Let's Text! Piloting the HealthySMS Text Messaging System Adjunct to Adolescent Group Cognitive Behavioral Therapy in the Context of COVID-19

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Abstract

Background: The widespread occurrence and devastating impact of adolescent depression warrants services research focused on feasible and acceptable Evidence-Based Intervention (EBI) efforts, particularly in context of shelter-in-place guidelines disrupting youth socialization and service utilization in the wake of the COVID-19 pandemic. Group cognitive behavioral therapy (CBT) is an EBI for adolescent depression, but effectiveness is inhibited by suboptimal treatment engagement, including inconsistent group attendance, incomplete homework completion, and treatment dropout. Our team designed the mobile health (mHealth) system HealthySMS system to supplement a CBT group for adolescents with depression. The system sends daily text messages requesting responses assessing mood, thoughts, and activities; weekly attendance reminder messages; daily tips about adherence (e.g., a prompt for activity completion); and personalized responses based on participants’ texts.

Objective: We conducted a mixed-method pilot study to implement HealthySMS adjunct to adolescent group CBT services and examine the system feasibility, acceptability, and impact on EBI engagement.

Methods: Over the course of 2020, we invited all twenty adolescents receiving CBT group services for depression at an outpatient psychiatry clinic to enroll in HealthySMS; ultimately, seventeen agreed to participate. Of note, the majority of CBT sessions occurred via remote delivery in context of COVID-19 shelter-in-place guidelines. We tracked participant initiation and engagement with the HealthySMS system and CBT group services, as well as the content of text message responses to HealthySMS, including messages flagged for suicide risk and responses to prompts for feedback. Finally, we invited each participant to engage in a semi-structured interview to provide additional qualitative input on the system.

Results: HealthySMS appears to be a feasible and acceptable adjunct to group CBT for adolescents with depression, as evidenced by high rates of HealthySMS initiation (i.e., 100% of those invited agreed to receive messages) and maintenance (i.e., 94% maintained usage within first month without opting-out). We uncovered meaningful qualitative themes which support promising feasibility and acceptability findings, as well as provide insight into potential system improvements to enhance feasibility and acceptability. Qualitative themes regarding potential mechanisms by which HealthySMS may enhance EBI engagement align with generally high rates of CBT group attendance (i.e., median rate of 85%) and low rates of dropout (i.e., 17%).

Conclusions: Taken together, findings support the promise of utilizing mHealth interventions, such as HealthySMS, adjunct to EBI for adolescents with depression. Future effectiveness research is warranted to examine if enhanced EBI engagement associated with mhealth text-message interventions produces superior patient treatment outcomes.

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Introduction

Depression is a major public health concern for adolescents [1]–[3]; it is a risk factor for mental health problems as an adult, medical illnesses, disability, substance abuse, and suicide [2]–[6]. Evidence-based efforts to improve adolescent depression and related risk became even more imperative during the COVID-19 pandemic due to concern about adolescent mental health deterioration in the context of shelter-in-place guidelines causing substantial educational and social disruptions [7]–[10]. Further, most in-person services were halted during shelter-in-place, rapidly necessitating transition to telehealth and digital health (dHealth) supports [7], [11]–[14]. In response, the need for pilot feasibility and acceptability testing of dHealth tools targeting adolescent depression in real-world settings became glaringly apparent. Such effort would provide an essential first step toward testing the effectiveness of dHealth tools on adolescent depression. The impact of this work would extend beyond the initial COVID-19 shelter-in-place context, given that research suggests many systems will and should continue utilizing telehealth and dHealth supports into the foreseeable future [13], [15], [16], which may be particularly beneficial to reduce disparities for historically marginalized populations [15].

Evidence-based Intervention for Adolescents with Depression

There are several effective evidence-based interventions (EBIs) for adolescent depression [17]–[19]. The most well-supported psychosocial approach is Cognitive Behavioral Therapy (CBT; Klein et al., 2007; Maalouf & Brent, 2012), which targets unhelpful thinking patterns and avoidance of goal-directed and social activities characteristic of depression [20]–[22]. CBT can be effectively delivered via group format [23], demonstrating similar efficacy to individual CBT in decreasing depression in a more cost-effective modality [24]. CBT also can be delivered electronically (eCBT), enhancing accessibility by eliminating the requirement for patients to travel for in-person services [25]–[29]. The potential benefits of electronically-delivered EBI became increasingly evident during SIP guidelines from the COVID-19 pandemic, which prohibited many from receiving in-person mental health treatment. Importantly, our society may experience future SIP guidelines during COVID surges, safety lock-downs, or natural disasters in response to climate change. Fortunately, recent research supports the effectiveness and efficacy of eCBT in decreasing depression [25]–

[29].

