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Ecological assessment of daily suicidal thoughts and attempts among suicidal teens after psychiatric hospitalization: Lessons about feasibility and acceptability

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ABSTRACT

Despite its potential to yield information about the dynamic course of suicidal ideation/behavior in individuals' natural environment, Ecological Momentary Assessment (EMA) has been strikingly underutilized among suicidal teens. This study reports on feasibility and acceptability of ecological assessment of daily suicide risk-related outcomes ("daily diaries," a special case of EMA) among adolescent inpatients in the critical post-discharge period. Thirty-four adolescents (76% female; ages 13–17) responded to daily electronic surveys for four weeks after discharge. Survey adherence was 69% (n = 650 days) and decreased each week. Adherence was half as likely among adolescents without attempt history (OR = 0.50, CI = 0.27–0.95). Mid- and end-point study responses indicated high acceptability of daily diaries. Most adolescents reported no change or more positive change in their thoughts/mood after daily surveys. Suicidal ideation was reported on 24.4% (n = 159) of the days. In the month post discharge, more teens reported suicidal thoughts using daily surveys (70.6%) compared to end-of-study assessment (45.2%) (Chi-square = 4.24, p = .039). Two participants (5.9%) reported an attempt. Ideation frequency and duration varied across time, suggesting utility of frequent assessments in this context. EMA data collection with high-risk adolescents offers a feasible approach to examining real-time suicidal ideation/behavior, yielding nuanced information that is critical to advancing suicide prevention efforts.

1. Introduction

Youth suicide, the second leading cause of death among adolescents (Centers for Disease Control and Prevention, 2015), has tragically increased in recent years (Curtin et al., 2016). Despite a great deal of knowledge concerning suicide risk and protective factors gained over the past several decades (see reviews by Bridge et al., 2006; Gould et al., 2003; Spirito and Esposito-Smythers, 2006), less is known about immediate (within hours or days) precursors to suicidal behavior that may be most clinically relevant (Glenn and Nock, 2014). The majority of existing studies have relied on longer assessment windows (weeks, months, or years), which precludes conclusions about who is at *imminent* risk for suicidal behavior and when (Bagge et al., 2013; Rudd et al., 2006). Indeed, a recent meta-analysis of longitudinal studies focusing on suicidal ideation and attempts indicated that the average follow-up period was almost 7 years (Ribeiro et al., 2016). However, to capture the dynamic nature of suicidal ideation and other suicide risk factors in the near-term requires more fine-grained analyses at frequent assessment time points. This might be especially relevant for high-risk youth in clinical settings who experience considerable shifts in suicide risk factors, such as suicidal ideation following psychiatric hospitalization (Czyz and King, 2015; Goldston et al., 1999; Prinstein et al., 2008).

1.1. Ecological momentary assessment and suicide risk-related outcomes

Largely underutilized in the field of suicide prevention (Davidson et al., 2017; De Beurs et al., 2015), ecological momentary assessment (EMA) (also known as experience sampling or diary studies) allows for intensive and repeated assessment of behavior in real-time and in the person's natural setting, thus minimizing recall bias and maximizing ecological validity (Moskowitz and Young, 2006; Shiffman et al., 2008). EMA strategies have the potential to yield more nuanced information about the temporal course of immediate precursors to suicidal behavior and the complex interplay between risk and protective factors in the person's natural environment. On a more

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fundamental level, EMA can reveal important information about the daily course and characteristics of suicidal thoughts (e.g., frequency, severity), which constitutes another important gap in the literature (Nock et al., 2009).

EMA approaches have been shown to be feasible with psychiatric adult and teen populations (Armey et al., 2015; Ebner-Priemer and Trull, 2009; Kaminer et al., 2006; Thompson et al., 2014; Wen et al., 2017), including studies assessing non-suicidal self-injurious thoughts and behavior (Armey et al., 2011; Santangelo et al., 2016; Selby et al., 2013; Turner et al., 2016). However, relatively few EMA studies explicitly assessing suicidal ideation and behavior (i.e. suicide attempts) have been carried out (see review by Davidson et al., 2017). Using a range of methods (PDAs, paper-based diaries, mobile phones) and assessment schedules (from once-daily to multiple times each day), studies assessing suicidal ideation or behavior have thus far been conducted among inmates (Humber et al., 2013), psychiatric inpatients (Ben-Zeev et al., 2012; Hallensleben et al., 2017; Kleiman et al., 2017), individuals recruited from the community or outpatient clinics (Law et al., 2015; Links et al., 2007; Torous et al., 2015), adults with previous suicide attempts (Husky et al., 2014; Kleiman et al., 2017), as well as self-injuring youth from the community (Nock et al., 2009). While these studies have made important contributions, there remain critical gaps concerning carrying out EMA data collection with individuals at risk for suicide. First, while most of these studies involved high-risk samples, only one (Husky et al., 2014) followed individuals during a high-risk period *following* psychiatric hospitalization. Second, the majority of EMA studies with suicidal individuals included a relatively short follow-up period (one or two weeks). Third, with one notable exception (Nock et al., 2009), EMA studies assessing suicidal ideation and behavior have been primarily conducted with adults, despite the fact that suicidal ideation and behaviors increase rapidly during adolescence (Nock et al., 2013). In particular, to our knowledge, EMA methods have not been utilized with suicidal teens after psychiatric hospitalization. This is a critical gap given that these teens are vulnerable to suicide attempts, rehospitalizations, and persistent suicidal ideation after discharge (Brent et al., 2013; Czyz and King, 2015; Czyz et al., 2016; Goldston et al., 1999; Yen et al., 2013), yet surprisingly little is known about clinically relevant information, such as post-discharge prevalence and characteristics of suicidal thoughts, on a daily level.

