Smartphone-Delivered, Therapist-Supported Digital Health Intervention for Physicians with Burnout

Anu Raevuori, MD, PhD,* Valerie Forman-Hoffman, PhD, MPH,† Philippe Goldin, PhD,‡ Erin Gillung, MA,§ Susan Connolly, MD,¶ Ellis Dillon, PhD,** Veko Vähämäki, MD,†† Kristian Ranta, MSc,‡‡ Outi Hilgert, MD,§§ Albert Nazander, MSc,¶¶ and Fannie Huang, MD#

The aim of this study was to examine change in burnout and depressive symptoms among physicians enrolled in an evidence-based digital health intervention, the Meru Health Program. We recruited 36 physicians with evidence of work-related stress as reported from a single-item burnout measure from the Palo Alto Foundation Medical Group and enrolled them into an eight-week, smartphone-delivered, evidence-based, and therapist-supported program that combines several evidence-based depression treatments such as cognitive behavioral therapy and mindfulness meditation. Among completers (n = 33, 91.7%), we observed a decrease in burnout (p = .049, effect size *r* = .71) and depressive symptoms (p = .001, effect size *d* = -0.9) post-treatment. Engagement metrics were not significantly associated with outcomes. This study suggests that the Meru Health Program shows preliminary evidence as a promising, discreet intervention for physicians suffering from burnout.

KEY WORDS: Mobile health; digital therapeutics; depression; burnout; mindfulness.

*Meru Health Inc., San Mateo, California, and Helsinki, Finland; Department of Adolescent Psychiatry, Helsinki University Central Hospital, Helsinki, Finland; and Clinicum, Department of Public Health, University of Helsinki, Helsinki, Finland. †Meru Health Inc., San Mateo, California, and Helsinki, Finland; phone: 319-321-4901; e-mail: valerie@meruhealth.com. ORCID: 0000-0001-7885-8873. ‡ Meru Health Inc., San Mateo, California, and Helsinki, Finland; and Betty Irene Moore School of Nursing, University of California, Davis, California. §Meru Health Inc., San Mateo, California, and Helsinki, Finland. ¶Palo Alto Foundation Medical Group, Palo Alto, California. **Palo Alto Medical Foundation Research Institute, Palo Alto, California. ††Palo Alto Foundation Medical Group, Palo Alto, California. ‡‡ Meru Health Inc., San Mateo, California, and Helsinki, Finland. §§Meru Health Inc., San Mateo, California, and Helsinki, Finland. ¶¶ Meru Health Inc., San Mateo, California, and Helsinki, Finland. #Palo Alto Foundation Medical Group, Palo Alto, California.

Conflicts of interest: Dr. Raevuori is employed as a medical director at Meru Health, Inc., receives salary from the company, and owns stocks and options of the company. Dr. Forman-Hoffman is employed as the Head of Research at Meru Health, Inc., receives salary from the company, and owns options of the company. Dr. Goldin owns options of Meru Health, Inc. Ms. Gillung is employed as a therapist at Meru Health, Inc., receives salary from the company, and owns options of the company. Dr. Vähämäki owns options of Meru Health, Inc. Mr. Ranta serves as the Chief Executive Officer at Meru Health, Inc., owns a large share of stock, and receives salary from the company. Dr. Hilgert is employed as Director of Therapy Development and Clinical Operations at Meru Health Inc., receives salary from the company, and owns stocks and options of the company. Mr. Nazander serves as the Chief Technology Officer at Meru Health Inc., owns a large share of stocks, and raises salary from the company. Dr. Connolly, Dr. Dillon, and Dr. Huang have no competing financial interests.

Burnout and depression continue to be a major source of distress among physicians worldwide.[1] In the United States, over 50% of physicians report significant symptoms of burnout, a rate more than twice that of other professionals.[2] In addition to the tremendous impact burnout has on the physician's mental health, it also negatively affects patient care, relationships with coworkers in the workplace, and family dynamics. Detrimental sequelae include medical errors and substandard physician–patient encounters that ultimately can result in poor patient outcomes.[3] The personal lives of physicians affected by burnout show higher rates of recurring or serious illnesses, divorce,[4] and, tragically, suicide. Indeed, the rate of suicide among physicians is believed to be more than twice that of the general population, and the highest among all professions.[5]

Burnout in physicians is driven largely by external factors, such as organizational structure, policies, and workflows, rather than by their personal characteristics.[6] Attitudes and behaviors that result in burnout may be encouraged in the predominant medical culture, which emphasizes perfectionism and denial of personal vulnerability, poor work–life balance, and complex demands from the work itself. Additional contributions to the demands of the work environment may include increased administrative tasks, managing multiple EHR systems, patient

complaints and heightened expectations, exponentially growing medical information, and extremely long working hours resulting in sleep deprivation and insufficient time for recovery from stress.

