IMPLEMENTATION OF A MEDICATION ADHERENCE RATING SCALE TO INCREASE ANTIDEPRESSANT MEDICATION COMPLIANCE IN THE VETERAN POPULATION: A PRACTICE CHANGE

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A dissertation submitted to the faculty at the University of North Carolina at Chapel Hill in partial fulfillment of the requirement for the degree of Doctor of Nursing Practice in the School of Nursing in the University of North Carolina.

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ABSTRACT

Bich-Tuyen Thi Nguyen: Implementation of a Medication Adherence Rating Scale to Increase Antidepressant Medication Compliance in the Veteran Population: A Practice Change (Under the direction of Grace Hubbard)

Background: It is estimated that 17.3 million adults suffer from Major Depressive Disorder (MDD) in the United States (US). Despite the availability and effectiveness of antidepressants, nearly one-third of Veterans were nonadherent with their antidepressant medication at the fourth- and twelfth-month follow-up visit. Nonadherence with a prescribed antidepressant medication regimen leads to poor health outcomes, exacerbates comorbidities, increases non-compliance with other medical interventions, and increases provider frustration.

A literature review yielded sufficient evidence to support administration of the Medication Adherence Rating Scale (MARS) to assess for medication-taking behaviors to help improve antidepressant adherence. The self-report MARS tool was developed in 1999 and adapted two previous tools, the four-item Morisky Medication Adherence Questionnaire (MAQ) and the Drug Attitude Inventory (DAI) scale.

Purpose: The purpose of this practice change was to implement screening with the MARS in adult Veterans to identify barriers to adherence to a prescribed antidepressant medication regimen. Clinical staff's perceptions and attitudes with the use of the tool were evaluated with an anticipated outcome of 90% rate of use of the MARS. The quality improvement project occurred over a span of six weeks.

Methods: The Plan Do Study Act (PDSA) model was used to guide the implementation process of using the MARS. There were six total PDSA cycles. Clinicians administered the MARS to Veterans who scored 5 or greater on the nine-item Patient Health Questionnaire (PHQ-9). At the end of each of the PDSA cycle, clinicians completed between cycle debriefing questions. After the sixth cycle, clinicians completed post-implementation questions.

Results: Five clinicians participated in this practice change and completed the between cycle debriefing and post-implementation questions. All agreed that utilization of the MARS tool was beneficial in helping to increase antidepressant adherence in the Veteran population. Overall compliance rate of use for the MARS was 72%. Barriers to MARS administration included time constraints, physical and cognitive impairments, and Veteran declination.

Conclusion: The data from this practice change suggested that MARS administration is a feasible intervention and would be beneficial to the Veteran population in helping to increase antidepressant adherence.

To my best friend and husband, Justin Fishel, I could not have done this without your support. I love you so much.

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LIST OF ABBREVIATIONS

ADRs	Adverse Drug Reactions
BMQ	Brief Medication Question
CINAHL	Cumulative Index to Nursing and Allied Health Literature
BPAD	Bipolar Affective Disorder
DAI	Drug Attitude Inventory
DNP	Doctor of Nursing Practice
IRB	Institutional Review Board
MAQ	Medication Adherence Questionnaire
MARS	Medication Adherence Rating Scale
MDD	Major Depressive Disorder
PCMHI	Primary Care Mental Health Integration Clinic
PDSA	Plan-Do-Study-Act
PHQ-9	9-Item Patient Health Questionnaire
PMHNP	Psychiatric Mental Health Nurse Practitioner
RCTs	Randomized Controlled Trials
SAILS	Strategic Analytics for Improvement and Learning
US	United States
VAHCS	VA Health Care System

CHAPTER 1: INTRODUCTION

Medication adherence is one of the most important factors in effectively treating depression among Veterans. Several studies have been conducted to assess what methods effectively measure medication adherence. Methods used to measure medication adherence can be classified dichotomously as direct or indirect. Examples of direct methods include direct observation of the Veteran taking the medication and lab draws such as blood or urine. Examples of indirect methods include pill counts, monitoring frequency of prescription refills, electronic medication monitoring systems, Veterans' clinical outcomes, and administering medication adherence questionnaires (Moon et al., 2017). This practice change initiative focused on utilization of a screening questionnaire to assess medication-taking behaviors for treatment of Major Depressive Disorder (MDD).

