when issues arose.

> If there was ever any issues with logging on … there's always someone available that you just give a quick phone-call and we troubleshoot it. (Female, 35)

At times, technical difficulties disrupted the sessions and delayed therapy, such as difficulties logging in to the videoconferencing platform, internet connection issues, video lagging, and background noise. However, these issues were resolved quickly and did not impact overall therapy satisfaction.

(ii) *Convenience*. All participants reported on the convenience of telerehabilitation, highlighting the comfort of participating within their own homes and the feelings of security. For individuals with mobility restrictions, this was reported as especially beneficial.

> We're living on a very restricted budget and, because of mobility issues, getting around is difficult for me, I love the idea of being able to do this, getting up in the morning and getting into the day with something that I found was very helpful and without going through the stress of negotiating whatever form of transit to get there. (Male, 56)

Participating online improved efficiency and allowed time-savings up to several hours per session. One individual remarked that rejoining the group after a distraction was straightforward. Several individuals highlighted the benefit of participating regardless of location (e.g., when travelling or visiting relatives). In addition, for individuals who became tired during the session, they were able to leave the computer screen temporarily and find a more comfortable position during the session.

(iii) *Accessibility*. Nine of 12 individuals reported they had no other access to brain injury rehabilitation at the time of participating. For individuals in rural areas, they remarked no comparable programs existed within their community. They reported that when programs did exist, they did not address mood and cognitive problems, were not relevant to their experiences, had extensive waiting lists, and/or had greater focus on discussion versus developing practical skills.

> For me to access that kind of doctor … the waiting list to get on anything to do with brain injury, [it's] very hard to find any program. (Female, 54)

(iv) *Cost benefits*. Eight participants reported cost savings as a result of their participation in remote as opposed to in-person rehabilitation. The majority of these individuals cited reduced transportation, parking, and gas costs. Several individuals reported they would not be able to afford psychological services outside the context of this free, clinical-research Centre.

> I would probably say [I saved] thousands of dollars because not only do I have to pay for transportation, I have to pay for that [clinician's] time and parking … Especially being on disability I have limited funds to begin with. (Female, 35)

(v) *Comparison to face-to-face therapy*. Several individuals reported differences between face-to-face therapy as compared to online therapy. For those who preferred face-to-face, they cited its personal quality, the "human aspect," the human contact, the reassurance of discussing in person, sincerity, lack of technology issues, and reduced distractions.

> I just don't want to sit down and talk on a computer to somebody that I never really met. (Male, 71)

Individuals who preferred online therapy reported the convenience and reduced travel time as motivation.

> I would probably prefer the online version because I wouldn't have to travel, and I didn't find that there were any disadvantages to doing it online versus in person. (Female, 63)

(2) The future of telerehabilitation for ABI

(i) *High satisfaction*. All participants reported they were highly satisfied with telerehabilitation, would participate again, and would recommend the program to others.

Table 4. Results of Telerehabilitation Satisfaction Survey ($n = 128$).

	Always (%)	Usually (%)	Rarely (%)
Interactions via telerehabilitation			
1. I could hear my therapist and group members during therapy	90 (70.3)	38 (29.7)	0
2. I could see my therapist and group members during therapy	93 (72.7)	32 (25.0)	3 (2.3)
3. My therapist and group members could hear me when I was speaking.	106 (82.8)	22 (17.2)	0
4. It was easy to ensure my therapy sessions were not overheard by people in my house.	118 (92.2)	10 (7.8)	0
	A lot (%)	A little (%)	Not a lot (%)
Technology experience/equipment			
5. My technical issues decreased my satisfaction with online therapy.	3 (2.3)	17 (13.3)	106 (82.8)
6. The technical issues of one or more group members disrupted the therapy sessions.	5 (3.9)	36 (28.1)	85 (66.4)

	Strongly agree (%)	Somewhat agree (%)	Disagree (%)
7. I am experienced using computers.	79 (61.7)	43 (33.6)	6 (4.7)

	Very straightforward (%)	Somewhat straightforward (%)	Not straightforward at all (%)
8. Technology setup was:	82 (64.1)	37 (28.9)	6 (4.7)

