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An Open Trial of Rolling Admission Mindfulness-Based Relapse Prevention (Rolling MBRP): Feasibility, Acceptability, Dose-Response Relations, and Mechanisms

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Abstract

Mindfulness-based relapse prevention (MBRP) is an effective treatment for substance use disorders (SUD). However, evidence is primarily based on studies of closed groups, and few studies support flexible formats of MBRP, such as rolling groups. This non-randomized, open trial evaluated the feasibility, acceptability, dose-response relations, and mechanisms of rolling admission MBRP ("Rolling MBRP") offered as part of short-term residential treatment for SUD. Rolling MBRP was developed prior to the trial through an iterative process over several years. Participants included 109 adults (46% female, 74.3% racial/ethnic minorities, mean age = 36.40). Rolling MBRP was offered to all patients in the program 2×/week, and attendance was tracked. Outcomes were craving, self-efficacy, mental health, mindfulness, and self-compassion at discharge. Self-reported out-of-session mindfulness practice was examined as a mediator of attendance-outcome relations. Analyses involved multiple regression and mediation models. Feasibility was demonstrated by good attendance rates. Acceptability was demonstrated by high engagement in mindfulness practice and high satisfaction ratings. Total sessions attended did not predict outcomes at discharge. However, attending 2+ sessions (versus one or none) significantly predicted better mental health and higher mindfulness at discharge, and these effects were mediated by informal and formal mindfulness practice. Total sessions attended had significant indirect effects on craving, self-compassion, mindfulness, and mental health, via mindfulness practice. Results support the feasibility and acceptability of Rolling MBRP and suggest mindfulness practice may be a key mechanism driving effects of MBRP on other key mechanisms during the recovery process, such as decreased craving and improved mental health.

Keywords Mindfulness-based relapse prevention · Substance use disorder · Rolling group adaptation · Open trial · Mindfulness practice

Substance use disorders (SUD) remain prevalent and account for a considerable proportion of global disease burden (Whiteford et al. 2013). SUD is a chronic relapsing condition in which substance use relapse following treatment and repeated admissions to treatment programs are common (Koob and Volkow 2016; McLellan et al. 2005; McKay 2009; McLellan et al. 2000; Nunes et al. 2018). Hence, there is a continued need for developing and refining effective treatments for SUD that promote long-term recovery and reduce rates of relapse.

Mindfulness-based interventions for SUD hold promise for supporting long-term recovery. A meta-analysis of 33 studies on mindfulness-based interventions for substance misuse found significant effects for substance use (small effect size), craving (medium effect size), and stress (large effect size; Li et al. 2017). Mindfulness-based relapse prevention (MBRP; Bowen et al. 2010) is one mindfulness-based intervention for SUD that integrates mindfulness training with cognitive-behavioral relapse prevention. The evidence base for MBRP is growing, and numerous randomized controlled trials support the efficacy of MBRP for SUD (Grant et al. 2017; Li et al. 2017). In the largest randomized trial of MBRP, Bowen et al. (2014) compared

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MBRP to treatment-as-usual (TAU) and standard relapse prevention and found that MBRP resulted in the lowest rates of heavy drinking and drug use 1 year following treatment.

Further work on implementation strategies is needed to expand the reach of mindfulness-based interventions for SUD (Wilson et al. 2017). Most randomized trials of mindfulness-based interventions for substance misuse (Li et al. 2017) involve closed-group treatment delivery (i.e., same group of individuals' complete treatment together and no new individuals enter the group during treatment). For MBRP specifically, most studies involve closed-group delivery, including the two largest randomized trials to date (Bowen et al. 2009; Bowen et al. 2014). Hence, there is a paucity of evidence on whether mindfulness-based interventions for SUD, such as MBRP, can be effectively delivered in more flexible formats, such as rolling groups, in which new participants can enter the group at any point. Moreover, closed groups are not feasible in many settings, especially community SUD treatment settings, because patients cannot wait for treatment and agencies often do not have the resources to coordinate multiple closed groups (McHugh and Barlow 2010; Wilson et al. 2017). Developing rolling admission versions of mindfulness-based interventions for SUD has the potential to greatly expand treatment uptake in real-world treatment settings.

To date, there is limited data to support the feasibility and effectiveness of rolling admission versions of mindfulness-based interventions for SUD. In a small pilot study among 36 adults, Brewer et al. (2009) demonstrated the effectiveness of a partially rolling group version of mindfulness training for SUD (participants could enter the group at module 1 or 4 out of eight modules). Shorey et al. (2017) conducted a randomized trial of an adjunctive mindfulness and acceptance group, offered in rolling admission format, among 117 individuals in residential SUD treatment. Results showed no differences in craving or mindfulness at treatment discharge between those assigned to TAU and those assigned to the adjunctive mindfulness and acceptance group. Witkiewitz et al. (2014) conducted a randomized trial comparing MBRP, offered in rolling admission format, to standard residential SUD treatment relapse prevention among 105 women convicted of criminal offenses. At 15 weeks post treatment, women who received MBRP reported fewer drug use days and fewer legal and medical problems. Hence, the evidence to date on the feasibility and effectiveness of rolling admission versions of mindfulness-based interventions for SUD has been mixed, and more research is needed.

The current authors focused on further developing and refining the rolling group format used in the Witkiewitz et al. (2014) study. The rolling admission version of MBRP used in the current study was developed through an iterative process over several years, which involved patient feedback, clinician feedback, and group discussion among the current authors. The current study was a preliminary open trial to evaluate feasibility, acceptability, dose-response relations, and mechanisms of the rolling admission version of MBRP, called "Rolling MBRP," offered as part of a short-term (3–4-week) residential treatment program for SUD.