Despite the promising efficacy research supporting CBT as an EBI for adolescent depression, effect sizes are heterogenous and low, demonstrating room for improvement [23], [30]. Optimal treatment of adolescent depression requires patient engagement, including initiation of treatment after referral, attendance of sessions, completion of homework between sessions, and not dropping out (i.e., getting the whole “dose” of treatment; [31]. Thus, poor initiation, adherence, and treatment dropout are barriers to effective services in real-world settings and are known to mediate treatment outcome [31]. A meta-analysis of EBIs concluded that the average treatment dropout rate is about 29% and that those with depression are at higher risk for dropout [32]. Treatment drop-out appears particularly pronounced among youth and in online mental health interventions, such that efforts to enhance engagement for eCBT with youth populations are especially called for [33].

Text Message Interventions as Automated dHealth Supports Aiming to Enhance EBI Engagement

There is a strong scientific premise and public health call to develop and evaluate dHealth supports adjunct to EBI that are easy to implement, efficient, and sustainable. Using text messages is a promising approach aiming to enhance adolescent EBI engagement by making use of a tool that is readily available and widely used by adolescents. Use of mobile phones is ubiquitous among adolescents and text messages, also known as short messaging services (SMS), are used at high rates. As of 2015, more than 85% of adolescents across race and ethnicities have access to a cell phone and 90% of them use cell phones to send text messages [34]. In fact, two-thirds of adolescents report that they are more likely to use their cell phones to text rather than talk to friends and a typical adolescent in the United States sends thirty or more text messages each day [34]. Importantly for mobile health (mHealth) research, youth report high satisfaction and readily engage with technology [35]–[37]. Additionally, digital technology allows for the automation of text messages; thus, a text message intervention leveraging automation should not add to provider burden, making it a more sustainable and efficient services intervention.

Text messaging interventions have several advantages over other forms of dHealth interventions, such as use of apps and website-based tools and are particularly well-suited to improve engagement. Text messages

allow for more equitable delivery of care given that they can reach anyone with a phone and do not rely on smartphone ownership or internet access, which are affected by socioeconomic, racial, and ethnic disparities[38]. Additionally, while dHealth interventions have demonstrated promise, web-based and mobile apps are subject to more difficulties with engagement such as problems with adherence and dropout [26], [39].

Some dHealth text message interventions are designed as stand-alone supports (e.g., [40], [41]; see [42] for a scoping review of text-message delivered adolescent mental health interventions); however, there may be unique benefit to text messages interventions designed to supplement EBI and enhance treatment engagement. There are many effective examples of adjunctive text message interventions for disease management and health behavior change (e.g., smoking cessation and diabetes management; [43]), including text message interventions with adolescents [44]. In the emerging literature on text message interventions, adolescents generally react favorably and have good compliance [35], [42], [45], [46]. Pilot research on integrating text messages into individual CBT also has demonstrated encouraging results [47].

Given the promise of text message interventions to enhance EBI engagement, our team developed the HealthySMS system as an adjunct to CBT for depression group services. HealthySMS sends customized text messages to participants inquiring about mood, as well as reminding participants to attend CBT and practice strategies learned during group treatment. For safety, teen text responses are monitored for keywords or phrases that could indicate if someone is expressing suicide risk; providers are sent immediate alerts if the system detectsis triggered by a teen text a response with these key words or phrases. Safety keyword triggers are important features of any that could indicate suicidal behavior.automated dHealth system implementing in real-world settings to keep participants safe and providers informed; in addition, this feature may be particularly helpful during shelter-in-place (SIP) guidelines given the probable decrease in adolescent safety monitoring from other settings, such as schools. The addition of HealthySMS to CBT for depressed adults in a public sector treatment setting was associated with increased number of sessions attended and lengthened duration in treatment [48]. The mood ratings sent by adults through HealthySMS also predicted attendance [49]. Thus, adding HealthySMS to EBI for adolescent depression may be a promising change to existing services targeting increased engagement and ultimately improving outcomes.

Current Study

As a first step in the process of implementing and evaluating the HealthySMS text message system adjunct to the most evidence-based treatment for adolescent depression (i.e., CBT), we conducted a feasibility pilot in an outpatient clinic embedded within an academic medical center's Department of Psychiatry and Behavioral Sciences. Our primary objectives were to investigate the feasibility and acceptability of HealthySMS implemented in a real-world setting, as well as explore potential mechanisms of change on EBI engagement, as a precursor to evaluation of the system's impact on adolescents' group CBT engagement and ultimately depression outcomes. We also aimed to monitor the HealthySMS safety keyword alert triggers and provider responses in order to inform system and research protocol adjustments prior to future HealthySMS research. This multi-phase design featuring a preliminary feasibility pilot to inform decisions about future effectiveness testing is aligned with the Medical Research Council Framework [50], [51], which has been prolifically utilized in mental health and dHealth intervention research. We predicted the following:

Hypothesis 1) The majority of adolescents invited to use HealthySMS (i.e., ≥ 75%) would initiate and maintain usage without opting-out during their CBT group experience.

