Integrating Mind-Body Skills With Physical Activity to Improve Physical and Emotional Outcomes in Patients With Chronic Pain

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I. BACKGROUND AND SIGNIFICANCE

1.1. Chronic pain is prevalent, costly, and associated with decreased emotional and physical function. Chronic pain, defined as persistent pain that lasts more than 3-6 months[1], has an estimated incidence of 100 million adults in the US[2]. The total annual incremental cost of health care due to pain ranges between $560 and $635 billions in the US, which combines the medical costs of pain care and the economic costs related to disability days and lost wages and productivity[2]. As a consequence, NCCIH has designated chronic pain as a national priority area[4]. A large body of research documents that patients with chronic pain have decreased emotional[26-28], and physical function [29,30], regardless of the location and severity of pain[31,32] . Patients with chronic pain also report nonadaptive coping strategies with pain catastrophizing and fear of pain being the most salient, and both associated with decreases in physical and emotional function [33-36].

1.2. Mind body programs show promise with chronic pain, but fail to improve physical function. Over the last decade, psychosocial treatments have evolved toward acceptance of pain and increased function regardless of pain sensations[37-39]. Mind body programs such as Acceptance and Commitment Therapy (ACT) and Mindfulness Skills Training (MST) programs focus on engaging in value driven behaviors, even if those are painful [39-42]. However, these interventions produce only small to moderate effect sizes for psychosocial outcomes like depression, anxiety, stress, and overall quality of life and effects diminish over time[43]. Further, although IMMPACT[44,8] recommendations clearly specify that physical function should be a required outcome in pain clinical trials, few studies include it[45] ; when physical function is included as an outcome, effect sizes are small and fade over time[46,47.]. Thus, there is a need for novel interventions to improve emotional and physical functioning in this population.

Physical function, defined following the ICF[9], implies "a person's capacity in a set of situations and includes engagement in meaningful aspects of one's life including performing activities of daily living such as household chores, walking, work and self care" and is consistently associated with mental and physical health benefits[30]. New recommendations from IMMPACT released during the summer of 2016[8] focus primarily on physical function, and urge researchers to directly target it during pain clinical trials as well as to conceptualize it comprehensively through self report measures of activity of daily living and physical activity (biased due to perceptions but important to patients), performance based measures (e.g., walk test; still subject to bias due to motivation and perceptions), and more objective measures of physical activity such as accelerometers or other digital monitoring devices like the Fitbit (which are valid and comparable to live observations of activity). **No mind body studies in chronic pain to date have comprehensively addressed and assessed physical function/activity consistent with ICF[9] and IMMPACT[8] 2016 criteria.** This represents an unexplored opportunity to improve outcomes and sustain improvements in this population.

1.3. Quota based walking is associated with improved outcomes in chronic pain patients, but not incorporated within mind

body programs. The US Department of Public Health's research has shown a clear relationship between daily physical activity such as a 30-minute walk and several health related outcomes such as mortality, cardiovascular diseases and cancer[48]. **Patients with chronic pain are sedentary** and take significantly fewer steps per day than an average healthy adult[49-52]. Deconditioning, common in chronic pain, can be a significant risk factor for *further* pain conditions and disability[52]. Aerobic exercise has been shown to be the mainstay of chronic pain treatments for multiple, heterogeneous pain conditions including low back pain, fibromyalgia, and chronic myofascial conditions, with walking being the most commonly prescribed, but adherence being problematic[51-53]. When walking is quota-based (i.e., not contingent on pain level), results are even more promising[54-56]. Prior research has identified barriers to engaging and adhering to physical exercise in chronic pain, which included decreased mood, pain, coping difficulties (e.g., fear avoidance, catastrophic thinking about pain), programs that were too challenging (e.g., going to the gym), not meaningful, interfering with one's life, or too difficult to implement[57-60]. Focus groups and qualitative interviews with patients with chronic pain have consistently showed that walking is the preferred method of physical activity in this population[59]. **Despite the aforementioned evidence physical activity including walking are not addressed or assessed in mind body programs**.

1.4. Digital monitoring devices (DMDs) simultaneously reinforce and assess objective physical function/activity while maintaining motivation and safely increasing physical activity. Digital monitoring devices can make tracking activity in healthcare more convenient, accurate and cost effective for patients. Pedometers are associated with a significant increase in physical activity and decrease in body mass and blood pressure[61,62]. Piezoelectric accelerometers measure proper acceleration ("g-force") and already have several clinical applications including validating self-report measures, assessing physical function via expended energy (EE) in different populations, as a novel way for clinicians to track physical activity and as a potential motivator for behavior, treatment alliance and adherence[17,18,63]. Although pedometers and accelerometers have been around for a long time[61,62], long term adherence to their use has been problematic, and the lack of real time feedback has limited their ability to act as an intervention [64, 65]. With the miniaturization of these devices and the advent of low energy Bluetooth 4.0 peripheral devices such as FitBit DMD, patients can now track their activity and receive real time feedback to increase motivation and reinforce activity. Fitbit DMDs represent an opportunity to directly measure objective physical functioning/activity, while actively reinforcing the patient in incremental, quota-based gains in activity that are individualized to each patient's ability and gradually increased[20]. They are just beginning to see promising use with disabling illness[66], while documentation of their adoption to chronic pain in adults has been through only anecdotal case reports. **DMDs represent an unexplored opportunity to objectively measure, target and reinforce improvements in physical activity/function in chronic pain patients.**

1.5. Combining mind body programs with the Fitbit DMD represents an opportunity to directly target increased physical activity and improve physical and emotional outcomes in chronic pain patients. Mind body program teach patients skills that can address some of the barriers to engaging and adhering to activity delineated above such as low mood, over focus on control of pain rather than acceptance, fear avoidance and nonadaptive thoughts about pain. Fitbit DMDs can provide real time reinforcements that can increase motivation and enhance adherence. Further, physical activity can be individualized based on patient's interest and paired with activities of daily living that are meaningful to participants and fit individual schedules, further decreasing barriers to engagement in exercise programs identified in prior research[57-59].

1.6. The Relaxation Response Resiliency Program (3RP[10]) is a comprehensive, multimodal mind body group based program that lends itself to the incorporation of the DMD. The 3RP is a novel multimodal mind body intervention that combines

relaxation response (RR) elicitation strategies (e.g. mindfulness, meditation) with increased awareness of emotional, cognitive, physical, behavioral and relational correlates of stress and symptoms and adaptive strategies such as positive perspectives, reappraisals and coping, social support and healthy lifestyle behaviors. All components of the 3RP have been individually found efficacious in improving outcomes in prior research[42,43,67-69]. Multimodal programs that incorporate a variety of skills (as the 3RP does) are more efficacious than unimodal programs[70] . The 3RP, a skills based multimodal treatment program, is a perfect fit for adaptation for chronic pain management including addressing increased activity aided by the DMD to address comprehensively physical function, consistent with IMMPACT recommendations. (Figure 1; Table 1).

Justification for using the 3RP: 1) it is a multimodal program consistent with recommendations for research in chronic pain[70]; 2) has built in SMART (Specific, Measurable, Attainable, Realistic and Time based) goal setting in each session thus providing a built in framework for setting goals for increased activity paired with activities of daily living that are meaningful to patients and monitoring through DMDs. 3) teaches evidenced based skills that were previously found promising in medical populations including chronic pain[42, 43, 67-69] when tested individually; 4) it has embedded educational information on the positive role of physical activity for healthy lifestyle; 5) it is designed to help patients adjust to chronic symptoms, rather than eliminate them, which is consistent with IMMPACT[8]; 6) the program accommodates a 6th grade reading level allowing for patients with low health literacy or learning disabilities; 7) it has evidence of high feasibility and acceptability in effectiveness studies[11-14, 16]and a recent preliminary RCT[16].; 8) it has an already developed time and dose matched attention placebo educational control, The Health Enhancement Program (HEP)[21], that has already been adapted for pain and is currently used with 80% feasibility in the Pain Clinic at MGH.

