Conversational AI to Improve Chronic Pain and Comorbid Conditions

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Abstract

Chronic pain management has proven to be a complex disease to treat within the realm of primary care. This necessitates the introduction of an innovative strategy that can bridge the gap between our patients' needs and the available resources through evidenced-based practice. The implementation of this Doctor of Nursing Practice (DNP) quality improvement project was centered around the use of a cognitive behavioral therapy (CBT) based intervention facilitated through an artificial intelligence (AI) enhanced mobile chatbot application, Wysa, to address the concomitant biopsychosocial comorbidities associated with chronic pain in the adult population. This project aimed to increase Pain, Enjoyment of Life and General Activity (PEG) scores by 15%, whilst concurrently aiming for associated reductions in Generalized Anxiety Disorder 7-item (GAD-7) and Patient Health Questionnaire-9 (PHQ-9) scores by April of 2025. Anchored in Dorothea Orem's self-care deficit theory, the implementation of this quality improvement project embraced a comprehensive biopsychosocial approach to chronic pain management within primary care. Implementation entailed patient recruitment, enrollment and administration of baseline and follow-up questionnaires through an 8-week Wysa-guided chronic pain focused CBT delivery program from 09/2024-12/2024. While limited by participant recruitment and retention, this intervention successfully achieved its aim of yielding clinically significant reductions in PEG, PHQ-9 and GAD-7 scores, with results exceeding the targeted 15% improvement threshold. Ethical and legal considerations were taken throughout this quality improvement project to uphold the tenets of patient autonomy, data privacy, and the patient-provider relationship. This study highlights the potential of AI-enabled CBT interventions as a scalable and accessible method for chronic pain management in primary care.

Keywords: Chronic pain management, Cognitive Behavioral Therapy (CBT), Artificial Intelligence (AI), Wysa, Self-Care Deficit Theory, Quality Improvement, Primary Care, Biopsychosocial Approach, Pain Management, Digital Health Interventions.

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Introduction

Chronic pain is defined as pain that persists for over 3 months and can result from inflammation, nerve injury, tissue damage, or central desensitization (Breivik et al., 2006). Primary care providers treat the vast majority of patients living with chronic pain in the United States via family practices or walk-in clinics (Kaseweter, Nazemi, Gregoire, Louw, Walsh & Holtzman, 2023). This is mostly attributed to the supply of pain specialists being greatly exceeded by the demand (Dubois & Follett, 2014). Family Nurse Practitioners (FNPs) play a crucial role in the delivery of effective, low-cost and quality healthcare services in primary care (Broderick et al., 2014). This is noteworthy as various prediction models have highlighted that the demand for primary care providers is expected to continue to overshadow provider supply (DePriest, D'Aoust, Samuel, Commodore-Mensah, Hanson, & Slade, 2021). These prediction models have also shown that by 2030, the shortage of primary care providers could exceed upwards of 43,100 nation-wide (DePriest et al., 2021). These models attribute the predicted shortage to factors including a 48% increase in patients over 65 years old, a decrease in the rate of production of primary care providers and an increased rate of current primary care providers retiring (DePriest et al., 2021). Research has shown that chronic pain care delivered by FNPs has produced significant improvements in pain coping, pain intensity, activity interference related to pain, self-efficacy for controlling pain, use of pain medication, physical functioning, fatigue, psychological distress and overall patient satisfaction with health (Broderick et al., 2014). FNPs are critical in managing chronic pain as their patient-centered approach and integration of non-opioid strategies align with evidence-based practices that improve function and patient satisfaction (D'Arcy & Kiley, 2021).

Management of chronic pain and its associated biopsychosocial detriments has proven to be a complex condition that requires a multifaceted approach for effective treatment. A major factor that complicates chronic pain management is its multidimensional nature which manifests with complex physical and psychological comorbidities such as depression, anxiety, fatigue and insomnia (Kaseweter et al., 2023). This project's approach to the management of chronic pain was grounded in Dorothea Orem's Self-Care Deficit Theory. Orem's theory is centered around the belief that individuals can recover more rapidly and holistically if they can perform their self-care to the best of their abilities (Yip, 2021). Orem's theory encompasses four key constructs; foundational capabilities and dispositions, basic conditioning factors, self-care requisites and overall ability to meet self-care needs (Yip, 2021). Foundational capabilities relate to an individual's characteristics, like the skills and/or traits that impact an individual's capacity to action (Yip, 2021). Basic conditioning factors encompass an individual's ability to undertake self-care activities and maintain the health of their environment (Yip, 2021). Self-care requisites takes into consideration the items and/or activities an individual requires in order to achieve holistic self-care (Yip, 2021). This theory supports the idea that the nurse practitioner's primary task is promoting each patient's self-care activities. The application of her theory acknowledges that patients living with chronic pain may experience difficulties in managing their condition due to the biopsychosocial impacts of the disease process (Yip, 2021). Guided by Orem's theory, this project addressed chronic pain through a multifaceted holistic approach to care (Yip, 2021). This project aimed to improve Pain, Enjoyment of Life and General Activity (PEG) scores in adult patients with chronic pain by 15% and secondarily, to have observed associated reductions in Generalized Anxiety Disorder 7-item (GAD-7) and Patient Health Questionnaire-9 (PHQ-9)

scores by April of 2025 using cognitive behavioral therapy (CBT) delivered via an artificial intelligence (AI) adjusted mobile chatbot application.

By integrating AI-enabled CBT (AI-CBT) using Wysa, this project overall aimed to enhance patient outcomes, reduce burden of pain and improve mental health along with quality of life for all patients. This aligns with Sustainable Development Goal #3 which seeks to ensure healthy lives and promote well-being for all at all ages (United Nations, 2023). Further, use of AI technology in healthcare, especially with AI-CBT via Wysa, represents a significant innovation in the health sector. Our project leveraged digital health infrastructure in order to provide accessible and cost-effective care, particularly for underserved populations. This also aligns with Sustainable Development Goal #9 by promoting the adoption of new technologies that can contribute to more effective and efficient healthcare delivery (United Nations, 2023).

Patient Population and Disease Process

Chronic pain is a significant health concern among adults in the United States with recent data estimating a prevalence of 20.4%, with 8% of these being high-impact chronic pain that limits completion of activities of daily life (ADLs) (Dahlhamer et al., 2018). Chronic pain in patients over the age of 65 results in an increased prevalence of reduced mobility, which is strongly correlated with depression/anxiety and has been shown to disrupt social and familial relationships (Schwan, Sclafani & Tawfik, 2019). Chronic pain has been documented to be one of the most common, debilitating and inadequately addressed disease processes (Schwan et al., 2019). Chronic pain has been found to affect 116 million Americans and cost the country $635 billion annually (Axon & Kamel, 2021). This is a significant finding because chronic pain itself is an immense obstacle for patients and is often the reason behind poor engagement in rehabilitation therapy and/or other ADLs (Dahlhamer et al., 2018). Furthermore, 6% of

Americans over the age of 65 are homebound due to chronic illnesses such as pain (Major-Monfried, DeCherrie, Wajnberg, Zhang, Kelley & Orenstein, 2018). The implications of chronic pain have also been documented to not be limited by age and found to often be impacting productivity and quality of life across the life course (Dahlhamer et al., 2018). Evidence has also highlighted that 20-50% of individuals who experience chronic pain have comorbid depression and/or anxiety, sleep disturbances, fatigue, and neurocognitive changes; in patients that live with chronic pain, 13% had changed their jobs, and 19% had lost their jobs all together (Mills, Torrance & Smith, 2016).