	Always (%)	Usually (%)	Rarely (%)
9. Whenever there was a technology issue it was resolved quickly.	87 (68.0)	41 (32.0)	0
10. I experienced problems connecting to the video conference.	1 (0.8%)	10 (7.8)	117 (91.4)

Telerehabilitation motives (Question: "I was motivated to participate in online therapy because: ")	
11a. I had no other options for accessing therapy.	78 (60.9)
11b. I wanted to reduce travel time.	85 (66.4)
11c. I wanted to reduce costs.	49 (38.3)

	Agree (%)	Neutral (%)	Disagree (%)
Satisfaction with online therapy			
12. This online therapy program met my expectations.	112 (87.5)	15 (11.7)	1 (0.8)
13. I am glad that I participated in online therapy.	121 (94.5)	7 (5.5)	0
14. The content of the therapy program met my needs.	106 (82.8)	22 (17.2)	0
15. I would have preferred in-person therapy	26 (20.3)	65 (50.8)	37 (28.9)
16. I would have preferred one-on-one therapy	28 (21.9)	64 (50.0)	36 (28.1)
17. I would recommend this online therapy to a family member or friend in need of similar help.	119 (93.0)	9 (7.0)	0
18. I would participate in this program or another online therapy program again.	117 (91.4)	10 (7.8)	1 (0.8)

Table 5. Semi-structured interview participant demographics ($n = 12$).

Participant	Gender	Age	Nature of injury	Therapies
1	Female	36	Neuro-oncology	CBT, GMT, RMS
2	Female	55	Traumatic brain injury	CBT, GMT, RMS
3	Female	70	Traumatic brain injury	CBT, GMT, RMS
4	Female	53	Stroke	GMT, RMS
5	Male	62	Traumatic brain injury	GMT, RMS
6	Female	32	Seizure disorder	CBT, GMT, RMS
7	Male	71	Traumatic brain injury	GMT, RMS
8	Female	63	Stroke	RMS
9	Male	61	Traumatic brain injury	GMT, RMS
10	Male	56	Stroke	CBT, GMT, RMS
11	Male	53	Traumatic brain injury	RMS
12	Female	62	Traumatic brain injury	CBT, GMT, RMS

Therapies enrolled are listed in no particular order. Therapies in which the participant completed at least one session at the time of interview are listed.

> I just want the program to be out there so people who were in my situation could have what I received. (Female, 54)

(ii) *Recommendations moving forward.* Ten participants provided suggestions for ABI telerehabilitation programs moving forward. Six individuals reported they would prefer a longer program duration and access to more telerehabilitation programs. Several individuals suggested developing an online support group where individuals with ABI could meet and discuss. Reminders, greater homework support, and session recordings were suggested as methods to improve support throughout the intervention.

(iii) *Areas for improvement.* Regarding therapy content, some individuals reported it was repetitive; others reported they would have preferred a slower pace. One individual reported that therapist switching between therapy modules was disruptive. One individual suggested switching platforms, as the videoconferencing platform lacked flexibility (*n.b.*, the platform was changed to Microsoft Teams after several months). Several participants remarked they felt distressed once the group was ending.

> I kind of felt a little bit stressed that I'm not going to see these people every week and that I'm kind of losing my friends. (Female, 35)

(iv) *Barriers to participation.* Eight individuals reported the homework was burdensome, overwhelming, and that scheduling conflicts hindered their adherence. One individual had significant language difficulties and required a speech language pathologist's support to complete the assigned homework.

(3) Group therapy

(i) *Benefits of group therapy*. Ten individuals reported benefits of the group aspect of telerehabilitation.

> The social aspect actually counted much more for me because I could talk about some of the things I could not talk about outside because I know people wouldn't understand. (Female, 34)

(ii) *Comparison with 1-on-1 therapy.* Participants remarked that group therapy reduced feelings of isolation, assured them they were "not alone," and provided a non-judgmental space to share.

> People who suffered a brain injury … could understand where I was coming from when … I'd have a bad day … whereas people in my everyday life they just kind of think … 'you're just complaining' … These women in the group, they really understood how devastating it is to have days like that … it was wonderful to just have a peer to understand". (Female, 35)

Additional highlighted benefits included: a safe venue to share lived experiences, validation, acceptance, hope, and friendship.