1.2. Current study

EMA studies have been strikingly underutilized with high-risk teens and, in particular, with suicidal teens following hospitalization. Given the ubiquity and acceptability of mobile communication among adolescents (Lenhart, 2015), a key barrier to implementing EMA studies with high-risk teens may thus be less influenced by technological limitations but is likely driven by procedural concerns, such as monitoring and managing risk. Previous studies with adults at risk for suicide provided automated prompts encouraging help seeking (Husky et al., 2014; Law et al., 2015) while the study involving youth recruited in the community (Nock et al., 2009) also included additional monitoring of responses and, if needed, contacting participants for risk assessment the following day. However, conducting repeated assessment of suicidal ideation and behavior with teens during a high-risk period following hospitalization when suicide-related crises may be more frequent requires additional and careful consideration of the critical issue of how and when to intervene when acute risk is indeed reported. In light of the aforementioned research gaps, and with the goal of paving the way for greater utilization of EMA procedures in studies with high-risk teens, this study sought to: (1) specifically address the feasibility and acceptability of an ecological assessment protocol for collecting daily suicide-risk related outcomes (i.e. suicidal ideation, suicide attempt) among high-risk suicidal adolescents followed after psychiatric hospitalization; (2) given that suicidal ideation and behavior were assessed repeatedly, explore factors associated with daily survey adherence; and (3) describe suicidal thoughts reported via daily surveys and compare these to suicidal thoughts reported at the end-of-study assessment. To achieve these goals, this study utilized daily diaries, which are a special case of EMA (Shiffman et al., 2008), for one month after discharge from hospitalization.

2. Methods

2.1. Participants

Participants were psychiatrically hospitalized adolescents (ages 13–17) admitted due to last-month suicide attempt and/or last-week suicidal ideation. Participants were recruited to participate in a pilot study of a brief psychosocial intervention, which took place at the time of hospitalization, with a daily follow-up assessment component (Czyz et al., under review). Exclusion criteria included: severe cognitive impairment or altered mental status (e.g., active psychosis or mania), transfer to medical unit or residential placement, no availability of a legal guardian (ward of state), and teen not having a cell phone with text messaging capability. Once inclusion and exclusion criteria were verified, based on a screening of admission records and consultation with inpatient team as needed, adolescents and their parents were approached to obtain consent and assent. Of the 50 potentially eligible participants, two (4%) did not own their own cell phone and one (2%) did not have cell phone access for disciplinary reasons. Of those meeting all eligibility criteria, 36 (76.6%) provided parental consent and teen assent. The analytic sample for this study was limited to 34 adolescents who continued in the study after baseline assessment (one teen withdrew from the study) and who continued to meet eligibility criteria following discharge (one teen no longer had a cell phone).

2.2. Procedures

The study was approved by the participating university's Institutional Review Board.

2.2.1. Assessment

Participants completed a series of self-report surveys during hospitalization. Following discharge, participants completed a brief online survey approximately 1–2 weeks after hospitalization and were also contacted two additional times by master's level clinicians to complete two phone-based assessments approximately 1 and 3 months after hospitalization.

2.2.2. Ecological assessment with daily diaries

Starting on the first day after the discharge, adolescents were asked to complete one survey each evening for 28 consecutive days. A single assessment per day (daily diary) is a special case of EMA (Shiffman et al., 2008), and this approach was selected in light of practical considerations (e.g., many teens had cell phone use restrictions while in school; greater ability to carry out risk management protocol [see below] when both teen and parent could to be reached in the evening). A link to the survey, developed using Qualtrics survey tool (http://www.qualtrics.com), was sent to participants' phones via text messages. Text messages were sent automatically and according to a pre-specified schedule using a secure research platform called TelEMA (Fernandez et al., 2013). Text messages were chosen to deliver daily surveys, rather than push notifications via a smartphone app, because unlike cell phones, smartphone ownership shows greater disparity based on household income and tends to be less common among teens, particularly younger adolescents (Lenhart, 2015). Participants had the option to fill out the survey on their smartphone or to copy the link in an internet browser on a computer. Because cell phone access for teens may at times be limited for disciplinary reasons, this approach allowed for the survey to be mobile compatible while ensuring that participants could respond to the survey even if their phone was restricted. The text

messages, and reminders as needed, were distributed between 5 and 7pm, with the exact time of the text messages being customized based on participants' preference and availability. Participants were asked to respond to the survey within 1–1.5 h from the time they received the survey link. This strategy of limiting the time fame for the daily surveys was intended to ensure consistency in participants reflecting on the same 24-h time interval each evening in addition to providing the research team with sufficient time to respond to risk concerns (see risk management). At the end of the four weeks, participants were compensated $20 to offset text messaging and/or data plan in addition to $4 for each completed survey.