The complex pathophysiology behind chronic pain and its associated biopsychosocial detriments involves interactions between the central and peripheral nervous systems. Hence, effective management of chronic pain requires a comprehensive understanding of the underlying pathophysiology. Due to these complexities, The International Association of the Study of Pain has formulated a guideline to outline the current understanding of chronic pain (Yasaei, Peterson & Saadabadi, 2023):

1. Pain is an individual's perceived experience and is influenced by social, psychological, and biological factors
2. Pain cannot be inferred from sensory neuronal activity alone
3. The concept of pain is learned throughout stages of life
4. An individual’s report of the severity of pain is to be respected
5. Pain can adversely affect social and psychological well-being

Within primary care, treatments for chronic pain include both pharmacologic and non-pharmacologic therapies (Hestmann, Bratås & Grønning, 2023). Patients with chronic pain have been found to use substantial amounts of both prescription and non-prescription pharmacologic

pain relief; as Mills, Torrance & Smith (2016) stated "…almost half of all people with chronic pain were taking non-prescription analgesics, including non-steroidal anti-inflammatory drugs (NSAIDs) (55%), paracetamol (acetaminophen) (43%) and weak opioids (13%)" (p. 18). The same study found that two thirds of patients with chronic pain were prescribed medications including "…NSAIDs (44%), weak opioids (23%), paracetamol (acetaminophen) (18%), COX-2 inhibitors (1–36%) and strong opioids (5%)" (Mills, Torrance & Smith, 2016, p. 18). Busse et al. (2018) found that between 2013 to 2016, the United States was the largest consumer of opioids globally. Non-pharmacological approaches include physical rehabilitation, psychological therapy and interventional treatments (e.g., acupuncture and dry-needling) (Schwan et al., 2019). Physical rehabilitation modalities used within primary care include education surrounding high-intensity and low-intensity strength training, T'ai Chi, aqua-aerobic regimens, and resistance training (Schwan et al., 2019). Psychological therapies encompasses interventions aimed at comorbid conditions such as depression, anxiety and lack of adaptive coping through acceptance and commitment therapy, CBT and dialectal behavioral therapy (Schwan et al., 2019). While combined pharmacologic and non-pharmacologic therapies are most helpful for chronic pain management, primary care clinicians lack adequate education surrounding non-pharmacologic management approaches. In one study, 59% of primary care physicians stated that they would benefit from education surrounding non-pharmacological treatment options, specifically psychotherapy and physiotherapy (Kaseweter et al., 2023).

Technology and Intervention

The technology and intervention implemented throughout this project recognized the importance of the self-management approach to chronic pain management. Mills, Torrance & Smith (2016) found that the self-management approach to chronic pain is both efficacious and

cost-effective in improving quality of life in patients with chronic pain. Sinha, Cheng & Kadaba (2022) emphasize that integrating digital tools can significantly enhance self-management by empowering patients to actively participate in their care, leading to improved health outcomes. Turner and Ogbeide (2019) state that the implementation of a biopsychosocial model when treating chronic pain in the primary care setting can assist providers in having access to a conceptual framework that addresses the somatic, cognitive, biological, and affective dimensions associated with chronic pain. Additionally, this approach has been documented to positively address central pain syndromes and target their associated effects on social support/isolation, social expectations, interpersonal relationships, ADLs and work history (Turner & Ogbeide, 2019). The interventions associated with the self-management approach include active and passive range of motion exercises, strength training, aerobic exercise, CBT, acceptance and commitment therapy, mindfulness, relaxed breathing and imagery (Turner & Ogbeide, 2019).

Despite the plethora of literature in support of the self-management approach, it has not been implemented broadly to assist patients that experience chronic pain to effectively manage their condition (Turner & Ogbeide, 2019). There exists a significant gap in the needs of those in chronic pain due to the lack of therapeutic resources, outpatient facilities being inundated and the rise in rates of mental health concerns following the pandemic (Gupta, Malik & Sinha, 2022). Further, barriers to use of non-pharmacological pain treatment modalities have been found to include; provider lack of awareness and provider/patient skepticism of treatment modality, lack of insurance coverage and providers disbelief surrounding patients' pain (Becker, Dorflinger, Edmond, Islam, Heapy & Fraenkel, 2017).

Although there are various evidence-based self-management approaches to chronic pain management, this project focused on the implementation of CBT. CBT has been shown to be an

effective treatment modality to address the biopsychosocial effects associated with chronic pain (Lim et al., 2018). This form of treatment assists patients by working with them to formulate coping strategies and improve overall psychological well-being. The emergence of AI technologies serves as a promising resource for providers to optimize chronic pain management and its comorbid conditions due to its increased efficiency in gathering, synthesizing, and analyzing the data points necessary for an effective treatment therapy (Gupta, et al., 2022). Specifically, the use of an AI-enabled chatbot to deliver CBT may address current barriers to non-pharmacological pain treatment. Inclusion of free-of-charge AI technologies, like Wysa which were used in this project, help overcome barriers to psychological treatment such as high-cost burden, lack of insurance coverage or lack of provider awareness through the production of real-time, evidence-based and patient-centered care (Gual-Montolio, Jaén, Martínez-Borba, Castilla & Suso-Ribera, 2022).

Wysa is an AI program that has had success in the primary care arena. Sinha et al. (2022) conducted a survival analysis that demonstrated significant retention and engagement rates among adults with chronic pain using the Wysa app. Wysa is an AI-enabled conversational agent that can provide CBT (Gupta et al., 2022). Wysa has the capability to provide real-time feedback, adapt to the patient's progress, and provide person-centered targeted treatment plans. Wysa is completely free and offers its users healthy coping mechanisms and self-care tools rooted in CBT, mindfulness, and behavioral reinforcement (Gupta et al., 2022). Patients can download Wysa as an app onto their devices and use the free-text conversational interface to interact with the AI (Meheli, Sinha & Kadaba, 2022). Studies have highlighted that the use of AI-CBT for chronic pain care produced patient outcomes that were noninferior to the standard approach of an in-person and therapist delivered CBT session for chronic pain (Piette et al.,

2022). AI-CBT for chronic pain has also been shown to overcome obstacles to seeking psychological therapy such as lack of anonymity, stigma, waiting times and high-cost burden with in-person sessions (Gual-Montolio et al, 2022). Sinha et al. (2022) found that in an 8-week CBT program for chronic pain through Wysa with adults over the age of 18, there was a 96% onboarding success rate of patients who were interested in trialing the program, along with a 70% retention rate at a one-month follow-up. The most frequently used interventions by participants in this study were: thought recording (19.7%), pain acceptance (16.0%), sleep meditation (14.9%), mindfulness (10.4%) and anxiety management (9.8%) (Sinha et al., 2022). Leo et al. (2022) highlighted findings suggesting that increased adherence to Wysa-provided treatment protocols resulted in improved psychological well-being. Wysa's ability to offer personalized support through interactive sessions was found to significantly enhance both user retention and engagement (Sinha et al., 2022). Some worry about lack of technology literacy among older adults as a barrier to uptake of these AI-enabled therapeutic interventions. However, studies have shown that the number of older adults with a smartphone has risen, finding that 85% of respondents aged 65-74 and 74% of respondents over 75 years old have used more than one digital health device (Győrffy, Boros, Döbrössy & Girasek, 2023). Additionally, 54.3% of respondents over the age of 65 had heard of digital health applications and 17.3% had used them (Győrffy et al., 2023). Together these findings show the relevance and promise of AI-CBT approaches to managing chronic pain.

Ethical Considerations

The implications of integrating AI-CBT through Wysa specifically, encompasses several domains including, but not limited to; patient autonomy, data privacy, and the patient-provider relationship. These issues are central to fostering trust, ensuring equitable care, and maintaining

the clinician-patient relationship (Durieux et al., 2024). To attend to these concerns, extensive measures were taken over the course of this study in terms of patient autonomy and data protection. This project was determined to be quality improvement and not human subject research (Appendix 1).

To respect patient autonomy, prior to enrolling patients, providers were educated on the intervention and asked to identify patients that fit into the inclusion criteria for this quality improvement initiative. Upon identifying patients from their panels, providers at a primary care clinic in Northern Vermont placed an attestation using an Epic smartphrase *".wysaconsent"* (Appendix 2) in the patients' chart stating that the patient provided consent for this DNP student to reach out to the patient regarding Wysa and to gather baseline metrics. Patients were contacted using the University of Vermont switchboard connection line and were provided with comprehensive information about Wysa, including its purpose and that participation was entirely voluntary with clear assurances that declining or withdrawing at any time would not affect their access to standard care.