The rise of digital health technologies offers a potential access point for physicians to anonymously seek and receive treatment for mental health problems.

The distinction between burnout and depression is conceptually vague.[7] Some theorize, based on the major overlap between symptoms such as physical and emotional exhaustion, depersonalization, and decreased accomplishment, that burnout is a form of depression[8] that develops specifically as a reaction to overwhelming occupational stress.[9] Because of its link to external, work-related conditions, burnout is thought to be less stigmatizing than depression.[10] Nevertheless, physicians experiencing burnout or depression in general may not seek help because of the prevailing stigma of mental health conditions, time constraints, and, further, the widely held belief that physicians should be infallible. Fortunately, the rise of digital health technologies offers a potential access point for physicians to anonymously seek and receive treatment for mental health problems.

To our knowledge, no previous reports utilizing eHealth interventions in physicians to target both burnout and depression symptoms exist, although the use of mobile applications to alleviate stress among residents and medical staff has been studied.[11-14] The aim of the current pilot, single-arm study was to explore the change in burnout and depression symptoms after participation in a newly developed, evidence-based, smartphone-delivered, therapist-supported eight-week eHealth intervention called the Meru Health Program (MHP) among physicians from a large multispecialty medical group in California. We also assessed the potential exposure–response relationship between engagement in the program, as measured by the number and time spent doing program practices, and symptom changes.

MATERIALS AND METHODS

The Meru Health Program Intervention

The online MHP consists of eight modules delivered in a fixed weekly order through a smartphone application. The program includes practices adapted from mindfulness-based stress reduction,[15] mindfulness-based cognitive therapy,[16] cognitive–behavioral therapy,[17] and behavioral activation.[18] Modules are introduced each week as follows: introduction to mindfulness; low mood and motivation; self-compassion; managing worry; overcoming thinking traps; rethinking your life values; being aware of your relationships and setting boundaries; and relapse prevention. The MHP is HIPAA compliant and adheres to General Data Protection Regulation (GDPR) requirements.

The MHP therapist, a board-certified and licensed mental health professional, provided ongoing individual support as needed and guidance for the online group during the intervention. The interaction took place via chat-messaging, and, in a few instances, by phone calls. The therapist used a professional dashboard, a secure Web-based tool to monitor participant engagement and chat with participants. The smartphone application included video lessons every week, audio-guided mindfulness meditation practices, visual graphics that illustrated cognitive-behavioral principles, and journaling prompts. Outcomes were collected at varying intervals during the program, with all assessed at the end-of-treatment.

The MHP smartphone application consisted of the following components:

- **"Me" screen:** to access daily practices and learning materials;
- **Program screen:** overview of the entire structure of the 8-week program, and links to access and review completed modules and practices;
- **Group screen:** to view other anonymous participants' reflections of practices and lessons. To ensure safety of the therapeutic environment, the Group screen did not allow participants to comment on peers' practices or reflections, but only to view the discussion thread between participants, who voluntarily posted comments in this format, and the therapist who moderated the group.
- **Notifications screen:** to review messages from the therapist or notifications about newly available lessons or practices; and
- **"Other" screen:** to view the Risk Management Plan, Privacy Policy, Terms of Use, and a single button to contact the therapist via chat.