Hypothesis 2) Adolescents enrolled in HealthySMS would display high rates of engagement with the text-message system (i.e., ≥50% response rate).

Hypothesis 3) Our team would uncover meaningful qualitative themes from participants' text responses and semi-structured interviews about HealthySMS feasibility and acceptability to inform iterative system and research protocol improvements supporting future HealthySMS effectiveness research.

Hypothesis 4) Our team would uncover meaningful qualitative themes from participants' text responses and semi-structured interviews about the potential impact of HealthySMS on EBI engagement to inform mechanisms of change to evaluate in future HealthySMS effectiveness research.

Methods

Participants

Participants were adolescents ages 13 to 18 years old. They were recruited from the [site name removed for masked review] Clinic between December 2019 through September 2020. Adolescents were

eligible to participate if they were enrolled in the clinic's CBT for depression groups running from January 2020 through September 2020.

Of the twenty eligible adolescents who started group CBT for depression services, seventeen agreed to participate in the study. Participant characteristics are shown in Table 1. Briefly, the average age was 15.4 years (standard deviation = 1.5) and the majority (88%) were diagnosed with Major Depressive Disorder (MDD). Most participants (70.6%) had engaged in prior mental health care. Three participants (17.6%) had a history of at least one suicide attempt with most (64.7%) reporting suicidal ideation in the past year. Just over half of participants (52.9%) were engaged in concurrent individual or family therapy.

Of note, our research protocol did not make any changes to how the real-world clinic provided services. ParticipantsAdolescents were not incentivized to start treatment, attend sessions, or complete homework. Adolescents in the clinic could be engaged in individual and/or family therapy simultaneously while attending group treatment.

Table 1.

Participant Demographic and Clinical Information (N = 17)

Demographic Information	**M**	**SD**	**Clinical History**	**f**	**%**
Age	15.4	1.5	**Prior Therapy Experience***		
	f	%	Participated in prior outpatient therapy	9	53
Gender			Participated in IOP or PHP	2	12
female	8	47.1	Psychiatric hospitalization	1	6
male	8	47.1	Residential treatment facility	2	12
transfemale	1	5.9	None	5	29
Ethnicity			**Prior suicide attempt**	3	18
Latinx	7	41.2	**Suicidal ideation at Intake**		
Non-Latinx	10	58.8	Denied	6	35
Race			SI in past week	3	18
Asian	1	5.9	SI in past month	2	12
Black	1	5.9	SI in past year	6	35
White	10	58.8	**NSSI at Intake**		
Biracial/Multiracial	4	23.5	Denied	10	59
Something else (Hispanic, Mexican)	1	5.9	NSSI in past week	1	6

Sexual Orientation			NSSI in past month	2	12
Heterosexual	8	47.1	NSSI in past year	4	23
Lesbian	1	5.9	**School Problems***		
Bisexual	3	17.6	None reported	9	53
Gay	1	5.9	IEP/accommodations	6	35
Pansexual	1	5.9	School refusal	3	18
Not sure/don't care	3	17.6	**Major Depressive Disorder**		
			Met criteria in past	1	6
			Reports some symptoms	1	6
			Currently meets criteria	15	88
			Symptoms from co-morbid disorders		
			Generalized anxiety disorder	5	29
			Panic Disorder	2	12
			Social Anxiety Disorder	1	6
			Eating Disorder	1	6
			ADHD	1	6
			None	7	41
			Concurrent Therapy*		
			Individual CBT	6	35
			Family therapy	4	24
			none	8	47
			Concurrent Medication management	15	88

Note. NSSI = Non suicidal self-injury. IOP = Intensive Outpatient Treatment. PHP = Partial Hospitalization Program. SI = suicidal ideation. IEP = Individualized Education Plna. ADHD = Attention Deficit-Hyperactivity Disorder. CBT = Cognitive Behavioral Therapy. *Response options are not mutually exclusive.

CBT Group Intervention

The CBT for Depression Group for Adolescents (CBT-D) consists of three four-week modules on thoughts, activities, and people (i.e., twelve group session total). It is based on the BRIGHT group CBT manual for depression for adults developed by Ricardo F. Muñoz and colleagues (Muñoz, et al., 2000), which was subsequently adapted for adolescents with a diagnosis of major depression and/or persistent depressive disorder. The thoughts module involves cognitive interventions with a focus on awareness of helpful and harmful thoughts, the activities module focuses on pleasant activities and behavioral activation, and the people module encourages group members to improve relationships and evaluate the impact of positive and negative

social relationships on mood. The sessions are structured with an initial homework check-in followed by didactic on the covered topic, an interactive discussion led by two group providers, and setting of homework goals related to skill use. In the current study, the first seven group sessions were held in-person; the remainder were held via HIPAA compliant Zoom platform after SIP orders were implemented in March 2020.