To ensure data privacy, use of secure systems ensuring data security are of paramount concern given the sensitive nature of protected patient health information (PHI) being collected. The patients' Epic charts were accessed via University of Vermont Medical Center's secure remote workspace portal through a password protected Apple Macbook. Baseline metrics collected during patient telephone encounters were stored in a password protected spreadsheet on a secure drive to which access was provided by the Clinical Manager of the primary care clinic where this quality improvement initiative was conducted. The extracted metrics were also deidentified by allocating unique access codes to associated metrics. Wysa itself also uses anonymized data and does not require users to create an account nor does it ask for personal

identification data such as; name, location or age (Gupta et al., 2022). If patients were to accidentally share PHI with Wysa, the information is redacted by an algorithm within Wysa to prevent retention in their servers (Gupta et al., 2022). Patients who received unique access codes were asked to use the code itself as their username to add another layer of anonymity.

As an AI-enabled intervention, the use of Wysa introduces questions surrounding whether traditional face-to-face therapy can be replaced by such technologies. Fiske, Henningsen & Buyx (2019) highlight that while AI-enabled tools offer unprecedented accessibility to therapeutic support, they may lack relational depth and empathy, which is intrinsic to therapy. An ethics of care argument posits that when AI systems are implemented in healthcare settings, its application must be rigorously evaluated and only used as an adjunct treatment (Savulescu, Giubilini, Vandersluis & Mishra, 2024). To tend to these concerns, Wysa was offered to participants as an adjunct to routine care in order to iterate that this is not a replacement of provider-based care.

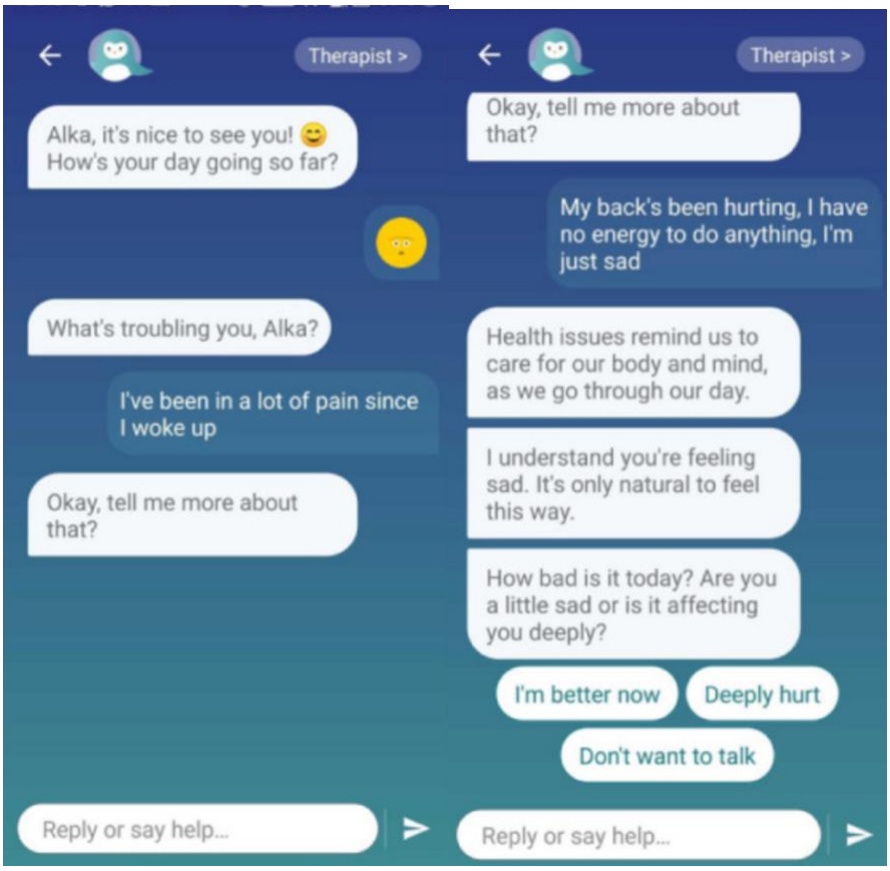
Measures, Methods & Data Collection

Wysa

The primary intervention in this study was the introduction of Wysa to patients with chronic pain. Wysa is designed to provide digital mental health support as it integrates evidence-based psychological interventions tailored to address the complex interplay of psychological distress and psychosomatic sensation (Gupta et al., 2022). Wysa delivers it's therapeutic approach by relying on natural language processing (NLP) (Gupta et al., 2022). NLP interprets user input and generates contextually appropriate responses (Gupta et al., 2022). Users interact with the app via a free-text interface (Figure 1.1), through which Wysa is able to demonstrate empathy and encouragement using conversational techniques, thereby fostering a sense of safety

and trust (Gupta et al., 2022). Its key advantage is its self-guided nature which addresses barriers such a geographic inaccessibility and high costs.

Figure 1.1



(Gupta et al., 2022).

Outcome Measures

This study measured effects of the intervention using the PEG, PHQ-9 & GAD-7 scores. The PEG was our primary outcome of interest; this measure focuses on the patients function and quality of life (Dydyk & Grandhe, 2023). The PEG score is crucial for use as the major areas that pain has been found to impact in adults have been highlighted to be sleep, general activity, social activity, self-care, fun, mental health, increased cognitive burden, fatigue, and intimate relationships (You, Ziadni, Hettie, Darnall, Cook, Von Korff & Mackey, 2022). Higher PEG

scores indicated increased interference of enjoyment of life and general activity by pain, whereas lower scores indicated the opposite. Stevens (2019) conducted a previous quality improvement initiative focusing solely on the implementation of the PEG score at the same primary care clinic in Northern Vermont where this project was implemented. Stevens (2019) found that consistent documentation of PEG scores resulted in increased conversations related to chronic pain (56%), better use of effective prescribing strategies (44%) and an improved understanding of a patients pain/function (38%).

Secondary outcomes of interest included the PHQ-9 and GAD-7 measures to assess depression and anxiety, respectively. Higher levels of both PHQ-9 and GAD-7 scores indicated increased severities of depression and anxiety respectively, whereas lower levels indicated the opposite. Studies have shown that these screening tools are well-suited for use in primary care for patients experiencing comorbid depression and/or anxiety due to chronic pain (Bisby et al., 2022). Additionally, these measures have been used in studies previously examining AI-CBT (Leo et al., 2022). A Geriatric Technology Literacy (GTL) questionnaire was administered using 1 question from the 3-item measure of digital health care literacy (Appendix 6) (Nelson, Pennings, Sommer, Popescu & Barkin, 2022). This question, termed the GTL score, asked patients about their perceived proficiency in using their cellphone to access mobile applications without needing assistance from another (Nelson et al., 2022). GTL questionnaires were administered in order to assess for differences in app usage according to technological familiarity. Higher GTL scores indicated that the individual was proficient with technology, whereas lower scores indicated lack of proficiency with technology.

Patient usage/engagement with the Wysa program was evaluated upon completion of the 8-week program by this DNP student using an Epic dotphrase *".wysause*" (Table 1.5; Appendix

8) which asked the patient, *"How often did you use Wysa per week?"*, *"How long was each session of use"* and *"Were there any barriers to using Wysa?"*. Participants were also asked to *"Provide a word that comes to mind when asked about Wysa"*. This assessment of engagement is similar to other studies using Wysa (Leo et al., 2022).

Information pertaining to participant diagnoses and high-risk medication use (eg. Hydrocodone-acetaminophen, buprenorphine and methadone) was gathered using Medical Record data via secure remote workspace access to Epic through Citrix.