Background

Major Depressive Disorder: Diagnosis and Treatment

It is estimated that 17.3 million adults suffer from Major Depressive Disorder (MDD) in the United States (US), representing 7.1 percent of all US adults (National Institute of Mental Health, 2019). For an individual to be diagnosed with MDD, at least five symptoms meeting the DSM-5 criteria must be met. These symptoms include depressed mood, anhedonia, problems with appetite, problems with sleep, psychomotor retardation/agitation, low energy, problems with concentration, and suicidal ideation (Table A1 in Appendix A). Additionally, symptoms must be present for a period of at least two weeks with either depressed mood or anhedonia being one of the five symptoms (APA, 2013).

There are three main treatment phases for individuals with MDD: acute phase lasting 12 weeks, continuation phase lasting three-to-six months, and a maintenance phase that can last indefinitely (Mignon & Stahl, 2009). The National Institute of Health and Care Excellence (NICE) and American Psychiatric Association (APA) recommend individuals, who are taking an antidepressant for MDD, continue taking the antidepressant beyond six months after remission of symptoms to lower risk of relapse of MDD (NICE, 2018). Monitoring of medication adherence to an antidepressant medication regimen is important to achieve remission of symptoms.

Medication Adherence Rating Scale

One such adherence monitoring tool is the self-report MARS tool. The MARS tool was developed in 1999 adapting two previous adherence tools: the four-item Medication Adherence Questionnaire (MAQ) and the Drug Attitude Inventory (DAI) scale (Thompson, Kulkarni, & Sergejew, 2000). The MARS scale was first validated in a research study with Veterans who had schizophrenia, bipolar affective disorder (BPAD), depression with psychotic features, and schizoaffective disorders (Thompson, Kulkarni, & Sergejew, 2000). Administration of the MARS allowed providers to quickly assess medication-taking behaviors in Veterans. The MARS tool is intended to assist providers with identification of barriers and behaviors contributing to nonadherence in Veterans with chronic diseases, such as psychiatric disorders.

The MARS tool consists of ten "yes" or "no" questions (Psychiatry & Behavioral Health Learning Network, 2020) (Table A2 in Appendix A). Questions one-to-four represent behaviors that contribute to medication adherence; questions five-to-eight represent attitudes toward taking medications; and questions nine and ten represent attitudes towards psychotropic medication and the negative side-effects associated with psychotropic use (Sowunmi & Onifade, 2019). The tool is scored by giving one point for each "no" response for questions 1-6 and 9-10 and 1 point for

"yes" response for questions 7-8 (Thompson, n.d.). Scores are ranked from zero to ten. A score of zero is suggestive of poor likelihood of adherence whereas a score of ten is suggestive of good likelihood of adherence (Sowunmi & Onifade, 2019).

Description of the Problem

Despite the availability and effectiveness of antidepressants, nearly one-third of U.S. Veterans are nonadherent with their antidepressant medication at fourth- and twelfth-month follow-up visits (Gerlach, Chiang, & Kales, 2019). In a local Veteran's Affairs primary care clinic, there are similar significant rates of nonadherence to an antidepressant medication. Nonadherence with a prescribed antidepressant medication regimen leads to poor health outcomes, exacerbates comorbidities, increases non-adherence with other medical interventions, and increases provider frustration. Challenges to antidepressant adherence can be classified into two main categories: Veteran specific and medication specific. Examples of Veteran specific challenges include erroneous myths about antidepressants; forgetting to take the antidepressant; negative attitudes or stigma; lack of education on antidepressant use; and presence of co-morbidities. Examples of medication specific challenges include burden of taking an additional pill; duration of treatment; cost of treatment; adverse drug reactions (ADRs), and side effects (Ho, Jacob, & Tangiisuran, 2017).