After completion of the program, the therapist and participant had a voluntary 30-minute phone interview to assess the participant's experience with the program and to provide additional referrals as needed. If there were any signs of mental state deterioration during treatment, the therapist conducted an additional phone-based assessment of the participant's condition. For emergencies, such as severe suicidality, the MHP includes a written safety plan, which all participants review with the therapist prior to starting the program. In the current study, we used MHP version 1.0. Additional details of the MHP development, components, and demonstrated efficacy in both end-of-treatment and longer-term outcomes have been published elsewhere.[19,20]

Participants and Recruitment

Physicians were recruited from the Palo Alto Foundation Medical Group (PAFMG). The MHP was promoted to physicians by the PAFMG Physician Wellbeing Committee via weekly email newsletters and word-of-mouth encouragement at individual clinics. Eligibility in the study required that physicians owned a smartphone, were able to communicate in English, and reported at least occasional work-related stress as assessed via a single-item burnout measure (described in the following section). Physicians who met this requirement were screened in a 20- to 30-minute interview conducted by the MHP study therapist. Exclusion criteria included suicide attempts or severe ideation, psychosis or other serious mental disorders, or active substance abuse, although none of these were present in the individuals screened.

Measures

A Single-Item Burnout Measure

Burnout was assessed with a single item that has been validated in previous studies as being highly correlated with the Maslach Burnout Inventory emotional exhaustion scale.[21,22] This single-item burnout measure instructs respondents to define burnout for themselves by answering the question "Overall, based on your definition of burnout, how would you rate your level of burnout?" Responses are scored on a five-category ordinal scale, as follows:

- 1: I enjoy my work. I have no symptoms of burnout.
- 2: Occasionally I am under stress, and I don't always have as much energy as I once did, but I don't feel burned out.
- 3: I am definitely burning out and have one or more symptoms of burnout, such as physical and emotional exhaustion.
- 4: The symptoms of burnout that I'm experiencing won't go away. I think about frustration at work a lot.
- 5: I feel completely burned out and often wonder if I can go on. I am at the point where I may need some changes or may need to seek some sort of help.

To be included in this study, physicians had to score at least a 2 on the measure (i.e., report having at least occasional symptoms of burnout) at the pre-program assessment. The response to this item collected at the end of treatment (post-program, after completion of the eighth week) was used to calculate a change score in the single-item burnout measure (range –4 to 4) as the primary outcome measure of interest.

Patient Health Questionnaire 9

The Patient Health Questionnaire 9 (PHQ-9) is the nine-item depression scale extracted from the full PHQ.[23] Because each of the nine items can be scored from 0 (not at all) to 3 (nearly every day), the PHQ-9 score ranges from 0 to 27. PHQ-9 scores are evaluated as follows:

- 5 to 9: mild depression;
- 10 to 14: moderate depression;
- 15 to 19: moderately severe depression; and
- 20 to 27: severe depression.

Prior studies show that the PHQ-9 has excellent internal consistency reliability, with Cronbach's α of 0.89 in primary care settings, and excellent test–retest reliability.[23] The changes in the PHQ-9 score from pre- to post-program assessment were included as a secondary outcome of interest in this study.

Intervention Engagement

Intervention engagement was measured by users' interactions with the MHP via the smartphone application. The app calculated the total number of seconds of completed mindfulness meditation practices and the number of days per week users completed these practices. Chat activity (i.e., engagement with a therapist) was calculated by summing the number of days per week that each participant communicated with their therapist via the chat function or individual messaging. These measures were used to answer the secondary research questions about the association between engagement and changes in burnout and depressive symptom outcomes that occurred during participation in the MHP.

Statistical Analyses

The significance in the change in single-item burnout score between baseline (pre-program) and eight-week (post-program) measurements was tested with the Wilcoxon signed rank test. The changes in PHQ-9 scores were analyzed with repeated measures analysis of variance (ANOVA) using heterogeneous compound symmetry covariance structure. To allow for missing values in the follow-up measurements, the restricted maximum likelihood estimation method was used.[24] PHQ-9 scores at follow-ups were compared to the baseline using Dunnett's adjustment in pairwise comparisons. Due to positively skewed distribution, PHQ-9 scores were natural log-transformed for analysis. Because of the few zero values in PHQ-9 scores, a constant (0.5) was added before the log transformation. The effect size of the change in depression was calculated as the mean change of PHQ-9 of the natural log-transformed values divided by the standard deviation at baseline and expressed as Cohen's *d*.[25] The effect size of the change in the single-item, five-category burnout variable was expressed by the matched-pairs rank-biserial correlation ($r_{r\text{-}b}$) as suggested by Kerby.[26] The $r_{r\text{-}b}$ is the difference between the proportion of participants with positive ranks (i.e., improvements in burnout from pre- to post-program) and those with negative ranks (i.e., worsening burnout from pre- to post-program). Associations between outcome and engagement variables were

