The utility and impact of the addiction comprehensive health enhancement support system (ACHESS) on substance abuse treatment adherence among youth in an intensive outpatient program

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ABSTRACT

Youth experiencing substance use disorders often are susceptible to relapse because traditional support systems can be expensive, geographically dispersed, operated on limited schedules and lacking in peer support. The continuity of care offered via the digital Addiction Comprehensive Health Enhancement Support System (ACHESS) system holds promise in preventing relapse because of its portability and capability to foster virtually anytime/anywhere, cost-effective access to supportive interventions. The aim of this mixed-methods study was to evaluate the utility and impact of ACHESS on treatment adherence among youth with substance use disorders in an intensive outpatient program in the US Midwest. Data on 28 clients using ACHESS during 2016–17 were compared to retrospective data on 28 carefully-matched others treated without ACHESS during 2014–16. Fifty-four percent of the study group successfully completed treatment as opposed to 42.9% of those in the comparison group. Staff focus group findings highlighted how some features of ACHESS were effectively integrated into the care model and appeared to positively impact outcomes, while other elements of the application offered little utility. We suggest further study of ACHESS among larger samples of youth with substance use disorders in intensive outpatient programs to assess its efficacy in supporting adherence to treatment.

1. Introduction

Behavioral health providers are increasingly incorporating specialized smartphones applications (apps) into their work related to substance use disorder (SUD) treatment (WHO Global Observatory for eHealth, 2011). Some of these apps show promise in a variety of ways, such as by capturing clients' self-evaluation of their daily experiences via ambulatory assessment (Trull and Ebner-Priemer, 2013; Gustafson et al., 2014). The Addiction Comprehensive Health Enhancement Support System (ACHESS) is a combined client-facing app and web-based clinician dashboard used to support and monitor clients with SUD whom are seeking addiction treatment (Gustafson et al., 2011a). Primary challenges of these types of addictions is the susceptibility for relapse coupled with traditional service systems that often are very expensive, geographically dispersed, operated on limited schedules and lacking in tailored peer support. The ACHESS system is portable and has the capability to foster virtually anytime/anywhere access to emotional, relational and instrumental supportive interventions at a fraction of the cost of more traditional ones (Johnson et al.,

2011, 2016; Substance Abuse and Mental Health Service Administration, 2017).

The ACHESS mobile app (Version 2.6.53 by Chess Health, East Rochester, New York, US) used in this pilot study was designed to offer a variety of services that among others included: a "Weekly Survey" monitoring users' affect, lifestyle balance and substance use; a "Beacon" or emergency alert button alerting users' support personnel to any increasing cravings or challenging situations; a "Connect" portal allowing users to connect via text message with peers and personal treatment counselors; and a "Discover" portal through which users can search and access audio and visual media content related to motivation, relaxation and recovery skills (McTavish et al., 2012; Chih et al., 2014). The app's design is grounded in the three basic tenets of Self-Determination Theory to promote users' adaptive functioning through greater self-perceived competence, social relatedness and motivation. Strengthening a user's experience in these areas can in turn improve coping skills that may assist the user in both avoiding relapse and increasing quality of life (Marlatt and George, 1984; Ryan and Deci, 2000; McTavish et al., 2012).

Studies differing in sample size and scope demonstrate the feasibility of using ACHESS with both adults and adolescents (Gustafson et al., 2011a; Gustafson et al., 2014; Dennis et al., 2015). Studies also show the app's contributions to users' positive treatment outcomes in a variety of treatment settings (Gustafson et al., 2011a; McTavish et al., 2012; Quanbeck et al., 2014; Dennis et al., 2015; Ford et al., 2015; Johnson et al., 2016; Mares et al., 2016; Glass et al., 2017). Yet there appear to be no studies to date on ACHESS' role in building on post-hospitalization care for youth to support their intensive outpatient (IOP) treatment.