Participants' responses to items assessing suicidal thoughts and attempts were monitored daily by study's on-call clinicians and were categorized using a two-tier risk status designation. A designation of a moderate risk level, defined as endorsement of any suicidal ideation within the last 24 hours but without current suicidal intent or plan, resulted in a display of an automated message at the end of the survey urging the teen to seek support along with providing the teen with phone numbers to a crisis line and to emergency services. A designation of an acute/high risk level, defined as endorsement of current suicidal ideation together with suicidal intent or plan and/or endorsement of a suicide attempt in the last 24 h, also resulted in participants receiving a similar message in addition to a follow-up call from the study's clinician. Immediately after a participant endorsed items associated with the acute/high risk designation, the on-call study clinician received an automated email message alert. To protect confidentiality, this notification only indicated the participant's study number. The on-call clinician initiated the study's risk management protocol, which involved calling the adolescent and the parent/guardian as soon as possible on the same evening, contacting the supervising psychologist (C.A King, co-author) for consultation, providing recommendations for the teen and the parent/guardian to seek an evaluation from the adolescent's provider(s) and/or emergency department services, reiterating the importance of lethal means restriction, and sharing crisis line and local emergency contact information.

2.3. Measures

2.3.1. Baseline and follow-up measures

2.3.1.1. Suicidal ideation and attempts. The Columbia-Suicide Severity Rating Scale (C-SSRS; Posner et al., 2011) assesses a range of suicidal thoughts and behaviors. Here, we report on suicidal ideation severity (6-point scale ranging from "wish to be dead" to "suicidal ideation with specific plan and intent") and lifetime suicide attempts (yes/no) at the time of admission, which we obtained via medical record review. We also report on suicidal ideation severity in the month since baseline assessed at the 1-month assessment. The C-SSRS has shown strong reliability and validity (Posner et al., 2011) and predictive validity for suicide attempts (Gipson et al., 2015).

2.3.1.2. Depressive symptoms. The Patient Health Questionnaire-9, modified for adolescents, (Johnson et al., 2002) ((PHQ-A), was used to assess symptoms of depression. Symptoms are assessed for the last two weeks from 0 ("not at all") to 3 ("nearly every day"). The PHQ-A has strong psychometric properties, including diagnostic agreement with clinical interviews (Johnson et al., 2002). In the current sample, internal consistency was good ($\alpha = 0.85$).

2.3.1.3. Hopelessness. The 6-item Brief Hopelessness Scale (Bolland et al., 2001), adapted form of the Hopelessness Scale for Children (Kazdin et al., 1986), was used to assess hopelessness using a 4-point scale ranging from "strongly disagree" to "strongly agree." The measure has sound psychometrics and is comparable to the full measure of hopelessness (Bolland et al., 2001). The internal consistency in this sample was very good ($\alpha = 0.93$).

2.3.1.4. Experience with daily diaries. Modeled after questions used in other studies (Fernandez et al., 2013; Granholm et al., 2007), adolescents indicated their experience with daily surveys (questions shown in Table 4) approximately 1–2 weeks after discharge and again at the 1-month assessment. We also assessed what impact, if any, filling out the daily surveys had on adolescents' thoughts and feelings, with answer choices being "Positive/I felt better," "Neutral/I felt the same," and "Negative/I felt worse."

2.3.2. Daily-level measures

Each day, participants reported on several aspects of their experience using a brief (2–5 min) questionnaire (up to 32 questions, depending on endorsement of suicidal ideation). Here, we focus on items assessing suicidal ideation and attempts, which were based on the C-SSRS (Posner et al., 2011) described above. Each day, adolescents were asked about suicidal ideation and behavior: "*At any point in the last 24 hours did you have any thoughts of killing yourself*?" and "*At any point in the last 24 hours, did you try to kill yourself or make yourself not alive anymore*?" An affirmative answer to these questions was followed with a prompt asking participants to indicate time intervals corresponding to all the times in the 24-h period they experienced suicidal thoughts and/or attempted suicide. A positive response to the suicide attempt question was followed with additional open-ended questions ("*What did you do*?" and "*Did you do this as a way to end your life?*"). A positive response to the suicidal ideation question was followed by questions assessing frequency ("*How many times did you have thoughts of killing yourself?*") and duration ("*How long did these thoughts last*?"). Using a 4-point scale, frequency response options ranged from "only one time" to "all the time." Using a 5 point-scale, duration response options ranged from "a few seconds or minutes" to "more than 8 hours/continuous." Importantly, teens who reported no presence of suicidal ideation on a given day responded to an equivalent number of follow-up "filler" items with a similar valence (e.g. inquiring about negative affect). This strategy was used to avoid inadvertently encouraging teens to underreport suicidal ideation on the basis of survey length.

2.4. Data analysis

We provide descriptive analyses of feasibility and acceptability indicators (i.e., adherence to and perception of daily surveys) and of suicidal ideation reported via daily surveys. To examine if perception of daily surveys differed at mid-point (week 2) relative to end-point (after week 4) of data collection, we used paired sample *t*-tests. Finally, we fitted a general estimating equations (GEE) model, using a proc genmod procedure in SAS (version 9.4) with an autoregressive working correlation structure, to explore the relationship between daily survey adherence and adolescent characteristics (smartphone access, sex, race, age, suicide attempt history, baseline suicidal ideation, depressive symptoms, and hopelessness) while accounting for within-individual correlations and time (study week). Given its exploratory nature, as well as the fact that multiple comparisons of adherence were included in the model, we emphasize effect sizes to ascertain if findings are potentially meaningful (e.g., Greenwald et al., 1996; Valentine et al., 2015).