Data Collection Procedures

Throughout the implementation of this project at a primary care clinic in Northern Vermont, the protocol followed was similar to existing work by Leo et al., (2022) who successfully implemented Wysa for the treatment of pain and comorbid psychological distress in an orthopedic care setting. Prior to implementing this quality improvement initiative, an educational seminar took place the primary care clinic in Northern Vermont with the practice staff to introduce our proposed intervention. Clinic staff received brochures and rack cards to provide to interested patients which had served to inform patients of Wysa's capabilities and included a QR code for patients to scan in order to download the Wysa application on their smartphones (Appendices 5 & 6). In scanning the QR code on the brochure or rack card and entering a unique access code, patients were enrolled into an 8-week Wysa AI-CBT for chronic pain program. Interested participants enrolled themselves by installing Wysa onto their smartphones which did not require inputting any PHI. After providers shared study info with patients that expressed interest, they placed an attestation using an Epic dotphrase *".wysaconsent"* (Appendix 2) in the patients chart stating that the patient provided consent for this DNP student to reach out to the patient regarding the intervention, to provide them with a

unique access code and gather baseline metrics. Originally focused on patients over the age of 65, this project's scope was expanded on 10/2024, to include all adults due to recruitment challenges within the initial demographic.

At baseline, PEG, PHQ-9, GAD-7 and GTL scores were gathered (Appendices 6 & 7). Scores were entered in telephone encounters entered into the patients chart documented using *".wysa"* (Appendix 3). Upon completion of the 8-week program, patients were called to gather information on Wysa use (i.e., asking about patient usage/engagement) and effectiveness (i.e., repeat PEG, PHQ-9 and GAD-7 questionnaires). The interventions effectiveness was measured through assessing changes in PEG, PHQ-9 and GAD-7 scores from baseline to 8-weeks for patients using Wysa.

Data Analysis

This quality improvement project employed descriptive statistics to evaluate patient outcomes measured via PEG, PHQ-9 and GAD-7 scales. This included calculations of means, medians and standard deviations to track changes in patient outcomes from baseline to post-intervention. A comparison of pre- and post-intervention PEG, PHQ-9 & GAD-7 scores via percentage-change was used to measure the degree of clinical improvement. Adherence metrics gathered via ".wysause" (Appendix 8) allowed for correlational analyses to be conducted. A word-cloud was created using the answers provided when participants were asked to *"Provide a word that comes to mind when asked about Wysa"* (Figure 1.4). Quantitative data was then analyzed in Microsoft Excel. Charts were created using Medical Record data via secure remote workspace access to Epic through Citrix.

Results

The initial sample was comprised of five adult patients (n = 5) who enrolled themselves into the AI-CBT program offered through Wysa between September to December of 2024. Participant ages ranged from 48 to 75 years old (mean age = 62.2 years old), including three individuals assigned female at birth (60%) and two individuals assigned male at birth (40%). Table 1.1 summarizes patient characteristics. Four participants were found to have been diagnosed with chronic pain syndrome (Patients A, C, D & E) and one had been diagnosed with chronic thoracic back pain (Patient B). Three of the five participants (Patients A, B & E) were found to have been prescribed high-risk opioid medications at the time of enrollment. These high-risk opioid medications were identified as hydrocodone-acetaminophen, buprenorphine and methadone.

Baseline metrics (Table 1.2) showed that the mean PEG score across the cohort was 16.8 (SD = 3.4), indicating moderate-to-severe pain interference in daily activity/enjoyment of life. At baseline, the highest PEG total was 22 (Patient B) and the lowest was 13 (Patient A). The average PHQ-9 score was 9.2 (SD = 5.6), and GAD-7 was 7.6 (SD = 3.6) suggesting mild-to-moderate levels of depression and anxiety, respectively. Mean GTL score was found to be a 3.0 (SD = 0.7) indicating overall moderate technological proficiency.

Of the initial cohort, three participants (Patients A, B & E; 60% of initial sample) did not complete the AI-CBT program offered through Wysa. Patient A unenrolled himself two weeks after onboarding citing disinterest whilst Patients B and E were lost to follow-up. These three participants were also those that had been prescribed high-risk opioid medications and were found to have lower GTL scores (mean GTL = 2.7), as well as higher baseline PEG, PHQ-9 and GAD-7 scores (mean PEG = 17.7; PHQ-9 = 11; GAD-7 = 7.3).

Two participants (Patients C & D; 40% of initial sample) completed the 8-week AI-CBT provided through the Wysa program. Tables 1.1 to 1.3 provide a comprehensive summary of baseline and post-intervention data, outlining significant decreases in symptom scores among those who completed the program. Patients C & D both demonstrated clinically significant improvements across all measures. Patient C experienced reductions in PEG, PHQ-9 and GAD-7 scores by 68.75%, 75.00% and 77.78%, respectively. Patient D experienced reductions of 86.67%, 60.00% and 85.71% across the same metrics, respectively. These reductions translate to an average reduction of 77.71% in PEG scores, 67.5% in PHQ-9 and 81.74% in GAD-7 scores (Figure 1.2 & 1.3). Table 1.4 described engagement data with Patient C reporting use of the Wysa program once per week and Patient D reporting use twice per week for 30 minutes and 45 minutes, respectively. Figure 1.4 summarizes words that were associated with Wysa use when asked post-completion of the 8-week AI-CBT program.

Table 1.1 Chart Review

Patient	**Diagnosis**	**Status**	**High-risk Medication**
A 75 year old female	Chronic pain syndrome	Onboarded 10/16 Dropped out 10/28 Cited disinterest	Hydrocodone-acetaminophen 10-325mg tablet
B 55 year old male	Chronic thoracic back pain	Onboarded 10/16 Lost to follow-up	Buprenorphine HCL 2mg sublingual tablets
C 74 year old female	Chronic pain syndrome	Onboarded 11/6	n/a
D 59 year old male	Chronic pain syndrome	Onboarded 11/5	n/a

E 48 year old female	Chronic pain syndrome	Onboarded 11/10 Lost to follow-up	Methadone 10mg tablet

Table 1.2 Baseline and Outcome Measures

Baseline Measures (n = 5)							
Patient	**PEG pain**	**PEG enjoyment**	**PEG activity**	**PEG Total**	**PHQ-9**	**GAD-7**	**GTL**
A	6	4	3	13	3	2	3
B	8	7	7	22	16	12	2
C	5	6	5	16	8	9	4
D	5	4	6	15	5	7	3
E	7	6	5	18	14	8	3
Outcome Measures (n = 2)							
C	3	2	2	5	2	2	
D	1	0	1	2	2	1	

Table 1.3 Descriptive Statistics

Baseline Descriptive Statistics (n = 5)		
Measure	**Mean**	**Standard Deviation (SD)**
PEG	16.8	3.4

PHQ-9	9.2	5.6
GAD-7	7.6	3.6
GTL	3.0	0.7
Outcome Descriptive Statistics (n = 2)		
PEG	3.5	2.1
PHQ-9	2.0	0.0
GAD-7	1.5	0.7

Table 1.4 Wysa Engagement

Patient	**Frequency of Use**	**Duration of Sessions**	**Barriers to Adherence**
C	Once a week	30 minutes	“remembering to use it”
D	Twice a week	45 minutes	**“**none”