HealthySMS Text Message System

We used the HIPAA-compliant, web-based texting platform called HealthySMS, developed by our team member, [investigator name removed for masked review], to send and receive text messages, administer weekly surveys, and track attendance. HealthySMS sent four types of automated text messages to participants: 1) daily mood prompts asking participants to rate their mood and reflect on their mood, thoughts, and behavior ("[First name], what is your mood right now on a scale of 1 to 9 (9 being best)? Please respond with a number and a message about what you are doing or thinking"), 2) personalized and reinforcing responses to 20% of participants' mood ratings (i.e., encouraging the participant to engage in behavioral activation in response to a low mood rating, and reinforcing the participant in response to a high mood rating), 3) daily reminders about concepts and skills learned during the corresponding CBT module for that month, and 4) weekly reminders to attend and come prepared to CBT the day before group. Participants could opt-out of receiving text messages at any point by texting "stop".

Our clinical research team oriented adolescent participants to the HealthySMS system. We also oriented providers to the text messages and HealthySMS web-based provider dashboard, which visualizes client responses to the text messages, including graphs of mood ratings. HealthySMS monitors and alerts providers to participant words and phrases that may correspond to suicidal behaviors (e.g., "die," "kill," "cut") and providers were trained on how to respond to these alerts aligned with existing clinic policies and procedures.

Measures

Participant demographics and clinical history. Participants were asked to complete a demographics survey before beginning group. CBT-D group providers recorded psychiatric diagnoses and treatment history information for each participant, including other therapy or medication management services, based on their evaluation and review of the medical record.

HealthySMS engagement. We tracked the number of participants who were invited to receive HealthySMS text messages, as well as those who agreed to initiate receipt of HealthySMS text messages. We also tracked the number of participants who texted "stop" to opt out of text messages before ending participation in group, as well how long each participant received the text messages before opting out. We measured engagement with the HealthySMS text messages by tracking the number of mood ratings that participants texted in response to mood rating request messages.

HealthySMS safety keyword triggers. We tracked the number and content of participant text message responses that were flagged for risk of suicide (see Appendix A for trigger words). We also kept observation notes about the provider responses.

Qualitative feedback. We collected qualitative feedback in several ways. We tracked responses to our monthly text message prompts to participants asking "What is the most positive part of receiving these text messages?" and "What do you not like about receiving the text messages?." We also invited all adolescent participants to share feedback in a semi-structured interview after their CBT-D group completion for a $25 Amazon gift card. Interviews were moderated by a member of our clinical research team who followed a semi-structured guide containing study objectives to explain, questions to pose, and prompts to use when needed. Specifically, we explained that researchers hoped to obtain information about mHealth interventions like HealthySMS and CBT group services for depression. Next, we asked for general feedback about the HealthySMS system, followed by asking more specifically about different aspects of HealthySMS, such as the mood prompts, responses to mood ratings, and group reminders. We also showed participants a list of the HealthySMS texts and asked for feedback on their impact, content, and phrasing. See Table 2 interview for questions and prompts. Each interview lasted between 19 and 45 minutes (mean = 32 minutes) with length depending on the amount of detail provided by the respondent(s).

Table 2.

Qualitative Semi-structured Interview Questions and Prompts

Questions (in order of outline)	Prompts
• How did you like the LET'S TEXT! message program overall?	• Was there anything that made it difficult for you to receive the messages? For example, how did you like: the timing

	of the messages, the amount of messages, the phrasing of messages? • Was there anything that made it difficult for you to respond to the messages? For example, how did you like: the timing of the messages, the amount of messages, the phrasing of messages? • Is there anything about it you would suggest we change?
• How did you like the LET'S TEXT! Mood Prompts and Responses? • *[after general feedback was given, participants were show the list of printed texts for specific feedback]*	• What did you think worked well? • What was difficult or did not go well? • Is there anything you would change? • Did these messages change your mood, thoughts, or behavior?
• How did you like the LET'S TEXT! Skill Practice Reminders? • *[after general feedback was given, participants were show the list of printed texts for specific feedback*	• What did you think worked well? • What was difficult or did not go well? • Is there anything you would change? • Did these messages change your mood, thoughts, or behavior? • For example, did you need more/less help with any of the skills; was the purpose of the reminders clear; -were the messages too few/many; were the reminders relevant to your goals; were they phrased appropriately?
• How did you like the LET'S TEXT! Group Reminders?	• Did these messages change your mood, thoughts, or behavior?
• Some teens find:	• …it easier to participate if they feel: comfortable, respected, and understood by the group members and group leader attached to the messages. How was your RELATIONSHIP WITH THE GROUP AND GROUP LEADER AND DID THAT AFFECT YOUR EXPERIENCE WITH THE TEXT MESSAGES? • …that the messages help them become more active. Do you think your ACTIVITY COMPLETION was impacted by the text messages? • …the messages help them go to group and participate more often and/or effectively. How was your GROUP ENGAGEMENT and did that change with the text messages? • …the messages are reinforcing and help them practice the group skills more often and/or effectively. How was your PRACTICE OF THE GROUP SKILLS and did that change with the text messages?
• Is there ANYTHING ELSE you would like to share that we haven't asked you?	