Table 1. Change of Depression Symptoms Measured by Patient Health Questionnaire 9 During and at Completion (8 week) of the Meru Health Program

Week	n	Mean[a]	Mean change (95% CI)	p value[b]	Effect size[c]
Baseline	33	5.51	–	–	–
1	33	5.16	0.94 (0.73–1.20)	0.93	– 0.08
3	31	4.22	0.77 (0.55–1. 07)	0.16	– 0.32
5	31	4.15	0.75 (0.51–1.11)	0.23	– 0.34
7	26	3.40	0.62 (0.40–0.96)	0.027	– 0.58
8 (at completion)	21	2.61	0.47 (0.29–0.786)	0.001	– 0.90

[a]Geometric mean; based on repeated measures ANOVA model.
[b]Repeated measures ANOVA; mean changes of the follow-up measurements compared with the baseline with Dunnett's adjustment method. Mean changes were calculated as the proportional changes in geometric means.
[c]Cohen's effect sizes were calculated as the mean change of the natural log-transformed values divided by the standard deviation at baseline.
CI, confidence interval.

calculated using Spearman rank-order correlation coefficients. Statistical analyses were done using SAS System for Windows, version 9.4 (2016).

Ethical Considerations

Prior to the start of the MHP, participants gave informed consent for the use of their data in scientific research. The app provided each user with a unique identification number included when answering questionnaires on the app. Consequently, the research dataset used to perform data analyses included only the user's unique identification number and did not reveal any personal identification data. The institutional review board granted approval to conduct the study in May 2018. Study procedures were conducted in accordance with the Helsinki Declaration, and data handling was performed according to U.S. and Finnish data protection legislation.

RESULTS

General

At baseline, there were 36 physicians (24 females, 12 males), ranging in age from 31 to 56 years (mean 45.6 years, median 45 years, standard deviation = 7.0 years). During the eight-week intervention, three participants (8.3%) dropped out. Baseline demographic characteristics and PHQ-9 or burnout score of those who dropped out of the study were similar (p > .05) to those who remained in the study. Thus, the remainder of the analyses reported focus on the 33 participants who completed the program.

The mean PHQ-9 score at baseline was 5.51 (range 1–18; Table 1). PHQ-9 scores at baseline were as follows:

- 14 individuals (42.4%) with scores less than 5, indicating less than mild depressive symptoms;
- 10 individuals (30.3%) with scores between 5 and 9 (mild depression);
- 2 individuals (6.1%) with scores between 10 and 14 (moderate depression);
- 2 individuals (6.1%) with scores between 15 and 19 (moderately severe depression); and
- None with scores between 20 and 27 (severe depression).

At baseline, 6 participants (18.8%) reported a 2 (occasional burnout symptoms); 15 (46.9%) reported a 3 (definitely burning out with at least one symptom of burnout); 9 (28.1%) physicians reported a 4 (symptoms of burnout that won't go away, leading to feelings of frustration); and 2 (6.3%) physicians reported a 5 (feeling completely burned out and needing to make some changes or seek help to be able to go on). At baseline, depressive symptoms and burnout were correlated ($r = 0.41$, $p = 0.02$). Table 2 shows burnout scores shown only for those participants (n = 23) who had reported the values at both time points (pre- and post-intervention). To gauge the generalizability of looking at only those data at both time points to make inferences about our whole sample, we compared baseline burnout characteristics between those with versus those without data at both time points and found no differences (p = .75).

Changes in Burnout and Depressive Symptoms During the Meru Health Program

A repeated-measures analysis of variance showed a significant reduction in depression symptoms measured with the PHQ-9 from baseline to immediately post-intervention (week 8) ($F_{5,129} = 3.31$, $p < .01$; mean change pre-program to post-program = –2.9 points [proportional change = –.47], Cohen's $d = –.90$). The decrease in burnout score from baseline to immediately post-intervention also was significant (p = .049, $r_{r\text{-}b} = .71$; Table 2). Like pre-program assessments, depressive symptoms and burnout were correlated at end-of-treatment assessment ($r = .42$) as well.