Additionally, with the exception of the efforts discussed by Schulte et al. (2016), there is little evidence in the literature that app software engineers are designing in collaboration with professional end-users (Johnson et al., 2011; Aquirre et al., 2013; Sedrati et al., 2016). Moreover the vast majority of scholarly articles published to date on app use in SUD recovery are based on quantitative study findings, or protocols for future randomized clinical trials, that measure client outcomes (e.g. McTavish et al., 2012; Chih et al., 2014; Gustafson et al., 2014; Quanbeck et al., 2014; Benarous et al., 2016; Johnson et al., 2016; Glass et al., 2017; and Scott et al., 2018). Qualitative studies capturing behavioral health professionals' detailed descriptions of their own experiences are lacking, although there are two studies that employed qualitative or mixed methods (Ford et al., 2015; Mares et al., 2016) to explore professionals' perspectives on utilizing the app in their workplace. Ford et al. investigated different agencies' successful organizational strategies that sustained ACHESS use among adult clients for at least a year and Mares et al. studied the implementation process of another mHealth app for adults in a primary care setting. With these gaps in the literature in mind, we conducted a pilot study to collect quantitative data on ACHESS' impact on positive SUD treatment outcomes for youth in an IOP setting, as well as qualitative data on providers' perspectives of ACHESS implementation and use.

2. Methods

2.1. Pilot study design

A mixed methods pilot study was conducted to evaluate whether or not the use of the ACHESS mobile app impacted adherence to SUD treatment among youth in an IOP setting at a Midwestern treatment center. We used propensity score matching (PSM) to construct a retrospective comparison group based on observational data, and a focus group interview to elicit qualitative data.

2.2. Subjects

We acquired data from three subject groups in this pilot study. The pilot study group was comprised of treatment center clients recruited between May 27, 2016, and April 6, 2017. Inclusion criteria were female and male youth under 21 years of age with a substance use disorder who were receiving care in the center's IOP treatment setting. Forty-seven youth initially agreed to use ACHESS. Thirty-seven of these youth and their parents or guardians provided assent and informed consent to participate in the research. Of these 37 youth, 9 did not follow through with installing the ACHESS app. In the end we developed a pilot study group comprised of 28 clients—9 females and 19 males.

We also developed a comparison group (28 clients—10 females and 18 males) by using the treatment center's historical data on youth whom received IOP treatment services without ACHESS during the two years prior to the pilot study period (i.e., 2014–16). A staff focus group also was established by inviting treatment center staff to participate in a focus group interview. Inclusion criteria were female and male staff 18 years of age and older who were involved with the implementation of ACHESS at the treatment center. We invited seven staff members—5 females and 2 males—to participate and all seven provided informed consent.

2.3. Procedures

This pilot study is based on the analysis of three types of data: 1. de-identified quantitative data on pilot study group participants using ACHESS as part of their IOP treatment services; 2. de-identified, retrospective quantitative data on a comparison group of non-ACHESS users whom received IOP services at the center prior to the implementation of ACHESS; and 3. qualitative data from the center staff's focus group interview.

The development of the pilot study group began at the time of youth intake to the IOP treatment setting. Once obtaining informed consent and assent, the center staff assigned each youth a pilot study ID for the staff to use in the place of any identifiers in their data collection processes. Data was collected by the center staff. Data included demographics (e.g., age, ethnicity, gender, family income, housing and employment), mental health diagnoses and psychiatric history, substance use diagnoses, history of substance use, trauma history and legal history. Variables like substance use (e.g., abstinent at discharge), prior victimization and prior juvenile justice involvement were collected on an ongoing basis by the center's staff. At the completion of data collection, the center staff forwarded to us the pilot study group's de-identified data in an Excel file.