Figure 1.2 Bar Chart of Baseline Measures

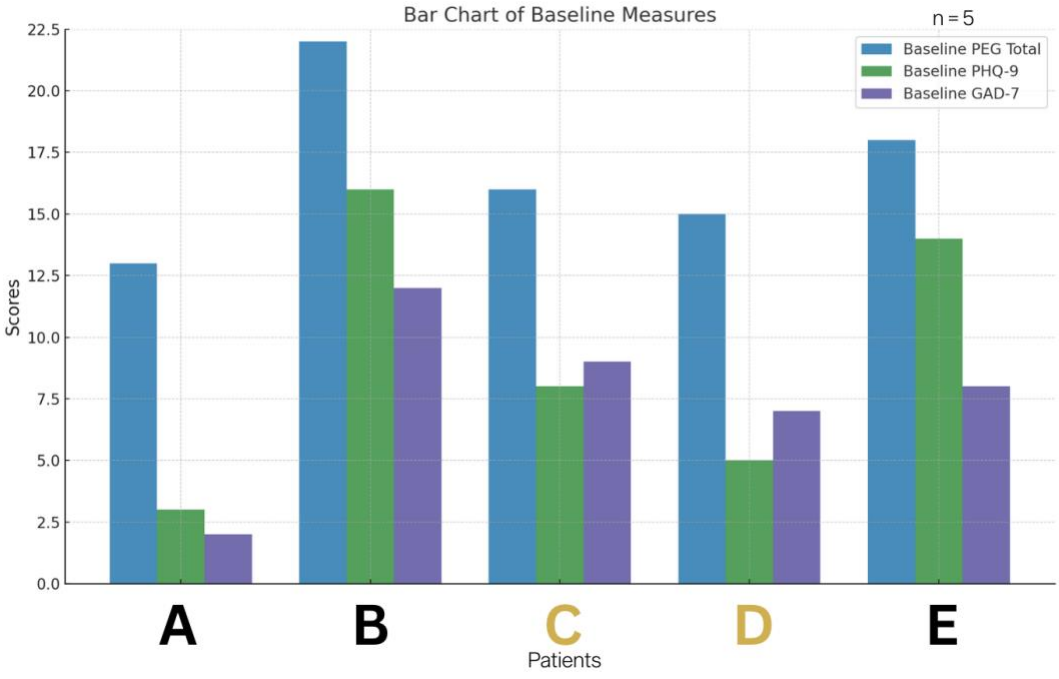


Figure 1.3 Bar Chart of Outcome Measures

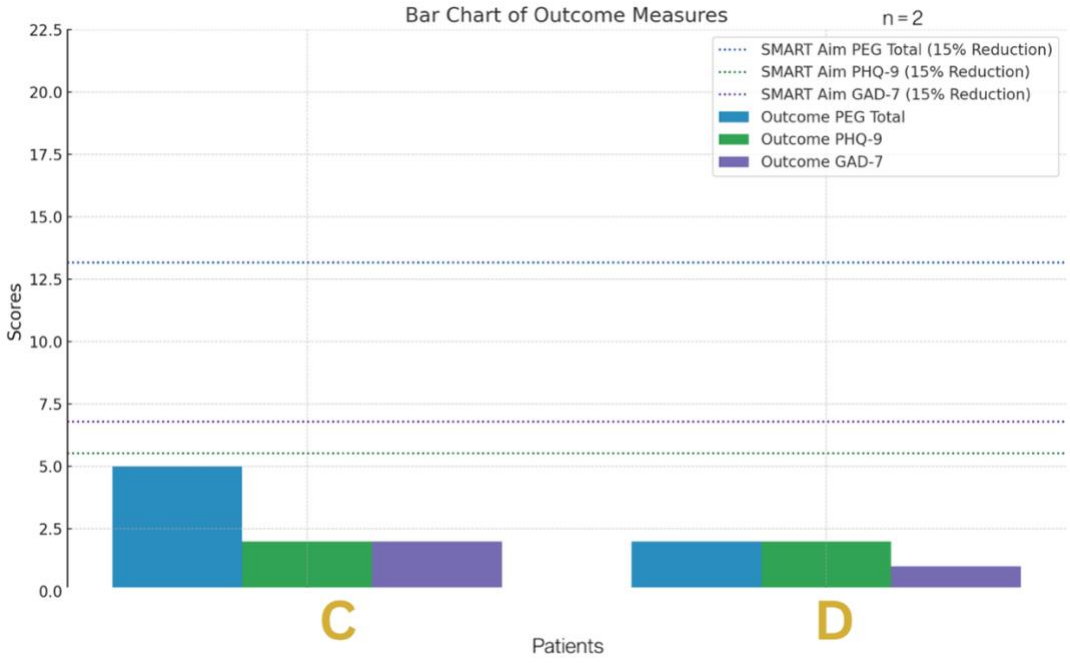


Figure 1.4 Words Associated with Wysa Use

Discussion

This quality improvement initiative demonstrates the potential of AI-CBT interventions to address both physical and psychological dimensions of chronic pain within primary care. Consistent with prior research, the integration of CBT into chronic pain care improves functional outcomes along with psychological distress. As previous literature has shown, AI-CBT

contributes to pain reduction, emotional regulation and enhanced coping (Lim et al. 2018; Leo et al. 2022; Piette et al. 2022). The improvements in PEG, PHQ-9 and GAD-7 scores within this study reflect the potential for AI-CBT to produce similar results as demonstrated in this initiative and the ones preceding it (Sinha et al., 2022; Meheli et al., 2022). While limited by recruitment challenges and unanticipated attrition, this quality improvement initiative successfully achieved its aim, demonstrating measurable improvements in patient-reported pain metrics along with psychological distress metrics through the use of AI-CBT via Wysa.

Attrition among patients with high-risk medication use and lower digital health literacy underscores the need for tailored patient support strategies as noted by Sinha et al. (2022). Furthermore, Meheli et al. (2022) emphasized the need for intuitive, supportive interfaces and guided support. To enhance implementation, future iterations should prioritize structured technological literacy training, opioid-specific motivational interventions and tailored onboarding support.

The theoretical framework grounding this initiative, Orem's Self-Care Deficit Theory remains crucial for understanding engagement. Orem emphasized that individuals who cannot meet their own self-care needs require interventions to restore balance (Yip, 2021). The use of Wysa aligned with this by fostering self-efficacy and by offering psychological tools that support patient autonomy. However, for patients with severe impairment, or lower technological proficiency, additional support is necessary. Bridging this deficit requires proactive clinical support, particularly in the form of hybrid models that blend digital and human contact. Ultimately, AI-CBT tools such as Wysa hold promise, but must be delivered through structured and patient-centered implementation strategies. Recommendations for future iterations including refining recruitment methods, ensuring digital accessibility, providing motivational content for

high-risk individuals and embedding supportive checkpoints. These changes would allow the intervention to remain consistent with Orem's model by meeting patients where they are and enabling progress toward self-care independence (Yip, 2021).

Limitations and Suggestions for Next Steps

While this quality improvement initiative provided valuable insights into the implementation of AI-CBT in primary care, several limitations must be acknowledged. These limitations include a small sample size and high attrition rate, suggesting barriers to the implementation of AI-CBT for chronic pain, such as digital health literacy, high-risk medication use, and higher baseline pain and psychological distress as predictors of dropout. The final analytical sample was limited to two patients due to a 60% attrition rate which reduced statistical power and limited generalizability. Recruitment was limited to one clinic and initially focused only on older adults. Despite expanding eligibility to all adults, uptake remained low. This may have been due to reliance on passive strategies (e.g., Brochures/rack cards and provider referral) rather than proactive outreach. Other studies, such as Gupta et al. (2022) incorporated structured onboarding and mid-point check-ins, which may have supported greater retention. This necessitates a larger-scale implementation for more robust outcome measures. Further suggestions include interviews with providers regarding barriers or facilitators to implementation.

Participants that were lost to follow-up were noted to have lower GTL scores indicating challenges in using digital health interventions, hence future implementations should incorporate a structured digital health literacy training, individualized onboarding support and alternative engagement options such as telephone-based CBT follow-ups to serve as weekly check-ins. Participants that were lost to follow-up were also noted to have been on a prescribed regimen of

high-risk medications prior to onboarding which may have influenced engagement in a behavioral-based intervention therapy, hence future implementations should explore hybrid CBT models that incorporate medication-assisted pain management approaches. Furthermore, participants lost to follow-up exhibited higher baseline PEG, PHQ-9 and GAD-7 scores suggesting severe pain interference and psychological burden. Future implementations should consider offering personalized retention interventions.