3. Results

3.1. Participant characteristics

The sample was comprised of 76.47% ($n = 26$) female adolescents, with a mean age of 15.5 years (SD = 1.35). The sample's racial/ethnic distribution was as follows (more than one category could be selected): 85.29% ($n = 29$) Caucasian, 8.8% ($n = 3$) African-American/Black, 8.8% ($n = 3$) Asian, 5.9% ($n = 2$) Hispanic, 2.9% ($n = 1$) American Indian or Alaska Native, and 2.9% ($n = 1$) Native Hawaiian or Other Pacific Islander. Thirty-one teens (91%) owned a smartphone. The

Table 1
Baseline clinical characteristics.

	M (SD) or % (n)
Clinical characteristics (range)	
Suicide attempt history	
Yes	52.9% (18)
No	47.1% (16)
Suicidal ideation severity (0–5)	4.06 (0.92)
Depressive symptoms (0–27)	18.21 (5.81)
Hopelessness (6–24)	16.71 (5.17)

remaining participants ($n = 3$) owned a phone with text messaging only. To our knowledge, at least 3 additional participants lost phone privileges or data access on their phone at some point during the course of the study and may have responded to some of the surveys using a computer instead. However, we did not collect this information systematically and the actual proportion of responses that were completed using a smartphone versus a computer is unknown.

Clinical characteristics assessed at baseline are shown in Table 1. At the 1-month assessment, 45.2% ($n = 14$) of adolescents reported having thought about suicide since hospitalization.

3.2. Survey completion

The 34 participants responded (either started or completed) to 654 surveys (69.35%) out of a total of 943 surveys sent to participants during the 28-day follow-up. Approximately 69% of the daily surveys (650 out of 943 or 68.93%) were started and completed, with participants completing an average of 19.12 (SD = 7.07) surveys. While survey completion decreased over time (Table 2), there was no statistically significant difference between weekdays versus weekend survey completion (OR = 0.90, $p = .496$). Results of the GEE model indicate that adolescents without previous suicide attempts were half as likely to complete daily surveys (OR = 0.50, CI = 0.27–0.95; $p = .034$). No other adolescent characteristics were significantly associated with daily survey adherence, nor were their associated effect sizes at or above a threshold of potential clinical significance (i.e. odds ratio of 2 or, its inverse, 0.50), consistent with previous recommendations (Ferguson, 2009).

Moreover, the likelihood of completing surveys decreased with each week (all p values $< .001$): The odds of survey completion were higher during week 1 relative to weeks 2 (OR = 1.86, CI = 1.55–2.24), 3 (OR = 2.99, CI = 2.34–3.81), and 4 (OR = 5.53, CI = 4.47–6.85), as were the odds of survey completion in week 2 relative to weeks 3 (OR = 1.60, CI = 1.40–1.83) and 4 (OR = 2.97, CI = 2.40–3.67) as well as in week 3 compared to week 4 (OR = 1.85, CI = 1.51–2.27).

3.3. Report of suicidal ideation and behavior

Out of the total of 652 days participants responded to daily surveys, suicidal ideation was reported on 159 days (24.4%) and was endorsed by 24 (70.6%) of individual participants across these 159 days. In contrast, only 45.2% ($n = 14$) of teens reported having had thoughts of suicide since discharge at the 1-month follow-up assessment (Chi-square = 4.24, $p = .039$). The percentage of survey responses with an endorsement of suicidal ideation on a given day ranged between 13% (days 11 and 18) to 38.1% (day 17) (see Fig. 1). The frequency and duration of suicidal thoughts is reported in Table 3 while their average fluctuation over the 28 days is shown in Figs. 2 and 3.

Current suicidal ideation with plan or intent was endorsed on 3.1% of the days any suicidal ideation was reported and on less than 1% of the days participants responded to daily surveys (Table 3). Over the course of the study, two participants reported a suicide attempt. These reports resulted in 6 separate risk management follow-up phone calls to 4 participants during the study period. Presence of suicidal behavior and intent/plan reported via daily surveys was verified at the time of the follow-up assessment.

Table 2
Daily survey completion by study week and by weekday versus weekday.

	Completed surveys % (n)	Not started or started and not completed % (n)
Study week*		
Week 1	79.6% (187)	48 (20.4%)
Week 2	72.6% (172)	65 (27.4%)
Week 3	63.8% (150)	85 (36.2%)
Week 4	59.7% (141)	95 (40.3%)
Weekdays	69.6% (471)	30.4% (206)
Weekend	67.3% (179)	32.7% (87)

Note: $N = 34$;
* Of a possible total of 943 surveys sent by text message.

3.4. Acceptability of daily assessments

Participants reported generally positive perception of daily surveys (Table 4). There was no difference in these ratings between assessment at 1–2 weeks (M = 8.75 days; SD = 2.40) versus 1 month (M = 35.19 days; SD = 5.52). In addition, participants generally reported no change or positive change in their thoughts and mood after completing the daily surveys; 1 participant reported negative change at the 1-month assessment.

