INVESTIGATOR STUDY PLAN - REQUIRED

Development of a Text Intervention for Perinatal Depression

NCS Number pending
Revised 12/15/2022

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1. TITLE
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2. EXTERNAL IRB REVIEW HISTORY*
N/A

3. PRIOR APPROVALS:

Conflict of Interest (COI):
All research staff with a COI to report have completed the necessary disclosure processes.

4. OBJECTIVES*
Aim 1: Draw upon the literature and a User Centered Design approach to collect data from content area experts, caregivers, and individuals with lived experience of perinatal depression, to iteratively develop the Text4Moms tool (tailored text messages, video content, and peer navigator dashboard).

Aim 2: Evaluate preliminary effect direction and magnitude of Text4Moms in a pilot randomized trial (Text4Moms vs educational texts; ratio 2:1) with 30 at-risk pregnant individuals not in an MDE. *Compared to participants randomized to the control condition, those in Text4Moms will*: **H1:** show target engagement through improvement in "self-efficacy" of ≥ d = 0.2 that can protect against development of an MDE; **H2:** show greater decline in Edinburgh Postnatal Depression Scale (EPDS) scores of ≥ d = 0.2, and items indicative of RDOC constructs of "loss" and "threat."[1]

Aim 3: Examine implementation outcomes by evaluating the usage, acceptability, and feasibility of Text4Moms and its components: **H3:** Participant ratings will average at least 68 on the System Usability Scale for the Text4Moms system and components. **H4:** >70% of patients will show engagement in Text4Moms by opening ≥80% of text messages and clicking on ≥30% of links to enhanced content. **H5:** ≥30% of mothers will engage with the chat and endorse 4 out of 5 on its utility.

5. BACKGROUND*
5.A.1 Significance
Perinatal depression is common, impairing, and preventable. In the United States, ~14% of pregnant individuals experience an incident major or minor depressive episode, with a similar rate occurring postnatally.[2,3] Depressive disorders always carry a high personal toll. However, during this pivotal time, depression is associated with risk of preterm birth[4]; can negatively affect the dyad through impaired maternal-child attachment[5-7]; can adversely affect infant development[8]; and decrease breastfeeding initiation/duration.[9,10] Federal agencies and provider organizations emphasize the need to screen individuals for depression in pregnancy and after delivery.[11,12] Additionally, the US Preventative Services Task Force (USPSTF) showed compelling evidence that counseling strategies can be deployed to ***prevent*** perinatal depression (pooled risk reduction (RR)=0.61 [95% CI, 0.47 to 0.78], k=17, n=3094, I2=39%).[13]

At risk individuals benefit the most from preventative interventions although at-risk determinations vary in the literature. While the USPSTF reviewed preventative strategies for both individuals considered "at risk" and those not necessarily at risk, high risk groups show the greatest reduction in depressive symptoms after engagement in an intervention (RR=0.55; 95% CI, 0.44 to 0.68).[13] A number of factors constitute risk including a past history of depression, especially perinatal depression[14-18]; genetic factors[19-21]; history of sexual abuse, early childhood abuse and intimate partner violence[22,23]; stress and poor social support[14,18,24-26]; low socioeconomic status[14]; undesired pregnancy[27]; perinatal complications[28]; certain demographic characteristics such as adolescence[26] and extant subsyndromal depressive symptoms.[29,30] Measures designed to *predict* who will become depressed[31-33] do not perform substantially better than questionnaires that include demographic items and query current symptoms, most likely because of collinearity among domains.[34,35] On the other hand, screening for existing depression is successful. A variety of approaches are used including screening and mood monitoring via mobile applications and text messaging.[36-39] Systems most commonly use the Edinburgh Postnatal Depression Scale (EPDS)[38,39] and the Patient Health Questionnaire-9 (PHQ-9)[36,37] as screeners. The acceptability of tech-based screeners is high.[37,38]

The most commonly used *criteria* to identify high risk individuals for participation in prevention trials was presence of depressive symptoms not meeting syndromal criteria. Although different questionnaires were employed in the various studies, the most frequent was the EPDS at a threshold score of 9.[40-44] Several successful studies also included individuals with a history of depression as at high risk.[45-48] This tracks with the strong signal in the literature placing this group at high likelihood of depression relapse.

Research Domain Criteria (RDOC) provide utility to further explore mechanisms related to preventative interventions. RDOC offers a model to understand and further explore the neurobiological systems involved in perinatal depression.[49] Depression falls into the negative valence domain with features of loss and threat (anxiety/fear).[50] Depression also falls within the postive valence system with (lack of) reward responding, i.e. anhedonia.[1,50-52] An empiric study supported the notion that among *perinatal* individuals, the systems placing them at risk include the negative valence domains such as threat (anxiety/fear) and loss.[53] Indeed, these systems fit in well with the risk factors noted above that are associated with perinatal depression. These include past trauma or adverse events related to being mothered and childhood, role transitions that can be exciting but also entail loss and anxiety, social isolation and poverty that increase feelings of loneliness, anhedonia, loss and anxiety. Enhanced self-efficacy and a sense of mastery can help perinatal individuals navigate these challenges.

Interventions based on interpersonal therapy (IPT), and peer support are proven to be effective in decreasing the risk of perinatal depression. Interventions based upon IPT[45,46,54,55] **reduce risk of a depressive episode by 50% or more**.[13] The IPT-based intervention (Reach Out, Stand strong, Esssentials for new mothers; ROSE) focuses on areas that place individuals at risk for perinatal depression including difficulties with social suport, role transitions and life stressors.[45,46,55] The paradigm on which ROSE is based focuses on interpersonal change processes to reduce stress, increase self-efficacy and ameliorate depressive symptoms.[56] This intervention was explicity tested in pregnant minority individuals and showed significant benefit compared to enhanced usual care.[57] Broadly speaking, this intervention can provide a road map to enhance self-efficacy and enhance resilience to mitigate risk of depression.[58-60] As well, IPT

principles may enhance social support through better acceptance and management of the interpersonal challenge (i.e. through improved social skills).
Support provision is critical but does not need to be extensive or in person. Provision of peer support also reduces risk of an MDE, particularly among those at highest risk.[40,43,61] One landmark study illustrating the utility of peer support for perinatal depression provided support via telephone[24] as well as email and text.[41] This finding mirrors evidence from internet-delivered interventions for depression, anxiety, and substance use, suggesting additional therapeutic benefit from guided electronic interventions (those with some human contact or involvement, however brief) over unguided interventions (those with no human contact).[62] Researchers hypothesize that strong social support increases self-efficacy[63-65] and this results in decreased risk of depression[63]; this was shown in a study that used peers.[65]

Self-efficacy and coping are important targets for decreasing depression risk. Self efficacy, or the extent to which people view their ability to exert control over themselves and/or their environment, is linked to risk of depression through its effects on hope, optimism and effort. It is a critical component of mental health and strong theories link it to risk of depression.[63,66-69] Not surprisingly, risk factors for depression, such as trauma and childhood adverse events, challenge one's sense of self-efficacy. Improved self-efficacy is also a key mediator between relationship challenges[63] and depressive symptoms as well as stressful life events[70], including those occurring in the perinatal period.[65,71] Mastery is related to self-efficacy but adds an emphasis on the ability of the self to emphasize control over the meaning and emotional consequences of events.[113] Strong coping skills decrease the risk of perinatal depression.[71] They relate to RDOC by diminishing negative valence (loss or threat) and enhancing the appreciation of positive events (positive valence). Accordingly, we will evaluate whether the proposed TMI engages self-efficacy and mastery in order to protect against the onset of a major depressive episode (MDE). Self-efficacy scales for perinatal individuals focus on the postnatal period and self-assessments of parenting abilities and activities, which are hard to assess in pregnancy and before parenting starts (for primigravidas). However, general assessments of self-efficacy and mastery may provide an area to target for symptom improvement and development of resilience against an incident MDE.

Technology based interventions show promising results. Helping perinatal individuals obtain the treatment they need can be challenging[72]; only ~20% of individuals meeting criteria for an MDE receive psychological treatment.[73] Technological approaches can improve the connection with mental health treatment by removing barriers of transportation, lowering cost, reducing stigma, and minimizing childcare needs. Digital Health interventions are a viable approach for ***preventing*** perinatal depression as well.[74-83] In general, the majority of programs are web-based applications (apps) deployed on computers or mobile devices. Although such interventions are potentially powerful, most have not made it into wider use. Of the mental health apps widely available, there is a lack of expert input and testing.[84] Whether evidence based or not, apps are used infrequently, even after they are downloaded.[85,86] Curated databases may help clinicians identify apps for their patients[87], but patients still need to actively seek them out, register, develop user names, passwords, and the user must have adequate internet access as well as appropriate devices.[88]

Text messaging interventions (TMIs) may engage more perinatal individuals compared to mobile Health (mHealth) apps. TMIs have a number of advantages that can increase access to preventative interventions; they require active consent only once, and then allow repeated,

proactive, and direct contact over extended periods of time. Texts allow participants to focus on the intervention content through a known user experience with minimum effort required. For example, texts can be read automatically when received and indeed, more than 90% of text messages are opened and read within a few minutes.[89] Text messages are also inexpensive to send and receive, **can be tailored, personalized and made interactive.**[88] In this way, TMIs can adopt some of the strong features seen in standard web-based programs yet avoid some of the issues that arise when using apps.

TMIs are proven to be effective and have a broad reach. TMIs are being deployed to support pregnant and postpartum individuals in a variety of domains. A national initiative, Text4Babies, was developed in 2010 "to promote healthy pregnancies and babies by the use of text messages."[90] Text4Babies and other systems are acceptable to pregnant and postpartum individuals, including underserved populations.[90] TMIs have significant therapeutic effects on attitudes toward alcohol use in pregnancy, smoking in pregnancy, compliance with prenatal visits, taking prenatal vitamins and eating fruits and vegetables.[91-95]

TMIs can be used as an adjunct to ongoing treatment with clinicians for depressed individuals. Above we note the feasibility and success of screening via text messaging[36,96,97], which can identify individuals who need clinician-delivered treatment. As well, TMIs can be used as an *adjunct* to help depressed, perinatal individuals and were used in conjunction with nurses making home visits to perinatal women.[98] Indeed, a TMI designed to prevent depression may require minimal modification to be used as an adjunct to depression treatment in perinatal individuals, although that is not the focus of this application. For example, additional encouragement for managing role transitions and developing a support network can be beneficial for both individuals at risk and individuals in an MDE.

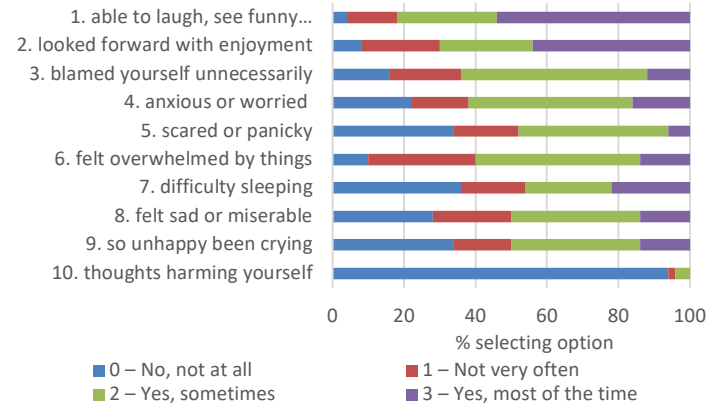
TMIs enhance self-efficacy. Non-enhanced text messages were used as a postnatal educational and peer support intervention for first time mothers with the goal of increasing parenting self-efficacy and decreasing postpartum depressive and anxiety symptoms.[64] In the initial pilot study, first time mothers were provided education through a TMI that delivered messages twice daily for 2 weeks and then daily for one month. The program, which was developed with expert and end-user (mothers) input, showed improvements in parenting self-efficacy.[99] A developer of this intervention is a consultant on the proposed project.

Design features to consider with mobile interventions. As work in this field matures, we can now appreciate that a number of components optimize design features of mobile interventions. Understanding and empathizing with the needs of the end-user (patient) is important for designing engaging mHealth interventions, including TMIs. It is clear that participant input can enhance engagement. User centered design (UCD) approaches enhance one's ability to operationalize end-user input. UCD incorporates the needs, preferences, and limitations of end users into all phases of product development and implementation.[100,101] In practice, UCD assesses these areas using repeated, mixed quantitative and qualitative measures to guide the design process. This approach allows for iterative refinement and product improvement through direct user input to increase the chance that systems work well in the native environment.[102-104] UCD can be applied to the development of TMIs to enhance content for the individuals who will ultimately be recipients of texts.