Data Analytic Plan

We analyzed quantitative data on participant characteristics, HealthySMS engagement, and safety keyword triggers using descriptive statistics in SPSS. We calculated text message response rates by dividing the number of responses by the number of text messages received for mood ratings.

We analyzed the qualitative data in a multistep process utilizing Thematic Analysis Principles (Creswell & Clarke, 2007). First, we developed a hierarchical coding system based on recurrent concepts we uncovered when conducting the qualitative interviews and in consideration of related theoretical literature. Next, members of our research team reviewed qualitative message content and interview transcriptions to collaboratively refine recurrent themes while iteratively updating the coding system. Our team selected exemplary quotes for each theme.

Results

Hypothesis 1

Our first hypothesis was that the majority (i.e., >75%) of adolescents invited to HealthySMS would initiate and maintain usage. All participants (100%) agreed to enroll in the HealthySMS system and initiate receipt of messages upon starting CBT-D group; 94% maintained usage during the CBT-D group experience. Only one participant opted out of the text messages by texting “stop” 30 days after initiation.

Hypothesis 2

Our second hypothesis was that adolescents enrolled in HealthySMS would display high rates of engagement with the text-message system (i.e., ≥75% response rate). As seen in Table 3, HealthySMS response rate varied between participants. The average response to daily mood ratings was 61% with a range of 0.00-1.77 responses per message. Only one participant did not respond to any of the text messages prompting mood ratings and two participants responded multiple times to several prompts (indicated by a response proportion greater than 1). Most participants (59%) responded to more than 50% of the daily mood ratings.

Table 3.

HealthySMS Engagement

Participant	Response Proportion to Mood Ratings	Weeks until opting out
1	0.04	N/A
2	0.16	N/A
3	0.30	N/A
4	0.64	N/A
5	0.01	N/A
6	1.54	N/A
7	0.00	N/A
8	0.87	N/A
9	0.05	N/A
10	0.82	N/A
11	1.77	N/A
12	0.12	N/A
13	0.87	N/A
14	0.77	N/A
15	0.79	N/A
16	0.75	N/A
17	0.84	4

Hypothesis 3

Our third hypothesis was that we would uncover meaningful qualitative themes from participants' text responses and semi-structured interviews about HealthySMS feasibility and acceptability. We posited that meaningful themes would be beneficial in informing iterative system and research protocol improvements supporting future HealthySMS effectiveness research. When examining the context of participant text responses to our monthly message prompts and semi-structured interviews asking for feedback, we identified themes and exemplary quotes regarding HealthySMS feasibility and acceptability (see Table 4).

Hypothesis 4

Our final hypothesis was that we would uncover meaningful qualitative themes from participants' text

responses and semi-structured interviews about the potential impact of HealthySMS on EBI engagement. We posited that meaningful themes would be beneficial in informing mechanisms of change to evaluate in future HealthySMS effectiveness research. When examining the context of participant text responses to our monthly message prompts and semi-structured interviews asking for feedback, we identified themes and exemplary quotes regarding potential HealthySMS impact on EBI engagement (see Table 4).

Table 4.

Qualitive Themes Uncovered and Example Quotes regarding HealthySMS Feasibility, Acceptability, and Potential Impact on EBI Engagement