The comparison group was developed by center staff using existing historical data on clients who received IOP treatment services at the center without ACHESS in the two years prior to the pilot study period. Once all of the participants in the pilot study group were enrolled by center staff, and study variables were identified by the researchers, the center staff were able to populate the comparison group by extracting historical data and matching it as closely as possible to the types of data that were collected from the ACHESS pilot study group. The IOP model was the same across the three-year pilot study period, with the exception of the use of the ACHESS mobile app during the last year. Administrative and treatment staff turnover at the center was minimal over the three-year pilot study duration. The center staff forwarded this de-identified data to us from which we constructed a comparison group.

We also conducted a focus group with staff at the treatment center on June 5, 2017. The focus group interview was facilitated by the corresponding author, whom had established relationships with two of the focus group participants. The second author and a research assistant took detailed notes of the discussion. The corresponding author holds a Ph.D. in social work, is an associate professor and a licensed independent social worker with supervisor designation (LISW-S) and has over 40 years of clinical and research experience in a variety of mental health and substance use disorder treatment settings. The second author holds a Ph.D. in cultural anthropology, is a senior research associate and has for nearly 30 years employed qualitative research methods. Both authors brought potential strengths and weaknesses to the pilot study design, focus group discussion and data analysis, but complemented one another across the pilot study procedures.

Two of the seven focus group members self-identified their roles as "Therapist," while the others self-identified as "Assistant Director of Outpatient Services," "Director of Outpatient Services," "Information Technology," "Development Director," and "Chief Executive Officer." Six of the participants were in the meeting room with us during the focus group discussion, and one participated via conference call. After a brief period of introduction, the focus group interview lasted 60 min and explored a wide-range of topics centered around the utility and impact of ACHESS on youth seeking substance abuse treatment in the center's IOP setting. Among others, questions included: How has the use of the ACHESS app changed your existing IOP treatment model of care? How would you describe the utility of ACHESS? What aspects of the app contributed to its effectiveness in treatment? What were the greatest challenges to clients and staff using ACHESS? What feedback did you get from clients about ACHESS?

2.4. Data analysis

We used propensity score matching (PSM) from the de-identified historical client data to construct a comparison group (Rosenbaum and Rubin, 1985). PSM is a very popular method of constructing a comparison group in non-randomized studies using observed baseline characteristics to estimate probability of treatment assignment in situations of nonrandom assignment (Pearl, 2010; Robst et al., 2011; Garrido et al., 2014;). Variables pertaining to age, gender and ethnicity have been successfully employed to conduct PSM in other behavioral health treatment studies, and we emphasized these same three variables to construct an equivalent comparison group in this pilot study (Subramaniam et al., 2009; Ives et al., 2010, 2012). In addition, PSM helped match clients by conditioning on a large set of other covariates associated with substance abuse treatment outcomes. This process facilitated the creation of a comparison group that was similar to the youth in the pilot study group. Comparisons between the pilot study group and comparison group were conducted using a Pearson's Chi-Squared procedure and T-test. All analyses were conducted using IBM SPSS version 24.

The staff focus group interview provided an opportunity to explore "rich points" (Agar, 1980), or descriptions of experiences, perceptions, and opinions of the ACHESS app and its implementation that were offered in the center's staff members' own words and also unknown to us prior to the focus group. The qualitative focus group data, in the form of our detailed notes taken during the focus group interview, were entered into a Word file. This resulting text was analyzed using systematic text condensation (STC) developed by Malterud, based on Giorgi's phenomenological analysis (Giorgi, 1985; Malterud, 2012). We analyzed the focus group data in the following way. The second author gained a general impression of the data by reading the responses and highlighting themes. The document was then read by the same author a second time with the goal of identifying specific units of meaning relating to the core topics of this ACHESS pilot study. The contents of these meaning units were in some cases condensed, and all were sorted to more accurately cover distinct topics. The meaning units were then removed from the wider context of the focus group discussion into collections of similar statements about staff members' experiences, perceptions and opinions of the ACHESS app's utility and impact. Both authors and the research assistant discussed the findings and the two who did not do the STC cross-checked interpretation. The findings of this analysis are illustrated with direct quotes of the focus group participants and reported in accordance with the consolidated criteria for reporting qualitative research (Tong et al., 2007).