Data collection relied on self-report measures, which are susceptible to bias and may over- or under-estimate symptom burden/improvement. In summary, key recommendations for the future implementation of AI-CBT for chronic pain within primary care settings should consider the following; expanded multi-site recruitment strategies with proactive outreach, structured onboarding sessions, integration of medication-assisted CBT, tailored retention strategies such as weekly check-ins and objective engagement metrics.

Conclusion

The findings from this quality improvement initiative affirm that AI-CBT has the potential to be an effective and accessible intervention for addressing the biopsychosocial complexities of chronic pain. The intervention successfully achieved its aim, yielding clinically significant reductions in PEG, PHQ-9 and GAD-7 scores, with results exceeding the targeted 15% improvement threshold. These findings align with existing literature supporting the efficacy of AI-CBT tools like Wysa in enhancing patient outcomes. Despite strong individual-level outcomes, high attrition rates (60%) underscore barriers, particularly among patients with high pain interference, lower technological literacy and high-risk medication use. These findings emphasize the need for enhanced patient engagement strategies, digital health literacy training and a tailored follow-up intervention to improve adherence and maximize effectiveness. Future

iterations should expand recruitment reach, integrate hybrid support models and tailor interventions to the needs of high-risk individuals. When grounded in theoretical frameworks such as that of Orem's Self-Care Deficit Theory, AI-CBT interventions represent a potentially scalable and impactful tool in chronic pain care. As digital health interventions continue to evolve, AI-enabled solutions, such as those used in this initiative, present a scalable and cost-effective adjunct to primary care pain management. Moving forward, healthcare providers must integrate structured digital health education, establish patient-centered retention protocols and address equity in access to digital therapeutics.

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Appendix 1

CERTIFICATION

TO: Manreet Purba

DATE OF CERTIFICATION: Wednesday, May 1, 2024 - 11:09

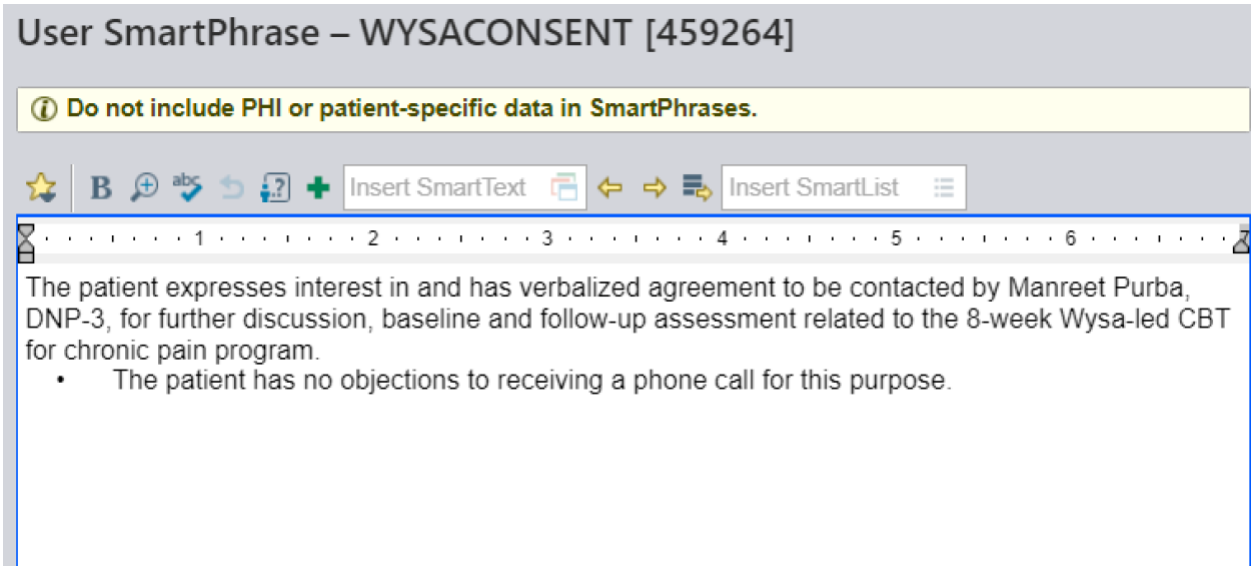
SUBJECT: Conversational AI to Improve Chronic Pain and Comorbid Conditions

Based upon answers to the self-determination tool, this project does not require IRB review because it does not meet the definition of a "research" activity under the regulatory definition. According to 45 CFR 46.102(d), the definition of "research" is "a systematic investigation, including research development, testing and evaluation, designed to develop or contribute to generalizable knowledge."

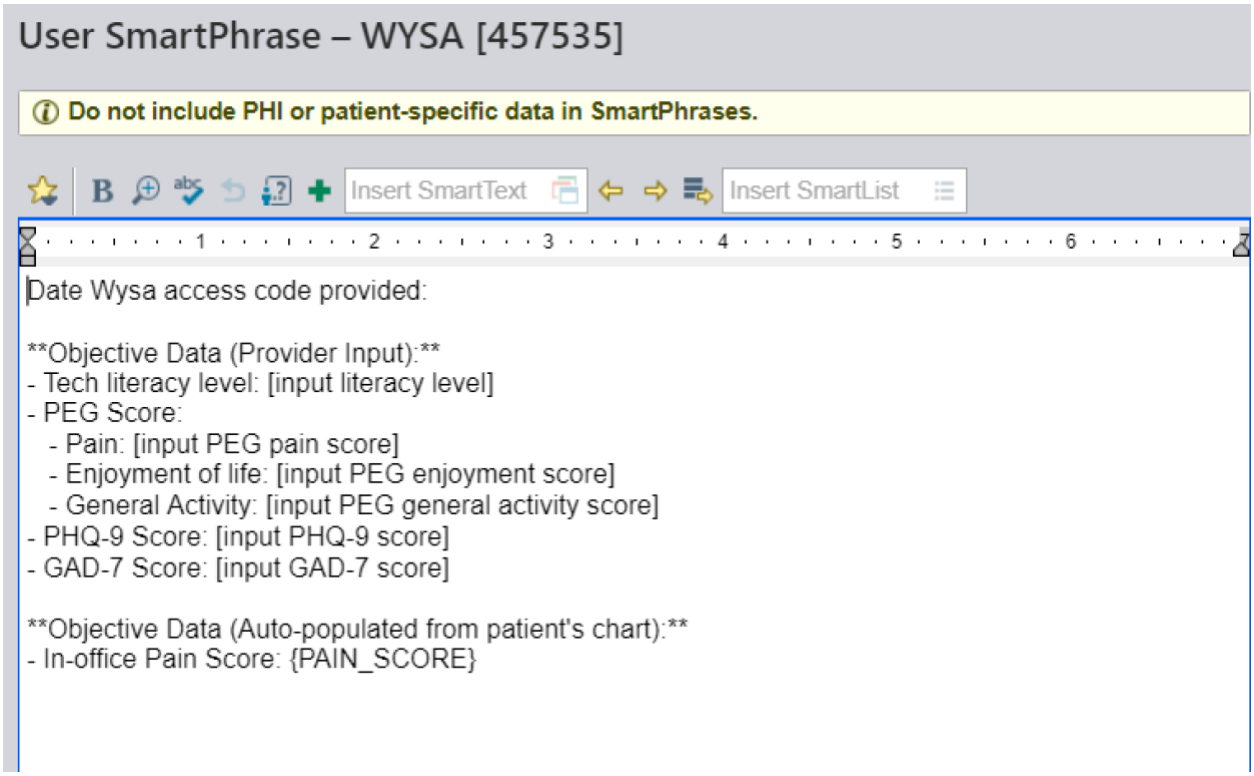
Projects that are not a systematic study or are not intended to contribute to generalizable knowledge, e.g. quality assurance, quality improvement, program evaluation, or public health practice, do not require IRB review.