4. Discussion

Our findings show that ecological assessment of daily thoughts of suicide and suicidal behavior with acutely suicidal teens followed after psychiatric hospitalization is both feasible and acceptable. Adolescent completed 69% of daily surveys, which fell in the adherence range of 62.0% (Kleiman et al., 2017) and 77.8% (Torous et al., 2015) of two studies assessing suicidal ideation for a similar length of time. It is notable that the rate of adherence gradually declined following week 1, which had a similar adherence rate when compared to studies of shorter duration (e.g., Hallensleben et al., 2017; Husky et al., 2014; Nock et al., 2009), and declined more sharply after the second week. Future ecological assessment studies might consider shortening the duration of data collection or, alternatively, implement additional strategies for improving engagement. For example, future studies could consider modifying question format, question presentation, or question order to minimize the perception of questions being repetitive. Modifying questions could involve minor language changes without changing question content, as reported in a previous study of similar duration where adherence with daily diaries was higher (Torous et al., 2015). Given the repeated administration of surveys, these strategies might additionally minimize possible practice effects. At the same time, it is noteworthy that, despite lower adherence over time, participating teens reported consistently positive perceptions of the daily surveys at both mid- and end-point of data collection.

With regard to adolescent characteristics associated with survey completion, results of the GEE analyses indicated that suicide attempt history was the only factor –along with study week—associated with daily survey adherence. It could be that teens with suicide attempt histories found responding to daily surveys helpful or, alternatively, they might have been less engaged in other activities and thus more available to complete the daily surveys on time. It is also important to highlight that survey adherence might have been affected by factors associated with participants' developmental phase (i.e. two teens reported that their phone privileges were suspended during the study period) as well as clinical factors unique to this teen population (i.e. three teens were psychiatrically rehospitalized during the month of data collection). As such, adherence in this study is measured more conservatively.

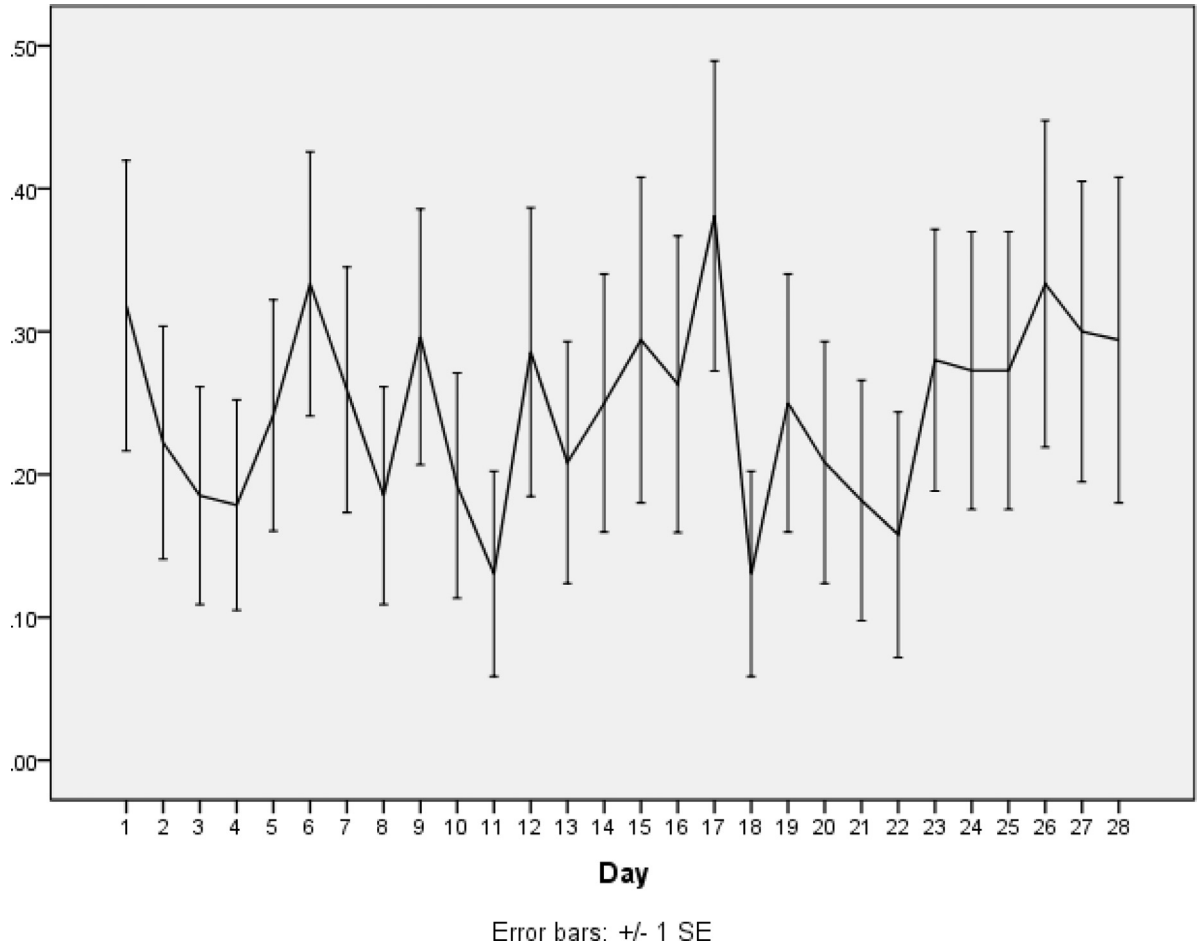

Fig. 1. Proportion of entries with suicidal ideation per day.