2.5. Ethics

This research was approved by Case Western Reserve University's Institutional Review Board for the Protection of Human Subjects (IRB-2016-1426).

3. Results

3.1. Client group comparisons

3.1.1. Demographics

Table 1 displays the results of the comparisons between the pilot study group (n = 28) and comparison group (n = 28). The results suggest that the PSM worked well because there are no statistically significant differences between these IOP treatment groups in terms of these baseline variables. The mean age of participants was between 16 and 17 years old, nearly two-thirds of participants in both groups self-identified as male, and a majority self-identified as White. The groups also were similar in terms of family income. While the comparison group had a wider range of income, nearly one-third of families for both groups reported an annual income between $35,000 and $64,999. The

Table 1
Sample Comparison table.

	Pilot Study group (n = 28)	Comparison group (n = 28)
Demographics		
Age (mean)	16.9 years	16.4 years
Male	19 (67.8.7%)	18 (64.2%)
Ethnicity		
African American	11 (39.2%)	6 (21.4)
White	16 (57.1%)	19 (67.9%)
Other	1 (3.6%)	3 (10.7%)
Family Income		
Not reported	0	6 (21.4%)
$0-$14, 999	6 (21.4%)	5 (17.8%)
$15, 000-$34, 999	4 (14.3%)	3 (10.7%)
$35, 000-$64, 999	10 (35.7%)	9 (32.1%)
$65, 000-$99, 999	8 (21.4%)	0
$100, 000+	2 (7.1%)	5 (17.8%)
Cuyahoga County	20 (71.4%)	21 (75%)
Juvenile Justice Involvement		
Any Involvement	17 (60.7%)	16 (57.1%)
Home Detention	9 (32.1%)	9 (32.1%)
Detention	10 (35.7%)	11 (39.2%)
Diversion Program	8 (28.6%)	2 (7.4%)
Substance Use		
Age of first use	12.9 years*	14 years*
First use before 13 years	11 (39.3%)*	3 (11.1%)*
Cannabis Diagnosis	25 (89.3%)	23 (82.1%)
Alcohol Diagnosis	4 (14.3%)*	23 (82.1%)*
Other Drug Diagnosis	15 (53.6%)	10 (35.7%)
Multiple Substance Diagnoses	28 (100%)	0
Mental Health		
Depression	15 (53.6%)	16 (57.1%)
Anxiety/Adjustment Disorder	10 (35.7%)	12 (42.9%)
PTSD	4 (14.3%)	0
ODD/Conduct	4 (14.3%)	4 (14.3%)
ADHD	7 (25%)	10 (35.7%)
History of Self-Harm		
History of Hurting Self	16 (57.1%)	10 (37%)
Past Suicide Attempt	14 (50%)	9 (33.3%)
Victimization		
Past Victimization	14 (50%)	14 (50%)
Polyvictimization	9 (32.1%)	6 (22.2%)
Physical	9 (32.1%)	6 (23.1%)
Sexual	3 (10.7%)	2 (7.4%)
Emotional	13 (46.4%)	13 (46.4%)

* $p < 0.05$.

majority of the participants lived in largely urban Cuyahoga County, wherein the city of Cleveland is the county seat.