1.7. Preliminary research with the 3RP is encouraging. The 3RP has evolved over the years from its inception as Medical Symptom Reduction Program to its current standardized form. Effectiveness and pilot studies have found that attendance of the 3RP is associated with improvement in mental and physical symptoms in a variety of populations[11-16]. The 3RP was also found to have high adherence and improve pain intensity, frequency, tolerability and objective functioning in an open pilot with patients with refractory chronic mandibular join disorder[14], and improve psychoemotional variables and pain catastrophizing in patients with neurofibromatosis [15,16]. In a RCT of the 3RP versus an attention placebo control HEP, Vranceanu et al.[16] found 100% adherence in both groups and significant improvement in both physical health and psychological quality of life in the 3RP group, which was over the minimal clinically important difference (MCID). Further, in patients with moderate and severe pain there was a decrease in both pain intensity and pain interference in the 3RP group, which were over the MCID. The 3RP is currently being tested in large RCT in medical populations such as multiple myeloma (PI: Denninger) and patients with comorbid PTSD and respiratory problems (PI: Gonzalez). Further, large RCTs of the 3RP are currently under review with NIH (e.g., U01NS102183 NINDS, Vranceanu PI; NINR Donelly PI) and DOD (PI: Vranceanu).

1.8. The Fitbit is a popular, user friendly and accurate DMD, but not yet incorporate in the care of patients with chronic pain. Fitbit is the most popular and easy to use digital monitoring device[71]. Similar to Accelerometers, it uses tri-axis piezoelectric accelerometers and sophisticated algorithms to accurately measure the number of steps one takes while wearing these devices with only a 10.1% error rate, as well as number of active minutes[72]. Even though these consumer-based activity trackers are popular, inexpensive, convenient and accurate, "the widespread integration of this technology into medical practice remains limited"[20]. Despite this, several studies have utilized Fitbit with positive results. Washington et, al (2014)[73] found that the use of Fitbit within an operant quota based exercise program was associated with a 23% increase in step count in healthy adults, which was significant. In sedentary adults who used the Fitbit and set step goals, number of steps increased

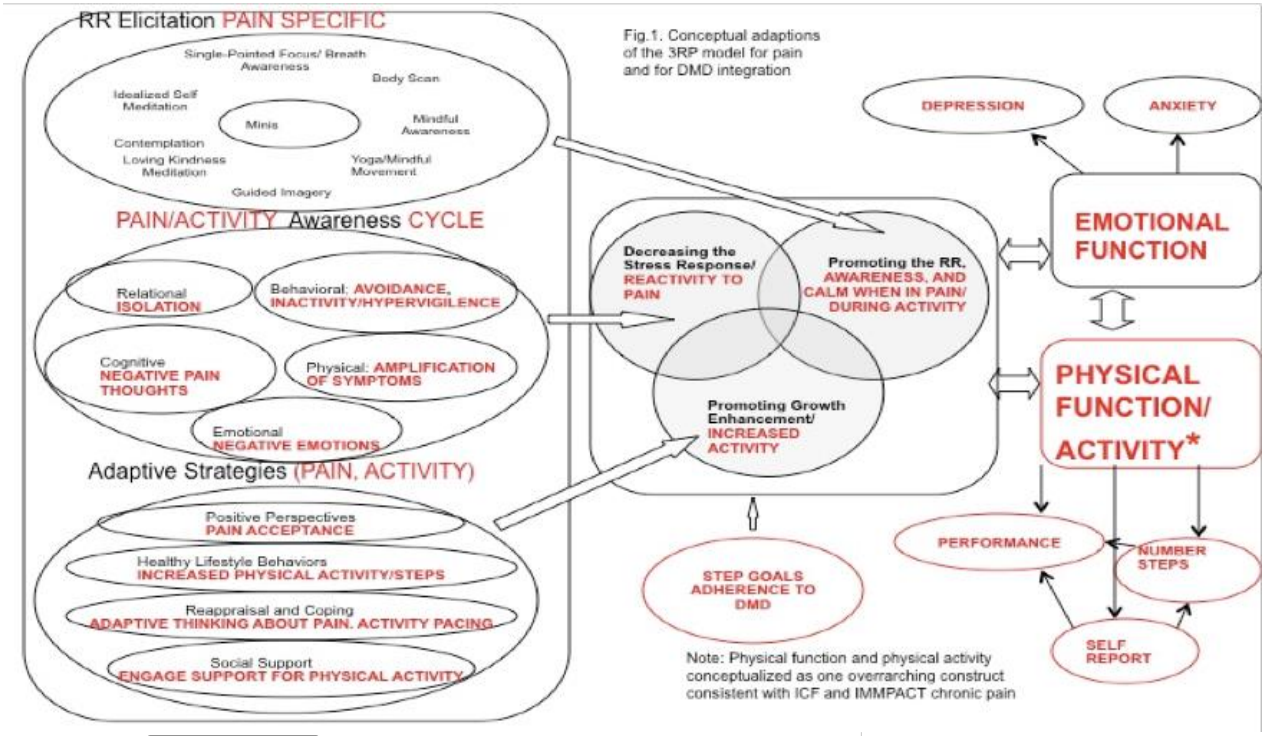
by 108% average, with adherence rates between 92 and 95%[19]. Fitbit DMDs are superior to Acccelerometers and pedometers when worn for a long period of time, with activity and/or number of steps doubled, and higher number of days wearing the tracker for the Fitbit group[18,19,74]. Adherence is also higher with the Fitbit, with 96% of participants wearing the tracker 4 or more days/week; 88% using the Fitbit website; 52% logging on 2-3 days per week; 72% viewing the tracker data 1 or more times per day; 80% having no computer issues or ; technical issues with tracker; 100% liked wearing the tracker; and 96% stating that the tracker was helpful in increasing activity vs. 32% thought a pedometer was helpful. Very few studies have examined the Fitbit DMD in patients with chronic pain. A recent study in patients with rheumatoid arthritis[74] who wore both the wrist Fitbit and an accelerometer as part of a 4-week protocol study found high adherence to the use of both devices, and higher preference for the Fitbit. Kulich et al (2015) conducted a case study and found an increase by 1,175 steps over 4 weeks in a sedentary adult with chronic hip pain[75]. In sum, the Fitbit DMD appears to have high adherence and acceptability, shows promise in increasing activity when paired with a behavioral program, but has not yet been properly tested in patients with chronic pain.

2.1. Conceptual model: Our conceptual model of adaptation of the general 3RP[10] follows recommendations from IMMPACT and combines key concepts of ICF with key features of relevance to patients with heterogeneous chronic pain that specifically target improved physical activity/function, and recommendations of multimodal programs to improve outcomes in chronic pain clinical trials[70]. We used a comprehensive conceptualization of physical function that includes patient reported outcomes (e.g., patient's perception of engagement in physical activity and activities of daily living), performance based function (e.g., a more objective test of walking ability) and objective function (in vivo assessment of number of steps). This comprehensive conceptualization is important because it provides data on the impact of pain and treatment effects beyond symptom reduction alone, a primary concern depicted by patient focus groups and surveys[32]. Our model is based on the guiding hypotheses that the synergistic association between the evidence based skills of the 3RP adapted for the needs of patients with chronic pain, and DMD is the most efficient and effective way to improve emotional function as well as ALL aspects of physical function depicted above, which have been shown as independent in prior research[8] . Adaptations of the multimodal general 3RP will be done consistent with theoretical models of the fear- avoidance model of pain[34], cognitive model of pain[6], acceptance and commitment therapy[76], mindfulness[77], and positive psychology[78], to help patients engage in activities that are meaningful and mapped to each individual's level of functioning and life circumstance through the use of quota based pacing with in vivo reinforcement facilitated by the DMD (Figure 1). As depicted, we propose that the interrelation among pain specific RR elicitation techniques, pain and activity awareness and adaptive strategy including increased activity will lead to decreased reactivity to pain, increased activity and promote awareness and calm during activities, even when these are painful. The built in, live reinforcement of activity through the DMD and pairing of physical activity with activities of daily living depicted by patients as important are conceptualized as key factors in improving outcomes will maintain motivation and help participants stay accountable for meeting specific physical activity goals. The p3RP and Fitbit DMD are conceptualized as acting synergistically. p3RP acts by directly addressing habitual negative affective reactions to pain and negative pain thoughts by focusing on accepting and learning to tolerate pain sensations (including during increased activity) by using various RR strategies, positive psychology concepts and adaptive thinking[10], while Fitbit DMDs, based on operant approaches previously depicted as promising in this population, directly increased activity through "quota-based" non "pain contingent" activity and direct feedback on number of steps achieved [79,80]. In our conceptualization the DMD is necessary in order to bypass barriers to physical activity, maintain motivation and reinforce activity in real time.