Other features important to health app development include accessibility, privacy/security, clinical foundation, and interoperability.[87] Compared to web-based apps, TMIs may have less

privacy and text messages need to be developed with that in mind by avoiding highly sensitive or incriminating content; but text messages can include links to content such as videos and live chat that can be provided with a high level of security.

Figure 1: EPDS Items Before Onset of MDE



Mobile health interventions focused on screening and prevention of perinatal depression are needed. Despite the proven potential of mHealth interventions in perinatal depression treatment, what is needed is an ***accessible*** system to identify risk among perinatal individuals and provide an intervention to ***prevent*** an MDE. This is particularly important for individuals from diverse racial and socio-economic backgrounds who may have few resources to care. In this application, we propose to apply UCD principles to:

- finalize and deploy a brief measure to screen pregnant individuals for an MDE and depression risk
- develop a subsequent set of one-way, tailored text messages based upon elements from preventative IPT interventions to improve self-efficacy and decrease the likelihood of perinatal depression
- provide peer support through secure chat functionality that will augment intervention elements to enhance social support for pregnant individuals at risk of depression.

5.B. Preliminary Studies

5.B.1. Depressive symptoms prior to an MDE. In the Yale Pink and Blue Study, we enrolled 2,654 pregnant individuals who had one of the following: were depressed, had a history of depression, were undergoing antidepressant treatment, or none of the above. Individuals were enrolled prior to 16 completed weeks gestation and were followed until 2 months post-delivery. We screened for depression with the EPDS and conducted diagnostic interviews with the Composite International Diagnostic Interview. We evaluated symptoms people experienced *before* an *incident* MDE (n=51) either in the 2nd or 3rd trimester. Figure 1 shows substantial distress with > 50% endorsing crying, feeling sad or miserable, overwhelmed, or anxious (scores of 2 or 3); fortunately, suicidal thoughts were low.

5.B.2. Screening for depression. Dr. Yonkers has been part of an international coalition to evaluate the psychometric properties of the EPDS in relation to diagnostic interviews. We contributed data from the Pink and Blue study. Results from 15,557 participants in 58 studies, including 2,059 individuals with an MDE indicated an optimal cutoff on the EPDS of 11.[105] This suggests that an EPDS score of 9 is likely to detect individuals at risk, but not in an episode of an MDE. The proposed study will also use CAT-MH for diagnostic information.

5.B.3. Social support and depression in pregnancy. My team evaluated the intersection between an MDE in pregnancy, pregnancy timing/wantedness and social support. Secondary analyses of our Pink and Blue data showed that individuals who said their pregnancy was poorly timed were 3.5 times more likely to be in an MDE[94]; additionally, individuals who indicated that

their pregnancy was poorly timed were nearly twice as likely to score in the bottom quartile of a social support measure. In a follow-up, cross sectional study of 161 individuals seeking pregnancy testing or termination, over one half of the cohort indicated low social support; unplanned pregnancies and depression were both associated with low social support.[106] This speaks to the role of social support in pregnancy and the possibility that peer support may mitigate risk of an MDE.

5.B.4. Computer vs. therapist-delivered screening and brief intervention for individuals seeking reproductive health care. Dr. Yonkers was corresponding co-PI of a recently completed NIDA-funded trial comparing person-delivered to a CIAS-based brief intervention for substance use among individuals seeking reproductive health services. Drs. Ondersma and Forray were co-Investigators in this study. Over a six-month follow-up, results of that trial show significant reductions in use of the primary substance for individuals in ob-gyn settings assigned to either the therapist-delivered or computer-delivered motivationally-based brief intervention, vs. an enhanced services condition.[107] Although small, effect sizes were more than sufficient to support a public health impact (e.g., 0.30 at 3 months and 0.17 at 6 months for the computerized intervention vs 0.22 and .06, respectively, for the therapist-delivered condition), particularly given the relative ease of implementation and low cost of technology delivered approach.

5.B.5. Integration of technology into prenatal care settings as part of usual care. Dr. Ondersma is currently leading a project implementing technology-based screening and brief intervention for behavioral health risks in prenatal care settings throughout Michigan. This project implements a mobile app that screens for a range of behavioral health risks including depression, provides a brief motivational intervention, and facilitates connection to other services. The app has been successfully integrated into ongoing clinical care at sites throughout Michigan, without provision of any additional funding for the sites, and without any study team involvement in the day-to-day integration of the technology. To date, over 5,000 pregnant patients have been successfully screened with high ratings for acceptability, high disclosure rates, and high rates of motivational intervention completion.

6. INCLUSION AND EXCLUSION CRITERIA*

Participants will be 40 individuals (10 in the pre-pilot and 30 in the pilot study) who are pregnant and at risk of, but not in a major depressive episode (MDE).

Inclusion/Exclusion Criteria for Participants:

- English speaking (it will be important to make this available in other languages eventually but for this preliminary work, translation processes and testing are not compatible with this scope of work and budget limits)
- "At risk" as determined by an Edinburgh Postnatal Depression Scale score of at least 9, or an average score >3 on the 6-item Medical Outcomes Social Support Survey or history of depression in pregnancy or postpartum depression
- At least age 16; we allow individuals who are as young as 16 because this is a high-risk group for perinatal depression and information on preventative interventions from this group is important
- Are willing and able to provide informed consent

- Are not in a major depressive episode
- Do not have panic disorder or substance use disorder
- Are not planning on terminating pregnancy
- Are willing to use a smart phone to receive texts
- Are not currently in behavioral health care treatment
- Are not blind; the text messaging intervention requires that the patient can see
- Are not permanently living in an institutional setting; many in institutional settings will either lack capacity or constitute a vulnerable research group (e.g., prisoners)

7. STUDY-WIDE NUMBER OF SUBJECTS*
N/A

8. STUDY-WIDE RECRUITMENT METHODS*
N/A

9. STUDY TIMELINES*
Enrollees in the pre-pilot will participate for 4 weeks. We anticipate this will require 6 months to complete.

Enrollees in the pilot will participate for 8 weeks, in addition to a 3-month follow-up. We anticipate this will take 9-12 months.
The study will require 36 months.

10. STUDY ENDPOINTS*
Outcome Measures:

- The Edinburgh Postnatal Depression Scale (EPDS) is a well validated[108], widely deployed, 10-item scale designed specifically for use with pregnant and postpartum individuals to measure depressive symptoms[109,110]; a cutoff of 13 is the most specific to identify individuals who likely have an MDE.[111] This will be used to screen for depressive symptoms and as an outcome measure.
- The CAT-MH including the CAT-DI[112] is a computerized adaptive test that draws from an item bank of 452 items; individuals typically need to answer 12 items to render an accurate diagnosis of an MDE. The CAT DI module has a sensitivity of 0.92 and specificity of 0.88 when compared to the Structured Clinical Interview for DSM-IV. The CAT-MH is integrated into CIAS 3.0, allowing for seamless integration with other assessments. This will determine who has depression and needs intervention at the outset of the study (exclusion criteria) and will be used as an outcome measure to determine if the intervention decresed the risk of an MDE or anxiety disorder.
- The General Self Efficacy Scale (GSE scale)[68] has 10 items scored from 1-4 that measures an individual's belief that she can respond to novel or challlenging situations. It takes ~2-4 minutes to complete, has a Chrombach's alpha of 0.82-0.93 and in individuals, is a single factor and correlated highly with self esteem and optimism. This is a target of the intervention that is putatively linked with depression risk. We evaluate whether the TMI changes self-efficacy and hence risk of an MDE.
- The Pearlin Mastery Scale (PMS)[113] has 7 items that are scaled 1-4 (1= strongly disagree to 4= strongly agree) with a range of 7-28, and low scores indicating low mastery (Chronbach's

alpha=0.78). This is also a target of the intervention and may be associated with lower risk of worsening depression.

- System Usability Scale[114] has 10 items and is scored 1-5 (strongly agree to strongly disagree). Scores are summed and multiplied by 2.5. A score of greater than 68 is considered above average. This is a measure of acceptability that bears on ability to implement the system.
- User Engagment Scale – short form[115] is a 12 item scale that scores from strongly disagree to strongly agree (1-5). It has 4 subscales with 3 items each. The subscales are Focused Attention; Perceived Usability; Aesthetic Appeal; Endurability. The overal reliability (ω) was 0.88 in formative work; subscales have reliability that is close to this statistic. This is an additional measure of acceptability and hence ability to implement the TMI.

11. PROCEDURES INVOLVED*

Text4Moms intervention and design. Text4Moms will consist of four primary components.

- ***First***, it will include a screening tool that will triage individuals to immediate care (an MDE, depressive symptoms or no-minimal depressive symptoms). We envision that the screener will include questions from the EPDS[108] but will also run a Computerized Adaptive Technology program called CAT-MH.[112] This program was integrated into CIAS and by clicking a link, participants can run CAT-MH. The program uses adaptive branching to select questions that determine whether the participant likely is in an MDE episode and thus requires a higher level of care.
- ***Second*** and most centrally, Text4Moms will include tailored text messages that are readily accessible to participants and, after consent is obtained, will arrive without requiring the participant to seek them out. This novel pro-active approach can enhance engagement among participants.
- ***Third,*** Text4Moms will include extended content that will be available as a simple link within text messages. We estimate that approximately half of all Text4Moms messages will include a link. Content will be kept extremely brief to increase the likelihood that even modestly motivated participants will click. All extended content will provide information regarding how to find additional information and higher-level support and will come in two forms: a) brief videos, tailored to participant needs and characteristics and designed to be consistent with the ROSE prevention models; and b) interactive micro-interventions approximately 60 seconds in duration, built using CIAS. These micro-interventions can themselves include brief video content or can involve short interactions with an animated narrator in which the participant can securely indicate their feelings or preferences and receive reflections and tailored information in response.
- ***Fourth,*** Text4Moms will include on-demand live chat access to a trained peer navigator who has access to pre-populated scripts. Available through a text message link or a link within a CIAS micro-intervention, this feature will allow secure (silent and end-to-end encrypted) contact with a peer who can provide social support or assistance with accessing services.

Peer Support. Our training of peers will be assisted by input from our consultants Dr. Cynthia Dennis who has conducted many studies in this arena; and Dr. Wendy Davis, Executive Director

of Postpartum Support International (PSI). We anticipate recruiting qualified peers from PSI and local resources. Peers will also receive training on how to be a peer, the limits of a peer, safety protocols for participants who show clinical worsening, including suicidal or homicidal ideation and use of the CIAS platform, all following adapted versions of existing peer training and supervision materials developed by Dr. Dennis, with ongoing support provided through regular meetings with the project manager (trained and supervised by Dr. Dennis). Importantly, all chat conversations between peers and participants can be readily reviewed and monitored, facilitating accurate supervision and support. Support materials, protocols, and texts to provide participants will also be available on the CIAS dashboard.

Peers will interact with participants using a dashboard within CIAS allowing them to view multiple chat threads at once message with participants one at a time, and access manualized content/key resources from a library of available messages. Through these four components, the Text4Moms intervention will be high-reach and low-burden, with a very high proportion of participants getting at least some key content. At the same time, the provision of attractive and brief extended content may allow participants with greater needs to receive assistance where and when they want it, ranging from simple information provision to direct interactions with a trained helper.

Aim 1: To iteratively develop the Text4Moms screening form, tailored text messages, video content, peer navigator manual and understand the population for whom it is needed. The development process is outlined in Figure 5. This addresses step 1 in PAR-21-131 in that it will help us understand the target population and ensure that the intervention is appropriate for the patients, providers, and settings relevant to perinatal depression. We will draw upon the literature with regard to behavioral interventions to prevent peripartum depression as well as new material from mHealth interventions for depression that employ text messages. We will collect expert opinion from two groups: 1) a Patient Guide Group (PGG) that consists of a diverse group of individuals with lived experience of perinatal depression, and 2) an Expert Advisory Board (EAB) comprised of team members and consultants with clinical and research experience in perinatal depression prevention and support of peer navigators (Drs. Dennis, Johnson, Davis, Forray and Zlotnick).