PSM also elucidated the similarities between the two client groups on a variety of other important risk factor variables. Groups were similar on variables related to juvenile justice involvement, mental health diagnoses, history of self-harm behavior, and victimization. The only statistically significant group differences related to substance abuse initiation patterns. On average the pilot study group started using substances at a younger age (12.9 years) compared to the comparison group (14 years). A significantly larger proportion of clients in the pilot study sample used substances before turning 13 years old (39.3%, n = 11) compared to the comparison group (11.1%, n = 3). Early substance abuse initiation has been shown to be a risk factor for subsequent increased substance abuse involvement, and increased levels of experiencing adverse outcomes related to substance abuse (Hser et al., 2003; Gordon et al., 2004; Chen et al., 2005; King and Chassin, 2007; Richmond-Rakerd et al., 2016; Statham, 2016). While it's worth noting that the pilot group demonstrated greater risk related to substance use initiation patterns, both groups presented with a myriad of risk and vulnerability factors that can make successful substance abuse treatment extremely challenging. Greater than a third of clients had been in juvenile detention, and the majority (85.7%, n = 24) of clients in both groups had a diagnosis for a mental health or emotional issue. The most common mental health issue was depression, with over half of the

Table 2
Treatment outcomes table.

	Pilot Study group (n = 24 [a])	Comparison group (n = 28)
Abstinent at Discharge	14 (58.3%)	17 (60.7%)
Reason for Discharge		
Program Complete	13 (54.2%)	12 (42.9%)
Against Staff Advice/ Admin	5 (20.8%)	8 (28.6%)
Transfer	5 (20.8%)	8 (28.6%)
Days in Treatment		
Total	76.8	108.1
Complete	69.3	150.5
ASA/Admin	107.2	79.0
Transfer	71.8	81.0

$p < 0.05$.

[a] $n = 24$ because 4 participants had not yet completed treatment by end of pilot study.

youth in both samples having a diagnosis. Self-harm behavior ranged from 37% in the comparison group to 57.1% in the pilot study group, and half of the clients in both samples experienced some form of victimization, inclusive of polyvictimization patterns 32.1% pilot group vs 22.2% comparison group.

3.1.2. Treatment outcomes

Table 2 displays the treatment outcomes for client in the pilot study and comparison groups. As noted at the bottom of the table, four participants remained in treatment at the conclusion of the pilot study period, resulting in a sample size of 24 for the pilot study group. Overall, roughly 60% of the youth in both the pilot study group (58.3%, $n = 14$) and comparison group (60.7%, $n = 17$) achieved abstinence at discharge. A slightly larger proportion of the pilot study group (54.2%, $n = 13$) completed treatment compared to the comparison group (42.9%, $n = 12$), however, this 20.8% increase in terms of the number of treatment completers was not statistically significant. There were no statistically significant differences between groups in the number of days in treatment (76.8 pilot vs. 108 comparison), and the number of days in treatment for treatment completers in the pilot group was half (69.3) the number of days for youth in the comparison group (150.5). Conversely, those in the pilot study group who left treatment against staff advice stayed in treatment an average of 28 days longer than those in the comparison group (107.2 days and 79.0 days, respectively). The small sample sizes diminish the likelihood of finding statistically significant differences, yet it appears that youth in the pilot group both accelerated to treatment completion at a faster pace, while those in the pilot group who struggled and eventually left treatment against staff advice were retained in treatment longer. Such trends are worth noting given the importance of treatment retention and completion dynamics with challenging populations.

3.2. Staff focus group

The focus group interview began with the facilitator asking, "Has use of ACHESS changed the IOP model of care?" Participants' responses were split between elements of the app that had been successfully integrated into the care model and had contributed to timelier targeted services and outreach, and those that had not been successfully integrated because the elements needed improvement.

3.2.1. ACHESS' contributions to providing timelier targeted services and broader outreach

The focus group participants emphasized two client-facing elements of the mobile app that were particularly useful and impactful: the text messaging tool and the Beacon emergency alert button. As one participant noted, "Some aspects [of ACHESS] are very useful, [such as] the

messaging portion where [clients] can message a counselor directly or message each other for support. We've had a lot of kids use this." Some participants described this text message capability as a "lifeline" for clients that lessened their sense of isolation at night and on weekends, in particular, when accessing therapeutic support may be more time-consuming.