In sum, both the adapted 3RP and the operant based Fitbit DMD approach improve physical and emotional function by focusing on increasing activity regardless of pain[81,19,10], and their interaction is hypothesized to further improve outcomes. Proposed changes to the general 3RP are depicted in CAPS IN RED. The DMD will give direct reinforcement and monitoring of activity, while the 3RP will aid with pain specific coping skills that act as deterrents from activity in chronic pain, such as nonadaptive cognitions, fear of pain, hypervigilence to pain sensations, among others. Adaptations for the pain specific 3RP (p3RP) will be identical but will not target adherence to the DMD including meeting daily step goals. The model depicted in the figure below specifies that the p3RP and DMD (e.g., p3RP-DMD) will interact and improve physical function both directly and indirectly through improved coping, decreased pain catastrophizing and decreased fear of pain.

3.1 Procedures Overview

The present proposal aims to adapt, pilot and examine the credibility, acceptability, adherence and feasibility of the 3RP adapted for chronic pain (p3RP), and the p3RP-DMD, which is the pain specific 3RP integrated with a commercial digital monitoring device (DMD), the Fitbit. This R34 feasibility project will lay the groundwork for a large RCT of the p3RP-DMD vs p3RP vs pHEP attention placebo control, and will help understand whether the DMD Fitbit is



necessary to comprehensively improve function. Consistent with prior theory within a subsequent R01 we will test the hypothesis that the p3RP-DMD will be superior to the p3RP and pHEP in improving and sustaining improvements in

objective, performance based and self-reported physical and emotional function in patients with heterogeneous chronic pain. Using the specific NCCIH R34 mechanism we now follow an iterative design [82,83] to adapt the general 3RP and refine both the p3RP and the integrated p3RP-DMD interventions to maximize feasibility, acceptability, credibility, recruitment protocol, adherence and measurements for patients with heterogeneous chronic pain. To allow objective measurement of activity in both p3RP and p3RP-DMD groups, we will use Accelerometer DMDs for 1 week at baseline and post-test. The Fitbit DMD will be used to address/reinforce activity consistent with an individualized pacing plan, and to assess daily activity during the program only for those randomized to the p3RP-DMD.

During the RCT phase, participants will be randomized 1:1 to p3RP-DMD or p3RP using block randomization. The study team will be blinded and the program manager, not involved in the study, will be responsible for assigning numbers to each participant. Participants will not know whether they are assigned to the p3RP-DMD intervention or the p3RP control. Rather, they will be informed that they will be randomized to one of 2 physical activity groups, in an effort to identify which one works best in patients with chronic pain. In order to prevent unblinding, participants will be asked to not share information discussed in the group on social media sites (e.g., Facebook groups or internet chat groups) or with other acquaintances for the duration of the study. We will also explain to study participants how sharing of information would potentially negatively impact the validity of study results.

3.2. The 3RP. The novel 8-week group-based general 3RP[10] has been developed by a team led by Dr. Park aided by Dr. Vranceanu, and will be further adapted for patients with heterogeneous chronic pain including increased physical activity. Drs. Vranceanu and Park have extensive experience adapting and delivering the 3RP to a variety of populations (see preliminary data). Dr. Vranceanu published the first and only RCT[16] of the 3RP adapted for patients with neurofibromatosis (NF; 3RP-NF) and found excellent feasibility and acceptability, as well as level 2 evidence of improvement in quality of life in those randomized to 3RP-NF versus those who attended the attention placebo control HEP-NF; improvements maintained at 6 months follow-up. The 3RP model and proposed adaptations for the needs of patients with chronic pain, including integration of DMD are depicted in Figure . A description of each of the 8 general 3RP group sessions as well as adaptations for proposed for the p3RP-DMD are depicted in Table 1. Adaptations for the pain specific p3RP will be identical but will not include DMD integration adaptations. The 3RP introduces and reinforces new skills through didactics, in-session activities, discussions, and daily home practice assignments. Homework involved setting SMART goals, recording type and amount of daily RR practice, and recording daily 1-3 appreciations. Each session begins with the practice of a new exercise to elicit the RR. The relaxation method is then coordinated with the remaining session content. For instance, the clinician may introduce imagery of a peaceful place as a relaxation method, and then transition to didactics and exercises that focus on skills for building a positive perspective. The main proposed adaptation is the focus on pain as a stressor, rather than on general stress, and uses skills to directly target increased physical activity. General adaptations will include: 1) setting weekly SMART goals specific to quota based pacing to increase activity, individualized to each patient based on baseline or subsequent activity level in the previous block, and instruction on how to pair these with feedback from Fitbit (in the p3RP-DMD only; 2) modification of all RR exercises to address habituation to pain, mindfulness when experiencing pain; 3) employment of RR during exercise to cope with pain and increase enjoyment; 4) pairing exercise with activities of daily living that are important to participants, and link these within the SMART goals; 5) education information of the benefits of exercise, decrease sedentary time, and healthy patterns of activity in chronic pain through non pain contingent pacing; 6) pain specific adaptations of all skills (pain acceptance, restructuring of nonadaptive pain thoughts, etc); 7) specific Fitbit instructions (charging, downloading, using feedback, etc).

Inclusion Criteria	Rationale
Male and female outpatients, age 18 years or older	Population under study
Have nonmalignant chronic pain for more than 3 months	International Association for Study of Pain (IASP)[1] criteria
Able to perform a 6-minute walk test	Program will involve increase number of steps/outcome measure
Owns a smartphone with Bluetooth 4.0	Necessary for pairing with DMD and storing/downloading data.
Willingness and ability to participate in the 3RP-DMD intervention and to comply with the requirements of the study protocol (including weekly sessions and daily DMD use).	Human Subjects concern, feasibility
Free of concurrent psychotropic or pain medication for at least 2 weeks prior to initiation of treatment, OR stable on current psychotropic or pain medication for a minimum of 6 weeks and willing to maintain a stable dose	Treatment confound
Leads a sedentary lifestyle	Treatment confound
Exclusion Criteria	**Rationale**
Diagnosed with a medical illness expected to worsen in the next 6 months (e.g., malignancy)	Treatment confound
Serious mental illness or instability for which hospitalization may be likely in the next 6 months	Feasibility, participant safety
Current suicidal ideation reported on self-report	Subject safety
Lifetime history of schizophrenia, bipolar disorder, or other psychotic disorder, current substance abuse or dependence and	Treatment confound
Current substance use disorder, within the past 6 months	Treatment confound
Practice of yoga/meditation, or other mind body techniques that elicit the RR, once per week for 45min or more within the last 3 months or less.	Treatment confound
Regular use of DMD in the last 3 months.	Treatment confound

Engagement in regular intensive physical exercise for >30 min daily.	Treatment confound
Unable to walk without use of assistance (e.g., walker, cane, wheelchair)	Treatment confound
Limitations/restrictions on physical activity due to health conditions	Feasibility, participant safety

Adaptations for the p3RP will follow the same framework without any of the DMD specific adaptations. All adaptations will occur after input from patients through the focus groups.

II. SPECIFIC AIMS

Specific aims for phase I are:

Aim 1: In the first step our multidisciplinary team will propose modifications to the general 3RP to address the needs of patients with chronic pain reported in the literature, with a focus on improving physical activity and function (see Figure , Table 1). Based on this information, we will develop a semi-structured qualitative interview script.

Hypotheses: NA

Aim 2: In the second step we will use the semi-structured qualitative interview to guide focus groups (30 total) to gather feedback on the intervention components, gauge treatment needs and expectations, as well as barriers and ways to facilitate participation in the intervention and adherence to the use of DMD and 3RP specific practice, among chronic pain patients. Participants will also be given an exit interview to answer questions that they might not feel comfortable discussing during the group setting (e.g., triangulation).