The core research team will develop a moderator guide to query information. This will be vetted with the EAB. The core team will interview individuals with lived experience of depression from the PGG and conduct a needs assessment that provides information directly from individuals including:

- their struggles with depression and areas where they perceive help would have been beneficial
- their course of illness and when help would have been needed and accepted
- barriers to receiving texts, engaging with video links, and using the chat function
- factors to tailor on that would help with engagement
- lessons to amplify with video texts that would make them more useful
- ways peers can be helpful
- areas to avoid if possible
- acceptable quantity (e.g., up to 5 messages per week), frequency (e.g., no more than once a day or every other day), and timing (e.g., between 10AM and 4PM) of text messages

- ways in which the intervention can fit in with perinatal care

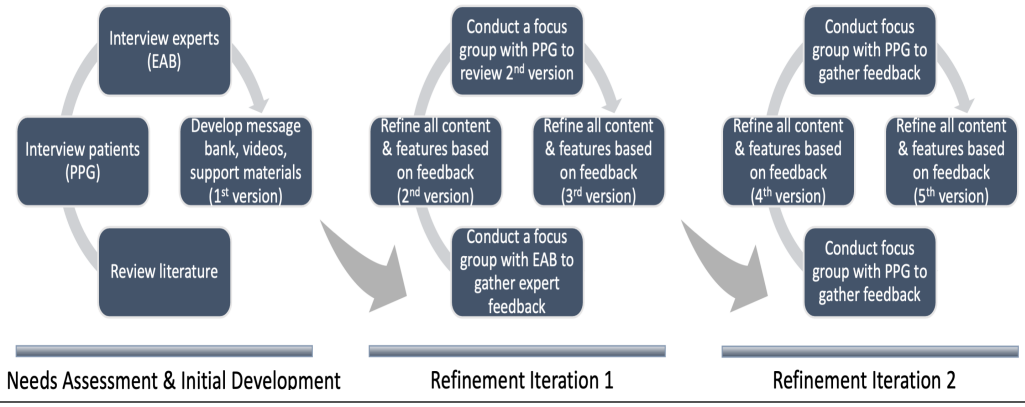
The EAB will contribute expertise on:

- important areas of focus
- perceptions of the active ingredients from existing interventions that could be used in texts and amplified in video content. While some are noted above, they will be flushed out during the development process.
- tailoring factors, which are powerful components of engagement. Candidates include: race/ethnicity, age (adolescent up to age 22 vs older mother), marital status, stage of pregnancy, etc.
- areas where video examples are needed to illustrate lessons (e.g., how to interact assertively, to problem solve, to engage others in support)
- materials needed to support peer navigators who communicate with participants over "chat" functionality
- protocols for peers to help manage and refer participants who may evidence clinical deterioration, including suicidal and homicidal ideation
- ways the intervention can fit with perinatal care sites
- how to include perinatal providers.

After individual PGG interviews are completed, the core team will develop a message bank, peer support materials, CIAS micro-interventions, and videos. Additionally, we will search the internet and educational resources for open-source video content. The PI and Co-I Tulu will convene the EAB. Using a 'think-aloud' approach[116], we will ask members to think aloud while reviewing topics, messages, and possible video content. A member of the research team will take notes to capture comments and suggestions. It is likely that additional video content or revisions to available content will be needed. Accordingly, we will encourage 'virtual white board' drawings of suggested video content and animations.[117] We will draft video content using virtual storyboards, sketches, and accompanying script. After the group has reached 80% consensus on the utility of prototypes, they will be presented to the PGG. We anticipate at least 2-3 meetings of the PGG to review and iteratively improve the materials developed by the research team and EAB. Iterations will include a health literacy evaluation to ensure that audiences who have a low level of literacy will find texts understandable.[118] From the PGG, we will elicit feedback on the content modification. Dr. Tulu's team will develop the new multimedia components, if needed. We will also solicit input on the message frequency and timing and peer helpfulness.

As part of the development process and to test the TMI in the field, we will conduct a pre-pilot study of 10 pregnant individuals, the recommended number of individuals for usability testing.[119] We will follow the approach outlined for Aim 2 (see **3.C.4.e**) except there will be no

Figure 5: TMI Development Plan



randomization and the intervention timeline will be shortened. The pre-pilot participants will be either before 16 weeks or in the end of their third trimester of pregnancy and will participate for 4 weeks in order to capture various stages of pregnancy and the postpartum period. We will stagger recruitment and have 2 groups of 5 participants. The first group will start the pre-pilot at time T1, and the second group starts at time T1+1 month. This will allow us time to collect feedback after 2 weeks from group 1 and make adjustments (if any) needed to improve the intervention for the second group. The pre-pilot is important since it will allow us to evaluate the usability issues that can come up only after repeated use in the users' native environment, allowing us to address these issues before proceeding to a feasibility pilot. We will also be able to pre-pilot the peer mentor chat support. This step will confirm that all major issues related to use and usability are resolved before going into the pilot, which entails a 2-month intervention and 3 months follow up. Based on the feedback, which will focus on the points covered in PGG meetings, usability of the technology and acceptability of the intervention, we will make a final set of refinements to the multimodal intervention and move to a pilot study.

Aim 2 & 3: Evaluate preliminary efficacy, mechanisms, and implementation of Text4Moms in a pilot randomized trial.

Inclusion/Exclusion Criteria. We realize that the sample size for the pilot is small and will seek to recruit a cohort that is racially, ethnically, and socioeconomically diverse. Individuals will be eligible if they are: a) "at risk" as determined by: an EPDS[108] score of at least 9, or an average score >3 on the 6-item Medical Outcomes Social Support Survey (MOS)[120], and/or history of an MDE in pregnancy or postpartum depression;[55,121] b) at least age 16; c) willing and able to provide informed consent. We allow individuals who are as young as 16 because this is a high-risk group for perinatal depression and information on preventative interventions from this group is important. Pregnancy confers "emancipated" status in Massachusetts, so these adolescents will be able to provide consent for participation. Pregnant individuals who are younger than 16 are uncommon in our setting.

Individuals will be excluded if they: a) are in an MDE, have panic disorder or substance use disorder; b) are planning on terminating pregnancy; c) do not want to use a smart phone to receive texts; d) are currently in behavioral health care treatment; e) do not speak English. While

our software can accommodate other languages, the research team will vet the information sent via chat and it is preferable to do this in English during the intervention development phase. Future work will not include this exclusion and will explore cultural tailoring that goes beyond language.

Recruitment: See #24

Enrollment: The full trial consent will also be presented electronically with study staff on the phone and available to answer questions. Drs. Yonkers, Forray and Ondersma are currently using this method for consent in their other studies. Participation will proceed only if individuals provide written informed consent via e-signature. This functionality is available in CIAS 3.0. Participants who meet all eligibility criteria and provide consent will then be randomly assigned to either educational texts or Text4Moms after completion of the baseline assessment. We will monitor recruitment for diversity. The staff member who enrolls the participant will not have access to the assigned condition/content, which will aid in blinding study staff.

Clinical Trial Process Procedures
Assessments. After the participant signs consent, we will send her a link to complete a REDCap baseline assessment that includes questions not necessary for eligibility but are important for the study:

- Additional necessary demographic/contact/treatment information
- Additional history of depression/anxiety/psychosis
- Questions that identify domains that the patient identifies as challenging (e.g., low self-esteem, difficulty with role transitions)
- Questionnaires in Table 1

The baseline assessment will be short and will not duplicate information from the screening and eligibility assessment. Individuals will receive a brief reassessment at 4 weeks that includes the EPDS, the CAT-MH, the General Self Efficacy Scale (GSE Scale), the System Usability Scale (SUS)[114] and User Engagment Scale (UES)[115] that will allow us to collect and address areas related to usability and ensure the intervention content is accessible to all participants. There will be an 8 week assessment that repeats these questions and the CAT-MH. The final assessment will also include the SUS and UES as well as questions on satisifaction of the system, relevance to their issues, what they liked about the system, and what they did not like. Study staff will contact all participants at 3 months to obtain additional qualitiative input. The research team will also evaluate the number of individuals who ask to stop texts, number of texts received, and number of links that are opened.

- Select items from the Inventory of Depressive symptomatology (QIDS)[122] that map onto RDOC domains[51] of negative valence (loss and threat) and positive valence (hedonia and reward): impaired capacity for pleasure, impaired general interest, impaired mood response to desired events, impaired energy level for reward and feeling anxious or tense, panic/phobia, interpersonal sensitivity for loss and threat. This will illustrate salience with RDOC constructs that map onto neural pathways that are putatively linked with depression.

Table 1. Timing of Assessments

MEASURE	Baseline	4 Wks	8 Wks
EPDS	X	X	X
MOS	X		X
QIDS items that track RDOC	X		
CAT-MH	X	X	X
General Self Efficacy	X	X	X
System Usability Scale	X	X	X
User Engagement Scale	X	X	X

- The CAT-MH including the CAT-DI[112] is a computerized adaptive test that draws from an item bank of 452 items; individuals typically need to answer 12 items to render an accurate diagnosis of an MDE. The CAT-DI module has a sensitivity of 0.92 and specificity of 0.88 when compared to the Structured Clinical Interview for DSM-IV. The CAT-MH is integrated into CIAS 3.0, allowing for seamless integration with other assessments. This will determine who has depression and needs intervention at the outset of the study (exclusion criteria) and will be used as an outcome measure to determine if the intervention decreased the risk of an MDE or anxiety disorder.
- The General Self Efficacy Scale (GSE scale)[68] has 10 items scored from 1-4 that measures an individual's belief that she can respond to novel or challlenging situations. It takes ~2-4 minutes to complete, has a Chrombach's alpha of 0.82-0.93 and in individuals, is a single factor and correlated highly with self esteem and optimism. This is a target of the intervention that is putatively linked with depression risk. We evaluate whether the TMI changes self-efficacy and hence risk of an MDE.
- The Pearlin Mastery Scale (PMS)[113] has 7 items that are scaled 1-4 (1= strongly disagree to 4= strongly agree) with a range of 7-28, and low scores indicating low mastery (Chronbach's alpha=0.78). This is also a target of the intervention and may be associated with lower risk of worsening depression.
- System Usability Scale[114] has 10 items and is scored 1-5 (strongly agree to strongly disagree). Scores are summed and multiplied by 2.5. A score of greater than 68 is considered above average. This is a measure of acceptability that bears on ability to implement the system.
- User Engagment Scale – short form[115] is a 12 item scale that scores from strongly disagree to strongly agree (1-5). It has 4 subscales with 3 items each. The subscales are Focused Attention; Perceived Usability; Aesthetic Appeal; Endurability. The overal reliability (ω) was 0.88 in formative work; subscales have reliability that is close to this statistic. This is an additional measure of acceptability and hence ability to implement the TMI.

Study Process: After randomization, participants will be sent texts 3-4 times per week (this may change depending upon input from the PGG). Texts will be short and for the TMI, will include video links that reinforce information relevant to IPT. Texts will also be tailored for stage of pregnancy, history of perinatal depression, and possibly other factors such as age depending upon input from the PGG and the EAB. Texts will continue for 8 weeks unless the participant elects to "STOP" texts. They will include a button that will invite individuals to chat with a peer.

Control Condition: The control condition will be limited to texts related to pregnancy, nutrition and sleep and will avoid elements that have behavioral therapeutic effects. We will develop a set of texts from openly available information about healthy pregnancy. Although this condition is meant to constitute time and attention control as recommended by an NIH expert panel[123], we will include material on recognizing depression and links to ways to attain depression treatment and suicide hotline information.

Peers: We will employ 2-3 individuals as peers; these will be individuals who experienced perinatal depression or were close to someone with perinatal depression. We will recruit from social media, contact providers and the local chapters of PSI. Peers will be encouraged to cluster their texts and will be paid hourly for training and meetings and a modest amount for each text (~$5). CIAS 3.0 will include a variety of phrases, messages and resources that can be copied and pasted into the chat and thus help peers with messaging about content. Chats will be monitored by the study team. This will ensure the safety of participants and peers and will allow the study team to know if the content is being utilized. Peers will have a safety protocol should a participant experience psychiatric worsening and/or develop suicidal ideation.

Randomization. The 30 participants for the pilot will be randomized in a 2:1 ratio for Text4Moms: Educational control. We acknowledge that the short duration of an R34, and the need to spend at least a year building the system, limits our follow-up period. To collect information about the TMI functionality at various times in pregnancy and after delivery, we will stratify enrollment to 15 individuals who are before 24 completed weeks of pregnancy and 15 who are after 24 completed weeks of pregnancy. This will allow us to pilot the TMI in all phases of pregnancy and the postpartum period since the TMI will endure for 8 weeks. The statistician will generate an allocation sequence for a random-permuted block randomization using identification numbers. After a participant meets criteria and provides consent, the statistician will email the research assistant (RA) the randomization condition. The RA will have no prior knowledge of the randomization sequence. Randomization will occur by the toss of a coin and will not rely on factors other than the stratification.