Table 2. Burnout Symptoms at Baseline and Week 8 (at completion) of the Meru Health Program Among Participants with Pre- and Post-Burnout Data

	Single-Item Burnout Score				
	2 = Occasionally I am under stress, and I don't always have as much energy as I once did, but I don't feel burned out.	**3** = I am definitely burning out and have one or more symptoms of burnout, such as physical and emotional exhaustion.	**4** = The symptoms of burnout that I'm experiencing won't go away. I think about frustration at work a lot.	**5** = I feel completely burned out and often wonder if I can go on. I am at the point where I may need some changes or may need to seek some sort of help.	**p Value for Comparison Over Time***
Baseline	4 (17.4%)	11 (47.8%)	6 (26.1%)	2 (8.7%)	
Week 8	12 (52.2%)	6 (26.1%)	3 (13.0%)	2 (8.7%)	0.049

*Wilcoxon signed rank test; p value for change between baseline and week 8 burnout scores
Effect size $r_{r\text{-}b}$ = 0.71

Table 3. Mean Amount of Mindfulness Meditation Practice and Program Chat Activity During the 8-Week Meru Health Program and Relation to Decrease in Depressive Symptoms (Patient Health Questionnaire 9) and to the Decrease in Burnout Symptoms at Week 8

	Mindfulness Meditation Practice (time in seconds)				Mindfulness Meditation Practice (active days per week)				Chat Activity (active days per week)			
Week	**n**	**Mean**	**SD**	**Range**	**n**	**Mean**	**SD**	**Range**	**n**	**Mean**	**SD**	**Range**
1	33	4775	1583	1318–8296	33	5.5	1.5	1–7	19	1.7	0.7	1–4
2	32	7220	2889	2244–12371	32	5.7	1.4	3–7	19	1.6	0.7	1–3
3	33	5157	1832	1137–8048	33	5.2	1.7	1–7	19	1.7	0.8	1–4
4	33	3935	2100	1066–1791	33	5.2	1.4	2–7	19	1.6	0.9	1–4
5	32	4782	3121	220–12181	33	4.5	1.9	1–7	15	2.1	1.1	1–4
6	31	4345	3177	690–14292	31	4.5	1.8	1–7	17	1.2	0.4	1–2
7	32	2862	2295	458–9338	32	4.3	1.8	1–7	15	1.4	0.5	1–2
8	30	2674	1624	60–6557	31	4.1	2.0	1–7	17	1.7	0.9	1–4
Mean	33	4440	1607	1547–7303	33	4.9	1.3	2–6.8	33	1.5	0.4	1–2.8
	Mindfulness Meditation Practice (time in seconds)				**Mindfulness Meditation Practice (active days per week)**				**Chat Activity (active days per week)**			
	n	**ρ***		**p value**	**n**	**ρ***		**p value**	**n**	**ρ***		**p value**
PHQ-9 Δ	21	0.23		0.31	21	0.07		0.77	20	0.06		0.79
Burnout Δ	23	0.24		0.28	23	0.24		0.27	23	0.18		0.42

*Spearman correlation
Δ Change is score between pre- and post-program
PHQ-9, Patient Health Questionnaire 9

Relationship Between the Amount of Mindfulness Practice and Chat Activity and the Change in Depression and Burnout Symptoms

The summary metrics of program-associated mindfulness practices and chat activity for each week of the program and correlations with outcomes (depression symptoms and burnout score) are displayed in Table 3. The mean number of minutes of meditation practiced per week ranged from about 120 minutes in week 2 to about 41 minutes in week 8. Likewise, the mean number of days of meditation practiced per week ranged from 5.7 in week 2 to about 4.1 in week 8. The mean number of days participating in chats with the therapist ranged from about 1 to 2 per week for the duration of the program. None of the correlations between program engagement (e.g., number or minutes of mindfulness practices or number of chat messages exchanged with therapists) and outcomes (depression symptoms or burnout score) was significant (Table 3).