Hypotheses: NA

Specific aims for phase II are:

Aim 3: In the first step, we will pilot the adapted p3RP-DMD and p3RP programs in two initial groups (N=10/group, 20 total) of chronic pain patients and assess preliminary credibility, acceptability, satisfaction of treatment, feasibility (of recruitment and instruments) and adherence to the use of the DMD and to p3RP-specific homework.
Hypotheses: N/A

Aim 4: In the second step, we will conduct a semi-structured comprehensive qualitative exit interview at the end of the groups focused on discussing patients' perception of the rationale for and helpfulness of each individual p3RP specific module, patients' perception of the rationale and helpfulness of using the DMD in increasing physical activity/function, patients' perception of the importance and ease of adherence to DMD and adherence to p3RP specific homework, and patients' burden of questionnaire completion.
Hypotheses: N/A

Specific aims for phase III are:

Aim 5: We will conduct an RCT (N = 80 chronic pain patients, 40/arm, 8 groups total, accounting for 25% attrition) of the newly refined p3RP-DMD versus the newly refined p3RP. We will compare the credibility, acceptability, adherence, satisfaction with treatment, feasibility (of recruitment, refined intervention, study procedures, and instruments) between the two interventions.
Hypotheses: N/A

Aim 6: By the end of this trial we aim to have two interventions (p3RP-DMD and p3RP) with high credibility, acceptability and feasibility, a recruitment, retention plan and study procedures protocol to ensure minimal random error, and outcome measures sensitive to change.
Hypotheses: N/A

Aim 7: At the end of study enrollment (e.g., no longer recruiting or enrolling participants and only conducting follow-ups with participants and conducting data analysis), we will conduct semi-structured qualitative interviews (12 total) once participants have completed all study procedures (e.g., completing both baseline and post-test questionnaires and wearing the accelerometer at both time points). This interview will be used to inform the future development of the program and to understand ways to better improve physical activity and discuss participants perceptions of the accelerometer.
Hypotheses: N/A

III. SUBJECT SELECTION

Subjects will be adult new patients presenting to Partners-affiliated medical practices (e.g., the Pain Clinic at Massachusetts General Hospital, the Spine Center at Massachusetts General Hospital, Brigham and Women's Hospital Anesthesia and Pain Management Center, and Spaulding Rehabilitation Hospital's outpatient center), and Boston area pain centers and medical practices that treat chronic pain patients. The MGH Center for Pain Medicine sees approximately 15,000 patient visits yearly. The main diagnoses are: chronic low back pain and fibromyalgia. Inclusion and exclusion criteria were selected following guidelines for psychosocial treatment development 82-83 (see Table 1. Above).

Participants will be recruited among patients with heterogeneous chronic pain who present to Partners-affiliated medical practices (e.g., the Pain Clinic at Massachusetts General Hospital, the Spine Center at Massachusetts General Hospital, Brigham and Women's Hospital Anesthesia and Pain Management Center, and Spaulding Rehabilitation Hospital's outpatient center), Boston area pain centers and medical practices that treat chronic pain patients, and meet study criteria. Participants may also hear about the study from Partners Rally, from chronic pain groups online, or recruitment flyers with tear-off research coordinator contact information that will be posted in the hospital and around referral sites. We will also post to our Twitter page, with the following content: "Can increased physical activity with or without the help of a Fitbit help with chronic pain? IBHCRP's GetActive! study is looking to find out! To learn more or get involved, click here:" with a link to our study on Rally or an attachment of the flyer. All patients within the clinic meet with a medical provider for a medical evaluation as part of usual care, which also includes a urine toxicology pain profile for patients on controlled substances and review of the MA Prescription Monitoring Program.

Recruitment will also occur through the Research Patient Database Registry (RPDR). The RPDR is a centralized clinical data registry that gathers data from various hospital legacy systems and stores it in one place. Researchers access this data using the RPDR online Query Tool. They may query the RPDR data for aggregate totals and, with proper IRB approval, obtain medical record data. The RPDR ensures the security of patient information by controlling and auditing the distribution of patient data within the guidelines of the IRB and with the use of several built-in, automated security measures. To identify potentially eligible patients:

1.) An RPDR query will be performed to identify those patients with chronic pain diagnoses. Study staff will review the medical record to confirm potential participant eligibility and to identify their linkage to an MGH primary care physician. Access to patients' medical records will be restricted to this pre-enrollment recruitment phase.
2.) Study staff then will obtain permission for initial contact from each potentially eligible patient's PCP by having providers review letters and discard ones that they do not approve.
3.) For physician-approved patients, study staff will send a study introduction letter from the patient's physician (with the clinician's name at the bottom) and a study opt-out letter signed by Ana-Maria Vranceanu (PI). The letter from the PCP informs the patient that he or she is allowing the study to contact patients with chronic pain in case they are interested in learning about the study. Dr. Vranceanu's letter is an opt-out letter describing the study, the procedure to opt out of further contact, and whom to call for further information.
4.) Should study staff receive no reply within 10 days, staff members will call the patient on the phone to assess interest in the study and to describe the study over the phone. If the patient remains interested, staff will confirm eligibility and assess for inclusion and exclusion criteria.

5.) For potentially eligible patients who are enrolled in the MGH Research Options Direct to You (RODY) Program, we will send them an opt-out letter and call 10 days later to inform them about the study. RODY identifies patients who are willing to be contacted directly about research studies. Patients who have agreed to be contacted directly are identifiable through the RPDR search; each patient's RODY status is available in the demographics table included in the RPDR output.

A research assistant will provide study details to interested participants and screen for eligibility; those who wish to participate will complete the informed consent process. These procedures will be done in a private setting, and will not impact in any way the delivery of care within the practice. This strategy has been used successfully in prior studies conducted by the PI. Data will be collected in MGH Integrated Brain Health Clinical and Research Program and will be managed and analyzed collaboratively by investigators at MGH.

4. Feasibility The Pain Clinic at MGH is a busy clinical and research practice. The Center has approximately 15,000 patient visits yearly. Of these, approximately 47% are new chronic pain patients and the rest are follow-ups. Approximately 10% of participants come in a wheelchair and would be excluded from this study. As such, we can be confident that we will be able to identify and recruit the necessary number of participants.

IV. SUBJECT ENROLLMENT

Interested participants who meet study criteria will be consented and then scheduled to participate in one of the focus groups (in Phase I) or intervention groups (in Phases II and III).

V. STUDY PROCEDURES

Phase I:

After enrollment, participants will be asked to attend one of the focus groups. The focus groups will be conducted in person at MGH by Dr. Vranceanu and Zale. At the end of the focus group participants will be asked to complete a paper and pencil exit interview including demographic questionnaire. Participants will be compensated $10 for transportation and $10 for completion of the focus group including the exit interview (maximum $20 per participant).

Focus group participants will be given an exit interview to provide additional private information that they might not be comfortable sharing in a group. Utilizing different data collection modalities (group and individual, in-person and written) is a qualitative strategy, known as triangulation, to enrich data collection and enhance data credibility. Focus group interview domains will include: 1) case based scenarios of perceived effects of chronic pain on quality of life and function; 2) areas of need for skills training; 3) impact of pain on activity, work, relationships, and 4) best strategies for recruitment and retention for chronic pain patients; 5) difficult situations/challenges experienced by chronic pain patients, 6) specific topics they would like to learn about; 7) knowledge about mild exercise such as walking and chronic pain; 8) barriers to exercise/walking; 9) barriers or concerns about the use of the DMD.

Focus group script (will be finalized in aim 1).

Exit interview (will be finalized in aim 2).

End of phase 1 deliverables: 1) adapt the original 3RP intervention/manual to address the needs of patients with chronic pain including incorporation of DMD and improvements in physical and emotional function (see Figure 1; Table 1); 2) identify/problem solve potential barriers to adherence to 3RP homework and DMD use during the duration of the program, and Accelerometer use for baseline and posttest assessments, including acceptability, credibility, feasibility, recruitment and adherence; 3) solidify inclusionary and exclusionary criteria and 4) finalized instruments to use in phase 2. At the end of this phase we will have 2 interventions: p3RP (3RP adapted for chronic pain and increased activity) and p3RP-DMD adapted for chronic pain and increased activity with live reinforcement through Fitbit DMD reinforcement.

Phase II:

After enrollment, participants will be asked to attend one of the two intervention groups, p3RP or p3RP-DMD (N= 30) in an open pilot. Participants will have a choice of either the p3RP or p3RP-DMD until one group is full; the remaining participants will then be assigned to the available group. The intervention groups will be conducted in person at MGH trained study therapists over 8 weeks. Participants will complete demographics questions, baseline psychological and behavioral questionnaires, as well as an exit interview. Interview domains will include: 1) satisfaction with the intervention, 5) areas that were most helpful, 6) areas that were least helpful, 7) ways to improve the intervention and its acceptability (e.g., satisfaction, fit of the intervention within daily life, confidence in treatment and therapist), 8) perceived increased in self report, objective and performance function. Participants will also give feedback about the assessments and whether they capture aspects important to them, and we will refine the length, timing, and content of these as needed. We will ask specific questions about any problems with adherence to DMD and 3RP homework. Questions will also be asked about the therapeutic alliance with the group leader, and the extent to which participants felt connected and understood by the group leader. Finally, we will ask questions about the best approaches for participant recruitment and retention. Drs. Vranceanu and Park have used these types of procedures in other mind-body intervention studies. Information from qualitative interviews will be corroborated with information from the satisfaction and the credibility questionnaires and will serve to refine the intervention for Phase 3.