In year 2, we will recruit 10 individuals who are pregnant for a pre-pilot who will participate for 4 weeks. We will reimburse them $20 for screening, $25 at baseline, $25 at 2 weeks, and $25 at 4 weeks (Total= $95 each). Toward the end of Year 2, beginning of Year 3, we will recruit 30 individuals for an 8-week pilot randomized clinical trial with a 3-month follow up. They will be reimbursed $20 for screening, $25 at baseline, $25 at 4 weeks, $25 at 8 weeks, and $25 at 3 months (Total= $120 each). We include $700 in years 2 and 3 for screening reimbursement. All compensation will be in the form of an Amazon gift card.

12. DATA AND SPECIMEN BANKING*

De-identified data will be stored in the National Library of Medicine (NLM) on clinicaltrials.gov. Results information will be submitted and will not include individual patient data. Following completion of the study, all identifiers will be permanently deleted after the final report to the sponsor has been completed

13. Data Analysis and Management*

Data will be collected by tablet and email links in REDCap. Our statistician at Yale will manage the data. To evaluate acceptability and use characteristics, we will collect descriptive statistics on satisfaction, helpfulness, and ease of use (SUS and UES) for the Text4Moms system and components (including chat), measured at the intervention (week 8). For engagement, data from the Text4Moms system will be reported showing the percentage of individuals who engage with Text4Moms and read at least 80% of texts and the percentage of individuals who engage with the chat. Qualitative responses from participants will offer further insight into these outcomes.

For efficacy outcomes, total scores on EPDS, GSE and PMS[113] (scales) and the onset of an MDE will be reported using means and standard deviations; frequencies and percentages for the EPDS, GSE and PMS scores will be reported as linear variables. Multiple regression will be used to test for differences in the EPDS, and the GSE and PMS scores between treatment groups at week 8, adjusting for baseline scores. Generalized estimating equations will be used to explore if changes in EPDS, GSE and PMS scores varied over time from baseline to week 4 and week 8. We will also examine whether the percentage of individuals who experience an MDE at week 4 and/or week 8 differed between treatment groups using chi-square tests.

We will test for target engagement by measuring changes in the self-efficacy construct (GSE and PMS) between the 2 groups at 4 and 8 weeks. We will do the same for RDOC constructs measured with IDS-SR items. As an exploratory analysis, we will estimate correlations between EPDS scores and the GSE and PMS scores with treatment. We note power is not sufficient to detect mediating effects.

Sample Size. Leon, Davis, & Kraemer state (2011) that "power analyses should not be presented in an application for a pilot study that does not propose inferential results".[124] Indeed, pilot studies are not expected to be fully powered. Instead, we based our sample size on accepted practice for pilot studies, the considerable experience of the research team, and practical considerations.[125] As a pilot study, we are powered at 80% to detect large effect sizes on continuous outcomes ($d>1.1$) with 20 participants in the Text4Moms group and 10 in the control group and a two-tailed alpha of 0.05. However, we include benchmarks of $d>0.20$ for the EPDS and possible mediators since this is consistent with the effect size for many digital interventions in the literature.

14. PROVISIONS TO MONITOR THE DATA TO ENSURE THE SAFETY OF SUBJECTS*

This project is considered minimal risk since a text messaging intervention (TMI) is envisioned to enhance the likelihood of detecting, referring, and decreasing the likelihood for a major depressive episode in perinatal women. The control condition includes educational texts. Thus, no DSMB is planned although we present a Data Safety and Monitoring Plan (DSMP).

The Principal Investigator will have the primary responsibility for monitoring data. The PI and their team (project manager and data manager) will review any sensitive data such as endorsement of suicidal ideation daily. We will monitor the texts as well as the results of the assessments outlined above (eg. EPDS, GSE, IDS, CAT-MH, Pearlin Mastery Scale). The research assistant (to be hired), with the assistance of the statistician, will prepare materials for weekly meetings to review the aspects of the pilot project, including recruitment, retention, and possible adverse events. This will be presented to the core team and consultants as needed.

Identified data will be collected only after provision of consent and will be de-identified for analysis. No personal health information will be used in any publications. Given the low risk and pilot nature of the project, there are no stopping rules.

Although this study presents minimal risk to participants, there is some risk that a participant's responses might become known against their will. Additionally, because text messaging takes place via cellular service providers, it is an insecure technology that does not allow for encryption. Finally, text messages on a participant's phone can potentially be seen by others with access to that phone. All participants will be made aware of any potential security risks. While links may not have enduring or searchable material, some of the texts might. Thus, we will be very careful when crafting text to not reveal any information unless it is necessary.

There is always a risk that participants will experience clinical worsening, including suicidal thoughts and psychosis. We are partnering with Postpartum Support International for peer support. They currently have a warm line throughout the country to which participants may be referred. As of the summer of 2022, and through the support of SAMHSA, they will also have a clinician staffed "hotline". Our texts will remind participants of these resources. If one of our peers is contacted off hours, they will be sent a message with these resources. As well, we will ask permission to contact their reproductive health provider should clinical worsening occur. We will share necessary information with the provider and will give the provider resources that are shared with the participant.

We will educate all peers on perinatal depression, evaluation of clinical worsening and suicidal/homicidal ideation. Additionally, they will be trained in protocols to follow should a participant disclose suicidal or homicidal ideation and will be provided with scripts and text that can help them manage this. Any such disclosure will also loop in the project manager and the Principal Investigator or a covering physician. Resources will be available on the dashboard for peers to provide participants. We will follow up with participants on the use of resources and how they are feeling after any indication of worsening.

The peers will be trained on the use of the text messaging intervention, will be monitored, and provided support on how best to use the system and provide support as a peer. We will provide training to the peer on the limits between being a "peer" and a treating clinician. We will have group meetings to trouble shoot and support peers. Protocols that are helpful to peers will always be available on the CIAS dashboard.

The PI will distinguish between SAEs and non-serious AEs, and will also make attributions regarding causality and severity. She will use the FDA definition of serious adverse events (SAEs). She will send a report of SAEs to the IRB. Any additional information regarding either an SAE or an unanticipated problem will be submitted as a follow-up report to the IRB within 15 calendar days of receiving the information. In the event that a participant either withdraws from the study or the investigator decides to discontinue a participant due to an SAE, the participant will be monitored by the investigator via ongoing status assessment until (1) a resolution is reached; (2) the SAE is determined to be clearly unrelated to the study intervention; or (3) the SAE results in death.

15. WITHDRAWAL OF SUBJECTS WITHOUT THEIR CONSENT*
N/A

16. RISKS TO SUBJECTS*

The potential risks in this study are loss of confidentiality for participants. Although not due to the study, we may also identify individuals in an MDE or who have suicidal thoughts.

Loss of Confidentiality:

A research assistant, Project Director, or Investigator will obtain verbal and written/virtual consent to screen and then enroll. Information will all be coded under a subject ID and kept on password protected data bases and in double locked files in the offices of research staff.

In addition to being made aware of possible risks via the consent process, participants will be protected against potential risks in several further ways.
1. The use of technology for gathering self-report data enhances participant protection, in that participant data or group assignment will not be available to anyone in the participant's clinic or hospital setting. Even the research assistant is unable to access participant responses.
2. The web-based CIAS software in this study uses 256-bit AES encryption in order to protect data in transit from the participant's electronic device to the dedicated and secured server on which the software resides. CIAS resides on a HIPAA-compliant MSU server with data encryption at rest, dual-factor authentication, malware protection, 24 x 7 monitoring of event notification, and a dedicated and fully managed firewall with active intrusion detection and prevention and access tracking.
3. Possible distress will be noted clearly in the informed consent information sheet, which will also indicate that a referral for counseling is available from the RA. In addition, in order to prevent risk regarding guilt, all intervention content is phrased as positively as possible. We will have staff available during the day should someone require immediate evaluation for depression or suicidal ideation.
4. The informed consent information sheets will explicitly acknowledge the limited security of text messages, both because they are not encrypted, and because the participant's phone itself may be accessible to others. Further, text messages—although tailored—will be written in a way that does not imply any details of the participant's mood; that is, they will look like general advice that might be provided to any pregnant individuals. Finally, participants will be informed that they can end the text messaging plan at any time by texting back "STOP."

Depression Risk and Management of Suicidal Patients:
We will monitor depression screening results and scores as reflected on the EPDS and CAT-DI. Scores indicating severe risk will result in an alert to the study team, who will evaluate risk and ensure that referrals for treatment are provided. We will have systems in place to immediately assess and refer individuals who endorse severe depression or suicidal ideation. Psychiatrists on the team can conduct an immediate assessment and contact the patient's obstetrical provider; UMass has a psychiatrist embedded in the clinic who can follow up with care. Beyond this project, a screener such as the one embedded in this form, if shown useful, can be used in non-research clinical settings to identify individuals who are depressed as well as those at risk of perinatal depression. In addition to local resources, we have access to the Massachusetts McPAP for Moms program, housed in the Department of Psychiatry at UMass, and the warm/hotline

staffed by PSI. Our consultant, Dr. Dennis, conducted studies that provided telephone and text support to high-risk pregnant individuals across Canada. She has protocols for managing the disclosure of suicidal ideation that could be deployed in a larger study. Thus, the study will allow us to pilot referral systems as well as the screener itself that can be used in a broader context.

It is possible that participants will disclose suicidal ideation during the evening or weekend when no one is available in the chat. Our pilot data suggest that suicidal thoughts are uncommon in perinatal women, even prior to MDE onset but when they occur, they must be managed since safety is a major concern. Some interventions attempt to solve report of suicidal thoughts or feelings by not asking about them. Our impression is that this does not address the problem but instead hides it. While 24-7 staffing of the system raises feasibility issues, we can instead leverage widely available resources such as the PSI suicide hotline that will be staffed 24-7 by clinicians starting the summer of 2022. Should a participant endorse suicidal thoughts off hours, CIAS 3.0 will be programmed to provide a statement such as, "It sounds like you are having a difficult time and we are concerned about how you are feeling…" and will include contact information for suicide hotlines and 211 numbers. The content of the chat will be checked in the morning and throughout the day to monitor for the expression of such statements and safety procedures will be followed.

17. POTENTIAL DIRECT BENEFITS TO SUBJECTS*

There are several potential benefits to the proposed research: First, screening may identify individuals with depression or another disorder who require treatment. Members of the study team will be able to refer these individuals for treatment. Two, the project will recruit high-risk women who otherwise may go on to develop an MDE. They may be less likely to do so in either condition but especially the intervention condition. Even individuals in the control condition will be provided with information on depression and treatment resources. Three, we will be monitoring participants for onset of an MDE, suicidal thoughts and worsening of depression. We will have the opportunity to refer participants to a higher level of care at any point.

18. VULNERABLE POPULATIONS*

The project will only enroll pregnant individuals into the pre-pilot and pilot trials since we are attempting to decrease risk of an MDE in perinatal individuals. Criteria for randomization include children between the ages of 16-18 because this is a high-risk group for depression. The characteristics of this group may differ substantially from pregnant women in their 20s to early 40s and merits exploration of interventions particularly geared to this group. Pregnancy confers "emancipated" status in Massachusetts, so these adolescents will be able to provide consent for participation.

We do not anticipate the research to involve more than minimal risk to these vulnerable populations, and a DSMP will monitor the safety of subjects, which is detailed above in #14. No inducements, monetary or otherwise, will be offered to terminate a pregnancy. Individuals engaged in the research will have no part in any decisions as to the timing, method, or

procedures used to terminate a pregnancy. Individuals engaged in the research will have no part in determining the viability of a neonate.

19. MULTI-SITE RESEARCH*

Recruitment will only occur at UMass Chan School of Medicine. The University of Massachusetts Medical School IRB will serve as the selected IRB with a request to Yale IRB, WPI IRB, and Michigan State University IRB to concede review. We have subcontracts at Yale and WPI. The UMass project director or designee will coordinate communication regarding IRB submission and modifications. We will hold monthly administrative and operations team meetings with participation by appropriate personnel at each study site. Telephone and email communication will also be used as needed. All identified participating sites will agree to rely on the proposed sIRB. Participating sites will sign an authorization/reliance agreement that will clarify the roles and responsibilities of the sIRB and participating sites. UMass will maintain records of the authorization/reliance agreements and of the communication plan. All engaged participating sites safeguard data as required by local information security policies. All local site investigators will conduct the study appropriately. All non-compliance with the study protocol or applicable requirements will be reported in accordance with local policy. All sites will be informed of problems, interim results, and the study closure.