The Strategic Analytics for Improvement and Learning (SAILs) metrics are used for monitoring continuous antidepressant usage within the VA Health Care system (Veterans Health Affairs, 2019). The two metrics are Effective Acute Phase Treatment (measure mnemonic is MDD43h) and Effective Continuation Phase Treatment (measure mnemonic is MDD47h). MDD43 measures the percentage of Veterans on new antidepressants who are adherent for 84 continuous days and MDD47h which measures percentage adherent with effective continuation

phase antidepressant treatment for six months. The antidepressant non-adherence percentage results from the SAILS metrics at 84 days and six months from a local VA hospital system, are similar to the results from the VA study conducted by Gerlach, Chiang, & Kales (2019).

Currently, clinicians are not utilizing a screening tool to assess for medication-taking behaviors. A practice change in which clinical staff administers a screening tool to further assess factors influencing adherence will facilitate identification of barriers to compliance with the antidepressant medication regimen. This will allow clinical staff to more effectively develop individualized interventions to increase antidepressant medication adherence.

Purpose of the Project

The quality improvement (QI) project proposed a practice change initiative to implement screening with the Medication Adherence Rating Scale (MARS) in adult U.S. Veterans to identify barriers to adherence to a prescribed antidepressant medication regimen. The anticipated primary outcomes were 90% rate of use of the MARS. In order to round out the feasibility of sustaining this practice change, clinical staff's perceptions and attitudes with the use of the tool were also evaluated .

CHAPTER 2: REVIEW OF LITERATURE

Literature Search Process

The literature search process focused on two areas: (1) best evidence to support antidepressant nonadherence is a clinical problem and (2) best evidence to support effectiveness of implementation of the MARS as a screening tool to facilitate identification of barriers for adherence to an antidepressant medication regimen.

Best Evidence

Antidepressant Nonadherence

PubMed and Cumulative Index to Nursing and Allied Health Literature (CINAHL) were searched for best evidence to support the clinical problem of antidepressant nonadherence. The search terms *antidepressant nonadherence and primary care or mental health* were used in PubMed, yielding a total of 13,480 articles. Limitations were set to include clinical trials, articles published within the last 10 years (January 1, 2010- February 8, 2020), and trials involving humans only; reducing total articles to 69.

The CINAHL search terms were *antidepressant nonadherence and mental health and primary care*. A limitation was set to articles published within the last 10 years (January 1, 2010-February 8, 2020). A total of 82 articles were identified and reviewed. There were no identified inclusion criteria for this first review of literature. Studies written in foreign languages that could not be translated to English were excluded. Of the 82 articles, four were considered as satisfactory levels of evidence to support the clinical problem of antidepressant nonadherence.

Implementation of MARS

PubMed and CINAHL were searched for best evidence to support implementation of the MARS tool to assess medication adherence with the following search terms: *Medication Adherence Rating Scale, screening tool and medication compliance or adherence and mental health.* The search yielded 143 articles. Limitations were set to human species and articles published within the past 20 years (January 1, 2000- February 8, 2020). With the set limitations, the number of articles decreased from 143 to 49. There were no identified inclusion criteria for this first review of literature. Studies written in foreign languages that could not be translated to English were excluded. Of the 49 articles, five articles were considered as satisfactory evidence to support implementation of the MARS tool.

Synthesis of Literature Search

Melynk & Fineout-Overholt's adaption of Guyatt & Sackett (1995) hierarchy of evidence for treatment outcomes was used to rate the evidence in the research studies. There are seven levels in the hierarchy ranging from Level I to Level VII. Research study designs that fall in Level I are regarded as the strongest level of evidence for treatment outcomes whereas research study designs that fall in Level VII are regarded as the weakest level of evidence for treatment outcomes (Melynk & Fineout-Overholt, 2019).