> "[The program] made me feel that it wasn't the end of the world for me, that other people shared the same thing and things could improve. (Female, 70)

Discussion with individuals with similar lived experiences was beneficial to validate participants' current areas of difficulty and to provide tips for coping with areas of difficulty. For several individuals, mobility, transportation, and geographic limitations prevented them from engaging in social activities, and they reported telerehabilitation circumvented this. Several individuals endorsed developing friendships within the groups and feeling very connected to their fellow group members. For some, the ending of the group was met with sadness as individuals felt they were losing their new relationships. Two individuals reported the benefits of meeting people they would have never otherwise encountered, especially those living in remote geographic locations. Four participants preferred group therapy compared to one-on-one therapy. Reasons reported for this included: learning from others, validation, and social interaction.

(iii) *Challenges of group therapy*. Participant attrition and variable attendance was reported to disrupt therapy sessions.

> The discontinuity I found was … difficult … let's say one person's there, and they missed two sessions and come back, and then that person's going 'Well I don't know what happened in the two sessions and what was covered.' (Male, 61)

One group in particular had a high absence rate and all participants interviewed remarked on drawbacks of the group setting. Changes in group composition and disruptive/disinterested group members were also reported to negatively impact the connection between group members.

> I felt really connected to them for the first couple of modules and then once the group changed then I didn't feel as connected to them. (Female, 32)

One individual reported a preference for being assigned to a group with individuals who have a more similar employment background and injury. Two individuals reported they would prefer one-on-one therapy to improve their openness and comfort.

(iv) *Comparison with other group members*. Four individuals reported comparing themselves to others in the group. Two individuals reported hearing the struggles of group members caused them to be more reflective about their injury and areas of difficulty. Two individuals reported the experiences of other group members caused them to minimize their own difficulties and feel guilty.

> I tried to keep my experience limited, unless I was asked a direct question because [their injuries] were much worse than mine was. (Male, 53)

(4) Perceived functional benefits

All participants reported perceived functional benefits of participating in telerehabilitation.

(i) *Implementation of intervention strategies*. Ten participants reported that they continued to use the strategies learned during telerehabilitation following completion of the program. Participants reported learning valuable skills that are purposeful for their daily lives. General skills acquired included time management, self-control, emotional regulation, present-mindedness, and stress reduction.

(ii) Changes to quality of life and daily functioning. Eight participants reported changes in their daily functioning due to telerehabilitation. For CBT, participants reported benefits for managing frustration, analyzing thought processes, jumping to conclusions, and emotion regulation. RMS participants reported using breathing exercises, body scans, being present in the moment, taking pauses, and meditation in their daily lives. Following GMT, participants continued to use the mental blackboard and reported benefits to organization, planning, and focus.

(iii) *Mood and cognitive benefits*. Nine individuals reported mood benefits stemming from telerehabilitation. Namely, participants highlighted reduced stress, increased relaxation, improved mood, positivity, improved trigger management, increased peacefulness, and reduced anxiety. Three individuals reported improved acceptance of their impairments and a shift in attitude regarding their limitations and relationships.

> For me that was a big issue of accepting and understanding that people still would love me even though I'm a little different now, so my quality of life really did change because of it. I don't know how I would have gone through that process without telerehab. (Female, 54)

One individual remarked their physician and wife had noticed significant improvements in their mood and functioning. Another individual highlighted the benefits of CBT for introducing a "dimmer switch" to control anxious and/or depressive thoughts.

> I'm going to be presented with many of those triggers over the foreseeable future … but when it does [happen] I can take a bit of time by myself to relax … to be more involved in right now and what's around me, to stop building the anxiety, stop those thoughts, just to change my thought process enough that I can take a big breath and rejoin my day in a good mood, before now that was almost impossible to me … I've went to the point where I've got that little, I don't know if you'd characterize it as a dimmer switch … that aspect of control has been incredibly beneficial to me. (Male, 56)

RMS techniques were valuable for managing mood difficulties during stressful moments:

> I think my mood is still good. I do have my moments, but it's nice that I have my mindfulness techniques to fall back on and just really pull me back into the present … I just … stop, take a breath, think 'Okay, now what is actually going on? What am I doing right now, I should focus on that and worry about all that other stuff later.' (Female, 35)

Seven individuals reported benefits for cognition following remotely delivered GMT. Namely, participants reported improved attention, memory, planning, goal setting, and organization.