Method

Participants

Participants were 109 individuals engaged in a short-term residential SUD treatment program (approximately 21 to 28 days). Residential treatment consisted mostly of group sessions, including Alcoholics Anonymous and Narcotics Anonymous groups and other group sessions focused on key themes (i.e., anger management, nutrition, relapse prevention). Patients also received individual counseling during their treatment stay. Eligibility criteria for the current study were as follows: (1) admitted to the residential treatment program, (2) able to read and write English, and (3) 18 years of age or older. Table 1 provides the descriptive statistics for the study sample.

Procedures

The current study was a non-randomized, open trial that recruited participants between July 2016 and May 2017. The study was approved by the University of New Mexico Institutional Review Board. One-hour Rolling MBRP groups were offered twice per week to all patients in the residential program. For patients who were enrolled in the study, attendance at the Rolling MBRP groups was tracked. Study participants were not required to attend Rolling MBRP and had the choice of attending other groups (e.g., Alcoholics Anonymous or Narcotics Anonymous groups) that were offered at the same time as Rolling MBRP. Patients were informed about the study through the posting and distribution of study flyers. Informed consent was obtained for all participants enrolled in the study. Participants completed one survey at baseline upon entering the residential program and another survey at discharge. Participants received a $5 gift card for completion of the baseline assessment and a $10 gift card for completion of the post-assessment.

To facilitate practice of formal meditation outside of the sessions, mp3 players with guided meditation recordings were made available to all participants. Each Rolling MBRP group was typically facilitated by one therapist, with occasional groups co-facilitated by two therapists. There were a total of five therapists who led the Rolling MBRP groups. All therapists were graduate students in a Ph.D. clinical psychology program who were formally trained in MBRP and received ongoing clinical supervision by Dr. Katie Witkiewitz, a licensed clinical psychologist and expert in MBRP. All therapists had personal mindfulness practices.

Table 1 Descriptive statistics for the study sample

Variable	N (%) or mean (SD)
Female gender	50 (45.9%)
Race/ethnicity	
African American/Black	7 (6.4%)
Non-Hispanic White	28 (25.7%)
American Indian/Alaskan Native	9 (8.3%)
Hispanic/Latino	57 (52.3%)
Asian/Pacific Islander	0 (0%)
Mixed	5 (4.6%)
Other	2 (1.8%)
Age	36.40 (9.4)
Married or in committed relationship	18 (16.7%)
Inpatient treatment episodes	1.27 (1.58)
Detoxification episodes	1.77 (1.44)
Primary drug of choice	
Alcohol	54 (49.5%)
Cocaine/crack	7 (6.4%)
Methamphetamine	13 (11.9%)
Marijuana	1 (0.9%)
Heroin	14 (12.8%)
Opioid pills	3 (2.8%)
Anti-anxiety pills	1 (0.9%)
Polysubstance use	56 (52.8%)
Substance dependence severity	10.82 (3.01)
Length of stay (weeks)	3.52 (0.71)
Days abstinent before baseline	12.21 (7.05)
Number of rolling MBRP sessions attended	3.69 (2.12)
Distribution of MBRP session attendance	
Attended 0 rolling MBRP sessions	5 (4.6%)
Attended 1 rolling MBRP session	19 (17.4%)
Attended 2 rolling MBRP sessions	8 (7.3%)
Attended 3 rolling MBRP sessions	20 (18.3%)
Attended 4 rolling MBRP sessions	16 (14.7%)
Attended 5 rolling MBRP sessions	17 (15.6%)
Attended 6 rolling MBRP sessions	13 (11.9%)
Attended 7 rolling MBRP sessions	9 (8.3%)
Attended 8 rolling MBRP sessions	1 (0.9%)
Attended 9 rolling MBRP sessions	1 (0.9%)

Development of Rolling Mindfulness-Based Relapse Prevention

Rolling MBRP is an adaption of the MBRP therapist manual (Bowen et al. 2010) and builds upon the rolling admission version of MBRP used in the Witkiewitz et al. (2014) study. The Witkiewitz et al. (2014) program was a preliminary rolling admission version of MBRP that included eight modules delivered over 8 weeks, with each module split into two 50-min sessions offered on separate days

during a given week (about 13 h total in programming). The Rolling MBRP program developed and evaluated in the current study included eight modules, with each module offered in a single 1-h session, and two sessions offered per week (8 h total in programming). The Rolling MBRP program in this study differs from the preliminary rolling version in the Witkiewitz et al. (2014) study in that we sought to further distill MBRP (i.e., reduce from 13 to 8 total hours in programming), and designed the program to be suitable for continual, ongoing delivery in shorter-term residential treatment programs (e.g., 3–4 weeks) in which patients often rotate in and out of the program. Over the course of several years, the Rolling MBRP protocol was developed through an iterative process involving patient feedback, clinician feedback, and group discussion among the current authors. The final version of Rolling MBRP used in the current study consisted of eight 1-h modules. Table 2 provides an overview of Rolling MBRP.

Here, we elaborate on several key features of the rolling protocol. Every session begins with the therapist guiding participants through the same core formal mindfulness practice, called "mindful check-in" (about 10 min). This practice involves "checking in" and observing one's internal experience (first body sensations, followed by thoughts and emotions) and then focusing one's attention on the breath for several minutes. The mindful check-in serves to orient newcomers to both open monitoring and focused attention. The mindful check-in was also chosen as core practice because a key focus of MBRP is noticing one's *internal experience* (e.g., thoughts, emotions, craving) with openness and curiosity. Following the mindful check-in, therapists inquire about what participants noticed during the mindfulness practice. Engaging in this inquiry process early on in every session serves to orient newcomers to the inquiry process, which is a common element of MBRP. At every session, following inquiry, therapists pose key "orienting questions" to the group, such as "What does mindfulness mean to you?" or "What does mindfulness have to do with recovery?" Therapists focus on engaging prior attendees during the discussion of orienting questions, which serves to keep prior attendees engaged during the process of orienting newcomers. To keep prior attendees continually engaged, a new core theme is covered in the second half of every session.