Participants in the p3RP-DMD group will pair their Fitbit DMD to a smartphone with Bluetooth, and the Fitbit will inform an individualized quota-based behavioral plan to improve both adherence and efficacy. All participants will also wear an accelerometer for 7 days at baseline and at the end of the intervention. After 7 days, participants will return the accelerometers in addition to an accelerometer wear time log. Participants will be compensated $20 for each assessment completed, $10 for transportation (for each visit), and $10 for completion of the exit interview.

Phase III:

During enrollment, participants have the option to consent to receiving reminders in the form of phone calls, text messages, or email over the course of the intervention, depending on personal preference. Between-session contact will be used with the goal of increasing treatment adherence and engagement. Participants may opt-out of the text message contact option at any point.

After enrollment, participants will be assigned to one of the two intervention groups using a randomized block design to ensure that equal numbers of patients are split into the p3RP-DMD and p3RP groups. To prevent participant unblinding, participants will be asked not to share specific information discussed in the group (e.g., skills learned, topics discussed) on social media sites (e.g., Facebook groups or internet chat groups) or with other acquaintances for the duration of the study. The groups will be conducted in person at MGH by trained study therapists over 12 weeks and include 10 active intervention sessions. Each session will last approximately 90 minutes. Participants will also be asked to answer follow-up assessment questionnaires 3 months following program completion. These questionnaires will be administered over the phone for 30-45 minutes.

Participants will complete demographics assessments at baseline, in addition to psychological/behavioral assessments and a 6-minute walk test at both baseline and post-test timepoints. Participants in the p3RP-DMD group will pair their Fitbit DMD to a smartphone with Bluetooth, and the Fitbit will inform an individualized quota-based behavioral plan to improve both adherence and efficacy. All participants will also wear an accelerometer for 7 days before the first treatment session (baseline) and for 7 days after the final treatment session (post-test). After each assessment week, participants will return the accelerometers in addition to a wear time log.

The following measures will be administered at all timepoints unless otherwise stated. Questionnaires at 3-month follow-up will be administered over the phone.

Demographics – *baseline only*
Credibility and Expectancy Questionnaire (CEQ) – *baseline only*
Pittsburgh Sleep Quality Index (PSQI)
PROMIS Physical Function SF
Physical Activity Scale for Individuals with Physical Disabilities (PASIPD)
WHO Disability Assessment Scale (WHODAS) 2.0

Numerical Rating Scale for Pain (NRS)
Pain Resilience Scale (PRS)
PROMIS Anxiety SF
PROMIS Depression SF
PROMIS Social Isolation SF
PROMIS Emotional Support SF
Measure of Current Status (MOCS)
Pain Catastrophizing Scale (PCS)
Tampa Kinesiophobia Scale
Cognitive and Affective Mindfulness Scale (CAMS-R)
Patient Global Impression of Change (PGIC) – *post-test and 3-month follow-up only*
Client Satisfaction Questionnaire (CSQ-3) – *post-test and 3-month follow-up only*

Participants will be given the option to complete a maximum of two make-up sessions via the Vidyo teleconferencing software. Vidyo is a HIPAA approved, secure web platform used in clinical care for patients at MGH. Participants will have a Vidyo meeting with study staff to ensure that they are comfortable using Vidyo for make-up sessions only. Ratings of patient satisfaction are high, and there have been no complaints of technological difficulties. Participants will be compensated $20 for each of three assessments completed and $10 for transportation (for each group session attended). They can also receive up to two additional $25 payments for completing 6 group sessions and 8 group sessions. The maximum compensation per participant is $230.

At study enrollment completion (e.g., no longer recruiting or enrolling, and only completing follow-up measures and data analysis), we will conduct 12 qualitative exit interviews with participants who have completed all study measures (e.g., completing questionnaires at both baseline and post-test and wearing the accelerometer at both baseline and post-test). Participants will be randomly selected to complete the interview, which will last 15 minutes and will be completed over the phone with the study clinician. We will conduct qualitative exit interviews within the following four categories: 1) 3 participants who were sedentary at baseline (i.e, less than 5,000 steps) and increased their step-count at post-test; 2) 3 participants who were sedentary and did not increase their step-count at post-test; 3) 3 participants who were not sedentary at baseline and did increase their step-count; 4) 3 participants who were not sedentary at baseline and did not increase their step-count at post-test. Participants will be called and will be contacted until clinician is able to speak to participant. If a participant declines, a new random participant number will be selected.

VI. BIOSTATISTIC ANALYSIS

Phase I

The qualitative focus group data and individual exit interview data will be transcribed and analyzed, using NVivo 10 qualitative software, and we will conduct thematic content analysis using guidelines provided by Miles and Huberman (1984). The 2 coders (AMV and study clinician) will meet on an ongoing basis with Dr. Park to discuss the structural thematic framework, categories, and coding plan. To ensure coding reliability, coding discrepancies will be resolved through discussion and comparison of raw data. Coding will continue until a high reliability (Kappa= >0.80) is established. Once these data analyses are completed, the multidisciplinary team will provide the expert review of data, to discuss the interpretation of our findings in the context of current research on chronic heterogeneous pain.

Phases II and III

The p3RP-DMD intervention group will use a Fitbit DMD through which participants will use Fitbit accounts with deidentified physical measurements (i.e., height and weight) and profile information with approximate birthdays (e.g., month and year only). Participant account names will be set up with a study ID number as the first name and “Participant” as the last name. De-identified DMD data will be processed securely though the Fitbit data collection company, Fitabase. Fitabase does not store identifiable data and all participant data is uploaded through encrypted server communication and stored in a highly secure infrastructure.

The qualitative exit interview data will be transcribed and analyzed, using NVivo 10 qualitative software, and we will conduct thematic content analysis using guidelines provided by Miles and Huberman (1984). The 2 coders (AMV and study clinician) will meet on an ongoing basis to discuss the structural thematic framework, categories, and coding plan. To ensure coding reliability, coding discrepancies will be resolved through discussion and comparison of raw data. Coding will continue until a high reliability (Kappa= >0.80) is established. Once these data analyses are completed, the multidisciplinary team will provide the expert review of data, to discuss the interpretation of our findings in the context of current research on chronic heterogeneous pain.

VII. RISKS AND DISCOMFORTS

Patients will be informed that there are no foreseeable physical risks from this research study. They will be informed that in the unlikely situation that they might feel uncomfortable with the topic of discussing within the group, they can alert the group leader who will provide help, as needed.

As Vidyo is HIPAA approved and secure, there are no risks associated with its use. However, participants will be asked to ensure that they are in a private room during the group sessions, to protect their privacy and that of group members. As with any group studies, there may be confidentiality issues, but we will discuss the importance of maintaining confidentiality at the beginning of each group.

VIII. POTENTIAL BENEFITS

Patients will be informed that there may be no direct benefit from participating in this research study. Some patients may become more physically active, more resilient, better able to cope with pain and stress, and experience a better quality of life.

In the future, knowledge from this research may benefit others by providing information on how to better mind body interventions for patients with chronic pain.

IX. MONITORING AND QUALITY ASSURANCE

Phase I: The focus groups will be conducted uniformly using a semi structured interview script that will be finalized during the first few months of the study. The Principal Investigator will be responsible for ensuring compliance with IRB procedures.

Phase II: Study therapists will have weekly team meetings and clinical supervision. Study staff will follow the patient manuals for each group and assure that all items on all questionnaires have been addressed. Once completed, data will be checked for out of range values using frequency distributions prior to analyzing the data. The Principal Investigator will be responsible for ensuring compliance with IRB procedures.

Phase III: Feasibility will be assessed as depicted in the prior section. We will calculate the proportion of patients who complete at least 6 of the 8-planned treatment sessions (75%), along with the 95% confidence interval (CI) around this discontinuation rate. Treatments are considered feasible if over 70% of participants complete at least 6 treatment sessions.