HealthySMS Feasibility		
Theme	**Example Quote Supporting Feasibility**	**Example Quote about Limited Feasibility**
Text modality	*“I am not really great with the emails. I think just going through texts is almost always better.”*	*“for a while, I just didn't even open the texts.”*
Consistency of delivery	*“I always got the text and sometimes if I didn't reply, like with my mood, I would get like a reminder, maybe 10 minutes later, respond your mood. So I would say technically or technologically, it was all good. I didn't run into any issues.”*	*“Sometimes my mood ratings just wouldn't come in. Like some days, like towards the ending of it, they just came in periodically like not every day.”*
Amount of Effort to Use	*“[it was fine to] like, give a number, how was your day? But if it was like kind of describe your day, I don't think anyone would want to do that because it would take too long.”*	*“if you didn't like type in your mood right away, it would like send you a reminder a lot. So I got those a lot if I wasn't doing it.”*
Timing of texts	*“I definitely didn't get anything like super early or late. I would say they did a pretty good job of, like, changing up time, so it wasn't like the same time every like 8AM and 10PM, like it was pretty good at switching up times so you could get like different times of the day.”*	*“I guess sometimes they came at weird times, like really early in the morning or really late at late night…It kind of felt less helpful if they came later in the day because either I had already figured it out or like got past it or it just didn't help anymore.”*
Amount of texts	*"I don't remember getting, like, bombarded with them. So I would say the amount is probably pretty good and reasonable.”*	*“It felt sometimes like it was getting too many. But that was mainly because that was like at a time when I didn't need them and so it just felt like a waste of message if that makes sense.”*
Text Length	*“they're all quick… It's short and simple and sweet…”*	*“I liked it, but it was also like kind of a lot sometimes.”*
HealthySMS Acceptability by Text Type		
Theme	**Example Quote Supporting Acceptability**	**Example Quote about Limited Acceptability**
Group reminders	*“I liked it, because sometimes when things got a little hectic, I would forget about group so it's a useful reminder.”*	*They weren't the most helpful, especially because I'm pretty sure I only ever got one text and it was just "there is group tomorrow. Don't forget your binder," which I realize is probably works a lot better when you actually have to go somewhere to do it. But like I already said, I have nothing else going on [in quarantine], so I remember yep, that's tomorrow. I felt like there definitely could be some variation in things like maybe it could bring up, like, remember the skills you learned or don't be scared to share or something like that, that could be a little*

		more emotional based."
Personalized response texts	*"I did like how if your mood was like a bad mood, it would give you like, it wouldn't it just be like that sucks feel better, but it would give you like advice and strategies of how you can get better. I think that was nice. And I liked when if you were in a good mood, it would kind of still give you like a different kind of advice to keep you in that space and like be like, like you could use that experience to feel better later when you remember."*	*"… having a little bit of background about like who it is I'm responding to, like, is it a computer or is it a person like this data is being used for what, kind of thing might be helpful."*
Mood ratings	*"the rating of the mood… it kind of helped me figure out how I was feeling, like in a number form."*	*"I would say it was kind of easy when I was like doing super well or super bad…, but little bit harder, I guess, like to be: 'OK, well, I don't really know. I'm average'."*
Skill reminder texts overall	*"I thought they really were helpful… a really nice boost, and it was and it would remind me of the other things I had learned that I could also use to feel better."*	*"Um if I was able to do something like kind of just the reminder was helpful. But with COVID a lot of the times, it wasn't applicable."*
Activity skill reminders	*"I always think it's good to like set goals for yourself so you have something to work towards. So it's almost like a little bit of motivation."*	*"…like: 'do a new activity'…a lot of activities have like kind of gotten harder to do with everything [in context of COVID]."*
Social skill reminders	*"I liked the people [texts], because I struggle with my relationships with people."*	*"Sometimes I couldn't hang out with friends. So then sometimes that even made me, like, a little frustrated."*
Cognition skill reminders	*"I think sometimes like I get so stuck in like the past or just like in the moment that it's good to just like think about your future and like the good things that are to come."*	*"…it was just odd getting text telling me to, like, change the way I'm thinking because I know like the way my brain works, it's not going to just happen. …So it was just annoying because I would like to make [the thoughts] go away, but they're not going to."*
Statements versus questions	*"I felt that they were good, I like them more when they were more statement based... I felt that just a clear like statement or like advice boost helped more for me personally."*	*"I got confused a bit with the questions they'd ask because I wasn't sure if I was supposed to, like, respond to them and it would respond back or it was just kind of a moment to reflect."*
Potential Impact on EBI Engagement to be evaluated in Future Effectiveness Research		
Theme	**Example Quote Supporting Impact on EBI Engagement**	**Example Quote about Limited Impact on EBI Engagement**
Participation in group sessions	*"It was just like a reminder to like start thinking about group. So like before group, I'd just like start thinking about it so I'd like have more to say."*	*"I wouldn't really say that the text messages changed my experience in the actual group. It felt more like kind of a recap throughout the week, and less than, sort of a second part of group, if that makes sense. Yeah like we talked about the text messages a bit in group, but the text messages were always about the thing that happened last week, and so we'd want to*

		move on. It could be helpful if the text messages like cover, like some newer things to introduce you, but um yeah."
Group homework completion	*"That was kind of like a good check in where I was like, OK, did I have homework? What was it? Could that help me? So I would keep that in there."*	*"I would definitely do techniques more if I got a text message reminding me to do it [the specific homework rather than the general skill reminder] in the week."*
Connection with others in group	*"it felt like we were closer because we were all getting the same messages and we were all in the same boat together."*	*"My experience with my group and group leader was pretty good, but I wouldn't really say my experience in group and my experience with the text messages were linked"*
Validation and support	*"And it felt like someone was like caring about me"*	*"but it also could backfire on if you don't do it [the suggestion in the text], feeling guilty."*
Impact on mood	*"It kind of gave me some positivity boost, and it was nice to have someone or something to talk to me while I was feeling that way."*	*"I wasn't doing anything because I couldn't go out and it just made me think about it more... So it just made me a little bit more sad."*
Behavior change and skill use	*"I got something like the, call or spend time with people who make you feel happy… And I ended up calling one of my closest friends and she did bring up my mood a little bit..."*	*"I didn't usually act on it, probably just because it was like, OK, well, right now I'm doing something. So then I wouldn't really remember to do it later, but I can see how, what the idea was."*