Antidepressant Nonadherence

Three of the four articles identified in the review of literature were Level IV articles (Gerlach, Chiang, & Kales, 2019; Kales et al., 2016; Serna et al., 2010) and one article (Sansone & Sansone, 2012) was a Level VII with respect to the rating system for hierarchy of research evidence (Melnyk & Fineout-Overholt, 2019).

In the three level IV articles, two of the level IV articles were prospective cohort studies (Gerlach, Chiang, & Kales, 2019; Kales et al., 2016) and one was a retrospective cohort study (Serna et al., 2010). The three studies (Gerlach, Chiang, & Kales, 2019; Kales et al., 2016; Serna et al., 2010) combined included 8114 participants. In the retrospective cohort study, data was collected from a city-wide public health prescription database from 2003-2007 (Serna et al., 2010) in Lleida, Spain.

In the retrospective study, antidepressant adherence was monitored via the pharmacy electronic database, and defined as the number of units obtained from the pharmacy relative to the number of months in the observation period (Serna et al., 2010). These studies supported the clinical problem of antidepressant nonadherence rates with the four-month rate between 27.3% to 29% (Gerlach, Chiang, & Kales, 2019; Kales et al., 2016), increasing to 52% at six months (Sansone & Sansone, 2012).

Strengths of these studies included large sample size (Gerlach, Chiang, & Kales, 2019; Kales et al., 2016; Sansone & Sansone, 2012; Serna et al., 2010), inclusion of primary care Veterans rather than only psychiatric Veterans (Sansone & Sansone, 2012), and very current data continuing to support the problem of antidepressant nonadherence (Gerlach, Chiang, & Kales, 2019). A limitation was the number of Level IV quality of evidence studies (Melnyk & Fineout-Overholt, 2019).

Implementation of MARS

All five studies identified in the literature review were Level IV articles (Fialko et al., 2008; Fond et al., 2017; Owie, Oluto, & James, 2018; Thompson, Kulkarni, & Sergejew, 2000; Sowunmi & Onifade, 2019) with respect to the rating system for hierarchy of research evidence (Melynk & Fineout-Overhold, 2019).

All the five studies were cross sectional studies using the MARS to measure medication adherence (Fialko et al., 2008; Fond et al., 2016 Owie et al., 2018; Thompson, Kulkarni, & Sergejew, 2000; Sowunmi & Onifade, 2019). Between the five studies, there were a total of 1112 participants recruited from community outpatient or inpatient settings and all participants had psychiatric diagnoses with symptoms of psychosis. All five studies (Fialko et al., 2008; Fond et al., 2017; Owie et al., 2018; Thompson & Sergejew, 2000; Sowunmi & Onifade, 2019) measured various psychometric properties of the MARS tool that included: validity, internal consistency, acceptability, and reliability.

The MARS tool was assessed as a reliable and valid tool to evaluate medication adherence, specific to the psychiatric population. Internal consistency was measured through Cronbach's alpha score in four of the five studies. Cronbach's alpha scores ranged from 0.6-0.76 (Fialko et al., 2008; Owie et al., 2018; Thompson & Sergejew, 2000; Sowunmi & Onifade, 2019). One study used the Kuder-Richardson formula to measure internal consistency, yielding a value of >0.6 (Fond et al., 2017). Additionally, one study concluded the MARS tool has an excellent acceptability rate and takes an average of five minutes to complete (Fond et al., 2017). The evidence provided in these five studies supports the use of the MARS as a valid screening tool to assess antidepressant adherence (Fialko et al., 2008; Fond et al., 2017; Owie et al., 2018; Thompson, Kulkarni, & Sergejew, 2000; Sowunmi & Onifade, 2019).