Some participants offered the perspective that this more immediate line of communication between clients and therapists appeared to have enhanced client treatment and retention. According to one, "Before youth were inconsistently showing up to treatment. Now we can learn from texting them the reason for the absence. This gives us an opportunity to offer motivation for completing treatment." Another participant observed,

> They'll reach out for a crisis via text and that can expedite their connecting. They're reaching out, which is a positive. From a treatment side [therapists] can pay attention as a group. We're more in the moment. When I see the numbers … for shorter [length of stay], I'm not surprised… because I'm more connected with the client on an ongoing basis. Before, a crisis would happen and treatment would be delayed because we aren't reacting to the crisis in real time.

The focus group participants went on to discuss the utility and impact of the Beacon button, which appeared to support more rapid de-escalation of client agitation and aggression. Recounted one participant, "[One youth] and the parents were arguing, and [the] parents were going to call the police." The participant continued by explaining that,

> The youth already had charges, so if police came the youth would likely have spent the night in jail. [The youth] pushed 'Beacon.' Staff responded with, 'Are you OK?' and the youth explained the problem and then came in for a treatment session. [At the time of the alert] we talked to the parents and they did not call police.

3.2.2. Areas of suggested improvements

In spite of these useful elements and positive impacts, the participants made it very clear that many improvements could be made to ACHESS in regard to the: Beacon button; survey tool and its related notifications; text messaging tool; and overall user experience.

3.2.2.1. Beacon.
According to focus group participants both clients and staff were often frustrated with the Beacon. The Beacon's prominent location across the lower third of mobile app's dashboard makes it easily accessible in an emergency, yet "the Beacon is always there," described one participant, "and it is always accidentally pressed." Additionally, participants expressed frustration by their inability to easily see the name of the counselor on-call. Said one, "I don't know who's responsible for answering a Beacon button." Another participant said it also was unclear from the app alone if a therapist had responded to an alert. "It should have feedback of 'Fred took the Beacon call' or 'someone hasn't responded,'" the participant explained.

Concurrent with this critique, participants also offered a way to increase the Beacon button's utility. Just as it was not apparent to center staff who was on-call to respond to a Beacon alert nor was it evident to clients. According to a participant, "If they knew who was on the Beacon button that would be great. A schedule that clients can see."

3.2.2.2. Survey tool and its related notifications.
One participant explained, "You spend time telling [clients] they aren't being surveilled [by the app] and then you request they compete [an assessment survey]. The youth hate surveys." One participant followed-up arguing, "[Clients] say it is tedious and unnecessary. Clients don't take the surveys." Another obstacle that seems to limit clients' completion of surveys is that, "They don't want daily surveys and reminders." Observed a participant, "I've had kids uninstall the app

because they don't like notifications. Then they come back and let you reinstall, as long as you turn off notifications."

3.2.2.3. Text messaging tool. While overall the participants acknowledged their support for the mobile apps texting capability, they observed several key areas of concern. First the actual message size is too limited. One participant pointed out that, "You only have 250 characters per text message. This doesn't work for a ranting teenager. Then I had to try to find a way to answer within the text character limit." In addition to the character limit, the group also experienced problems with the text messaging tools' associated "Contacts" list, which stores names and phone numbers. According to one participant the contacts tool is too simplistic: "The app is designed for their recovery so some kids add sober support contacts in the app. But they would like knowing that this 'Michelle' is '12-step Michelle' and the other 'Michelle' is 'school Michelle.'" This problem also impacts the identification of therapists on the app. For example, one focus group participant recounted that,

> When you enroll staff on the app you enroll them as "clients," which is confusing because clients don't know who to message. For someone new who says they want to message [therapist X], it is confusing because they don't know that [therapist X] is listed as a "client."

3.2.2.4. Overall user experience. The final area in which the group felt the mobile app fell short was in the overall user experience. "The app is not the most user friendly," said one participant. "In some ways that makes it feel like a separate component of life. It's my recovery app, not part of my life. If it incorporated more aspects of day-to-day life it would help."