> I was starting to realise that I had to set more smaller, more achievable goals for myself and celebrate the fact that I managed to accomplish them. (Male, 56)

(5) Perceptions of program

Participants were asked to comment on their perceptions of the program's structures, interventions, and measures.

(i) *Community building*. They remarked that the therapists were able to create a supportive environment and give all members equal opportunity to speak. Moreover, the therapists led the group in a manner that allowed participants to challenge themselves and elicit diverse perspectives.

> I thought she was really good at eliciting things from the group rather than being instructive. (Female, 63)

Participants highlighted the knowledge and support of the therapist as an important component to facilitate their participation. In particular, having one therapist included in the procedures for all modules was highlighted as a benefit for continuity.

(ii) *Increased deficit awareness*. Five participants reported participating in telerehabilitation made them more aware of their areas of difficulty. Participants reported increased reflectiveness and awareness of their current thought processes and actions.

> I think I am more aware of when I'm sort of going, 'I shouldn't be doing that,' or 'I've got to be thinking of something else.' (Male, 62)

The intervention content was reported to be appropriate, relevant, helpful, informative, and tailored to their present situation. Three individuals reported feeling empowered (e.g., beginning new projects) and having greater control of their lives following program completion. Two individuals reported the benefit of the program for providing routine and purpose on a weekly basis.

(iii) *Perception of program surveys*. The majority of participants did not find the surveys administered pre- and post-intervention to be burdensome. However, two individuals reported they were repetitive and long.

> I found [the surveys] very repetitive to be honest. And some things I didn't think that they would even apply to me in my situation. (Female, 35) One suggestion for the surveys was to add more options for the survey questions to capture what's "in-between the lines."

Discussion

The study examined whether *remote* and *group*-based delivery of treatments was feasible for patients with ABI in the chronic stages of injury, with persisting self-reported cognitive impairments. We were also interested in whether this type of clinical setting was conducive to integrated research. Lastly, we were interested in understanding feasibility from the patient's perspective, particularly with respect to technology uptake. Overall, our study found very good feasibility in this setting, with little indication of difficulty navigating the combination of remote delivery and group-based treatment. The large majority of patients followed the interventions through to completion and attended the majority of sessions. In support of an integrated clinical care/research environment, the vast majority of patients consented to have their data used for research purposes, and most completed online outcome measures reliably. Patients reported overall positive experiences with the technology, appreciated remote delivery, and found the group context beneficial. As described below, specific facilitators and barriers were articulated by patients that can be considered by clinicians in their delivery of care, and for future research (Table 6).

Recruitment, retention, adherence, and consent

High recruitment, retention, and adherence – both for attendance at sessions and for completion of online outcome measures – were observed across all four modules of care. The program's overall retention rate of 89.3% above the high end of the range when compared to in person, group-based intervention research for neurological populations, which has found retention rates between 60 and 81% [66–69]. The therapy adherence rate of 87% was also toward the higher end of previously reported adherence ranges in telerehabilitation studies in patients with neurological disorders (63.9–93.8%) [28,37,70,71]. Importantly, the majority of the present study took place prior to the COVID-19 pandemic, underscoring the feasibility of this intervention in a non-pandemic context.

In our program, regular phone calls and reminder emails were provided that may have augmented retention and adherence. Automated reminder methods (e.g., text messaging, calendar invites, and email reminders) could reduce clinical resource burden and enhance sustainability, and thus should be evaluated for enhancing retention [29]. Only one individual who dropped out cited technology as a barrier to participation, but several cited work and family scheduling conflicts. A benefit of remote delivery is that without the need to travel, it is easier to accommodate scheduling alternatives to 9-to-5, such as evening and weekend sessions [72], and a larger number of briefer sessions.

With regard to integrating research into this clinical context, there was high rate of completion of online outcomes and the large majority of patients consented to the use of their clinical data for research purposes. Given the dearth of available treatment options in the chronic stages of injury, it is encouraging that group-based, tele-neurorehabilitation with online, self-administered outcomes offers a cost-effective environment in which to conduct research into the refinements of existing treatments and/or the development of novel ones.