Safety during HealthySMS intervention

A secondary aim of our pilot was to monitor the HealthySMS safety keyword alert triggers and provider responses to inform system and research protocol adjustments prior to future HealthySMS research. During the study period, 76 of the 1002 total text messages sent by participants alerted providers to potential suicide risk throughout our flagged keyword system. When examining the content of participant text responses that were flagged for risk of suicide, only two of these messages were determined to contain true risk-related content (e.g., text about wanting hurt oneself or suicide). In one case, the notified provider determined that the text may be an indication that the participant was about to self-harm and they followed the clinic's safety protocol; no indication that harm occurred was received and the participant continued attending group and engaging in the study. In the second case, the notified provider determined that the message did not represent an increase in risk and addressed the client's worry about the future in their following session.

Discussion

The results of this feasibility pilot demonstrate that use of HealthySMS adjunct to adolescent CBT group for depression (CBT-D) services appears feasible and acceptable, as evidenced by high rates of HealthySMS initiation and low rates of drop-out, as well as meaningful themes uncovered from participant qualitative feedback. Importantly, findings also provide evidence regarding iterative improvements to the HealthySMS system and research protocol, as well as potential mechanisms of change for enhanced EBI engagement and ultimately adolescent depression outcomes, that can be used in future effectiveness research. It is compelling that the current study results occurred in-context of ongoing clinical services at a real-world outpatient clinic experiencing transition to telehealth services amidst the onset of the COVID-19 pandemic and that the research protocol did not alter the clinical service procedures in any way, such as incentivizing adolescents to attend groups. It also is notable that we were able to implement this intervention in a safe manner during this time of increasing numbers of youth being at risk for suicide; the two instances of HealthySMS alerts indicating risk were managed via clinic procedures and no adverse outcomes occurred to any participant during the study.

HealthySMS Feasibility and Acceptability

As predicted, teens enrolled and maintained use of HealthySMS at high rates; in fact, no one declined participation and only one adolescent opted-out after a month of usage. HealthySMS response rate was slightly lower than predicted, but of note, varied participant. Some teens had very low response rates (i.e., one never responded to any messages) and some teens had high response rates (i.e., one responded multiple times to most prompts). Overall, most teens responded more than half the time to daily mood rating prompts (i.e., response rates averaging over 60%). Qualitative feedback suggested that quick and short messages, as well as midday versus early or late message timing, may be most feasible to respond to. In addition, some teens shared that they were motivated to respond by the "interactive" nature of the mood rating texts which triggered responses back 20% of the time. We received feedback that the amount of HealthySMS messages and reminders felt appropriate for some; however, we received other feedback indicating a preference for less frequent messages and reminders. A future direction to explore is whether personalizing the message and reminder timing and frequency (e.g., request preferences in initial survey and include in monthly feedback prompts; adapt system to allow for differences by preference) may increase response rates. Interestingly, some teens also sent text messages back to the skill reminder messages (i.e., response rates averaging 12%) even though there weren't explicit requests for responses. Adding explicit response requests into skill reminder messages may be another way to explore potential benefits of HealthySMS.

Regarding the HealthySMS safety triggers, the system appeared to appropriately monitor risk. Throughout the ten months of the study, 76 of the 1002 total messages sent by participants during the study period triggered providers alerts via flagged keywords (e.g., cut, kill, die; listed in Appendix A). We added words to the system for the current trial after consulting with data from the teen crisis text line. Importantly, only two of the alerts in the current study indicated potential suicide risk and required clinical follow-up. Providers complied with the established clinic policies/procedures and no known adverse outcomes occurred amongst any participant throughout the study. In fact, the vast majority of alerts were false-positives (e.g., I just got my haircut; I went for a bikeride over the bridge; my throat

hurts). One of the most sensitive keywords appeared to be “end” given that it is a frequently used word and is included in many words (e.g., almost the end of the day; FaceTime with friend). This information can be used to iteratively improve the HealthySMS system to balance the need to detect safety concerns with high sensitivity while trying to avoid false-positives and therefore reducing provider burden in reviewing alerted text messages, such as programming keyword trigger alerts to only trigger when the word “end” by itself is sent and not when it’s included in other words, like “friend”. It will be important for future HealthySMS efforts to consider how Future HealthySMS research designed to evaluate the appropriateness of the safety keyword triggers and subsequent provider responses to prevent self-harming behaviors would be beneficial.