For Rolling MBRP, there is a consistent focus on the SOBER (stop, observe, breathe, expand, respond) space, which is thoroughly reviewed in three of the eight modules. Whereas the mindful check-in is the central formal meditation, the SOBER space is the central informal practice that is the "on-the-go" version of the mindful check-in. Having two central practices, the mindful check-in and the SOBER space, is intended to create consistency and clarity within the rolling admission format. Finally, practice review (discussion of outside mindfulness practice) is integrated throughout each

Table 2 Overview of Rolling MBRP

Common components covered at every module

Components at the beginning of every session:	General learning objectives related to common components:
• Brief introduction of the group and review of group rules	• To understand what mindfulness is, how to practice it, and how it relates to recovery
• Mindful check-in meditation (~ 10 min)	• To practice noticing present moment experiences with openness and curiosity
• Inquiry following the mindful check-in (e.g., therapist-led discussion about direct experiences during the practice)	• To practice anchoring one's attention on the breath
• Posing orienting questions (e.g., How does mindfulness relate to recovery)	• To practice staying with difficult or uncomfortable internal experiences
	• To practice describing in words one's direct experience
Components integrated throughout each session:	
• Emphasizing importance of regular practice and encouraging and supporting outside practice	
• Discussing participant experiences, observations, and challenges with outside practice	

Module-specific components

Module	Learning objectives	Specific practices and content
1. Stepping out of autopilot	• To practice bringing mindfulness to an activity (eating) that often involves autopilot mode • To understand the role of autopilot in substance use • To learn and practice the SOBER space, an on-the-go technique	• Mindful eating meditation, plus post-practice inquiry • Discussion of autopilot versus mindfulness • Review and practice of SOBER space
2. Mindfulness and thoughts	• To understand that thoughts are words or images that arise in the mind, rather than facts about reality • To practice noticing when the mind gets caught up in thoughts and returning one's attention to a focal point (e.g., the breath) • To understand how awareness of thoughts in challenging situations can create perspective and promote skillful responding	• Discussion about the nature of thoughts • Mindful breathing meditation (with a focus on noticing when thoughts arise) plus post-practice inquiry
3. Mindfulness and valued living	• To learn and practice the SOBER space, an on-the-go technique • To understand how mindfulness relates to valued action and how actively living by one's values is part of the recovery process • To understand that mindfulness skills, particularly the SOBER space, are not just for *avoiding* substances but can be used for *approaching* valued goals	• Review and practice of SOBER space • Value worksheet • Discussion of mindfulness, values, and the recovery process
4. Developing a mindfulness practice	• To practice paying attention to body sensations as a way to connect to present moment experience • To understand how mindfulness is practiced and how individuals develop and sustain a personal mindfulness practice	• Body scan meditation, plus post-practice inquiry • Discussion about the process of developing and sustaining a personal mindfulness practice
5. Self-compassion	• To understand the role of self-compassion in the recovery process • To practice offering compassion or kindness to oneself and noticing what arises	• Kindness meditation, plus post-practice inquiry • Discussion about self-compassion and recovery
6. Mindfulness in challenging situations	• To learn and practice the SOBER space, an on-the-go technique • To learn how the SOBER space can be used in high-risk situations • To practice the SOBER space during an exercise that involves elicitation of distress	• Review and practice of SOBER space • SOBER space in a challenging situation exercise, plus post-practice inquiry • Discussion of using the SOBER space in challenging situations
7. Mindfulness and emotions	• To understand how mindfulness involves being willing to experience emotions • To understand how acceptance and change go together in the recovery process	• Brief mindfulness of emotions practice, followed by reading of guest house • Post-practice inquiry and discussion of poem

Table 2 (continued)

	• To practice noticing one's emotional experience with openness and curiosity	• Discussion about being willing to experience emotions
8. Checking in during difficult moments	• To develop curiosity about direct experiences (thoughts, sensations, feelings), one has while "being upset or stressed" or having an "urge" • To practice noticing one's experience with openness and curiosity during an exercise that involves elicitation of distress	• Discussion about body sensations, emotions, thoughts, actions, and their differences and interconnections • Checking-in during a difficult moment meditation (a variant of urge surfing), plus post-practice inquiry • Discussion about bringing mindfulness to urges and craving

module in a flexible manner that engages both newcomers and prior attendees. For example, after reviewing the steps of the SOBER space, the therapist often emphasizes the importance of regular outside practice, asks new attendees what specific situations or times they plan to practice the SOBER space, and then asks prior attendees to share recent experiences with the SOBER technique outside of sessions.

Therapist Fidelity

Therapist fidelity to the Rolling MBRP treatment was assessed using the MBRP Adherence and Competence (MBRP-AC) Scale (Chawla et al. 2010), a validated fidelity rating tool for MBRP. The adherence section includes items assessing adherence to MBRP treatment components (e.g., leading a particular mindfulness practice) and adherence to discussion of key concepts (e.g., acceptance of current experience). The competence section includes items assessing therapist competence in delivering specific components, and items assessing overall therapist competence during the session (e.g., rating of overall quality of session). The items in the competence section were measured on a Likert-type scale (0 = low ability/not satisfactory and 4 = high ability/excellent). Two independent raters simultaneously observed one session (in-person) for the MBRP therapists and completed independent fidelity ratings using the MBRP-AC. There were three independent raters total: one licensed clinical psychologist and two master's level clinical psychology graduate students.

Measures

Cronbach alphas for study measures are provided in the diagonal of Table 3.

Treatment History Items A single item was used to assess the total number of times participants had completed inpatient or intensive outpatient treatment for alcohol/drug or other mental health problems. Another single item was

used to assess the total number of times participants had completed medical detoxification.

Days Abstinent Prior to Treatment A single self-report item was used to assess days abstinent from substances prior to admission to the residential program.