Participant perceptions of tele-neurorehabilitation

Motivation to participate. The survey and qualitative interviews identified that the primary drivers of participation in tele-neurorehabilitation were reducing travel time (66.4%), costs (38.3%), and having no therapy alternatives (60.9%). Many patients remarked that there was a dearth of rehabilitation services for their chronic disabilities due to brain injury. Financial limitations, mobility restrictions, and geographic remoteness are well-known barriers to access when services are available [53,73], but even without these impediments, most neurorehabilitation in North America is provided in the early weeks and months of injury, and thereafter, there is very limited treatment designed to ameliorate symptoms and enhance functioning. Indeed, while disability persists during the chronic stages, the majority of rehabilitation focuses on hospital-based medical treatment and physical ailments for *acute* brain injury [74], which itself is costly, short in duration, and often neglects "hidden" behavioral and emotional disturbances following ABI [75–77].

Technology uptake. Previous research found persons with ABI encounter significant challenges using everyday technology including computers [78]. In the present study, the majority of patients surveyed reported positive interactions with the technology used (e.g., ability to see and hear, privacy, technical support). In qualitative interviews, high satisfaction with the technical aspects of therapy was reported, with patients commenting that technical difficulties, when they arose, were quickly resolved. However, some found the technical issues of others disruptive, and that it decreased satisfaction with online therapy. Therefore, expectation management regarding technology limitations – along with availability of technical support to patients is

Table 6. Recommendations to optimize feasibility of group telerehabilitation for persons with chronic acquired brain injury.

1. Screen for technology proficiency and increase technical support for individuals who self-identify as less experienced.
2. Set expectations early on regarding technology limitations.
3. Emphasize the importance of attendance, set rules regarding attendance ahead of embarking on a group, and consider delaying the enrolment of participants with expected absences.
4. Consider offering a hybrid model that permits either in-person treatment, remote or a combination of the two.
5. Consider offering an online support group to encourage communication between patients.
6. Increase supports for patients, including session reminders and homework support to enhance retention and adherence.
7. Be proactive about addressing possible comparisons between patients and ensure patients do not minimize each other's impairments.
8. Consider offering beginner, intermediate, advanced groups to allow patients to have further opportunities to engage in telerehabilitation.
9. Construct a management plan for the end of therapy with further opportunities for social engagement.

important. However, only one patient cited technology as a reason for leaving the intervention.

In the current program, technical training was provided to all participants prior to the commencement of the intervention. Patients also required basic computer skills to participate and in general, reported confidence in their computer abilities in the survey. Taken together, computer skills and technical support may be an important facilitator for the success of online programs. Increasing technical support, at least to individuals who self-identify as less experienced, may increase feasibility and ultimately response to treatment. Our findings that patients with self-reported cognitive impairments are able to navigate technology required for tele-neurorehabilitation in this group context are encouraging.

Satisfaction with remote-delivery and group context. While participants presented with cognitive and mood difficulties, they were still able to engage with the interventions and reported benefiting from therapy. Participant reported benefits of group-based telerehabilitation included improved mood, stress management, coping, relaxation, emotional regulation, interpersonal relationships, cognitive functioning, and present-mindedness. Given the known sequelae of mood disorders, emotional regulation challenges, interpersonal difficulties, and cognitive impairment following ABI, the benefits identified by the participants are promising for addressing the needs of patients during the chronic stages of injury. Moreover, participants identified that the group environment provides validation regarding their daily challenges and a venue for comradery.

When asked for recommendations going forward, patients requested more therapy sessions and also an online support group to further communicate with other patients. In addition, more supports were requested, such as session reminders and homework support. Patients also suggested recording sessions.

Nearly, all patients (94.5%) were satisfied with remote delivery of therapies (Table 4). These findings are in keeping with previous studies examining telerehabilitation for persons with brain injury [25,37]. Consistent with past research, the most notable benefits of remote delivery reported were convenience and comfort of participating from home [48,79,80]. Nonetheless, one-third noted they would have preferred in-person therapy; ideally, a hybrid model that permits either in-person treatment, remote, or a combination of the two may satisfy the greatest number of patient needs.