An identified strength from four of the five studies was the large sample size (Fialko et al., 2008; Fond et al., 2017; Owie et al., 2018; Sowunmi & Onifade, 2019). One study had a small sample size (n=66); the study conducted by the developer of the MARS tool (Thompson, Kulkarni, & Sergejew, 2000). One limitation to the study was that the population had either psychosis or a combination of psychotic and depressive symptoms. There were no studies in

which the MARS was used in a population of individuals who were taking only antidepressants for just depressive symptom without the presence of psychotic symptoms. All the studies involved participants who were taking at least one antipsychotic and had symptoms of psychosis (i.e. Schizophrenia, Bipolar Affective Disorder, Depression with Psychotic Features) (Fialko et al., 2008; Fond et al., 2017; Owie et al., 2018; Thompson, Kulkarni, & Sergejew, 2000; Sowunmi & Onifade, 2019). Another limitation was the number of Level IV quality of evidence studies and the lack of Level I and II studies (Melnyk & Fineout-Overholt, 2019).

CHAPTER 3: FRAMEWORK FOR PROJECT IMPLEMENTATION

The Plan-Do-Study-Act (PDSA) model, which consists of four stages was chosen to guide the implementation process of the Doctorate of Nursing Practice (DNP) QI practice change (Moen, 2009; Sollecito & Johnson, 2013). The field of nursing has utilized the PDSA model many times for QI projects. The purpose of selecting the PDSA model as a framework is that it guided the QI implementation process by segregating the process into four different stages and allowing for multiple cycles. Furthermore, it allowed the change agent (i.e. DNP Project lead) to have the flexibility to re-assess the implementation process and adjust as needed.

The PDSA model provides a cyclical and sequential process of testing and learning from data to improve outcomes. The *planning* phase involves identification of a clinical problem and processes required to improve the clinical problem. The *doing* phase involves trialing the proposed process change on a small scale (i.e. small clinic setting). The *studying* phase involves evaluating the process change and making modifications to the process change based on the evaluation of the data (i.e. provider adherence and provider satisfaction). Lastly, the *acting* phase involves testing the modified process change to improve the process (Moen, 2009).

The PDSA is a continuous cycle in which the four stages can be repeated as many times as needed to achieve identified outcomes with a particular intervention. There was no evidence supporting the use of the MARS tool in the primary care setting to assess antidepressant medication adherence, therefore, this practice change initiative would benefit from check-ins to assess the effectiveness of the process.

CHAPTER 4: DESIGN

The DNP project focused on a practice change initiative for a Primary Care Mental Health Integration (PCMHI) clinic serving a Veteran population. The PDSA model was used to guide the six-week process. Between-cycle PDSA debriefings were conducted to determine if revisions in the implementation process were indicated. At the conclusion of implementation, a final debriefing was conducted to discuss implementation team members' feedback about the feasibility and the sustainability of the practice change.

CHAPTER 5: METHODOLOGY

Key Stakeholders

The implementation team members were individuals on the health care team who administered the tool. Five staff participated in the implementation and consisted of a social worker, a psychologist, two psychology fellows and a psychiatric mental health nurse practitioner. Meetings were held with clinic leadership (i.e. clinic director and clinic coordinator) and approval was obtained to proceed with the QI project (Appendix B).

Setting and Population

The setting for the project was a VA PCMHI clinic. The mission of the VA emphasizes measurement-based care and the addition of a screening tool aligned with that mission. The implementation team administered the MARS tool to the Veteran population who scored ≥5 on the 9-item Patient Health Questionnaire (PHQ-9) during a PCMHI screening appointment.

IRB Submission

While it is not typical that QI practice change initiatives require IRB review, this project was submitted to the UNC IRB for determination of whether it constituted research with human subjects. Approval of this project was received from the University of North Carolina Institutional Review Board (IRB Number 20-0867). With respect to the local Veteran Affairs hospital IRB process, the project did not require review or oversight from the local VA human research protection program committee or sub-committee as the clinical coordinator

deemed the project as a QI practice change initiative that did not constitute research with human subjects.

Implementation Process

The administration of the MARS tool was intended to improve identification of barriers to adherence with antidepressant medication regimens and improve provider satisfaction regarding quality of care.