Severity of Dependence Scale The Severity of Dependence Scale (SDS) is a 5-item self-report questionnaire that was used to assess substance use disorder severity (Gossop et al. 1995). It has demonstrated good psychometric properties among individuals with SUD (Gossop et al. 1995).

Self-Compassion Scale-Short Form The Self-Compassion Scale-Short Form (SCS-SF) is a 12-item self-report questionnaire that was used to assess self-compassion (Raes et al. 2011). The SCS-SF includes items rated on a scale from 0 (almost never) to 4 (almost always). The SCS-SF has demonstrated good psychometric properties among community samples and is highly correlated with the long form of the SCS (Raes et al. 2011).

Cognitive and Affective Mindfulness Scale-Revised The Cognitive and Affective Mindfulness Scale-Revised (CAMS-R) is a 10-item self-report questionnaire of dispositional mindfulness (Feldman et al. 2007). It has demonstrated good psychometric properties among community samples (Feldman et al. 2007).

Short Form Health Survey Two items from the Short Form Health Survey (SF-12; a widely used measure of mental health; Ware Jr. et al. 1996) were used to assess mental health. The two items are Likert-type items ("How much of the time during the past week have you felt calm and peaceful?" and "How much of the time in the past week have you felt down-hearted and blue") rated from 0 (none of the time) to 5 (all of the time).

Penn Alcohol Craving Scale An adapted version of the Penn Alcohol Craving Scale (PACS), a 5-item self-report questionnaire, was used to assess alcohol/drug craving (Flannery et al. 1999).

Table 3 Bivariate correlations (significant correlations in italics) and internal consistency reliabilities (in bold) for key study variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Number of sessions attended	−	*.235*	*.294*	.183	−.132	.071	*−.281*	.070	*.264*	−.048	−.021	−.051	−.161	.190	.037
2. Informal practice frequency		**.891**	*.778*	*.665*	−.190	.090	*.353*	*.300*	*.400*	.104	−.049	−.213	−.003	.021	−.123
3. Formal practice frequency			−	*.812*	−.122	.071	*.260*	*.247*	*.381*	.086	−.165	*−.222*	−.032	−.011	−.074
4. Formal practice-typical duration				.760	−.105	.129	*.258*	*.294*	*.385*	.186	−.193	−.160	.036	.003	.013
5. Craving P					**.875**	*−.565*	*−.562*	*−.412*	*−.419*	.212	−.025	−.128	.034	*−.312*	−.082
6. Self-efficacy P						−	*.338*	*.476*	*.432*	−.033	.054	−.049	−.185	.134	.152
7. Mental health P							**.721**	*.453*	*.480*	−.143	.017	−.038	*.024*	.224	.002
8. Self-compassion P								**.803**	*.572*	.090	−.066	−.023	−.046	.005	.179
9. Mindfulness P									**.868**	−.064	−.119	−.090	−.132	.036	.140
10. Substance dependence severity										**.755**	.073	−.052	.046	*−.266*	−.053
11. Gender											−	−.085	−.013	−.006	−.046
12. Age												−	−.045	.156	.079
13. Race													−	−.140	.079
14. Length of treatment														−	−.030
15. Days abstinent prior to baseline															−

In italics = $P < .05$. P = measured at the discharge post-assessment; values in bold on the diagonal are the Cronbach's alphas for multi-item measures

Self-Efficacy Item A single item was used to measure abstinence self-efficacy, or self-rated confidence, to abstain from alcohol/drugs after treatment (Hoeppner et al. 2011). The single item is "How confident are you that you will be able to stay clean and sober in the next 90 days, or 3 months?" from 1 (not at all confident) to 10 (very confident).

Treatment Length Item A single item was used to measure length of treatment stay.

Mindfulness Group Follow-up Questionnaire A questionnaire was administered as part of the discharge assessment to assess perceived helpfulness of the MBRP group and self-reported informal and formal mindfulness practice. This measure was based on a questionnaire that has been used in prior studies of MBRP (Bowen et al. 2009, 2014). Perceived helpfulness of the MBRP group was assessed with a single item ("Overall, how helpful has the mindfulness class been for you?") on a scale from 0 = not at all helpful to 4 = very helpful. Frequency of informal mindfulness practice was computed from five items, each rated on a scale with 0 = almost never, 1 = two to three times total, 2 = 1 to 2 days per week, 3 = 3 to 4 days per week, and 4 = 5 or more days per week. These items included the following: (1) "how often have you been practicing the SOBER technique?", (2) "how often have you been using mindfulness to check-in with yourself?", (3) "how often have you been using mindfulness to cope with stress and difficult emotions?", (4) "how often have you been using mindfulness to stay focused on your environment or the activity you were doing?", and (5) "how often have you been using breathing to handle a difficult moment?"

Frequency of formal practice was assessed with a single item: "how often have you been setting aside time when you are alone to practice mindfulness exercises?" The response options for this item were the following: 0 = almost never, 1 = two to three times total, 2 = 1 to 2 days per week, 3 = 3 to 4 days per week, and 4 = 5 or more days per week. Typical duration of formal practice was assessed with the single item: "On days you set aside time to practice mindfulness exercises on your own, about how many total minutes do you typically practice?" The response options were the following: 0 = I do not set aside time, 1 = 2 to 5 min, 2 = 6 to 10 min, 3 = 11 to 23 min, and 4 = 21 or more minutes.

Statistical Analyses

Descriptive analyses, t tests, chi-square tests, bivariate correlations, and reliability analyses were conducted in SPSS. Inter-rater reliability was tested using mean competence ratings across the two raters. Two-way mixed model intraclass correlation coefficients (ICCs) were examined. Multiple regression models and mediation analyses were conducted using Mplus version 8 (Muthén and Muthén 1998).

To evaluate the feasibility of Rolling MBRP, we computed the mean number of sessions attended. To evaluate the acceptability of Rolling MBRP, we computed the mean for the perceived helpfulness item and self-reported mindfulness practice.