Table 3
Suicidal Ideation (SI) days reported via daily surveys.

	n	%
Suicidal Ideation in last 24h[a]		
Yes	159	24.4%
No	493	75.6%
Current suicidal ideation[b]		
Yes	88	55.3%
No	71	44.7%
Current ideation with plan or intent[c]		
Yes	5	5.7%
No	83	94.3%
Suicidal ideation characteristics[b]	*n*	%
Frquency of suicidal ideation		
Only one time	15	9.5%
A few times	52	32.9%
A lot/ many times	40	25.3%
All the time	51	32.3%
Duration of suicidal ideation		
A few seconds or minutes	23	14.5%
Less than 1 h / Some time	40	25.2%
1–4 hours / A lot of time	34	21.4%
4–8 hours / Most of day	20	12.6%
More than 8 hours / Continuous	42	26.4

Notes: CSSRS = Columbia suicide severity rating scale.
[a] Out of a toal of 652 days.
[b] Out of 159 days suicidal ideation was reported.
[c] Out of 88 days current suicidal ideation was reported.

As another indicator of acceptability of daily assessments of suicidal thoughts among these high-risk teens, we found that nearly a quarter (24%) of daily diaries included reports of suicidal ideation. While we are not able to determine the extent to which suicidal ideation was underreported, our findings suggest that this approach may have in fact encouraged greater disclosure. Specifically, for the month after discharge, significantly more adolescents reported suicidal ideation via daily surveys than at the 1-month follow-up assessment (71% vs. 45%). This suggests that ecological assessment of daily suicidal thoughts and behavior is not only acceptable to this teen population but also may capture more accurate and nuanced reports of suicidal ideation compared to traditional assessments. Consistent with this finding, another study involving adults found that more participants endorsed thoughts of suicide, in addition to more severe symptoms of depression, through EMAs than on a traditional assessment (Torous et al., 2015). It is possible that factors such as reduced recall bias or greater comfort with disclosing suicidal ideation using self-report format may have accounted for the differences in reporting. Finally, the observed fluctuation in average daily frequency and duration of suicidal ideation over the study period captured by daily surveys points to the value of these frequent assessments or EMA methods more broadly in providing more nuanced information as well as in their potential to informing interventions that can flexibly accommodate the dynamically changing needs of individuals in real time, such as just-in-time adaptive interventions (Nahum-Shani et al., 2015, 2017).

With regard to feasibility of risk monitoring and management, we found that less than 1% of responses met the threshold of acute/high risk level. While this relatively small number of responses requiring risk management suggests feasibility, it is important to highlight that