During the *planning* phase for implementation of the PDSA Model, evidence was obtained that supported the clinical significance of antidepressant nonadherence in the primary care setting. Evidence consisted of external evidence (i.e. literature review) and internal evidence. Internal evidence obtained from pharmacy records that track antidepressant refills, revealed antidepressant nonadherence remained a consistent problem. A team champion and key stakeholders, who expressed buy in, were identified. The implementation team members received a document that described the QI project's purpose, outcomes, and the implementation team member's role during the implementation process of this practice change. Individual team members signed a document, and their signature constituted their consent to participate. Each implementation team member was provided a copy and the DNP project lead kept a copy of the signed document (Appendix C).

There were a total of six weekly implementation cycles, with each cycle having an identified implementation team member(s) administering the MARS during certain days and times of the week (Appendix D). Feedback about the implementation process was elicited between cycles. The purpose of the scheduled feedback meetings was to discuss any barriers that arose during each cycle and to develop possible solutions before the next cycle started.

The *doing* phase consisted of the implementation team administering the MARS tool to Veterans, during a regular scheduled clinic screening visit, who scored five or higher on the PHQ-9 tool. The PHQ-9 is a valid depression screening scale (Beard et al., 2016), currently administered by providers to all Veterans who are referred from primary care clinic for PCMHI screening. The implementation team member scored the completed PHQ-9 tool. If the Veteran scored ≥ 5 on the PHQ-9 the implementation team member requested permission from the Veteran to administer the MARS tool. If the Veteran provided permission, the MARS tool was administered. If the Veteran declined, the MARS tool was not administered, and the implementation team member noted "*Declined"* on the document. If the Veteran scored < 5 on the PHQ-9, the implementation team member wrote *"not applicable"* on the MARS document. All MARS tools, including *"Declined,"* and *"not applicable,"* were collected by the DNP project lead.

The *studying* phase consisted of between-cycle telephone or email debriefings to obtain feedback on what was working, as well as identification of barriers to the process of the practice change. Between-cycle questions (Table E1 in Appendix E) was administered to an identified implementation team member(s) via telephone or email on Mondays, following the Fridays when the cycle ended. Based on feedback obtained during the debriefings, modifications were made before the next cycle began to improve the process and facilitate achievement of target goal. At the completion of the implementation, all data was analyzed to evaluate if outcomes were met.

The last step of the PDSA Model, is the *actin*g phase. Problems with or barriers to the process were identified during between-cycle debriefings. Changes in the process were made based on this feedback. These improvements were made in "real time" to promote success for the next repetition of the planned cycles. At the completion of implementation, a final post-

implementation debriefing was conducted (Table E2 in Appendix E). It is in this phase the decision occurred whether to adopt, adjust, or abandon the practice change based on the analysis of the collected data. Sustainability was emphasized.

The start date for the project was June 1, 2020. The project occurred over a span of six weeks from the start date with a completion date of July 10, 2020

CHAPTER 6: DATA COLLECTION

Rate of provider adherence to administration of MARS tool was collected. Semi-structured debriefings occurred between each PDSA cycle to assess the implementation process and identify necessary adjustments in the process before initiating the next cycle. The debriefings consisted of established questions asked of each implementation team member (Table E1 in Appendix E). The questions were developed based on evidence in the literature. At the conclusion of the implementation, a final debriefing was conducted to evaluate the process, assess barriers and solutions during cycles, and to discuss implementation team members' perceptions about sustainability of the practice change. Specific questions were asked regarding feasibility, relevance, usefulness, and timeliness of the tool (Table E2 in Appendix E). These questions were also developed based on evidence in the literature. Aggregate data from the completed MARS tools were collected. The data consisted of "yes" or "no" responses.