To evaluate attendance-outcome relations, multiple regression analyses were conducted with Rolling MBRP attendance as the predictor. First, we conducted multiple regression models with a continuous attendance variable as the predictor (total number of sessions attended). Then, we conducted multiple regression models with a binary attendance variable as the predictor (1 = attended ≥ 2 sessions of Rolling MBRP, an "adequate dose"; 0 = attended one or no sessions of Rolling MBRP, "a minimal dose or no dose"). We chose at least two sessions as a cutoff primarily based on the distribution of the "number of sessions attended," (see Table 1), which indicated that two or more sessions was a reasonable cutoff point. Additionally, prior studies have demonstrated that brief mindfulness interventions for substance misuse consisting of two sessions have resulted in positive treatment effects (de Dios et al. 2012; Mermelstein and Garske 2015). To evaluate the role of informal and formal mindfulness practice in mediating the relations between Rolling MBRP attendance and outcomes, we conducted mediation analyses using the distribution of products of coefficients approach with bias-corrected bootstrapped confidence intervals (Hayes and Rockwood 2017). We conducted separate mediation models for each mindfulness practice variable. We first conducted a set of models with the continuous attendance variable as the independent variable and another set of models with the binary attendance variable as the independent variable.

For all regression models, including the mediation models, the following covariates were included as predictors to control for potential confounding effects of other relevant factors: the baseline score of the particular dependent variable included in each model, baseline substance use disorder severity (total score on SDS), gender, age, race (0 = white, 1 = racial/ethnic minority), length of treatment, and days abstinent prior to baseline.

A total of 21 participants (19.3% of the full sample) were missing data on the discharge assessment. Four of these participants left the treatment program prematurely against medical advice. Exposure to Rolling MBRP versus no exposure was not related to leaving the program against medical advice. The 17 other participants with missing discharge data had planned discharges but ended up being discharged at a different date than the discharge date set at treatment entry (e.g., discharged 1 day earlier than the originally set discharge date), and research staff were not present at the treatment center to administer the discharge assessment. Attrition analyses revealed that baseline demographic variables were not related to missing data at discharge. In turn, parameters were estimated using full information maximum likelihood estimation with all available data for the intent-to-treat sample.

Results

Therapist Fidelity Ratings

On average, therapists adhered to 99% of intervention components. Inter-rater reliability for mean competence ratings was good (ICC = 0.857). The mean competence score across therapists was 3.8 (SD = 0.26); this score falls between 3 = good and 4 = excellent.

Table 4 Baseline to discharge changes in outcomes among adequate dose group and minimal/no dose group

	Craving M (SD)	Self-efficacy M (SD)	Mental health M (SD)	Self-compassion M (SD)	Mindfulness M (SD)
Minimal/no dose group attended zero or one session	Baseline: 8.31 (7.64)	Baseline: 7.77 (2.09)	Baseline: 6.47 (2.23)	Baseline: 22.33 (9.74)	Baseline: 14.57 (8.14)
	Discharge: 6.07 (5.36)	Discharge: 8.69 (1.97)	Discharge: 6.13 (2.17)	Discharge: 28.66 (8.18)	Discharge: 16.76 (6.36)
	Change: −2.23 (8.61); Cohen's $d = 0.25$	Change: 0.92 (2.06); Cohen's $d = 0.44$	Change: 0.33 (3.33); Cohen's $d = 0.09$	Change: 6.33 (14.03); Cohen's $d = 0.45$	Change: 2.21 (9.24); Cohen's $d = 0.24$
Adequate dose group attended two or more sessions	Baseline: 10.50 (7.92)	Baseline: 8.52 (1.91)	Baseline: 5.67 (2.17)	Baseline: 20.78 (8.24)	Baseline: 15.41 (6.26
	Discharge: 5.58 (5.02)	Discharge: 8.81 (1.47)	Discharge: 7.46 (1.50)	Discharge: 31.83 (6.74)	Discharge: 22.10 (4.17)
	Change: −4.91 (7.51)*; Cohen's $d = 0.65$	Change: 0.29 (1.80); Cohen's $d = 0.16$	Change: 1.79 (2.55)*; Cohen's $d = 0.70$	Change: 11.08 (9.85)*; Cohen's $d = 1.12$	Change: 6.69 (6.55)*; Cohen's $d = 1.02$
Between-group effect size for difference in change on outcome	$d = 0.33$	$d = 0.32$	$d = 0.49$	$d = 0.39$	$d = 0.56$

M mean, *SD* standard deviation

*Difference is significant at $P < .05$ from paired sample t test

Feasibility

Descriptive analyses of Rolling MBRP session attendance (see Table 1) showed that the mean number of Rolling MBRP sessions attended was 3.69 (SD = 2.12). The median number of sessions attended was 4. Descriptive analyses demonstrated that the mean score on the perceived helpfulness item (which ranged from 0 = "not at all helpful" to 4 = "very helpful") was 3.38 (SD = 0.77), indicating high satisfaction. Mean scores among the full sample for self-reported out-of-session mindfulness practice were as follows: frequency of informal practice (mean = 2.72, SD = 0.89, corresponding with response anchor 3 = 3 to 4 days a week), frequency of formal practice (mean = 2.53, SD = 1.17, in-between response anchors 2 = 1 to 2 days a week and 3 = 3 to 4 days a week), and typical length of time spent engaging in formal practice (mean = 2.06, SD = 1.03, corresponding with response anchor 2 = 6 to 10 min).