This certification can be provided as documentation that this project does not meet the definition of research. Public presentations, academic curriculum vitae, publications, etc., with a planned statement similar to *"According to the policy defining activities which constitute research at the University of Vermont/University of Vermont Medical Center, this work met criteria for operational improvement activities exempt from ethics review."*

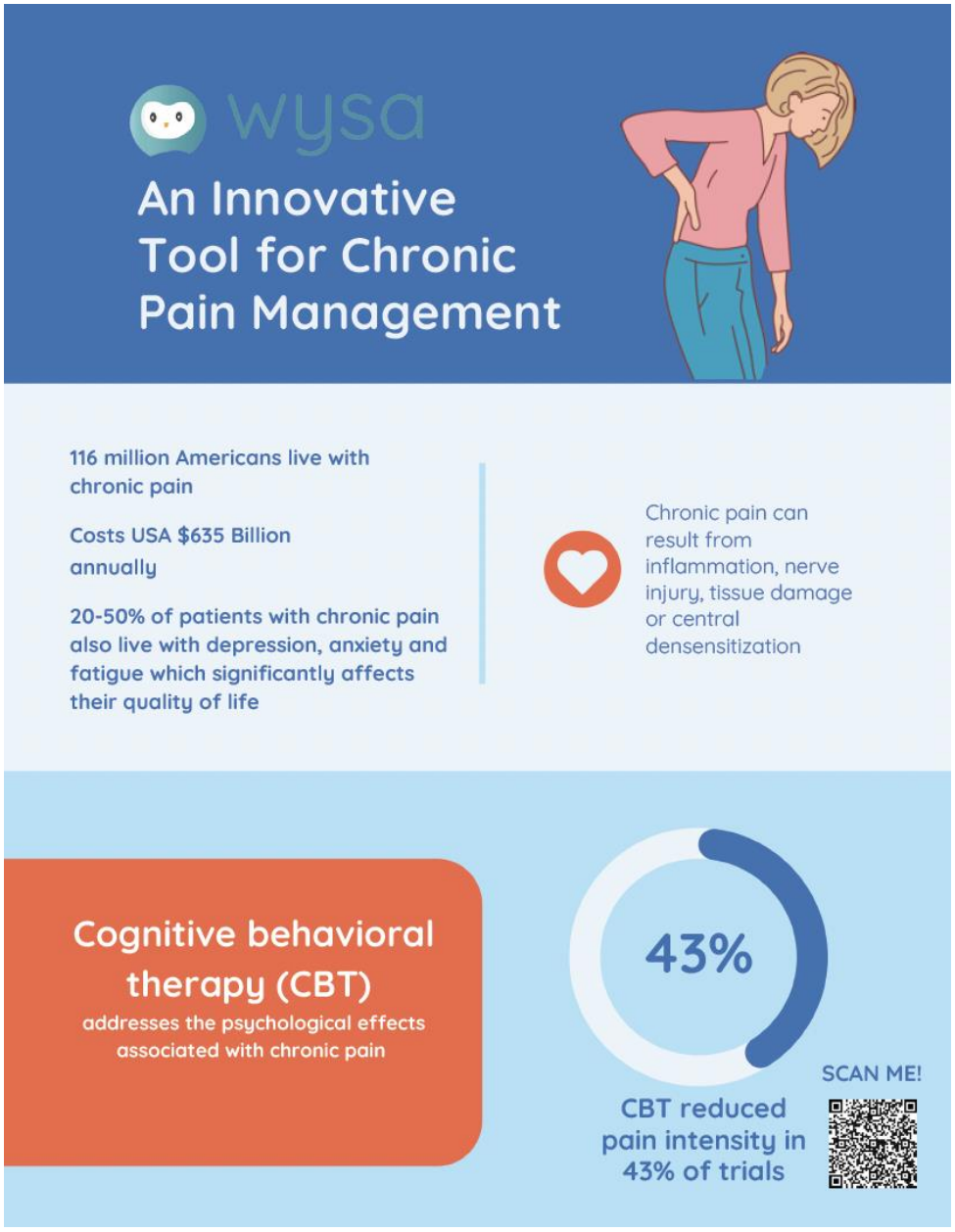
Appendix 2


User SmartPhrase – WYSACONSENT [459264]
Do not include PHI or patient-specific data in SmartPhrases.
Insert SmartText
Insert SmartList
The patient expresses interest in and has verbalized agreement to be contacted by Manreet Purba, DNP-3, for further discussion, baseline and follow-up assessment related to the 8-week Wysa-led CBT for chronic pain program.
• The patient has no objections to receiving a phone call for this purpose.

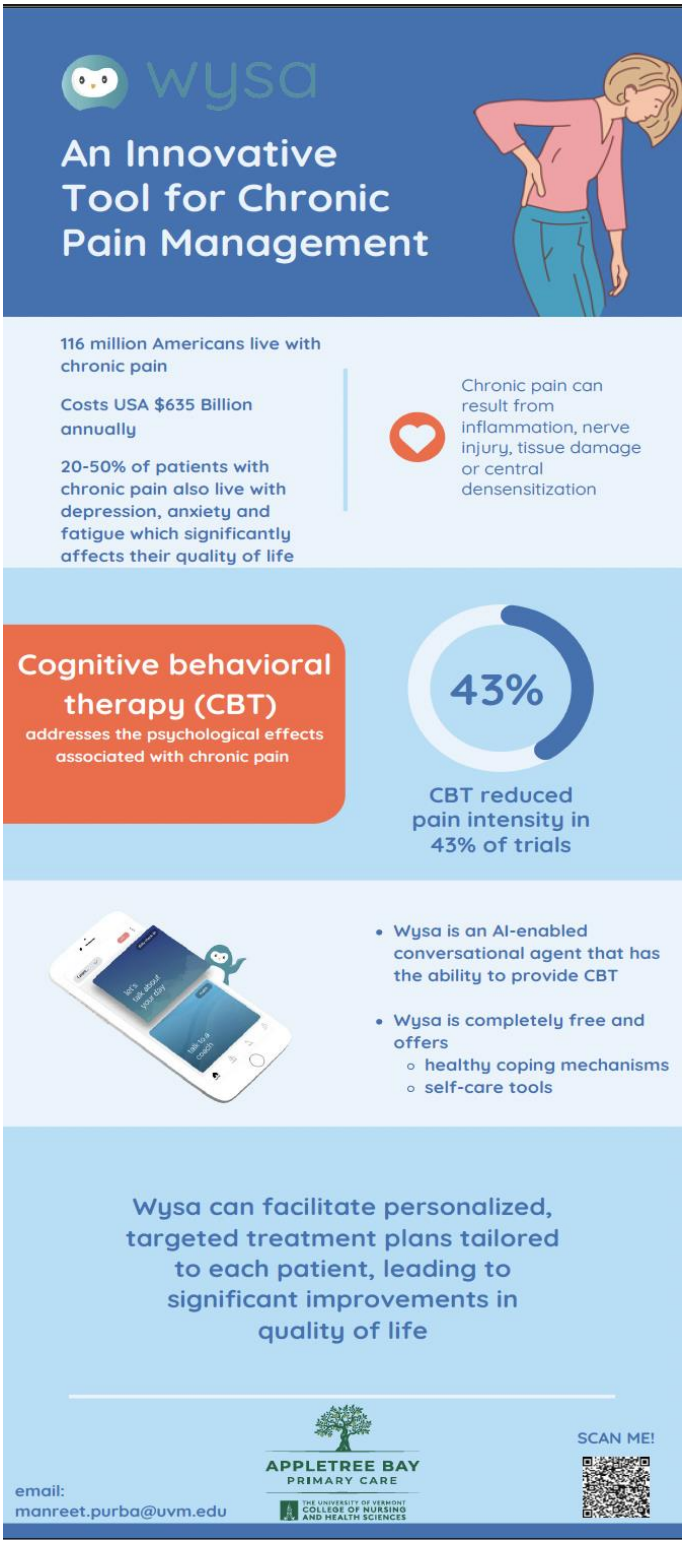
Appendix 3


User SmartPhrase – WYSA [457535]
Do not include PHI or patient-specific data in SmartPhrases.
Insert SmartText
Insert SmartList
Date Wysa access code provided:
Objective Data (Provider Input):
- Tech literacy level: [input literacy level]
- PEG Score:
- Pain: [input PEG pain score]
- Enjoyment of life: [input PEG enjoyment score]
- General Activity: [input PEG general activity score]
- PHQ-9 Score: [input PHQ-9 score]
- GAD-7 Score: [input GAD-7 score]
Objective Data (Auto-populated from patient's chart):
- In-office Pain Score: {PAIN_SCORE}

Appendix 4


wysa
An Innovative Tool for Chronic Pain Management
116 million Americans live with chronic pain
Costs USA $635 Billion annually
20-50% of patients with chronic pain also live with depression, anxiety and fatigue which significantly affects their quality of life
Chronic pain can result from inflammation, nerve injury, tissue damage or central densensitization
Cognitive behavioral therapy (CBT)
addresses the psychological effects associated with chronic pain
43%
CBT reduced pain intensity in 43% of trials
SCAN ME!