Adherence to treatment manual: Drs. Vranceanu and Park will assess adherence to treatment by listening to the audio recorded sessions, completing and analyzing the therapist adherence checklists. Dr. Park will rate adherence for the groups led by Dr. Vranceanu in phase 3. Dr. Vranceanu will rate adherence of study clinician in phase 3. The therapists will also complete session adherence checklists.

Adherence to Accelerometer and Fitbit DMD: We will report number of days participants in both groups wore the Accelerometers at baseline and at post-test, and average number of days the Fitbit was used in the p3RP-DMD group.

X. REFERENCES

1. Merskey, H., & Bogduk, N. (1994). Part III: Pain terms, a current list with definitions and notes on usage. *Classification of Chronic Pain, 2*, 209-214.
2. Institute of Medicine (US). Committee on Advancing Pain Research, Care, and Education. (2011). *Relieving pain in america: A blueprint for transforming prevention, care, education, and research* National Academies Press.
3. Glajchen, M. (2001). Chronic pain: Treatment barriers and strategies for clinical practice. *The Journal of the American Board of Family Practice, 14*(3), 211-218.
4. Research Funding Priorities. (n.d.). Retrieved April 1, 2015, from https://nccih.nih.gov/grants/priorities
5. den Boer, J. J., Oostendorp, R. A., Beems, T., Munneke, M., Oerlemans, M., & Evers, A. W. (2006). A systematic review of bio-psychosocial risk factors for an unfavourable outcome after lumbar disc surgery. *European Spine Journal, 15*(5), 527-536.
6. Turk, D. C., & Okifuji, A. (2002). Psychological factors in chronic pain: Evolution and revolution. *Journal of Consulting and Clinical Psychology, 70*(3), 678.
7. Veehof, M. M., Oskam, M., Schreurs, K. M., & Bohlmeijer, E. T. (2011). Acceptance-based interventions for the treatment of chronic pain: A systematic review and meta-analysis. *Pain®, 152*(3), 533-542.
8. Taylor, A. M., Phillips, K., Patel, K. V., Turk, D. C., Dworkin, R. H., Beaton, D., . . . Witter, J. (2016). Assessment of physical function and participation in chronic pain clinical trials: IMMPACT/OMERACT recommendations. *Pain, 157*(9), 1836-1850. doi:10.1097/j.pain.0000000000000577 [doi]
9. World Health Organization. (2001). *International classification of functioning, disability and health: ICF.* World Health Organization.
10. Park, E. R., Traeger, L., Vranceanu, A., Scult, M., Lerner, J. A., Benson, H., . . . Fricchione, G. L. (2013). The development of a patient-centered program based on the relaxation response: The relaxation response resiliency program (3RP). *Psychosomatics, 54*(2), 165-174.
11. Vranceanu, A., Gonzalez, A., Niles, H., Fricchione, G., Baim, M., Yeung, A., . . . Park, E. R. (2014). Exploring the effectiveness of a modified comprehensive mind-body intervention for medical and psychologic symptom relief. *Psychosomatics, 55*(4), 386-391.
12. Denninger, J., Jacquart, J., Miller, K., Radossi, A., Haime, V., Macklin, E., . . . Yeung, A. (2014). The effectiveness of a community-based mind body group intervention for depression & anxiety: A pilot study. *The Journal of Alternative and Complementary Medicine, 20*(5), A55-A55.
13. Miller, K. M., Chad-Friedman, E., Haime, V., Mehta, D. H., Lepoutre, V., Gilburd, D., . . . Fricchione, G. L. (2015). The effectiveness of a brief mind-body intervention for treating depression in community health center patients. *Global Advances in Health and Medicine, 4*(2), 30-35.
14. Vranceanu, A., Shaefer, J. R., Saadi, A. F., Slawsby, E., Sarin, J., Scult, M., . . . Denninger, J. W. (2013). The relaxation response resiliency enhancement program in the management of chronic refractory temporomandibular joint disorder: Results from a pilot study. *Journal of Musculoskeletal Pain, 21*(3), 224-230.
15. Vranceanu, A., Merker, V. L., Plotkin, S. R., & Park, E. R. (2014). The relaxation response resiliency program (3RP) in patients with neurofibromatosis 1, neurofibromatosis 2, and schwannomatosis: Results from a pilot study. *Journal of Neuro-Oncology, 120*(1), 103-109.
16. Vranceanu, A. M., Riklin, E., Merker, V. L., Macklin, E. A., Park, E. R., & Plotkin, S. R. (2016). Mind–body therapy via videoconferencing in patients with neurofibromatosis An RCT. *Neurology*, *87*(8), 806-814.
17. Appelboom, G., Camacho, E., Abraham, M. E., Bruce, S. S., Dumont, E. L., Zacharia, B. E., . . . Bruyère, O. (2014). Smart wearable body sensors for patient self-assessment and monitoring. *Archives of Public Health, 72*(1), 1.
18. Cadmus-Bertram, L. A., Marcus, B. H., Patterson, R. E., Parker, B. A., & Morey, B. L. (2015). Randomized trial of a fitbit-based physical activity intervention for women. *American Journal of Preventive Medicine, 49*(3), 414-418.
19. Kurti, A. N., & Dallery, J. (2013). Internet-based contingency management increases walking in sedentary adults. *Journal of Applied Behavior Analysis, 46*(3), 568-581.
20. Patel, M. S., Asch, D. A., & Volpp, K. G. (2015). Wearable devices as facilitators, not drivers, of health behavior change. *Jama*, *313*(5), 459-460.
21. Mahaffey B, Gonzalez A, Reffi A, Kotov R, Bromet E,Luft B, Vranceanu AM, Park E.. The development of a credible comparison treatment for the 3RP. Poster presented at the 48th annual Association for Behavioral and Cognitive Therapies conference. Philadelphia, PA, 2014, November.
22. Devilly, G. J., & Borkovec, T. D. (2000). Psychometric properties of the credibility/expectancy questionnaire. *Journal of Behavior Therapy and Experimental Psychiatry, 31*(2), 73-86.