Dose-Response Relations

Table 4 shows the mean scores at baseline and discharge for each outcome among those who attended two or more sessions ("adequate dose group") versus those who attended only one or zero sessions ("minimal/no dose group"). Whereas the minimal/no dose group showed no significant changes on outcomes, the adequate dose group showed significant pre-post changes in craving, mental health, self-compassion, and mindfulness (ranging from medium to large pre-post effect sizes). Table 5 summarizes the results from regression models testing between-group differences (i.e., adequate dose group versus minimal/no dose group) on discharge outcomes, while controlling for baseline values of the outcome. Attending two or more Rolling MBRP sessions (versus one or less) was not significantly associated with self-compassion, craving, or self-efficacy at discharge. Hence, although the adequate dose group (but not the minimal/no dose group) showed significant within-group pre-post changes on craving and self-compassion, there was not a significant between-group difference for these outcomes at discharge. However, attending two or more Rolling MBRP

sessions (versus one or less) significantly predicted higher mindfulness at discharge and better mental health at discharge (medium between-group effect sizes). Total number of Rolling MBRP sessions attended was not significantly associated with discharge outcomes (see Table 5).

Mechanisms of Change

Tables 6 and 7 provide a summary of the results from mediation models. Across all mediation models, the model fit was acceptable based on CFI > 0.9 and RMSEA < 0.08. For models with total sessions as the independent variable, we found the following significant effects: (a) frequency of informal practice (i.e., on-the-go practice) mediated the associations between total sessions and craving, mental health, self-compassion, and mindfulness at discharge; and (b) frequency of formal practice (i.e., setting aside time to meditate) mediated the associations between total sessions and mental health and mindfulness at discharge. For models with attending two or more sessions as the independent variable, we found the following significant effects: (a) frequency of informal practice mediated the associations between attending two or more sessions and craving, mental health, and mindfulness at discharge; (b) frequency of formal practice mediated the association of attending two or more sessions and mental health and mindfulness at discharge; and (c) duration of formal practice mediated the association between attending two or more sessions and mental health and mindfulness at discharge.

Discussion

This study evaluated the feasibility, acceptability, dose-response relations, and mechanisms of a rolling admission version of MBRP (Rolling MBRP) offered to adults ($N = 109$) with SUD receiving short-term residential treatment. Feasibility was demonstrated by good attendance rates. Acceptability was demonstrated by high satisfaction ratings and high rates of out-of-session mindfulness practice. Total

Table 5 Summary of results from regression models with Rolling MBRP attendance as a predictor of outcomes at discharge

	Craving	Self-efficacy	Mental health	Self-compassion	Mindfulness
Total number of sessions attended	$B = -0.275$	$B = -0.060$	$B = 0.154$	$B = 0.185$	$B = 0.504$
	SE = 0.257	SE = 0.077	SE = 0.087	SE = 0.402	SE = 0.278
	$\beta = -0.114$	$\beta = -0.081$	$\beta = 0.198$	$\beta = 0.055$	$\beta = 0.222$
Attended two sessions or more	$B = -0.673$	$B = -0.237$	$B = 1.214*$	$B = 0.461$	$B = 4.391**$
	SE = 1.478	SE = 0.438	SE = 0.479	SE = 0.323	SE = 1.461
	$\beta = -0.048$	$\beta = -0.055$	$\beta = 0.277*$	$\beta = 0.163$	$\beta = 0.351**$

B unstandardized coefficient, β standardized coefficient, SE standard error

$*P < .05$; $**P < .01$

Table 6 Summary of models testing indirect effects of number of sessions on outcomes via mindfulness practice variables

	Craving B (SE)	Self-efficacy B (SE)	Mental health B (SE)	Self-compassion B (SE)	Mindfulness B (SE)
Frequency of informal practice as mediator	Effect of number of sessions on mediator: 0.495 (0.260)	Effect of number of sessions on mediator: 0.509 (0.264)	Effect of number of sessions on mediator: 0.472 (0.244)	Effect of number of sessions on mediator: 0.496 (0.241)*	Effect of number of sessions on mediator: 0.500 (0.250)*
	Effect of mediator on outcome: − 0.442 (0.133)**	Effect of mediator on outcome: − 0.003	Effect of mediator on outcome: 0.163 (0.050)**	Effect of mediator on outcome: 0.520 (0.248)*	Effect of mediator on outcome: 0.486 (0.176)**
	Indirect effect of number of sessions on outcome: − 0.219 (0.127) 95% CI [− 0.540, − 0.019]	Indirect effect of number of sessions on outcome: − 0.001 (0.028) 95% CI [− 0.08, 0.045]	Indirect effect of number of sessions on outcome: 0.077 (0.051) 95% CI [0.002, 0.206]	Indirect effect of number of sessions on outcome: 0.258 (0.183) 95% CI [0.004, 0.755]	Indirect effect of number of sessions on outcome: 0.243 (0.157) 95% CI [0.029, 0.678]
Frequency of formal practice as mediator	Effect of number of sessions on mediator: 0.185 (0.070)**	Effect of number of sessions on mediator: 0.178 (0.072)*	Effect of number of sessions on mediator: 0.148 (0.067)*	Effect of number of sessions on mediator: 0.173 (0.065)**	Effect of number of sessions on mediator: 0.146 (0.069)*
	Effect of mediator on outcome: − 1.03 (0.618)	Effect of mediator on outcome: − 0.081 (0.203)	Effect of mediator on outcome: 0.495 (0.208)*	Effect of mediator on outcome: 1.66 (0.993)	Effect of mediator on outcome: 1.78 (0.685)**
	Indirect effect of number of sessions on outcome: − 0.191 (0.131) 95% CI [− 0.537, 0.003]	Indirect effect of number of sessions on outcome: − 0.014 (0.040) 95% CI [− 0.119, 0.047]	Indirect effect of number of sessions on outcome: 0.073 (0.049) 95% CI [0.005, 0.202]	Indirect effect of number of sessions on outcome: 0.288 95% CI [− 0.012, 0.839]	Indirect effect of number of sessions on outcome: 0.260 (0.179) 95% CI [0.016, 0.748]
Typical duration of formal practice as mediator	Effect of number of sessions on mediator: 0.076 (0.059)	Effect of number of sessions on mediator: 0.097 (0.058)	Effect of number of sessions on mediator: 0.086 (0.054)	Effect of number of sessions on mediator: 0.085 (0.055)	Effect of number of sessions on mediator: 0.075 (0.056)
	Effect of mediator on outcome: − 1.12 (0.674)	Effect of mediator on outcome: 0.223 (0.180)	Effect of mediator on outcome: 0.538 (0.225)*	Effect of mediator on outcome: 2.628 (1.00)**	Effect of mediator on outcome: 2.34 (0.693)**
	Indirect effect of number of sessions on outcome: − 0.086 (0.094) 95% CI [− 0.374, 0.024]	Indirect effect of number of sessions on outcome: 0.022 (0.024) 95% CI [− 0.006, 0.094]	Indirect effect of number of sessions on outcome: 0.046 (0.039) 95% CI [− 0.154, 0.005]	Indirect effect of number of sessions on outcome: 0.223 (0.168) 95% CI [− 0.019, 0.660]	Indirect effect of number of sessions on outcome: 0.176 (0.152) 95% CI [− 0.047, 0.580]