20. COMMUNITY-BASED PARTICIPATORY RESEARCH*
N/A

21. SHARING OF RESEARCH RESULTS WITH SUBJECTS*

We will share the results of the diagnostic evaluation (CAT-MH) with potential and enrolled participants. This will be done by the project director (a masters or Ph.D. level clinician) with the supervision of the PI. This will allow us to arrange for treatment and follow up. Similarly, any mention of self or other harm will be immediately evaluated and any assessment will be shared with the participant.

22. SETTING

Participants will be recruited via flyers, social media, and information sheets placed in UMass prenatal care and other obstetric sites and assistance from obstetrical providers. Although most of recruitment will be completed virtually, patients may also complete a form on-site that includes their name and phone number; it can be placed in a box at their prenatal site and collected for follow-up by study staff.

23. RESOURCES AVAILABLE

The staff for the project include:

1) Principal Investigator who is responsible for the overall supervision of the project. This is a doctorate level position that will be filled by the person who designed the project and received funding. This is a person with a history of conducting NIH projects. (20.0% FTE)

2) Co-Investigators who will work on the build of the TMI and the clinical trials. These are doctorate level collaborators who have expertise to contribute to the project, i.e., building TMIs and apps, etc. (2%-15% FTE)
3) Project manager who will work closely with the PI and other members of the team. This is a masters to doctorate level person who has the expertise to oversee the components of a small field study. (25% FTE)
4) Research Assistant who will help with administrative tasks and recruitment and follow-up. This is a bachelors to masters level individual who can be trained to assist the Project manager with various aspects of the project. (25% FTE)
5) Graduate student/post doc who will help with the TMI build (20% FTE)
6) Statistician who will develop data base, monitor its functionality, and conduct analyses. This is a masters level person who has experience developing data bases, cleaning data, and conducting analyses. (5% FTE)
7) Expert consultants who will provide input into the TMI and work to be done recruiting and training peers (1-2% FTE)
8) Peer consultants with lived experience who will provide guidance on content and usability of the TMI during the build

We will share the IRB and protocol with all investigators and consultants. We will also write a protocol paper that can be published. We will meet with clinical sites to explain the project and the recruitment needs and procedures.

24. LOCAL RECRUITMENT METHODS

The flyers and sheets will contain basic information indicating that we are recruiting for a health-related study that will include pregnant individuals at least 16 years of age; materials include a website and a QR code with minimal information and a link to the study website. The website information sheet will:

- Provide basic information on the study (it evaluates stress and health habits across pregnancy and the postpartum period and provides information on pregnancy and health)
- State broadly who we are looking for (individuals who are pregnant, not planning to terminate their pregnancy, and willing to use a smartphone)
- Indicate what participants will be asked to do (be willing to receive text messages on a smartphone and complete several short assessments).
- Inform them that they if they are interested, they can complete a form (i.e., the study eligibility form) and will be reimbursed $20 for their time. Those who click “I agree to find out more” at the end of the information sheet will then be offered the computer-directed eligibility survey programmed in REDCap.

Individuals who elected to fill out a form by paper will be called by or meet with research staff who will obtain consent to screen the possible participant, explain the study, and obtain information about access to a personal smartphone. Staff will work with possible participants to complete eligibility questions. We provide this option to determine how much a barrier ownership or use of a smart phone will be and whether a completely virtual enrollment process for this project is feasible. We acknowledge that smart phone ownership and use is high (>95%) but is somewhat lower (>85%) among minority individuals. It is important that the intervention and its elements be available to a diverse group of individuals. We will not exclude individuals

but to ensure smart phone ownership is not a substantial barrier, we will provide individuals with a smart phone and a data plan; this will allow them to receive texts and click on links that are provided in our messages.

This eligibility survey will be structured in such a way that the study's inclusion and exclusion criteria are not readily apparent (to minimize risk of fraud), until the end of the survey, when a diagnosis of MDE is excluded. For example, we will ask information on demographics, nutrition health habits, exercise, thoughts about breastfeeding as well as mood and past history of depression. The eligibility survey will include the "screener." The final step will be administration of a Computerized Adaptive Testing-Mental Health (CAT-M) including the depression diagnostic module (CAT-DI) and anxiety modules to confirm that someone is not in an MDE and does not have panic disorder or a SUD. These individuals require treatment rather than the proposed intervention. The eligibility survey will also include the potential participant's prenatal care site and permission to contact the site in case there is a medical problem they report, including thoughts of self-harm. Possible participants will be emailed a $20 Amazon gift card as reimbursement for their time.

After a potential participant completes the eligibility form, study staff will contact her by telephone in order to validate her eligibility (survey completed by a real person who can communicate in English, has a working smartphone, or agrees to use one provided by the study team, is willing and able to receive text messages, and understands study requirements). The following strategies will be implemented to reduce the possibility of fraudulent participation for those not seen face to face:

- Manual review of IP addresses to screen for duplicates, identify addresses of non-US origin, and detect fraudulent completion (e.g., bots)
- Manual review of REDCap survey data to detect suspicious response times (e.g., completing the survey too quickly), unusual patterns in responses, respondent names, respondent email addresses, and patterned completion timestamps indicating that one person/bot is completing the survey repeatedly until eligible
- Inclusion of a required open-ended narrative response to detect fraudulent completion.

IP addresses will be deleted from the participant's screening data when no longer needed. Unnecessary eligibility data will be deleted from those who do not qualify, and remaining information will be de-identified.

We will have access to several thousand pregnant individuals locally and more via the internet. The number of pregnant individuals for the pre-pilot is 10 and for the pilot is 30. Past experience by the PI indicates little concern for this level of recruitment. In the past, she recruited and followed 2800 pregnant individuals in CT and MA through pregnancy and the postpartum period.

25. LOCAL NUMBER OF SUBJECTS

For the pre-pilot and pilot studies we will recruit 40 individuals. We assume we will have to screen 200 individuals to fill this number.

26. CONFIDENTIALITY

The use of technology for gathering self-report data enhances participant protection, in that participant data or group assignment will not be available to anyone in the participant's clinic or hospital setting. All data will be stored under a participant number and not a name that can identify the individual. Even the research assistant is unable to access participant responses or information about group assignment.

Data will be electronically captured in CIAS or REDCap. Web-based CIAS software in this study uses 256-bit AES encryption in order to protect data in transit from the participant's electronic device to the dedicated and secured server on which the software resides. CIAS resides on a HIPAA-compliant MSU server with data encryption at rest, dual-factor authentication, malware protection, 24 x 7 monitoring of event notification, and a dedicated and fully managed firewall with active intrusion detection and prevention and access tracking. Access to data will require use of appropriate passwords.

REDCap is an electronic data capture software system supported by UMASS. Data in REDCap databases can be exported within the regulated environment to rSTATS or can be de-identified using the REDCap de-identification tool and exported via controlled CGI script interface to locations on the UMass network outside of the regulated environment. Within REDCap, IRB approved PIs and the CITI certified staff can edit records entered and generate PDF copies of individual forms.

Data Security:

- The project manager, data manager, and statistician will be responsible for receipt and transmission of data.
- CIAS 3.0 is an NIH-funded Software-as-a-Service (Saas) platform for data collection and digital intervention authoring. CIAS is HIPAA compliant and protects participant data using encryption in transit and at rest. Data are accessed via a direct download from CIAS from within UMass.
- Data will be transferred via secure file transfer or encrypted email, methods that are HIPAA compliant.
- REDCap and CIAS are web-based systems. Downloaded data will be password protected and stored on secure UMass servers.
- Data shall be retained at UMass for at least three years after the final report to the sponsor has been submitted, or the ending date of the project, whichever is later. In no case will the data be discarded or destroyed when it is known to be in use. Paper documents will be destroyed in a manner that leaves no possibility of reconstruction of information (e.g., secure document shredding). Electronic data will be permanently deleted.
- No portable devices (e.g., laptops, thumb drives) will be used.
- PIs and select CITI certified staff (including project manager, research assistants, data manager, statistician) who have an absolute need to access data will be able to access CIAS data and REDCap data.

- Access to REDCap and CIAS Data will be limited by defining user rights and roles. User rights and roles will be defined so that each staff member has the minimum access they need to complete their job.
- Only required CITI certified staff will have access to server files storing data downloaded from REDCap and CIAS and access to research files will be granted so that each staff member has the minimum access they need to complete their job.
- All staff will be CITI certified and will also receive training specific to the use of the REDCap and CIAS platforms.
- All study computers will be password protected and connect to a secure network.
- Access to computers storing study data will be limited by keeping office doors locked. Study data will not be accessible by computers in open spaces.
- Information in consent forms will all be coded under a subject ID and kept on password protected data bases and in double locked files in the offices of research staff.
- IP addresses will be deleted from the participant's screening data when no longer needed (i.e., when study enrollment is complete). Unnecessary eligibility data will be deleted from those who do not qualify after ineligibility is determined. Remaining identifiers will be permanently deleted after the final report to the sponsor has been completed.
- A certificate of confidentiality is automatically deemed to be issued to this NIH-funded study.

27. PROVISIONS TO PROTECT THE PRIVACY INTERESTS OF SUBJECTS

Participants will consent and enroll in the study using standard procedures for research with individuals recruited remotely from perinatal settings. All research activities will be conducted in as private a setting as possible. Prospective participants will complete an eligibility survey and, if eligible, will participate in an informed consent process which includes an explanation of the study protocol, the time points for follow-up, and potential risks and benefits related to study participation. Study staff will address any questions, and individuals will be encouraged to take time to think about participation in the study prior to consenting. All participants will receive a copy of the signed consent document.

Possible distress will be noted clearly in the informed consent information sheet, which will also indicate that a referral for counseling is available from the RA. Participants may discontinue an interview or skip questions if they feel uncomfortable answering. Information will be coded under a subject ID and kept on password protected data bases and in double locked files in the offices of research staff. Data will not be shared with anyone outside the research team except in emergency situations (threat to self/others) and/or as required by law.

28. COMPENSATION FOR RESEARCH-RELATED INJURY

We will not provide compensation for injury but will arrange for additional mental health care if needed.

29. ECONOMIC BURDEN TO SUBJECTS

Participants will pay for cell phone and texting service. We will assist individuals who are economically challenged and cannot afford these costs.

30. CONSENT PROCESS

Once identified as potentially eligible, study staff will contact each potential participant to see if they are interested in consenting for the study. The full trial consent will be presented electronically with study staff on the phone and available to answer questions. When study staff connects with participants by phone, they will review the content of the consent form. Participation will proceed only if individuals provide written informed consent via e-signature. This functionality is available in the Computerized Intervention Authorizing System, Version 3 (CIAS 3.0). All participants will receive a signed copy of these documents for their records.

We will ensure that all study staff are familiar with and will follow **HRP-090 – SOP – Informed Consent Process for Research**. See # 27 for provisions to protect the privacy interests of subjects.

31. PROCESS TO DOCUMENT CONSENT IN WRITING

Consent will be documented in writing using HIPAA compliant CIAS 3.0. Participants will complete this after reviewing the consent form and will receive a copy of the signed consent form.