23. Attkisson, C. C., & Zwick, R. (1982). The client satisfaction questionnaire: Psychometric properties and correlations with service utilization and psychotherapy outcome. *Evaluation and Program Planning, 5*(3), 233-237.
24. Weber, W. (2015). The R34: An opportunity for critical groundwork in clinical trials research. *NCCIH Research Blog,* , https://nccih.nih.gov/research/blog/r34.
25. Leon, A. C., Davis, L. L., & Kraemer, H. C. (2011). The role and interpretation of pilot studies in clinical research. *Journal of Psychiatric Research, 45*(5), 626-629.
26. Ericsson, M., II, W. P., Linder, J., Taylor, J. E., Haddock, C. K., & Foreyt, J. P. (2002). Depression predicts disability in long-term chronic pain patients. *Disability and Rehabilitation, 24*(6), 334-340.
27. Dersh, J., Polatin, P. B., & Gatchel, R. J. (2002). Chronic pain and psychopathology: Research findings and theoretical considerations. *Psychosomatic Medicine, 64*(5), 773-786.
28. Keefe, F. J., Rumble, M. E., Scipio, C. D., Giordano, L. A., & Perri, L. M. (2004). Psychological aspects of persistent pain: Current state of the science. *The Journal of Pain, 5*(4), 195-211.
29. Azevedo, L. F., Costa-Pereira, A., Mendonça, L., Dias, C. C., & Castro-Lopes, J. M. (2012). Epidemiology of chronic pain: A population-based nationwide study on its prevalence, characteristics and associated disability in portugal. *The Journal of Pain, 13*(8), 773-783.
30. Garin, N., Olaya, B., Perales, J., Moneta, M. V., Miret, M., Ayuso-Mateos, J. L., & Haro, J. M. (2014). Multimorbidity patterns in a national representative sample of the spanish adult population. *PLoS One, 9*(1), e84794.
31. den Boer, J. J., Oostendorp, R. A., Beems, T., Munneke, M., Oerlemans, M., & Evers, A. W. (2006). A systematic review of bio-psychosocial risk factors for an unfavourable outcome after lumbar disc surgery. *European Spine Journal, 15*(5), 527-536.
32. Turk, D. C., Swanson, K. S., & Tunks, E. R. (2008). Psychological approaches in the treatment of chronic pain patients--when pills, scalpels, and needles are not enough. *Canadian Journal of Psychiatry.Revue Canadienne De Psychiatrie, 53*(4), 213-223.
33. Vranceanu, A. M., Bachoura, A., Weening, A., Vrahas, M., Smith, R. M., & Ring, D. (2014). Psychological factors predict disability and pain intensity after skeletal trauma. *The Journal of Bone and Joint Surgery.American Volume, 96*(3), e20. doi:10.2106/JBJS.L.00479 [doi]
34. Crombez, G., Eccleston, C., Van Damme, S., Vlaeyen, J. W., & Karoly, P. (2012). Fear-avoidance model of chronic pain: The next generation. *The Clinical Journal of Pain, 28*(6), 475-483. doi:10.1097/AJP.0b013e3182385392 [doi]
35. Wideman, T. H., Asmundson, G. G., Smeets, R. J., Zautra, A. J., Simmonds, M. J., Sullivan, M. J., . . . Edwards, R. R. (2013). Rethinking the fear avoidance model: Toward a multidimensional framework of pain-related disability. *Pain, 154*(11), 2262-2265. doi:10.1016/j.pain.2013.06.005 [doi]
36. Lamé, I. E., Peters, M. L., Vlaeyen, J. W., Kleef, M. v., & Patijn, J. (2005). Quality of life in chronic pain is more associated with beliefs about pain, than with pain intensity. *European Journal of Pain, 9*(1), 15-24.
37. Goyal, M., Singh, S., Sibinga, E. M., Gould, N. F., Rowland-Seymour, A., Sharma, R., . . . Shihab, H. M. (2014). Meditation programs for psychological stress and well-being: A systematic review and meta-analysis. *JAMA Internal Medicine, 174*(3), 357-368.
38. Schutze, R., Slater, H., O'Sullivan, P., Thornton, J., Finlay-Jones, A., & Rees, C. S. (2014). Mindfulness-based functional therapy: A preliminary open trial of an integrated model of care for people with persistent low back pain. *Frontiers in Psychology, 5*, 839. doi:10.3389/fpsyg.2014.00839 [doi]
39. Wetherell, J. L., Afari, N., Rutledge, T., Sorrell, J. T., Stoddard, J. A., Petkus, A. J., . . . Lang, A. J. (2011). A randomized, controlled trial of acceptance and commitment therapy and cognitive-behavioral therapy for chronic pain. *Pain, 152*(9), 2098-2107.
40. Veehof, M. M., Oskam, M., Schreurs, K. M., & Bohlmeijer, E. T. (2011). Acceptance-based interventions for the treatment of chronic pain: A systematic review and meta-analysis. *Pain®, 152*(3), 533-542.
41. Grabovac, A. D., Lau, M. A., & Willett, B. R. (2011). Mechanisms of mindfulness: A buddhist psychological model. *Mindfulness, 2*(3), 154-166.
42. Holzel, B. K., Lazar, S. W., Gard, T., Schuman-Olivier, Z., Vago, D. R., & Ott, U. (2011). How does mindfulness meditation work? proposing mechanisms of action from a conceptual and neural perspective. *Perspectives on Psychological Science : A Journal of the Association for Psychological Science, 6*(6), 537-559. doi:10.1177/1745691611419671 [doi]
43. Gotink, R. A., Chu, P., Busschbach, J. J., Benson, H., Fricchione, G. L., & Hunink, M. M. (2015). Standardised mindfulness-based interventions in healthcare: An overview of systematic reviews and meta-analyses of RCTs. *PLoS*

One, 10(4), e0124344.
44. Dworkin, R. H., Turk, D. C., Farrar, J. T., Haythornthwaite, J. A., Jensen, M. P., Katz, N. P., . . . IMMPACT. (2005). Core outcome measures for chronic pain clinical trials: IMMPACT recommendations. *Pain, 113*(1-2), 9-19. doi:S0304-3959(04)00440-3 [pii]
45. Jackson, W. C., Kulich, R. J., Malacarne, A., Lapidow, A., Berman, S., Vranceanu, A. M., (2016). Physical functioning and mindfulness skills training in chronic pain: a systematic review. (Submitted to *Pain Medicine*).
46. Bawa, F. L., Mercer, S. W., Atherton, R. J., Clague, F., Keen, A., Scott, N. W., & Bond, C. M. (2015). Does mindfulness improve outcomes in patients with chronic pain? systematic review and meta-analysis. *The British Journal of General Practice : The Journal of the Royal College of General Practitioners, 65*(635), e387-400. doi:10.3399/bjgp15X685297 [doi]
47. Wetherell, J. L., Afari, N., Rutledge, T., Sorrell, J. T., Stoddard, J. A., Petkus, A. J., . . . Lang, A. J. (2011). A randomized, controlled trial of acceptance and commitment therapy and cognitive-behavioral therapy for chronic pain. *Pain, 152*(9), 2098-2107.
48. United States. Department of Health, & Human Services. (1996). *Physical activity and health: A report of the Surgeon General*. DIANE Publishing.
49. Kaleth, A. S., Slaven, J. E., & Ang, D. C. (2014). Does increasing steps per day predict improvement in physical function and pain interference in adults with fibromyalgia? *Arthritis Care & Research, 66*(12), 1887-1894.
50. van den Heuvel, Swenne G, Heinrich, J., Jans, M., Van der Beek, A., & Bongers, P. (2005). The effect of physical activity in leisure time on neck and upper limb symptoms. *Preventive Medicine, 41*(1), 260-267.
51. Kroll, H. R. (2015). Exercise therapy for chronic pain. *Physical Medicine and Rehabilitation Clinics of North America, 26*(2), 263-281.
52. Geneen, L., Smith, B., & Clarke, C. (2014). Physical activity and exercise for chronic pain in adults: An overview of cochrane reviews (protocol). *Cochrane Database Syst Rev, 8*
53. Nijs, J., Kosek, E., Van Oosterwijck, J., & Meeus, M. (2012). Dysfunctional endogenous analgesia during exercise in patients with chronic pain: To exercise or not to exercise? *Pain Physician, 15*(3S), ES205-ES213.
54. Richards, M. C., Ford, J. J., Slater, S. L., Hahne, A. J., Surkitt, L. D., Davidson, M., & McMeeken, J. M. (2013). The effectiveness of physiotherapy functional restoration for post-acute low back pain: A systematic review. *Manual Therapy, 18*(1), 4-25.
55. Kent, P., & Kjaer, P. (2012). The efficacy of targeted interventions for modifiable psychosocial risk factors of persistent nonspecific low back pain–a systematic review. *Manual Therapy, 17*(5), 385-401.
56. Rainville, J., Hartigan, C., Martinez, E., Limke, J., Jouve, C., & Finno, M. (2004). Exercise as a treatment for chronic low back pain. *The Spine Journal, 4*(1), 106-115.
57. Slade, S. C., Patel, S., Underwood, M., & Keating, J. L. (2014). What are patient beliefs and perceptions about exercise for nonspecific chronic low back pain? A systematic review of qualitative studies. *The Clinical Journal of Pain, 30*(11), 995-1005. doi:10.1097/AJP.0000000000000044 [doi]
58. Perruchoud, C., Buchser, E., Johanek, L. M., Aminian, K., Paraschiv-Ionescu, A., & Taylor, R. S. (2014). Assessment of physical activity of patients with chronic pain. *Neuromodulation: Technology at the Neural Interface, 17*(S1), 42-47.
59. O'Connor, S. R., Tully, M. A., Ryan, B., Bleakley, C. M., Baxter, G. D., Bradley, J. M., & McDonough, S. M. (2015). Walking exercise for chronic musculoskeletal pain: Systematic review and meta-analysis. *Archives of Physical Medicine and Rehabilitation, 96*(4), 724-734. e3.
60. Ambrose, K. R., & Golightly, Y. M. (2015). Physical exercise as non-pharmacological treatment of chronic pain: Why and when. *Best Practice & Research Clinical Rheumatology, 29*(1), 120-130.
61. Prince, S. A., Adamo, K. B., Hamel, M. E., Hardt, J., Gorber, S. C., & Tremblay, M. (2008). A comparison of direct versus self-report measures for assessing physical activity in adults: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity, 5*(1), 1.
62. Bravata, D. M., Smith-Spangler, C., Sundaram, V., Gienger, A. L., Lin, N., Lewis, R., . . . Sirard, J. R. (2007). Using pedometers to increase physical activity and improve health: A systematic review. *Jama, 298*(19), 2296-2304.
63. Walter, P. L. (2007). The history of the accelerometer: 1920s-1996-prologue and epilogue, 2006. *Sound & Vibration, 41*(1), 84-90.
64. Lee, I. M., & Shiroma, E. J. (2014). Using accelerometers to measure physical activity in large-scale epidemiological studies: Issues and challenges. *British Journal of Sports Medicine, 48*(3), 197-201. doi:10.1136/bjsports-2013-