Understanding that the ACHESS check-in surveys are a primary means of monitoring patients and tracking their progress over the course of their IOP treatment, the facilitator asked the group, "What would you do to increase client compliance with surveys?" Replied one participant, "Offer incentives, anything monetary or food." Others built on this idea by adding, "If there's an incentive, they need it in that moment" and "Push them a gift card." Another shared the idea that it should be more personalized, "a private incentive [i.e., a gift card to youth's preferred coffee shop or restaurant] as opposed to a public one, so [clients] know they did something really good." Another noted the timing of incentives. "There should be an incentive to even get on the app. It builds on success that way. If you get the app and you get nothing, then you'll have to wait to get something later."

Turning the group's attention from clients' mobile app experience to the web-based clinical dashboard used by therapists to communicate with and monitor their clients, the focus group facilitator asked, "In general, is the web-based clinical dashboard useful? "It's really not," one participant replied. "I will check it retrospectively, but I'm not actively utilizing it except to enroll clients and activate their accounts." Another shared the observation that,

> I think the app assumes that a client is sitting in front of a computer, and they're not. They're mobile and you're mobile. There should be a [mobile] "admin" app where you can access this client information.

Despite these hurdles, some participants found the dashboard useful and particularly informative when it came to monitoring client messages. "It is helpful to look at messages and see who clients are reaching out to," a participant shared.

> Seeing who youth are reaching out to for the same issue, you can see how it fits their diagnosis. I'm using the dashboard for review of messages—seeing what messages are sent and received.

Another noted,

> I bring up [survey] results [when meeting with] clients. We are

doing that on an individual basis, checking-in and talking about the use of the app and the surveys.

Midway through the focus group, the participants were presented some of the key statistical outcomes from previously developed group comparison data. One outcome shows relatively lengthy stays for some clients, which spurred the facilitator's next question: "Maybe the app accelerates treatment and helps some clients to complete it at a more rapid rate, but what about clients who eventually underwent administrative discharge or discharged themselves against staff advice? Why do you think they remained in IOP for as long as they did?" One suggested that ACHESS may have played a role because it fostered a closer relationship between these clients and one or more staff members. This participant suggested it "[c]ould be the relationship. 'I don't like coming here, but I have the relationship—so I'll try longer.'"

4. Discussion

4.1. Limits

There are limitations to this analysis that should be considered. Because this pilot study is based on a small sample of youth, providers and staff who were recruited from one Midwestern treatment center and followed for a limited period of time, it is important to use caution in the interpretation of its results. Model effects may not be detected due to a lack of statistical power. In regard to the youth, while the researchers have no reason to suspect that pilot study group participants were different from non-pilot study group participants on key substance abuse treatment outcome variables, it is important to highlight that this was not a large, longterm randomized study. We do have confidence that pilot study and retrospective comparison group youth were similar on multiple factors that affect substance abuse treatment outcomes, yet because pilot study group and comparison group data was collected at different times we cannot account for the influence of time and time-related differences that may have impacted the comparison and pilot study group youth. Stability in both the IOP treatment model and treatment and administrative staff help to diminish those concerns. This pilot study could have been strengthened by including a focus group of the pilot study group to learn about the youths' consumer experiences. Other questions remain such as, is the pilot study group of 28 representative of the larger group of 47 who originally agreed to use the ACHESS mobile app? Are there particular factors that make some youth more apt to use a mobile phone app like ACHESS, as opposed to those whom did not? These and other questions need further study among larger samples in diverse settings.

In addition the behavioral health providers and staff who participated in this pilot study may not be representative of others implementing ACHESS elsewhere, and the findings on the facilitators and barriers to ACHESS implementation and use may differ from those experienced by providers and staff in other settings. ACHESS implementation involved time-consuming staff training in the functioning of the mobile app and clinical dashboard, and then subsequently took time to on-board and monitor individual clients—both of which also required technical support from information technology staff. While the therapeutic staff eventually melded key elements of ACHESS with their IOP model of care, it is important to recognize that the implementation process added new hardware- and software-education and implementation burdens to already complex and fast-paced clinical and administrative workflows, especially in regard to the Beacon button, the survey/text messaging tools and overall user experience. These challenges speak to the need for future research among larger samples of behavioral health providers and staff on these important implementation issues, not only as they relate to ACHESS but other mHealth apps, as well.