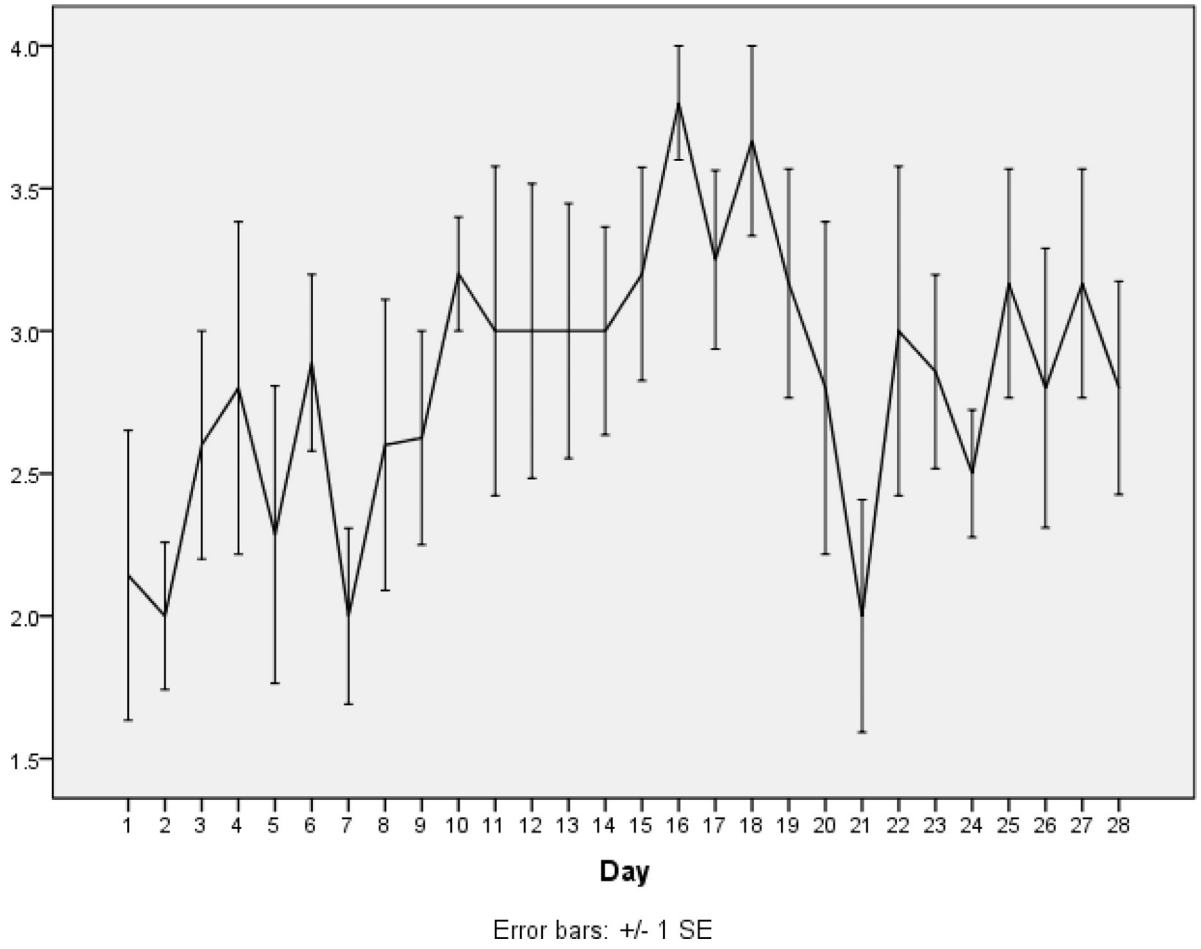

Fig. 2. Average frequency of suicidal ideation per day.
Notes: Frequency raw scores (y axis) ranged from 1 (one time) to 4 (all the time).

including a risk monitoring component may, depending on the size of a study, call for considerable staff resources. The question concerning when and how to respond to risk should be considered in a broader context of ethics and the study design, such as who are the participants in the study (e.g., youth versus adults) and what information is assessed (e.g., suicidal behavior, suicidal intent and planning). There is also the concern that participants may provide different responses depending on whether or not their surveys are being monitored. Given the seriousness of the outcomes assessed, the fact that this study's participants were youth, and that we followed teens during a high-risk period, we believe that risk monitoring is not only warranted but also necessary. While monitoring responses may require a relatively demanding research protocol, we hope that the overall rate of high-risk/acute responses observed in this study might serve as a benchmark for future studies and encourage more EMA studies with high-risk youth. We further believe that the results of this study might be useful to researchers using different strategies for collecting this type of data with high-risk teens (text messaging, apps, etc.).

Finally, it is noteworthy that the majority of teens reported no change in their thoughts or feelings after filling out the daily surveys. Previous studies have shown that asking about suicide does not induce suicidal thoughts or increase the likelihood that an individual will engage in suicidal behavior (DeCou and Schumann, 2017; Gould et al., 2005), yet this concern often persists and might be even greater in case of collecting EMA data. However, a recent study using a randomized control design concluded that repeatedly assessing suicidal ideation does not appear to trigger suicidal ideation or behavior (Law et al., 2015). In the current study, it is notable that nearly a quarter of participants reported that they felt better after filling out daily surveys. As previously suggested in EMA studies with depressed and self-harming individuals, it may be that the teens felt better as a function of greater self-awareness or a sense of empowerment (Marzano et al., 2015; Os et al., 2017; Simons et al., 2015). Here, given that nearly a quarter of responses were followed by a supportive message encouraging help seeking, it may also be this reminder had a therapeutic effect.

4.1. Limitations and conclusions

Generalizability of findings is limited by the fact that the sample was drawn from one inpatient unit in the midwestern region of the United States. The sample size is comparable to EMA studies involving individuals at risk for suicide (Ben-Zeev et al., 2012; Kleiman et al., 2017; Nock et al., 2009; Torous et al., 2015); however, future research would benefit from larger studies allowing for a richer examination of repeated-measures data alongside between-person characteristics. Although daily surveys still allow for capturing nuanced information about the nature of suicidal thoughts, daily surveys are subject to greater recall bias compared to more frequent assessment schedules. On the other hand, once-daily assessment may have practical advantages for this population given that many teens had cell phone use restrictions while in school and also considering the feasibility of implementing the risk management protocol (e.g., contacting the teen and parent) with high-risk teens. While this study provides initial evidence of feasibility and acceptability and indicates that teens at risk for suicide are willing to disclose thoughts of suicide on a repeated basis for an extended period of time, our work should be extended in future studies. In