In italics = indirect effect is statistically significant based on 95% bootstrapped confidence interval

B unstandardized coefficient, *SE* standard error, *CI* confidence interval

*$P < .05$; **$P < .01$

number of Rolling MBRP sessions attended was not related to discharge outcomes. However, attending two or more sessions (versus one or none) was significantly associated with better mental health and higher mindfulness at discharge. Other studies among young adult substance users have found positive effects of just two brief mindfulness training sessions (de Dios et al. 2012; Mermelstein and Garske 2015). Our study provides preliminary evidence that just two sessions of Rolling MBRP could be beneficial for adults receiving residential SUD treatment. Given the similarities between MBRP and mindfulness-based stress reduction (MBSR; Kabat-Zinn 1990) and mindfulness-based cognitive therapy (MBCT; Segal et al. 2002), which have strong evidence for improving mental health outcomes (Khoury et al. 2013), it is not surprising that MBRP may also improve mental health. Our findings regarding mental health are also consistent with studies that have found that mindfulness-based treatments for SUD are related to improvements in stress and mental-health related outcomes (Garland et al. 2016; Glasner et al. 2016; Li et al. 2017; Zemestani and Ottaviani 2016).

We found that frequency of informal practice (i.e., on-the-go practice), frequency of formal practice (i.e., setting aside

Table 7　Summary of models testing indirect effects of attending two or more sessions on outcomes via mindfulness practice variables

	Craving B (SE)	Self-efficacy B (SE)	Mental health B (SE)	Self-compassion B (SE)	Mindfulness B (SE)
Frequency of informal practice as mediator	Effect of 2+ sessions on mediator: 4.860 (1.64)**	Effect of 2+ sessions on mediator: 4.458 (1.774)*	Effect of 2+ sessions on mediator: 3.723 (1.620)*	Effect of 2+ sessions on mediator: 4.237 (1.781)*	Effect of 2+ sessions on mediator: 3.587 (1.715)*
	Effect of mediator on outcome: 0.473 (0.133)**	Effect of mediator on outcome: − 0.011 (0.058)	Effect of mediator on outcome: − 0.151 (0.051)**	Effect of mediator on outcome: 0.468 (0.275)	Effect of mediator on outcome: 0.425 (0.167)*
	Indirect effect of 2+ sessions on outcome: − 2.297 (1.016) 95% CI [− 4.874, − 0.777]	Indirect effect of 2+ sessions on outcome: − 0.047 (0.292) 95% CI [− 0.668, 0.483]	Indirect effect of 2+ sessions on outcome: − 0.564 (0.354) 95% CI [− 1.428, − 0.054]	Indirect effect of 2+ sessions on outcome: 1.983 (1.677) 95% CI [− 0.096, 6.202]	Indirect effect of 2+ sessions on outcome: 1.526 (1.001) 95% CI [0.130, 4.180]
Frequency of formal practice as mediator	Effect of 2+ sessions on mediator: 1.620 (0.446)**	Effect of 2+ sessions on mediator: 1.442 (0.483)**	Effect of 2+ sessions on mediator: 1.088 (0.467)*	Effect of 2+ sessions on mediator: 1.409 (0.488)**	Effect of 2+ sessions on mediator: 1.073 (0.469)*
	Effect of mediator on outcome: − 1.142 (0.653)	Effect of mediator on outcome: − 0.130 (0.254)	Effect of mediator on outcome: 0.435 (0.215)*	Effect of mediator on outcome: 1.351 (1.132)	Effect of mediator on outcome: 1.530 (0.645)*
	Indirect effect of 2+ sessions on outcome: − 1.850 (1.170) 95% CI [− 4.575, 0.070]	Indirect effect of 2+ sessions on outcome: − 0.188 (0.400) 95% CI [− 1.138, 0.355]	Indirect effect of 2+ sessions on outcome: 0.473 (0.333) 95% CI [0.005, 1.315]	Indirect effect of 2+ sessions on outcome: 1.904 (1.958) 95% CI [− 0.731, 6.857]	Indirect effect of 2+ sessions on outcome: 1.641 (1.169) 95% CI [0.082, 4.827]
Typical duration of formal practice as mediator	Effect of 2+ sessions on mediator: 1.018 (0.336)**	Effect of 2+ sessions on mediator: 1.135 (0.341)**	Effect of 2+ sessions on mediator: 0.981 (0.295)**	Effect of 2+ sessions on mediator: 0.085 (0.055)	Effect of 2+ sessions on mediator: 0.924 (0.294)**
	Effect of mediator on outcome: − 1.038 (0.689)	Effect of mediator on outcome: 0.190 (0.177)	Effect of mediator on outcome: 0.439 (0.239)	Effect of mediator on outcome: 2.628 (1.00)**	Effect of mediator on outcome: 2.072 (0.691)**
	Indirect effect of 2+ sessions on outcome: − 1.057 (0.777) 95% CI [− 2.981, 0.112]	Indirect effect of 2+ sessions on outcome: 0.215 (0.210) 95% CI [− 0.141, 0.700]	Indirect effect of 2+ sessions on outcome: 0.430 (0.263) 95% CI [0.012, 1.078]	Indirect effect of 2+ sessions on outcome: 0.223 (0.168) 95% CI [− 0.019, 0.660]	Indirect effect of 2+ sessions on outcome: 1.916 (0.896) 95% CI [0.555, 4.226]