In keeping with prior studies [81], participants cited feelings of acceptance, validation, friendship, connection, and reduced isolation when participating in group therapy. Several participants requested greater opportunities for social interaction and discussion with peers. These findings are not surprising given individuals with ABI frequently cite social isolation and loss of social contact as their primary concerns following injury [82,83] – a problem that was exacerbated by the COVID-19 pandemic. Social isolation is associated with depression and cognitive decline following ABI [82,84]. Critically, delivering therapies in a group format can increase treatment availability by reducing costs [30].

Importantly, one-third of the survey respondents indicated they would have preferred one-to-one therapy, and several participants in the qualitative interview reported undesirable effects of the group format. This included a greater awareness of their impairments or minimizing their own challenges after hearing about the relatively greater difficulties of their peers. While increased awareness may be beneficial for identifying targets for improvement and acceptance of limitations caused by ABI [85], it necessitates clinical management; opportunities for revealing these feelings must be provided to facilitate their management. Strategies (pre-emptive or *ad hoc*) to ensure patients do not minimize impairments must also be embedded in group therapy.

Several participants reported feeling distressed when the group was ending for fear of recurring social isolation, losing friends made, as well as lack of services thereafter. These findings echo previous research suggesting social connectedness is a priority goal for individuals living with ABI [86]. A management plan for the end of therapy and potential opportunities for continued engagement should be considered. Lastly, several individuals reported that the absences of their peers at sessions undermined the experiences of others. Group telerehabilitation programs should emphasize the importance of attendance, set rules regarding attendance ahead of embarking on a group, and consider delaying the enrolment of participants with expected absences to prevent these disturbances.

Limitations

Due to the nature of developing a new clinical program iteratively, the procedures of the program changed during the course of the study, including the videoconferencing program. The program used for the majority of patients (Microsoft Teams) presented many fewer technical challenges. Those in the qualitative interview (all of whom used the original platform), may therefore have had disproportionately negative technology experiences. Nonetheless, they did not find the platform overly onerous, perhaps because of the availability of technical supports in the current study (however, we did not quantify the amount of technical support provided to patients). The opportunity to utilize the two different platforms underscored the need for a simple, user-friendly platform for patients, and the need for technical supports where this is not possible.

The COVID-19 pandemic has been a driver for videoconferencing platform technological advances that will only increase the ease of the patient technology experience. While our sample was diverse with patients having experienced a range of injury etiologies, the majority of patients had sustained a concussion which may limit the generalizability of the findings to patients who sustained more severe injuries. However, of note, all patients with concussion reported ongoing post-concussive symptoms at the time of enrolment.

Two of our surveys were developed in-house without external validation, which may limit the generalizability of the survey findings. Furthermore, participants did not have the opportunity to comment on interview transcripts or the research findings.

Future directions

Future research may seek to examine the generalizability of these findings to additional neurological populations with more severe cognitive impairment. Furthermore, researchers may explore differences in dosing of interventions to determine whether shorter or longer interventions provide similar benefits to improve stewardship of resources and ensure a greater number of people have access to these services.

Conclusions

To the authors' knowledge, this is the largest study to investigate the perspectives of chronic ABI patients on group-based telerehabilitation delivered via videoconferencing. Participants identified multiple benefits of remotely delivered neurorehabilitation,

including convenience, accessibility, cost savings, and reduced travel time. Group therapy was found to confer additional benefits including a sense of community and reductions in social isolation. The combination of remotely delivered care and group-based care did not seem to pose challenges. Overall, the study observed high retention and adherence, and the majority of patients consented to use of their data. The participants identified that technology was not a barrier to their participation and despite reported cognitive impairments, engagement with videoconferencing was possible. Lastly, the study found that this remote delivery group treatment context was conducive to integrated research, given high consent for use of data and high completion rates of online outcomes. Given the dearth of accessible interventions for ameliorating symptoms and improving outcomes in the chronic stages of ABI, these findings encouragingly support an approach to treatment and research that is cost-effective, scalable, and widely accessible.

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ORCID

Mary E. Boulos http://orcid.org/0000-0001-5046-598X
Robin E. A. Green http://orcid.org/0000-0001-9451-3963

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