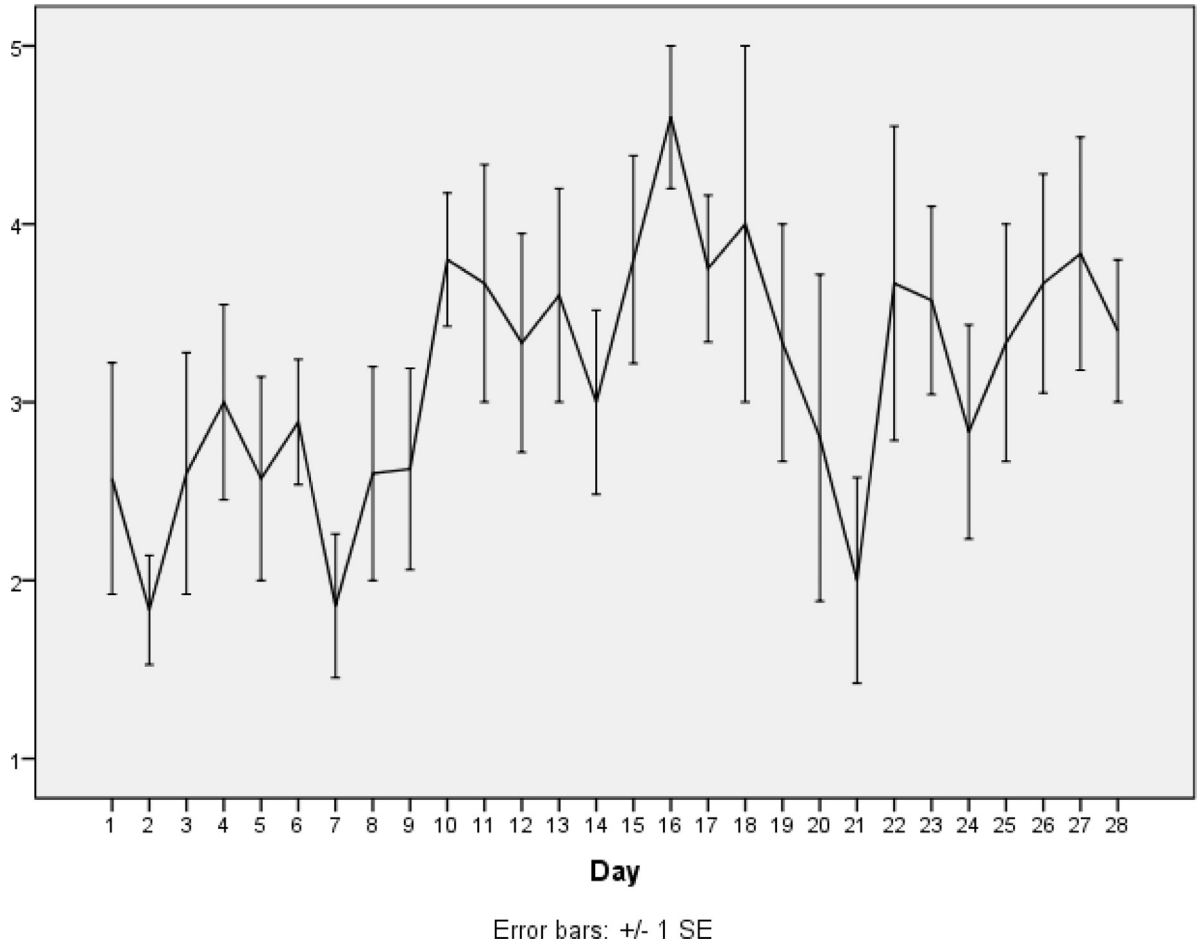

Fig. 3. Average duration of suicidal ideation per day.
Notes: Duration raw scores (y axis) ranged from 1 (few seconds or minutes) to 5 (more than 8 h/ continuous).

Table 4
Participant perception and acceptability of daily surveys.

	Week 2 (n = 28)		Month 1 (n = 32)		
Variable (1–7 range)[a]	M	SD	M	SD	p^b
I was able to access the Internet during this study	6.36	1.13	6.56	0.98	.363
I found the daily questionnaires to be annoying and/or disruptive	2.25	1.62	2.34	1.56	.725
The questions were easy to understand	6.43	1.07	6.59	1.13	.615
I was able to complete the daily questionnaires in a private way, and I did not fear that others would see my responses	5.93	1.65	6.53	1.27	.171
I would participate in a study like this again	6.43	0.88	6.66	0.60	.136
Variable					
After filling out the daily questionnaires, my thoughts and feelings were usually					
Positive/I felt better	6	21.4%	9	28.1%	
Neutral/I felt the same	22	78.6%	22	68.8%	
Negative/I felt worse	0	0%	1	3.1%	

Notes:
[a] responses range from 1 (not true for me) to 7 (extremely true for me); N = 27.

particular, because multiple daily assessments have an even bigger advantage in reducing recall bias and capturing greater nuance in daily experiences, future research is needed to examine additional issues of feasibility and acceptability (including teens' perception of this experience) related to sampling responses from high-risk teens multiple times per day. Research considering the optimal frequency of sampling responses pertaining to suicide risk-related constructs in studies with high-risk teens is also needed, particularly with regard to balancing ethical obligation of risk monitoring, reducing participant burden, and maximizing validity of data (e.g., is there a significant advantage to inquiring about suicidality more than once or twice a day?). The extent to which compensation for completed surveys played a role in adherence also deserves additional focus: an important question for future studies or implementation efforts with this population is if adherence can be sustained without, or at different levels of, compensation. Despite these limitations, this study is the first to provide evidence that adolescents at high risk for suicide are willing to respond to daily surveys and share information about suicidal ideation and behavior. Moreover, significantly more teens reported thoughts of suicide using daily diaries compared to the end-of-study assessment. Because high-risk individuals may be more likely to disclose thoughts of suicide via EMA compared to traditional assessments, an important question for future research will involve determining if EMA might also yield additional information about ideation severity (suicidal plans and intent).

Importantly, the associated risk management protocol was feasible and allowed the study team to respond to indicators of heightened risk. While the majority of teens reported that filling out daily surveys had a neutral impact on their mood and thoughts, over 20% reported a positive impact, indicating that self-monitoring in this context may be perceived as helpful.

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