Appendix 5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addresses the psychological effects associated with chronic pain
43%
CBT reduced pain intensity in 43% of trials
Wysa is an AI-enabled conversational agent that has the ability to provide CBT
Wysa is completely free and offers
healthy coping mechanisms
self-care tools
Wysa can facilitate personalized, targeted treatment plans tailored to each patient, leading to significant improvements in quality of life
APPLETREE BAY PRIMARY CARE
THE UNIVERSITY OF VERMONT COLLEGE OF NURSING AND HEALTH SCIENCES
email:
manreet.purba@uvm.edu
SCAN ME!

Appendix 6

Survey

Adapted from:

Nelson, L. A., Pennings, J. S., Sommer, E. C., Popescu, F., & Barkin, S. L. (2022). A 3-Item Measure of Digital Health Care Literacy: Development and Validation Study. JMIR formative research, 6(4), e36043. https://doi.org/10.2196/36043

Geriatric Technology Literacy Scale

Please rate your agreement with the following statement on a scale from 0 to 5:

- 0 = Strongly Disagree
- 1 = Disagree
- 2 = Somewhat Disagree
- 3 = Neutral
- 4 = Agree
- 5 = Strongly Agree

1. I can use applications/programs (like Zoom) on my cell phone, computer, or another electronic device on my own (without asking for help from someone else).

- 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Appendix 7

Measurement Tools

Pain, Enjoyment of Life and General Activity Scale

Please rate the following questions from 0 to 10:

- 0 = No interference
- 10 = Complete interference

1. What number best describes your pain on average in the past week?

- 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

2. What number best describes how, during the past week, pain has interfered with your enjoyment of life?

- 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

3. What number best describes how, during the past week, pain has interfered with your general activity?

- 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐
-

PHQ-9: Patient Health Questionnaire

Over the last 2 weeks, how often have you been bothered by the following problems?

1. Little interest or pleasure in doing things

- Not at all ☐ Several days ☐ More than half the days ☐ Nearly every day ☐

2. Feeling down, depressed, or hopeless

- Not at all ☐ Several days ☐ More than half the days ☐ Nearly every day ☐

3. Trouble falling or staying asleep, or sleeping too much

- Not at all ☐ Several days ☐ More than half the days ☐ Nearly every day ☐

4. Feeling tired or having little energy

- Not at all ☐ Several days ☐ More than half the days ☐ Nearly every day ☐

5. Poor appetite or overeating

- Not at all ☐ Several days ☐ More than half the days ☐ Nearly every day ☐

6. Feeling bad about yourself — or that you are a failure or have let yourself or your family down

- Not at all ☐ Several days ☐ More than half the days ☐ Nearly every day ☐

7. Trouble concentrating on things, such as reading the newspaper or watching television

- Not at all ☐ Several days ☐ More than half the days ☐ Nearly every day ☐

8. Moving or speaking so slowly that other people could have noticed? Or the opposite — being so fidgety or restless that you have been moving around a lot more than usual

- Not at all ☐ Several days ☐ More than half the days ☐ Nearly every day ☐

9. Thoughts that you would be better off dead or of hurting yourself in some way

- Not at all ☐ Several days ☐ More than half the days ☐ Nearly every day ☐

GAD-7: Generalized Anxiety Disorder Scale

Over the last 2 weeks, how often have you been bothered by the following problems?

1. Feeling nervous, anxious, or on edge

- Not at all ☐ Several days ☐ More than half the days ☐ Nearly every day ☐

2. Not being able to stop or control worrying

- Not at all ☐ Several days ☐ More than half the days ☐ Nearly every day ☐

3. Worrying too much about different things

- Not at all ☐ Several days ☐ More than half the days ☐ Nearly every day ☐

4. Trouble relaxing

- Not at all ☐ Several days ☐ More than half the days ☐ Nearly every day ☐

5. Being so restless that it is hard to sit still

- Not at all ☐ Several days ☐ More than half the days ☐ Nearly every day ☐

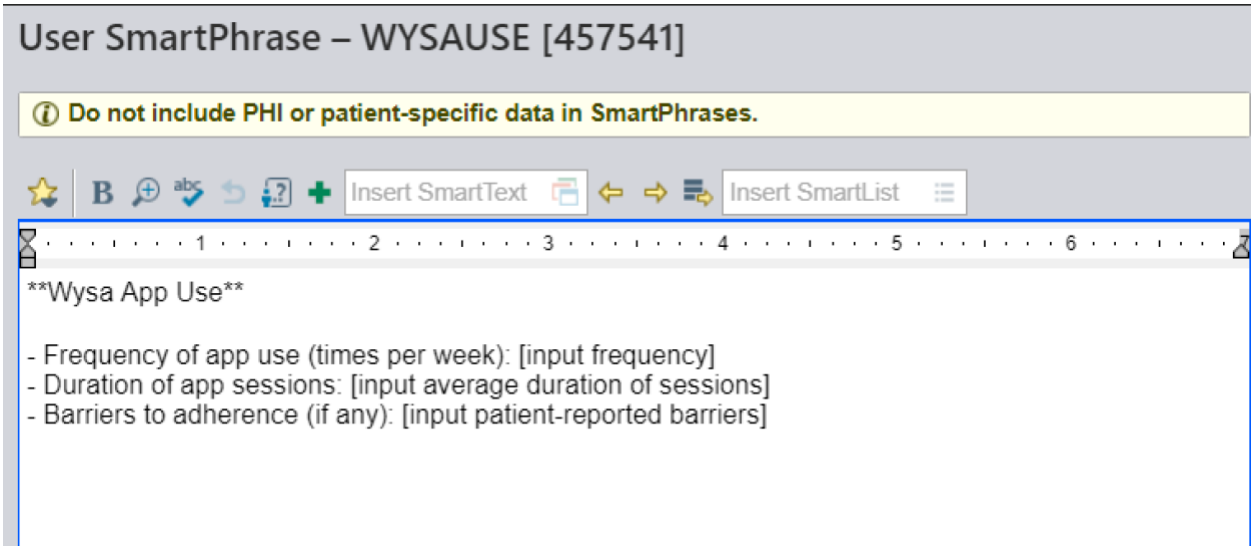
6. Becoming easily annoyed or irritable

- Not at all ☐ Several days ☐ More than half the days ☐ Nearly every day ☐

7. Feeling afraid as if something awful might happen

- Not at all ☐ Several days ☐ More than half the days ☐ Nearly every day ☐

Appendix 8


User SmartPhrase – WYSAUSE [457541]
Do not include PHI or patient-specific data in SmartPhrases.
Insert SmartText
Insert SmartList
Wysa App Use
- Frequency of app use (times per week): [input frequency]
- Duration of app sessions: [input average duration of sessions]
- Barriers to adherence (if any): [input patient-reported barriers]