093154 [doi]
65. Gusmer, R., Bosch, T., Watkins, A., Ostrem, J., & Dengel, D. (2014). Comparison of FitBit® ultra to ActiGraph™ GT1M for assessment of physical activity in young adults during treadmill walking. *The Open Sports Medicine Journal, 8*(1)
66. Takacs, J., Pollock, C. L., Guenther, J. R., Bahar, M., Napier, C., & Hunt, M. A. (2014). Validation of the fitbit one activity monitor device during treadmill walking. *Journal of Science and Medicine in Sport, 17*(5), 496-500.
67. Eccleston, C., Williams, Amanda C de C, & Morley, S. (2009). Psychological therapies for the management of chronic pain (excluding headache) in adults. *The Cochrane Library,* Syst Rev 2012;11
68. Holzel, B. K., Lazar, S. W., Gard, T., Schuman-Olivier, Z., Vago, D. R., & Ott, U. (2011). How does mindfulness meditation work? proposing mechanisms of action from a conceptual and neural perspective. *Perspectives on Psychological Science : A Journal of the Association for Psychological Science, 6*(6), 537-559. doi:10.1177/1745691611419671 [doi]
69. Cherkin, D. C., Sherman, K. J., Balderson, B. H., Cook, A. J., Anderson, M. L., Hawkes, R. J., . . . Turner, J. A. (2016). Effect of mindfulness-based stress reduction vs cognitive behavioral therapy or usual care on back pain and functional limitations in adults with chronic low back pain: A randomized clinical trial. *Jama, 315*(12), 1240-1249.
70. Eisenberg D. M., Buring J. E., Hrbek A. L., et al. A model of integrative care for low-back pain. *Journal of Alternative and Complementary Medicine*. 2012;18(4):354–362. doi: 10.1089/acm.2011.0408.
71. Llamas, R., Urbani, J., & Shirer, M. (2015, June 3). Wearable Market Remained Strong in the First Quarter Despite the Pending Debut of the Apple Watch, Says IDC. Retrieved December 28, 2015, from http://www.idc.com/getdoc.jsp?containerId=prUS25658315
72. Lee, J., Kim, Y., & Welk, G. J. (2014). Validity of consumer-based physical activity monitors. *Med Sci Sports Exerc, 46*(9), 1840-1848.
73. Washington, W. D., Banna, K. M., & Gibson, A. L. (2014). Preliminary efficacy of prize-based contingency management to increase activity levels in healthy adults. *Journal of Applied Behavior Analysis, 47*(2), 231-245.
74. Feehan, L., Clayton, C., Carruthers, E., & Li, L. (2014). FRI0579-HPR feasibility of using fitbit flex to motivate people with rheumatoid arthritis to BE physically active. *Annals of the Rheumatic Diseases, 73*(Suppl 2), 1204-1205.
75. Kulich, R., Berna, C., Backstrom, J., & Mao, J. (2015). (476) The use of a commonly-used digital monitoring device as a post treatment activity measure to encourage function after structured opioid tapering, a case report. The Journal of Pain, 16(4), S95
76. McCracken LM, Carson JW, Eccleston C, Keefe F. (2004). Acceptance and change in the context of chronic pain. *109*, 4-9.
77. Grabovac, A. D., Lau, M. A., & Willett, B. R. (2011). Mechanisms of mindfulness: A buddhist psychological model. *Mindfulness, 2*(3), 154-166.
78. Fredrickson, B. L. (2001). The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *American Psychologist, 56*(3), 218.
79. Fordyce, W. E. (1984). Behavioural science and chronic pain. *Postgraduate Medical Journal, 60*(710), 865-868.
80. Eccleston, C., Williams, Amanda C de C, & Morley, S. (2009). Psychological therapies for the management of chronic pain (excluding headache) in adults. *The Cochrane Library,*
81. Richards, M. C., Ford, J. J., Slater, S. L., Hahne, A. J., Surkitt, L. D., Davidson, M., & McMeeken, J. M. (2013). The effectiveness of physiotherapy functional restoration for post-acute low back pain: A systematic review. *Manual Therapy, 18*(1), 4-25.
82. Rounsaville, B. J., Carroll, K. M., & Onken, L. S. (2001). A stage model of behavioral therapies research: Getting started and moving on from stage I. *Clinical Psychology: Science and Practice, 8*(2), 133-142.
83. Czajkowski, S. M., Powell, L. H., Adler, N., Naar-King, S., Reynolds, K. D., Hunter, C. M., . . . Peterson, J. C. (2015). From ideas to efficacy: The ORBIT model for developing behavioral treatments for chronic diseases. *Health Psychology, 34*(10), 971.
84. Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P., . . . Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: Explanation and elaboration. *Annals of Internal Medicine, 151*(4), W-65-W-94.
85. Rodriguez, C. S. (2001). Pain measurement in the elderly: A review. *Pain Management Nursing, 2*(2), 38-46.
86. Farrar, J. T., Young, J. P., LaMoreaux, L., Werth, J. L., & Poole, R. M. (2001). Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale. *Pain, 94*(2), 149-158.

87. Stone, A. A., Broderick, J. E., Junghaenel, D. U., Schneider, S., & Schwartz, J. E. (2015). PROMIS fatigue, pain intensity, pain interference, pain behavior, physical function, depression, anxiety, and anger scales demonstrate ecological validity. *Journal of Clinical Epidemiology,*
88. *PROMIS Physical Function Scoring Manual*. Patient Reported Outcomes Measurement Information System, 2015. Retrieved January 25, 2016, from https://www.assessmentcenter.net/documents/PROMIS%20Physical%20Function%20Scoring%20Manual.pdf
89. Broderick, J. E., Schneider, S., Junghaenel, D. U., Schwartz, J. E., & Stone, A. A. (2013). Validity and reliability of Patient-Reported outcomes measurement information system instruments in osteoarthritis. *Arthritis Care & Research, 65*(10), 1625-1633.
90. Cain, K. L., Conway, T. L., Adams, M. A., Husak, L. E., & Sallis, J. F. (2013). Comparison of older and newer generations of ActiGraph accelerometers with the normal filter and the low frequency extension. *International Journal of Behavioral Nutrition and Physical Activity, 10*(1), 1.
91. Wanner, M., Martin, B. W., Meier, F., Probst-Hensch, N., & Kriemler, S. (2013). Effects of filter choice in GT3X accelerometer assessments of free-living activity. *Medicine and Science in Sports and Exercise, 45*(1), 170-177. doi:10.1249/MSS.0b013e31826c2cf1 [doi]
92. BALKE, B. (1963). A simple field test for the assessment of physical fitness. rep 63-6. *[Report].Civil Aeromedical Research Institute (U.S.),* , 1-8.
93. *PROMIS Depression Scoring Manual*. Patient Reported Outcomes Measurement Information System, 2015. Retrieved January 25, 2016, from https://www.assessmentcenter.net/documents/PROMIS%20Depression%20Scoring%20Manual.pdf
94. *PROMIS Anxiety Scoring Manual*. Patient Reported Outcomes Measurement Information System, 2015. Retrieved January 25, 2016, from https://www.assessmentcenter.net/documents/PROMIS%20Anxiety%20Scoring%20Manual.pdf
95. Sullivan, M. J., Bishop, S. R., & Pivik, J. (1995). The pain catastrophizing scale: Development and validation. *Psychological Assessment, 7*(4), 524.
96. Woby, S. R., Roach, N. K., Urmston, M., & Watson, P. J. (2005). Psychometric properties of the TSK-11: A shortened version of the tampa scale for kinesiophobia. *Pain, 117*(1), 137-144.
97. Carver, C. (2006). Measure of current status. Retrieved December 30, 2015, from http://www.psy.miami.edu/faculty/ccarver/sclMOCS.html
98. Geisser, M. E., Clauw, D. J., Strand, V., Gendreau, R. M., Palmer, R., & Williams, D. A. (2010). Contributions of change in clinical status parameters to patient global impression of change (PGIC) scores among persons with fibromyalgia treated with milnacipran. *Pain®, 149*(2), 373-378.
99. Miles, M. B., & Huberman, A. M. (1984). Drawing valid meaning from qualitative data: Toward a shared craft. *Educational Researcher, 13*(5), 20-3