32. DRUGS OR DEVICES

N/A

Literature Cited

1. Ahmed AT, Frye MA, Rush AJ, Biernacka JM, Craighead WE, McDonald WM, Bobo WV, Riva-Posse P, Tye SJ, Mayberg HS, Hall-Flavin DK, Skime MK, Jenkins GD, Wang L, Krishnan RR, Weinshilboum RM, Kaddurah-Daouk R, Dunlop BW. Mapping depression rating scale phenotypes onto research domain criteria (RDoC) to inform biological research in mood disorders. J Affect Disord. 2018;238:1-7. Epub 2018/05/29. doi: 10.1016/j.jad.2018.05.005. PubMed PMID: 29807322; PMCID: PMC6374030.
2. Gaynes BN, Gavin N, Meltzer-Brody S, Lohr KN, Swinson T, Gartlehner G, Brody S, Miller WC. Perinatal depression: prevalence, screening accuracy, and screening outcomes. Evidence Report: Technology Assessment (Summary). 2005(119):1-8. PubMed PMID: 15760246.
3. Gavin N, Gaynes B, Lohr K, Meltzer-Brody S, Gartlehner G, Swinson T. Perinatal depression: A systematic review of prevalence and incidence. Obstetrics and Gynecology. 2005;106(5, part 1):1071-83.
4. Grote NK, Bridge JA, Gavin AR, Melville JL, Iyengar S, Katon WJ. A meta-analysis of depression during pregnancy and the risk of preterm birth, low birth weight, and intrauterine growth restriction. Arch Gen Psychiatry. 2010;67(10):1012-24. doi: 10.1001/archgenpsychiatry.2010.111. PubMed PMID: 20921117; PMCID: 3025772.
5. Alhusen JL, Hayat MJ, Gross D. A longitudinal study of maternal attachment and infant developmental outcomes. Arch Womens Ment Health. 2013;16(6):521-9. Epub 2013/06/06. doi: 10.1007/s00737-013-0357-8. PubMed PMID: 23737011; PMCID: PMC3796052.
6. Righetti-Veltema M, Conne-Perreard E, Bousquet A, Manzano J. Postpartum depression and mother-infant relationship at 3 months old. Journal of Affective Disorders. 2002;70:291-306.
7. Gress-Smith JL, Luecken LJ, Lemery-Chalfant K, Howe R. Postpartum depression prevalence and impact on infant health, weight, and sleep in low-income and ethnic minority women and infants. Maternal & Child Health Journal. 2012;16(4):887-93. PubMed PMID: 21559774.
8. Evans J, Melotti R, Heron J, Ramchandani P, Wiles N, Murray L, Stein A. The timing of maternal depressive symptoms and child cognitive development: a longitudinal study. J Child Psychol Psychiatry. 2012;53(6):632-40. Epub 2012/01/04. doi: 10.1111/j.1469-7610.2011.02513.x. PubMed PMID: 22211468.
9. Wouk K, Stuebe AM, Meltzer-Brody S. Postpartum Mental Health and Breastfeeding Practices: An Analysis Using the 2010–2011 Pregnancy Risk Assessment Monitoring System. Maternal and Child Health Journal. 2017;21(3):636-47. doi: 10.1007/s10995-016-2150-6.
10. Dennis C-L, McQueen K. The Relationship Between Infant-Feeding Outcomes and Postpartum Depression: A Qualitative Systematic Review. Pediatrics. 2009;123(4):e736. doi: 10.1542/peds.2008-1629.
11. Myers E, Aubuchon-Endsley N, Bastian L, JM, Kemper A, Wamy G, WAld M, McBroom A, Lallinger K, Gray R, Green C, Sanders G. Efficacy and Safety of Screening for Postpartum Depression. . Rockville, MD: Agency for Healthcare Research and Quality, 2013 Contract No.: AHRQ Publication No. 13-EHC064-EF.
12. Gynecologists" ACoOa. Screening for perinatal depression. Obstetrics & Gynecology. 2018;132:e208- e2012.

13. O'Connor E. Interventions to Prevent Perinatal Depression: Evidence Report and Systematic Review for the US Preventive Services Task Force. JAMA : the journal of the American Medical Association. 2019;321(6):588-601. doi: 10.1001/jama.2018.20865.
14. Beck CT. A meta-analysis of predictors of postpartum depression. Nursing Research. 1996;45(5):297- 303.
15. Bernazzani O, Saucier JF, David H, Borgeat F. Psychosocial predictors of depressive symptomatology level in postpartum women. J Affect Disord. 1997;46(1):39-49. Epub 1997/12/05. doi: 10.1016/s0165- 0327(97)00077-3. PubMed PMID: 9387085.
16. Da Costa D. Psychosocial correlates of prepartum and postpartum depressed mood. Journal of Affective Disorders. 1999;59(1):31-40.
17. Da Costa D, Brender W, Larouche J. A prospective study of the impact of psychosocial and lifestyle variables on pregnancy complications. Journal of Psychomatic Obstetrics and Gynaecology. 1998;19:28-37.
18. Robertson E, Grace S, Wallington T, Stewart DE. Antenatal risk factors for postpartum depression: a synthesis of recent literature. General Hospital Psychiatry. 2004;26(4):289-95.
19. Murphy-Eberenz K, Zandi PP, March D, Crowe RR, Scheftner WA, Alexander M, McInnis MG, Coryell W, Adams P, DePaulo JJR, Miller EB, Marta DH, Potash JB, Payne J, Levinson DF. Is perinatal depression familial? Journal of Affective Disorders. 2006;90(1):49-55.
20. Forty L, Jones L, Macgregor S, Caesar S, Cooper C, Hough A, Dean L, Dave S, Farmer A, McGuffin P, Brewster S, Craddock N, Jones I. Familiality of postpartum depression in unipolar disorder: results of a family study. American Journal of Psychiatry. 2006;163(9):1549-53. PubMed PMID: 16946179.
21. Payne JL, MacKinnon DF, Mondimore FM, McInnis MG, Schweizer B, Zamoiski RB, McMahon FJ, Nurnberger JI, Rice JP, Scheftner W, Coryell W, Berrettini WH, Kelsoe JR, Byerley W, Gershon ES, Raymond DePaulo J, Potash JB. Familial aggregation of postpartum mood symptoms in bipolar disorder pedigrees. Bipolar Disorders. 2008;10(1):38-44. doi: 10.1111/j.1399-5618.2008.00455.x.
22. Wu Q, Chen H-L, Xu X-J. Violence as a risk factor for postpartum depression in mothers: a meta-analysis. Archives of Women's Mental Health. 2012;15(2):107-14. PubMed PMID: 22382278.
23. Gaillard A, Le Strat Y, Mandelbrot L, Keïta H, Dubertret C. Predictors of postpartum depression: prospective study of 264 women followed during pregnancy and postpartum. Psychiatry Res. 2014;215(2):341- 6. Epub 2013/12/29. doi: 10.1016/j.psychres.2013.10.003. PubMed PMID: 24370337.
24. Dennis CL, Letourneau N. Global and relationship-specific perceptions of support and the development of postpartum depressive symptomatology. Soc Psychiatry Psychiatr Epidemiol. 2007;42(5):389-95. Epub 2007/03/31. doi: 10.1007/s00127-007-0172-5. PubMed PMID: 17396205.
25. Pao C, Guintivano J, Santos H, Meltzer-Brody S. Postpartum depression and social support in a racially and ethnically diverse population of women. Arch Womens Ment Health. 2019;22(1):105-14. Epub 2018/07/04. doi: 10.1007/s00737-018-0882-6. PubMed PMID: 29968129; PMCID: PMC6800248.
26. Brown JD, Harris SK, Woods ER, Buman MP, Cox JE. Longitudinal study of depressive symptoms and social support in adolescent mothers. Maternal & Child Health Journal. 2012;16(4):894-901. PubMed PMID: 21556696.

27. Gariepy AM, Lundsberg LS, Miller D, Stanwood NL, Yonkers KA. Are pregnancy planning and pregnancy timing associated with maternal psychiatric illness, psychological distress and support during pregnancy? J Affect Disord. 2016;205:87-94. Epub 2016/07/17. doi: 10.1016/j.jad.2016.06.058. PubMed PMID: 27423065; PMCID: PMC5048515.
28. Blom EA, Jansen PW, Verhulst FC, Hofman A, Raat H, Jaddoe VW, Coolman M, Steegers EA, Tiemeier H. Perinatal complications increase the risk of postpartum depression. The Generation R Study. Bjog. 2010;117(11):1390-8. Epub 2010/08/05. doi: 10.1111/j.1471-0528.2010.02660.x. PubMed PMID: 20682022.
29. Suri R, Stowe ZN, Cohen LS, Newport DJ, Burt VK, Aquino-Elias AR, Knight BT, Mintz J, Altshuler LL. Prospective Longitudinal Study of Predictors of Postpartum-Onset Depression in Women With a History of Major Depressive Disorder. J Clin Psychiatry. 2017;78(8):1110-6. Epub 2017/03/16. doi: 10.4088/JCP.15m10427. PubMed PMID: 28297589.
30. Yawn BP, Pace W, Wollan PC, Bertram S, Kurland M, Graham D, Dietrich A. Concordance of Edinburgh Postnatal Depression Scale (EPDS) and Patient Health Questionnaire (PHQ-9) to Assess Increased Risk of Depression among Postpartum Women. J Am Board Fam Med. 2009;22(5):483-91. doi: 10.3122/jabfm.2009.05.080155.
31. Beck C, Gable R. Postpartum depression screening scale: Development and psychometric testing. Nursing Research. 2000;49(5):272-82.
32. Beck C, Gable R. Postpartum depression screening scale. Western Psychological Services. 2000.
33. Beck C, Gable R. Further Validation of the Postpartum Depression Screening Scale. Nursing Research. 2001;50(3):155-64.
34. Cai M, Wang Y, Luo Q, Wei G. Factor Analysis of the Prediction of the Postpartum Depression Screening Scale. Int J Environ Res Public Health. 2019;16(24). Epub 2019/12/15. doi: 10.3390/ijerph16245025. PubMed PMID: 31835547; PMCID: PMC6950650.
35. Marcano Belisario JS, Doherty K, Donoghue J, Ramchandani P, Majeed A, Doherty G, Morrison C, Car J. A bespoke mobile application for the longitudinal assessment of depression and mood during pregnancy: protocol of a feasibility study. BMJ Open. 2017;7(5):e014469. doi: 10.1136/bmjopen-2016-014469.
36. Ricketts S, Nguyen TNB, Narasimhan V. Screening for Depression in Pregnancy—There's an App for That! The Annals of Family Medicine. 2019;17(3):275. doi: 10.1370/afm.2388.
37. Hantsoo L, Criniti S, Khan A, Moseley M, Kincler N, Faherty LJ, Epperson CN, Bennett IM. A Mobile Application for Monitoring and Management of Depressed Mood in a Vulnerable Pregnant Population. Psychiatric Services. 2017;69(1):104-7. doi: 10.1176/appi.ps.201600582.
38. Lawson A, Dalfen A, Murphy KE, Milligan N, Lancee W. Use of Text Messaging for Postpartum Depression Screening and Information Provision. Psychiatric Services. 2019;70(5):389-95. doi: 10.1176/appi.ps.201800269.
39. Jiménez-Serrano S, Tortajada S, García-Gómez JM. A Mobile Health Application to Predict Postpartum Depression Based on Machine Learning. Telemedicine and e-Health. 2015;21(7):567-74. doi: 10.1089/tmj.2014.0113.
40. Dennis CL, Hodnett E, Kenton L, Weston J, Zupancic J, Stewart DE, Kiss A. Effect of peer support on prevention of postnatal depression among high risk women: multisite randomised controlled trial. BMJ. 2009;338:a3064. PubMed PMID: 19147637.