DISCUSSION

In this single-arm pilot study, the MHP, a smartphone-delivered, therapist-supported intervention for depression and burnout, appeared to be both feasible and efficacious. A high percentage of physicians who enrolled completed the program (91.3%), and they reported in-program completion of an average of 40 to 120 minutes spread over 4 to 5

days per week consistently throughout the program. At end of treatment, physicians enrolled in the MHP experienced a significant decrease in both burnout (effect size $r_{r\text{-}b}$ = .71) and depression symptoms (effect size Cohen's d = –.90). These improvements in both outcomes of interest are not surprising, given the correlation between the two measures both pre- and post-program.

The link between mindfulness and physician well-being has been demonstrated in several prior investigations.

We did not find significant linear correlations between engagement with the program and outcomes. There are several possible explanations for this. First, the pairs of available data for each correlation ranged from n=20 to n=23, so the analyses were underpowered to detect significant findings. Also, the small sample sizes precluded the use of multivariate models that controlled for potential confounders. For example, characteristics such as severity of symptoms at the beginning and during the program could have influenced the amount of time spent on program activities. That is, physicians who felt better shortly after starting the program, for example, might not be as motivated to keep practicing during the remainder of the program, reducing the values of their average engagement metrics over the course of the entire 8-week program. Larger, controlled studies are needed to confirm these findings and investigate the associations between engagement and outcomes, which might not be linear in nature.

The link between mindfulness and physician well-being (including generalized stress, burnout, and depressive symptoms) has been demonstrated in several prior investigations.[27-30] Several prior studies have tested interventions that included a mindfulness component to target physician stress and related constructs.[31-35] For example, a randomized controlled trial that tested the effects of medical students using an audio-guided mindfulness program delivered via a mobile application, Headspace, found that, compared with the control group, the intervention group had significant reductions in perceived stress and increases in general well-being after 30 days of use.[13] Another study provided preliminary evidence that a flexible, video-based mindfulness program could lead to decreases in stress and emotional exhaustion, increases in well-being, and mastery of lasting mindfulness skills in physicians.[11] Our study results confirm these findings but also provide preliminary evidence of efficacy of an intervention that specifically targets burnout and depressive symptoms that can be feasibly delivered via a mobile app.

These findings of feasibility and preliminary efficacy of the MHP are important in light of recent calls for more attention to physician wellness and burnout.[36] Various interventions have been created to tackle potential dysfunctions in the clinical work environment and in the predominant medical culture that permeates the medical community.[14,37] Indeed, the National Academy of Medicine in the United States recently launched a national Action Collaborative on Clinician Well-Being and Resilience[38] to study and address these types of concerns. The goals of this initiative include better understanding of the challenges faced by physicians, identifying evidence-based solutions, monitoring their effectiveness, and increasing the visibility of stress and burnout issues faced by physicians. In addition to using more rigorous study designs with adequate power to test some of the interventions that have been proposed, further interventions that address some of the key barriers that physicians cite as reasons for not seeking care, such as lack of time and stigma of seeking treatment, are needed. Moreover, additional research is needed to determine how an individual's vulnerability factors contribute to both burnout and depression to better explain the overlap between the two phenomena.[7]

STRENGTHS AND LIMITATIONS

Several strengths of our study examining outcomes after physicians participate in a structured eHealth intervention can address barriers to treatment receipt frequently cited by physicians (e.g., time, stigma). First, this is one of the first studies conducted among physicians of a mobile health intervention that has specifically targeted burnout and depressive symptoms and reported changes in these outcomes at the end of treatment. Second, the data collected in the app on both outcomes and engagement metrics provided an automated way to gather and analyze detailed information about activities throughout the eight-week program. Our study also has several limitations, however, including small sample size, lack of a control group, and limited number of outcomes measured in a control group. In addition, our sample included some physicians with only mild levels of either burnout or depressive symptoms at baseline who might not have had much room for improvement. The fact that our analyses still indicated medium to large effect sizes after program completion despite relatively small sample sizes suggests the need for additional studies to confirm these results.

CONCLUSIONS

The MHP, a digital therapist-supported intervention delivered via a smartphone application that targets burnout and depressive symptoms, was found to be a promising intervention for physicians suffering from burnout. Given the current epidemic of physician burnout and frequently cited barriers to seeking treatment, we invite future studies testing programs similar to MHP's eHealth programs in controlled

designs combined with systematic actions aimed at improving healthcare organizations as healthy workplaces.

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