In italics = effects that are statistically significant based on 95% bootstrapped confidence interval

B unstandardized coefficient, SE standard error, CI confidence interval

time to meditate), and typical duration of formal practice each mediated the abovementioned effects of attending two or more sessions on discharge mental health and mindfulness. Although total sessions did not have a main effect on discharge outcomes, several indirect effects also emerged when testing total sessions attended as the predictor. That is, mindfulness practice also significantly mediated the association between total sessions and several discharge outcomes, including craving, mental health, self-compassion, and mindfulness. This study demonstrated a gradient effect showing that higher doses of MBRP may foster greater mindfulness practice, which in turn affects outcomes. Kazdin (2007) noted that providing evidence of a gradient effect offers additional support for a putative mechanism of change. Overall, results

provide evidence for both informal and formal mindfulness practice as mechanisms of change in Rolling MBRP. Moreover, our findings suggest that mindfulness practice may be a key mechanism driving effects of MBRP on other important mechanisms during the recovery process, such as reductions in craving, and improved mental health, trait mindfulness, and self-compassion.

Our results regarding mindfulness practice are consistent with theorized mechanisms of how MBRP works. These results also add to existing literature, with some studies supporting both formal and informal mindfulness practice as mechanisms of change (Elwafi et al. 2013; Grow et al. 2015), and another recent study showing that formal practice in particular may reduce the link between craving and substance use (Enkema and Bowen

2017). Overall, a key focus of MBRP is promoting both on-the-go practice of mindfulness in daily life and sustained formal mindfulness practice. Our findings provide evidence that practice is indeed important and reaffirms that it is vital for therapists to actively facilitate and reinforce outside practice.

Limitations

The primary limitation of this study was that it was a non-randomized, open trial, and causal conclusions regarding Rolling MBRP cannot be drawn from our design. Although we statistically controlled for several potentially confounding factors, it is possible that there were other important confounding factors that we did not account for in the analyses. Another key limitation is that study participants were only assessed after admission into the residential program and upon discharge. A follow-up assessment was not administered, and actual substance use behavior following treatment was not examined. Hence, it is still not known whether Rolling MBRP impacts long-term outcomes, including risk and severity of substance use relapse following treatment. The current study relied exclusively on retrospective self-report questionnaires, which have many limitations, such as recall biases and response biases. Most assessments in this study were relatively brief, which could have resulted in measurement error and affected the results. The study was conducted in a residential setting and may not generalize to other treatment settings. Finally, we did not control for other treatment options that participants engaged in while residing at the residential treatment center.

One key conclusion from this study is that delivering MBRP as a rolling admission group may be a viable and effective alternative to delivering MBRP in a closed-group format. However, it is important to note that collective research to date on rolling versions of mindfulness-based interventions for SUD is still mixed in regard to effectiveness, as some studies have found significant treatment effects for rolling groups (Brewer et al. 2009; Witkiewitz et al. 2014) and some have not (Shorey et al. 2017). The current study also has mixed findings regarding effectiveness as attending two or more sessions was related to outcomes, but total sessions attended was not. Importantly, both our study and the Shorey et al. (2017) study did not include longer-term follow-ups after residential treatment and did not directly assess the treatment's effect on substance use relapse or problems. To better understand the efficacy and effectiveness of rolling mindfulness-based interventions for SUD, it will be necessary to conduct well-designed randomized controlled trials with longer-term follow-ups that directly assess substance use relapse and problems.

Our study also contributes to the literature on mechanisms of change related to mindfulness-based interventions for addictive disorders. In particular, findings suggest that both informal and formal mindfulness practice may be key mechanisms of MBRP that mobilize other important mechanisms in the recovery process, such as reduced craving, and improved mental health, trait mindfulness, and self-compassion. Our study is unique from prior studies of MBRP by shedding light on dose-response relationships (Garland and Howard 2018). Our study shows that a relatively small dose of Rolling MBRP (e.g., two or more 1-h sessions) may be beneficial for clients. However, further research is needed to confirm the benefits of small doses of MBRP. Importantly, clients benefiting from small doses of MBRP do not preclude the notion that clients may benefit more, especially in regard to long-term recovery, from larger doses or ongoing small doses over time. Altogether, future work on rolling adaptions of mindfulness-based interventions is warranted and has the potential to ultimately make mindfulness-based treatments for addictive disorders more accessible and available in a diverse range of treatment settings.

Compliance with Ethical Standards

The study was approved by the University of New Mexico Institutional Review Board. All procedures were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflict of Interest Drs. Bowen and Witkiewitz have conducted MBRP trainings for which they received monetary incentives, although the findings presented in this article have not yet been presented as part of these trainings. The current study is the dissertation of the first author, who led the data analysis and interpretation. The results and findings have been reported in the dissertation repository https://digitalrepository.unm.edu/psy_etds/260/. Drs. Bowen and Witkiewitz served on the dissertation committee and provided guidance throughout, but have not attempted to influence data interpretation or tone to highlight or overinterpret effectiveness of the program. No other authors have conflicts, and there has been no significant financial support for this work that could have influenced its outcome.

Informed Consent All participants enrolled in the study gave their informed consent prior to their inclusion in the study.

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