Potential Impact on EBI Engagement to be evaluated in Future Effectiveness Research

When asked about the utility of HealthySMS, we received input providing initial evidence that the system may indeed enhance EBI engagement. Our identified themes may be used to inform mechanisms of change to evaluate in future HealthySMS effectiveness research designed to measure impact of the system on EBI engagement and ultimately adolescent depression outcomes. To begin, most teens gave feedback that group reminder texts may have increased their likelihood to attend and meaningfully participate in group; though one participant felt that group reminder texts were intrusive and did not impact engagement in group. Variation in responses again highlighted that a personalized text messaging system would be ideal to accommodate individual needs and desires.

Qualitative responses also suggest that the HealthySMS skill messages provided beneficial reminders and motivation for some teens to engage in the CBT strategies, including behavioral activation and helpful thinking. Some participants did suggest we sync skill messages with the content being delivered each week (rather than with each module, as is the current set-up) to optimize relevance. While weekly agendas are generally known from the beginning given the CBT-D group format in the current study, group providers may adjust agendas to meet the needs of current group members. Thus, personalizing the timing and content of messages and syncing messages more precisely to weekly content would likely be perceived as helpful by participants but would need to be weighed against the feasibility

of such measures, which could increase provider burden.

We were also interested in the impact of HealthySMS on interpersonal connection of the adolescents in the current trial, given the reports of adults in our team's prior trial of HealthySMS that participants felt cared for and supported by the messages, as well as closer to the CBT group (sources removed for masked review). We received feedback suggesting that HealthySMS may help some teens feel more connected to the group leader and other members, as well as validated and supported even with the knowledge that it is a "bot" responding. One provider shared that a participant felt that HealthySMS was like a "friend." Feedback from participant interviews indicated that this sense of connection was especially true when they received the responses to their mood rating texts, which were aligned with how they rated their mood (i.e., different response were sent for high, medium, or low mood ratings).

Limitations and Future Directions

There are several limitations to our study that should be acknowledged and addressed in future work. To begin, the nature of our pilot investigating HealthySMS feasibility and acceptability in a real-world treatment setting was not designed to evaluate the system's role in improving the ultimate target of adolescent depression. To accomplish this, future effectiveness research building upon lessons learned and iteratively-updated deliverables (i.e., the HealthySMS system and research protocol) from the current study employing is warranted. Specifically, although we were able to explore the potential impact of HealthySMS on EBI engagement in participants' qualitative feedback, we did not have the data or sample size needed to quantitatively evaluate this construct. Additionally, our decision to conduct the current pilot in a real-world setting without making changes to existing clinic procedures created several potentially confounding variables between participants, such as the number of other EBI services engaged in adjunct to the CBT-D group. Subsequent studies fully-powered to detect mechanisms of change, as well as control for potential covariates to EBI engagement and outcomes, employing a control group are called for. Finally, this pilot study took place in the beginning months of shelter-in-place due to the COVID-19 pandemic and thus it is not known how well our findings will generalize beyond this context.

Conclusions

Our pilot suggests HealthySMS adjunct to the most evidence-based treatment for adolescent depression (i.e., CBT) is feasible and acceptable, warranting future effectiveness research evaluating the system's impact on teen EBI engagement and subsequent depression outcomes. As SMS is cheap and uses technology already in the hands of most teen, text messaging is well-suited to be added to existing clinical services. Feedback from participants in our studies suggested that mHealth may be particularly helpful during times of SIP given the limited ability for teens to engage in activities, social interactions, in-person mental health treatment and safety monitoring by adults in their lives (e.g., teachers, providers). However, it is possible that SMS systems are beneficial adjuncts to EBI in all contexts given their potential to increase the likelihood and effectiveness of service participation, enhance feelings of connectedness and validation, and encourage skill use in-between sessions. Continued services research on the implementation and effectiveness of mHealth tools has the potential to improve mental health services for a population experiencing drastic increases in depression and suicide risk: teens!

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Appendix A: Risk Alert Words

Kill, Die, Suicide, Suicidal, Don’t want to live, Do not want, Bridge, What is the point, Harm, hang, Hurt, Gun, Cut, Pills, Death, cop, midnight, train, syringe, excedrin, myself, die, antifreeze, noose, revolver, tablets, 11:11, 800mg, bathtub, safe, rum, ibuprofen, looney, nightstand, electrocution, vampire, railroad, bridge, acetaminophen, god, abuse, end, finish, Jesus, dead, heaven, hell, knife, razor, Do not want to live, Don’t want, Hopeless