41. Shorey S, Chee CYI, Ng ED, Lau Y, Dennis C-L, Chan YH. Evaluation of a Technology-Based PeerSupport Intervention Program for Preventing Postnatal Depression (Part 1): Randomized Controlled Trial. J Med Internet Res. 2019;21(8):e12410. doi: 10.2196/12410.
42. Chabrol H, Teissedre F, Saint-Jean M, Teisseyre N, Roge B, Mullet E. Prevention and treatment of post-partum depression: a controlled randomized study on women at risk. Psychological Medicine. 2002;32(6):1039-47. doi: Doi 10.1017/S0033291702006062. PubMed PMID: ISI:000177600500009.
43. Dennis CL. The effect of peer support on postpartum depression: a pilot randomized controlled trial. Can J Psychiatry. 2003;48(2):115-24. Epub 2003/03/27. doi: 10.1177/070674370304800209. PubMed PMID: 12655910.
44. Jardri R, Pelta J, Maron M, Thomas P, Delion P, Codaccioni X, Goudemand M. Predictive validation study of the Edinburgh Postnatal Depression Scale in the first week after delivery and risk analysis for postnatal depression. Journal of Affective Disorders. 2006;93(1-3):169-76. PubMed PMID: 16644021.
45. Zlotnick C, Miller IW, Pearlstein T, Howard M, Sweeney P. A preventive intervention for pregnant women on public assistance at risk for postpartum depression. American Journal of Psychiatry. 2006;163(8):1443-5. PubMed PMID: 16877662.
46. Zlotnick C, Tzilos G, Miller I, Seifer R, Stout R. Randomized controlled trial to prevent postpartum depression in mothers on public assistance. Journal of Affective Disorders. 2016;189:263-8. doi: https://doi.org/10.1016/j.jad.2015.09.059.
47. Kenyon S, Jolly K, Hemming K, Hope L, Blissett J, Dann S-A, Lilford R, MacArthur C. Lay support for pregnant women with social risk: a randomised controlled trial. BMJ Open. 2016;6(3):e009203. doi: 10.1136/bmjopen-2015-009203.
48. Tandon SD, Perry DF, Mendelson T, Kemp K, Leis JA. Preventing perinatal depression in low-income home visiting clients: a randomized controlled trial. J Consult Clin Psychol. 2011;79(5):707-12. Epub 2011/08/03. doi: 10.1037/a0024895. PubMed PMID: 21806298.
49. Cuthbert BN, Insel TR. Toward the future of psychiatric diagnosis: the seven pillars of RDoC. BMC Medicine. 2013;11(1):126. doi: 10.1186/1741-7015-11-126.
50. Woody ML, Gibb BE. Integrating NIMH Research Domain Criteria (RDoC) into depression research. Current Opinion in Psychology. 2015;4:6-12. doi: https://doi.org/10.1016/j.copsyc.2015.01.004
51. Medeiros GC, Rush AJ, Jha M, Carmody T, Furman JL, Czysz AH, Trombello JM, Cooper CM, Trivedi MH. Positive and negative valence systems in major depression have distinct clinical features, response to antidepressants, and relationships with immunomarkers. Depression and Anxiety. 2020;37(8):771-83. doi: https://doi.org/10.1002/da.23006.
52. Williams LM. Precision psychiatry: a neural circuit taxonomy for depression and anxiety. Lancet Psychiatry. 2016;3(5):472-80. Epub 2016/05/08. doi: 10.1016/s2215-0366(15)00579-9. PubMed PMID: 27150382; PMCID: PMC4922884.
53. Putnam KT, Wilcox M, Robertson-Blackmore E, Sharkey K, Bergink V, Munk-Olsen T, Deligiannidis KM, Payne J, Altemus M, Newport J, Apter G, Devouche E, Viktorin A, Magnusson P, Penninx B, Buist A, Bilszta J, O'Hara M, Stuart S, Brock R, Roza S, Tiemeier H, Guille C, Epperson CN, Kim D, Schmidt P, Martinez P, Di Florio A, Wisner KL, Stowe Z, Jones I, Sullivan PF, Rubinow D, Wildenhaus K, Meltzer-Brody S. Clinical phenotypes of perinatal depression and time of symptom onset: analysis of data from an international consortium. Lancet Psychiatry. 2017;4(6):477-85. Epub 2017/05/10. doi: 10.1016/s2215-0366(17)30136-0. PubMed PMID: 28476427; PMCID: PMC5836292.

54. Phipps MG, Raker CA, Ware CF, Zlotnick C. Randomized controlled trial to prevent postpartum depression in adolescent mothers. American Journal of Obstetrics and Gynecology. 2013;208(3):192.e1-.e6. doi: https://doi.org/10.1016/j.ajog.2012.12.036.
55. Zlotnick C, Johnson S, Miller I, Pearlstein T, Howard M. Postpartum Depression in Women Receiving Public Assistance: Pilot Study of an Interpersonal-Therapy-Oriented, Group Intervention. The American Journal of Psychiatry. 2001;158(4):638-40.
56. Weissman MM, Markowitz JC, Klerman GL. The guide to interpersonal psychotherapy, Updated and expanded ed. New York, NY, US: Oxford University Press; 2018. xv, 283-xv, p.
57. Howell EA, Balbierz A, Wang J, Parides M, Zlotnick C, Leventhal H. Reducing Postpartum Depressive Symptoms Among Black and Latina Mothers: A Randomized Controlled Trial. Obstetrics & Gynecology. 2012;119(5).
58. Barboza GE, Schiamberg L. Dual trajectories of parenting self-efficacy and depressive symptoms in new, postpartum mothers and socioemotional adjustment in early childhood: A growth mixture model. Infant Ment Health J. 2021. Epub 2021/08/12. doi: 10.1002/imhj.21937. PubMed PMID: 34378809.
59. Mohammadi F, Kohan S, Farzi S, Khosravi M, Heidari Z. The effect of pregnancy training classes based on bandura self-efficacy theory on postpartum depression and anxiety and type of delivery. J Educ Health Promot. 2021;10:273. Epub 2021/09/07. doi: 10.4103/jehp.jehp_105_21. PubMed PMID: 34485570; PMCID: PMC8396055.
60. Bandura A. Model of Causality in Social Learning Theory. In: Mahoney MJ, Freeman A, editors. Cognition and Psychotherapy. Boston, MA: Springer US; 1985. p. 81-99.
61. Shorey S, Chee C, Chong YS, Ng ED, Lau Y, Dennis CL. Evaluation of Technology-Based Peer Support Intervention Program for Preventing Postnatal Depression: Protocol for a Randomized Controlled Trial. JMIR Res Protoc. 2018;7(3):e81. Epub 2018/03/16. doi: 10.2196/resprot.9416. PubMed PMID: 29540338; PMCID: PMC5874437.
62. Karyotaki E, Efthimiou O, Miguel C, Bermpohl FMG, Furukawa TA, Cuijpers P, Riper H, Patel V, Mira A, Gemmil AW, Yeung AS, Lange A, Williams AD, Mackinnon A, Geraedts A, van Straten A, Meyer B, Björkelund C, Knaevelsrud C, Beevers CG, Botella C, Strunk DR, Mohr DC, Ebert DD, Kessler D, Richards D, Littlewood E, Forsell E, Feng F, Wang F, Andersson G, Hadjistavropoulos H, Christensen H, Ezawa ID, Choi I, Rosso IM, Klein JP, Shumake J, Garcia-Campayo J, Milgrom J, Smith J, Montero-Marin J, Newby JM, BretónLópez J, Schneider J, Vernmark K, Bücker L, Sheeber LB, Warmerdam L, Farrer L, Heinrich M, Huibers MJH, Kivi M, Kraepelien M, Forand NR, Pugh N, Lindefors N, Lintvedt O, Zagorscak P, Carlbring P, Phillips R, Johansson R, Kessler RC, Brabyn S, Perini S, Rauch SL, Gilbody S, Moritz S, Berger T, Pop V, Kaldo V, Spek V, Forsell Y. Internet-Based Cognitive Behavioral Therapy for Depression: A Systematic Review and Individual Patient Data Network Meta-analysis. JAMA Psychiatry. 2021;78(4):361-71. Epub 2021/01/21. doi: 10.1001/jamapsychiatry.2020.4364. PubMed PMID: 33471111; PMCID: PMC8027916
63. Saltzman KM, Holahan CJ. Social Support, Self-efficacy, And Depressive Symptoms: An Integrative Model. Journal of Social and Clinical Psychology. 2002;21(3):309-22. doi: 10.1521/jscp.21.3.309.22531.
64. Dol J, Tomblin Murphy G, Aston M, McMillan D, Campbell-Yeo M. Design, development and usability testing of Essential Coaching for Every Mother: A postnatal text message

educational intervention. Women and Birth. 2021;34(3):e228-e36. doi: https://doi.org/10.1016/j.wombi.2020.05.004.

65. Cutrona C, Troutman BR. Social support, infant temperment, and parenting efficacy: A mediational model of postpartum depression. Child Development. 1986;57:1507-18.
66. Bandura A. Self-efficacy: toward a unifying theory of behavioral change. Psychol Rev. 1977;84(2):191- 215. Epub 1977/03/01. doi: 10.1037//0033-295x.84.2.191. PubMed PMID: 847061.
67. Bandura A. Self-efficacy: The exercise of control. New York, NY, US: W H Freeman/Times Books/ Henry Holt & Co; 1997. ix, 604-ix, p.
68. Schwarzer R, Jerusalem M. Measures in Health Psychology: A User's Portfolio. Causal and Control Beliefs. Causal and Control Beliefs. 1995;1:35-7.
69. Schwarzer R, Renner B. Social-cognitive predictors of health behavior: action self-efficacy and coping self-efficacy. Health Psychol. 2000;19(5):487-95. Epub 2000/09/28. PubMed PMID: 11007157.
70. Maciejewski PK, Prigerson HG, Mazure CM. Self-efficacy as a mediator between stressful life events and depressive symptoms: Differences based on history of prior depression. British Journal of Psychiatry. 2000;176(4):373-8. Epub 2018/01/02. doi: 10.1192/bjp.176.4.373.
71. Julian M, Le HN, Coussons-Read M, Hobel CJ, Dunkel Schetter C. The moderating role of resilience resources in the association between stressful life events and symptoms of postpartum depression. J Affect Disord. 2021;293:261-7. Epub 2021/07/05. doi: 10.1016/j.jad.2021.05.082. PubMed PMID: 34217964.
72. Woolhouse H, Brown S, Krastev A, Perlen S, Gunn J. Seeking help for anxiety and depression after childbirth: results of the Maternal Health Study. Archives of Women's Mental Health. 2009;12(2):75-83. doi: 10.1007/s00737-009-0049-6.
73. Byatt N, Xiao RS, Dinh KH, Waring ME. Mental health care use in relation to depressive symptoms among pregnant women in the USA. Arch Womens Ment Health. 2016;19(1):187-91. Epub 2015/04/08. doi: 10.1007/s00737-015-0524-1. PubMed PMID: 25846018; PMCID: PMC5515586.
74. Baumel A, Tinkelman A, Mathur N, Kane JM. Digital Peer-Support Platform (7Cups) as an Adjunct Treatment for Women With Postpartum Depression: Feasibility, Acceptability, and Preliminary Efficacy Study. JMIR Mhealth Uhealth. 2018;6(2):e38. Epub 2018/02/15. doi: 10.2196/mhealth.9482. PubMed PMID: 29439944; PMCID: PMC5829455.
75. Hussain-Shamsy N SA, Vigod S, Zaheer J, Seto E. Mobile Health for Perinatal Depression and Anxiety: Scoping Review . J Med Internet Res. 2020;22(4):e17011. doi: DOI: 10.2196/17011.
76. Broom MA, Ladley AS, Rhyne EA, Halloran DR. Feasibility and Perception of Using Text Messages as an Adjunct Therapy for Low-Income, Minority Mothers With Postpartum Depression. JMIR mental health. 2015;2(1):e4-e. doi: 10.2196/mental.4074. PubMed PMID: 26543910.
77. Haga SM, Drozd F, Lisøy C, Wentzel-Larsen T, Slinning K. Mamma Mia - A randomized controlled trial of an internet-based intervention for perinatal depression. Psychol Med. 2019;49(11):1850-8. Epub 2018/09/08. doi: 10.1017/s0033291718002544. PubMed PMID: 30191779; PMCID: PMC6650775.

78. Jones BA, Griffiths KM, Christensen H, Ellwood D, Bennett K, Bennett A. Online cognitive behaviour training for the prevention of postnatal depression in at-risk mothers: a randomised controlled trial protocol. BMC Psychiatry. 2013;13(1):265. doi: 10.1186/1471-244X-13-265.
79. O'Mahen HA, Woodford J, McGinley J, Warren FC, Richards DA, Lynch TR, Taylor RS. Internet-based behavioral activation—Treatment for postnatal depression (Netmums): A randomized controlled trial. Journal of Affective Disorders. 2013;150(3):814-22. doi: https://doi.org/10.1016/j.jad.2013.03.005.
80. Danaher BG, Milgrom J, Seeley JR, Stuart S, Schembri C, Tyler MS, Ericksen J, Lester W, Gemmill AW, Kosty DB, Lewinsohn P. MomMoodBooster web-based intervention for postpartum depression: feasibility trial results. Journal of medical Internet research. 2013;15(11):e242-e. doi: 10.2196/jmir.2876. PubMed PMID: 24191345.
81. Barrera AZ, Wickham RE, Muñoz RF. Online prevention of postpartum depression for Spanish- and English-speaking pregnant women: A pilot randomized controlled trial. Internet interventions. 2015;2(3):257-65. doi: 10.1016/j.invent.2015.06.002. PubMed PMID: 26273567.
82. Chan KL, Leung WC, Tiwari A, Or KL, Ip P. Using Smartphone-Based Psychoeducation to Reduce Postnatal Depression Among First-Time Mothers: Randomized Controlled Trial. JMIR Mhealth Uhealth. 2019;7(5):e12794. Epub 2019/05/17. doi: 10.2196/12794. PubMed PMID: 31094354; PMCID: PMC6537506.
83. Duffecy J, Grekin R, Hinkel H, Gallivan N, Nelson G, O'Hara MW. A Group-Based Online Intervention to Prevent Postpartum Depression (Sunnyside): Feasibility Randomized Controlled Trial. JMIR Ment Health. 2019;6(5):e10778. Epub 2019/05/30. doi: 10.2196/10778. PubMed PMID: 31140443; PMCID: PMC6707575.
84. de Chantal P-L, Chagnon A, Cardinal M, Faieta J, Guertin A. Evidence of User-Expert Gaps in Health App Ratings and Implications for Practice. Frontiers in Digital Health. 2022;4. doi: 10.3389/fdgth.2022.765993.
85. Torous J, Wisniewski H, Liu G, Keshavan M. Mental Health Mobile Phone App Usage, Concerns, and Benefits Among Psychiatric Outpatients: Comparative Survey Study. JMIR Ment Health. 2018;5(4):e11715. doi: 10.2196/11715.
86. Georgiou M. Developing a healthcare app in 2021: What do patients really want? 2021 [cited 2021 Oct 2]. Available from: https://www.imaginovation.net/blog/developing-a-mobile-health-app-what-patients-really-want/.
87. Lagan S, Aquino P, Emerson MR, Fortuna K, Walker R, Torous J. Actionable health app evaluation: translating expert frameworks into objective metrics. npj Digital Medicine. 2020;3(1):100. doi: 10.1038/s41746- 020-00312-4.
88. Mayberry LS, Jaser SS. Should there be an app for that? The case for text messaging in mHealth interventions. Journal of Internal Medicine. 2018;283(2):212-3. doi: https://doi.org/10.1111/joim.12687.
89. Hall AK, Cole-Lewis H, Bernhardt JM. Mobile text messaging for health: a systematic review of reviews. Annu Rev Public Health. 2015;36:393-415. Epub 2015/03/19. doi: 10.1146/annurev-publhealth-031914- 122855. PubMed PMID: 25785892; PMCID: PMC4406229.
90. Gazmararian JA, Elon L, Yang B, Graham M, Parker R. Text4baby program: an opportunity to reach underserved pregnant and postpartum women? Matern Child Health J. 2014;18(1):223-32. Epub 2013/03/16. doi: 10.1007/s10995-013-1258-1. PubMed PMID: 23494485.