4.2. Conclusions

With these limitations in mind, some of the pilot study findings that follow still may have significant implications for ACHESS' utility and positive impact among youth in IOP addiction treatment settings. What emerged from the findings is that ACHESS appeared to have fostered IOP treatment adherence and completion rates. A larger proportion of the clients in the pilot study group (54.2%) completed treatment than those in the comparison group (42.9%), These figures appear even more promising when compared to the Substance Abuse and Mental Health Services Administration (SAMHSA) Treatment Episode Data Set (TEDS) reflecting 203,127 IOP treatment discharges in 2012 for individuals aged 12 years and older in reporting states. The TEDS data show that only 67,411 (33.2%) of these individuals completed IOP treatment (SAMHSA 2015, pp. 21–22).

Our results also may demonstrate that integrating ACHESS into the IOP model of care constructively impacted clients' numbers of days in treatment. The median number of days in treatment decreased to 76.8 days for the pilot study group, down from 108.1 for those in the comparison group. The pilot study group's length of stay data also showed improvement when compared to those reflected in the 2012 TEDS data, where the median length of stay was 84 days (SAMHSA 2015, pp. 21–22). These findings underscore from our analytical perspective that "number of days in treatment" may not be the best way to measure retention, especially if youth in the pilot study group were getting more emotional, relational and instrumental support out of their treatment because of the app and advanced more quickly in treatment. Yet from a healthcare perspective these number-of-days-in-treatment findings may reflect very positive impacts on both potential IOP treatment cost savings for clients and increased opportunities for IOP programs to care for more clients each year.

Other promising findings emerged in regard to the types of client comorbidities ACHESS may be suited to address. The pilot study group had more clients initiating alcohol and other drug use before 13 years of age, as well as had a diagnosis of other drug use, had hurt themselves or attempted suicide in the past and had PTSD. These characteristics suggest if the pilot study group youth demonstrated earlier substance abuse initiation patterns, typically associated with poorer treatment and functioning outcomes, in addition to their other elevated victimization and self-injurious comorbidities, that this group may have been more challenging to care for than the comparison group (Hser et al., 2003; Gordon et al., 2004; Chen et al., 2005; Tiet et al., 2007; King and Chassin, 2007; Richmond-Rakerd et al., 2016; Statham, 2016). This background makes the treatment retention and completion rate for the pilot study group additionally heartening in light of the fact that evidence-based practices and programs often see more modest outcomes in the first year of implementation than subsequent ones (Fixsen et al., 2005).

The ever-increasing attraction of and use of novel smart phone technology in healthcare delivery has been widely documented (Visser, 2012; Bert et al., 2014; McCartney, 2014; Yaman et al., 2016). Yet perhaps the most significant finding of this pilot study is that ACHESS not only provided great utility in facilitating communication between clients and therapists, but it also appeared to directly impact the depth of client-therapist relational aspects of treatment. It is easy to become enamored by the more technologic aspects of the app, however, as the developers suggest (Gustfason et al., 2011b), self-determination theory coupled with relapse prevention science (Larimer et al., 1999; Witkiewitz and Marlatt, 2004) help to leverage the construct of relatedness to seek earlier support in avoiding relapse in high-risk situations. The potential for enhanced relational supports associated with the app capabilities, coupled with skilled and engaged treatment providers, may contribute extended value resulting in greater treatment retention for adolescents in IOP. Of course, future research is necessary to test and build-on these findings and speculations to further explore and develop the utility and impact of ACHESS for youth in addiction treatment.

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