91. Evans WD, Wallace Bihm J, Szekely D, Nielsen P, Murray E, Abroms L, Snider J. Initial Outcomes From a 4-Week Follow-Up Study of the Text4baby Program in the Military Women's Population: Randomized Controlled Trial. J Med Internet Res. 2014;16(5):e131. doi: 10.2196/jmir.3297.
92. Demirci JR, Cohen SM, Parker M, Holmes A, Bogen DL. Access, Use, and Preferences for Technology-Based Perinatal and Breastfeeding Support Among Childbearing Women. J Perinat Educ. 2016(1):29-36. doi: 10.1891/1058-1243.25.1.29.
93. Rathbone AL, Prescott J. The Use of Mobile Apps and SMS Messaging as Physical and Mental Health Interventions: Systematic Review. J Med Internet Res. 2017;19(8):e295. Epub 2017/08/26. doi: 10.2196/jmir.7740. PubMed PMID: 28838887; PMCID: PMC5590007.
94. White JS, Toussaert S, Thrul J, Bontemps-Jones J, Abroms L, Westmaas JL. Peer Mentoring and Automated Text Messages for Smoking Cessation: A Randomized Pilot Trial. Nicotine & Tobacco Research. 2020;22(3):371-80. doi: 10.1093/ntr/ntz047.
95. Spohr SA, Nandy R, Gandhiraj D, Vemulapalli A, Anne S, Walters ST. Efficacy of SMS Text Message Interventions for Smoking Cessation: A Meta-Analysis. Journal of Substance Abuse Treatment. 2015;56:1-10. doi: https://doi.org/10.1016/j.jsat.2015.01.011.
96. La Porte LM, Kim JJ, Adams MG, Zagorsky BM, Gibbons R, Silver RK. Feasibility of perinatal mood screening and text messaging on patients' personal smartphones. Archives of Women's Mental Health. 2020;23(2):181-8. doi: 10.1007/s00737-019-00981-5.
97. Silver RK, Kim JJ, La Porte L, Zagorsky B, Desmarais E, Gibbons RD. Mobile Phone-Based Perinatal Depression Screening: Feasibility and Acceptance [15R]. Obstetrics & Gynecology. 2017;129(5).
98. Barrera AZ, Aguilera A, Inlow N, Servin J. A preliminary study on the acceptability of a brief SMS program for perinatal women. Health Informatics Journal. 2019;26(2):1079-87. doi: 10.1177/1460458219866560.
99. Dol J, Aston M, McMillan D, Tomblin Murphy G, Campbell-Yeo M. Effectiveness of a Postpartum Text Message Program (Essential Coaching for Every Mother) on Maternal Psychosocial Outcomes: Protocol for a Randomized Controlled Trial. JMIR Res Protoc. 2021;10(3):e27138. Epub 2021/03/26. doi: 10.2196/27138. PubMed PMID: 33764309; PMCID: PMC8088838.
100. Bickman L, Kelley SD, Athay M. The Technology of Measurement Feedback Systems. Couple Family Psychol. 2012;1(4):274-84. Epub 2013/09/26. doi: 10.1037/a0031022. PubMed PMID: 24066274; PMCID: PMC3779359.
101. Mohr DC, Burns MN, Schueller SM, Clarke G, Klinkman M. Behavioral Intervention Technologies: Evidence review and recommendations for future research in mental health. General Hospital Psychiatry. 2013;35(4):332-8. doi: https://doi.org/10.1016/j.genhosppsych.2013.03.008.
102. Glasgow RE, Kessler RS, Ory MG, Roby D, Gorin SS, Krist A. Conducting rapid, relevant research: lessons learned from the My Own Health Report project. Am J Prev Med. 2014;47(2):212-9. Epub 2014/06/24. doi: 10.1016/j.amepre.2014.03.007. PubMed PMID: 24953520; PMCID: PMC4609529.
103. Chambers DA, Glasgow RE, Stange KC. The dynamic sustainability framework: addressing the paradox of sustainment amid ongoing change. Implement Sci. 2013;8:117. Epub 2013/10/04. doi: 10.1186/1748-5908-8-117. PubMed PMID: 24088228; PMCID: PMC3852739.

104. Lyon AR, Koerner K. User-Centered Design for Psychosocial Intervention Development and Implementation. Clinical Psychology: Science and Practice. 2016;23(2):180-200. doi: 10.1111/cpsp.12154.
105. Bhandari PM, Levis B, Neupane D, Patten SB, Shrier I, Thombs BD, Benedetti A. Data-driven methods distort optimal cutoffs and accuracy estimates of depression screening tools: a simulation study using individual participant data. J Clin Epidemiol. 2021;137:137-47. Epub 2021/04/11. doi: 10.1016/j.jclinepi.2021.03.031. PubMed PMID: 33838273.
106. Lundsberg LS, Cutler AS, Stanwood NL, Yonkers KA, Gariepy AM. Association of Pregnancy Contexts with Depression and Low Social Support in Early Pregnancy. Perspect Sex Reprod Health. 2020;52(3):161-70. Epub 2020/10/14. doi: 10.1363/psrh.12155. PubMed PMID: 33047499.
107. Martino S, Ondersma SJ, Forray A, Olmstead TA, Gilstad-Hayden K, Howell HB, Kershaw T, Yonkers KA. A randomized controlled trial of screening and brief interventions for substance misuse in reproductive health. American Journal of Obstetrics and Gynecology. 2018;218(3):322.e1-.e12. doi: https://doi.org/10.1016/j.ajog.2017.12.005.
108. Cox J, Holden J. Perinatal Psychiatry. Use and Misuse of the Edinburgh Postnatal Depression Scale. Glasgow: The Royal College of Psychiatrists; 1994. 275 p.
109. Cox JL, Holden JM, Sagovsky R. Detection of postnatal depression: Development of the 10-item Edinburgh Postnatal Depression Scale. The British Journal of Psychiatry. 1987;150:782-6.
110. Cox JL, Chapman G, Murray D, Jones P. Validation of the Edinburgh Postnatal Depression Scale (EPDS) in non-postnatal women. Journal of Affective Disorders. 1996;Volume 39(Issue 3):185-9.
111. Levis B, Negeri Z, Sun Y, Benedetti A, Thombs BD. Accuracy of the Edinburgh Postnatal Depression Scale (EPDS) for screening to detect major depression among pregnant and postpartum women: systematic review and meta-analysis of individual participant data. Bmj. 2020;371:m4022. Epub 2020/11/13. doi: 10.1136/bmj.m4022. PubMed PMID: 33177069; PMCID: PMC7656313.
112. Gibbons RD, Weiss DJ, Pilkonis PA, Frank E, Moore T, Kim JB, Kupfer DJ. Development of a Computerized Adaptive Test for Depression. Archives of General Psychiatry. 2012;69(11):1104-12. doi: 10.1001/archgenpsychiatry.2012.14.
113. Pearlin LI, Schooler C. The Structure of Coping. Journal of Health and Social Behavior. 1978;19(1):2- 21. doi: 10.2307/2136319.
114. Sauro J. Measuring usability with the System Usability Scale 2011 [Sept, 2021]. Available from: https://measuringu.com/sus/.
115. O'Brien HL, Cairns P, Hall M. A practical approach to measuring user engagement with the refined user engagement scale (UES) and new UES short form. International Journal of Human-Computer Studies. 2018;112:28-39. doi: https://doi.org/10.1016/j.ijhcs.2018.01.004.
116. Jaspers MW, Steen T, van den Bos C, Geenen M. The think aloud method: a guide to user interface design. Int J Med Inform. 2004;73(11-12):781-95. Epub 2004/10/20. doi: 10.1016/j.ijmedinf.2004.08.003. PubMed PMID: 15491929.
117. Palmiero M, Piccardi L. Is Visual Creativity Embodied? Thinking Aloud While Performing the Creative Mental Synthesis Task. Brain Sci. 2020;10(7):455. doi: 10.3390/brainsci10070455. PubMed PMID: 32708579.
118. Wen K-Y, Miller SM, Kilby L, Fleisher L, Belton TD, Roy G, Hernandez E. Preventing Postpartum Smoking Relapse Among Inner City Women: Development of a Theory-Based

and Evidence-Guided Text Messaging Intervention. JMIR Res Protoc. 2014;3(2):e20. doi: 10.2196/resprot.3059.

119. Hwang W, Salvendy G. Number of people required for usability evaluation: the 10±2 rule. Commun ACM. 2010;53(5):130–3. doi: 10.1145/1735223.1735255.
120. Holden L, Lee C, Hockey R, Ware RS, Dobson AJ. Validation of the MOS Social Support Survey 6-item (MOS-SSS-6) measure with two large population-based samples of Australian women. Quality of Life Research. 2014;23(10):2849-53. doi: 10.1007/s11136-014-0741-5.
121. Webster J, Linnane J, Roberts J, Starrenburg S, Hinson J, Dibley L. IDentify, Educate and Alert (IDEA) trial: An intervention to reduce postnatal depression. British Journal of Obstetrics and Gynaecology. 2003;110:842-6.
122. Rush AJ, Trivedi MH, Ibrahim HM, Carmody TJ, Arnow B, Klein DN, Markowitz JC, Ninan PT, Kornstein S, Manber R, Thase ME, Kocsis JH, Keller MB. The 16-Item quick inventory of depressive symptomatology (QIDS), clinician rating (QIDS-C), and self-report (QIDS-SR): a psychometric evaluation in patients with chronic major depression. Biological Psychiatry. 2003;54(5):573-83. doi: 10.1016/s0006-3223(02)01866-8.
123. Freedland KE, King AC, Ambrosius WT, Mayo-Wilson E, Mohr DC, Czajkowski SM, Thabane L, Collins LM, Rebok GW, Treweek SP, Cook TD, Edinger JD, Stoney CM, Campo RA, Young-Hyman D, Riley WT. The selection of comparators for randomized controlled trials of health-related behavioral interventions: recommendations of an NIH expert panel. J Clin Epidemiol. 2019;110:74-81. Epub 2019/03/04. doi: 10.1016/j.jclinepi.2019.02.011. PubMed PMID: 30826377; PMCID: PMC6543841.
124. Leon AC, Davis LL, Kraemer HC. The role and interpretation of pilot studies in clinical research. J Psychiatr Res. 2011;45(5):626-9. Epub 2010/11/03. doi: 10.1016/j.jpsychires.2010.10.008. PubMed PMID: 21035130; PMCID: PMC3081994.
125. Thabane L, Ma J, Chu R, Cheng J, Ismaila A, Rios LP, Robson R, Thabane M, Giangregorio L, Goldsmith CH. A tutorial on pilot studies: the what, why and how. BMC Medical Research Methodology. 2010;10(1):1. doi: 10.1186/1471-2288-10-1.