CHAPTER 7: DATA ANALYSIS AND OUTCOMES

Quantitative and qualitative data were collected. Descriptive statistics were used to analyze provider adherence rates and aggregate data from the administration of the MARS tool. The target rate for provider implementation of the tool was 90%. Data from the MARS tools were entered and analyzed using Microsoft Excel version 2007. Questions 1-10 yielded dichotomous categories from "yes" or "no" responses. Qualitative data obtained from the semi-structured debriefings yielded qualitative information which was analyzed using a content analysis procedure (Colorado State University, 2020). The interviews were transcribed by the DNP project lead. Transcripts were reviewed for themes by the DNP project lead and the DNP project chair. The identified themes were discussed to determine congruence between both reviewers.

Outcomes

The anticipated primary outcome for the practice change initiative was a 90% compliance rate for provider adherence to administration of the MARS screening tool to Veterans who scored ≥ 5 on the PHQ-9. The outcome of 90% rate of provider adherence, which was identified as a reasonable target goal, was the benchmark to determine success of the implementation. Additionally, feedback was obtained from the implementation team members regarding whether sustainability of the practice change was feasible.

Screening

Across the 6 cycles, there were a total of 25 Veterans eligible for MARS tool administration. Eighteen of the 25 Veterans had recorded PHQ-9 scores. The PHQ-9 scores ranged from 5 to 15, with an average score of 9.55 (SD= 2.81). The frequency of each PHQ-9 score is displayed below in Table 1.

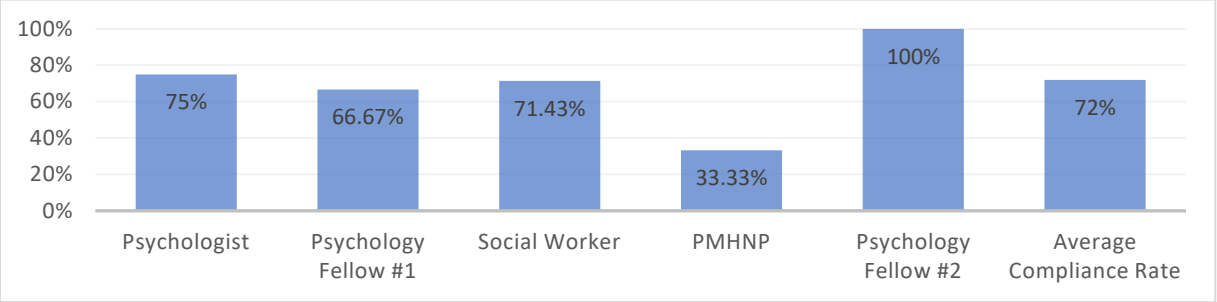
Table 1: PHQ-9 Frequencies

PHQ Score	n (%)
5	1 (5.6%)
6	1 (5.6%)
7	2 (11.1%)
8	4 (22.2%)
9	2 (11.1%)
10	2 (11.1%)
11	2 (11.1%)
13	2 (11.1%)
14	1 (5.6%)
15	1 (5.6%)

Adherence to Administration of the Medication Adherence Rating Scale

The MARS administration compliance rates, sorted by discipline, are displayed below in Figure 1. The compliance rate (calculation: numbers of MARS administered divided by Veterans eligible for MARS) delineated by disciplines is as follows: psychologist was six out of eight (75%), psychology fellow #1 was two out of three (66.67%), social worker was five out of seven (71.43%), PMHNP was one out of three (33.33%), and the psychology fellow #2 was four out of four (100%). The psychology fellow #2 had the highest rate at 100%. The overall compliance rate was 72%, with a total of 18 MARS administered out of 25. The variation in compliance rates between disciplines appeared arbitrary and was not dependent on the type of discipline.

Figure 1: MARS Administration Compliance Rate



MARS-10 Results

Each of the 10 questions received one point with scores ranked from 0-10. One point is given for each "no" response for questions 1-6 and 9,10; and 1 point for each "yes" response for questions 7 and 8 (Thompson, n.d.). Higher scores suggest greater adherence to the medication regimen. For example, a score of 0 is suggestive of poor likelihood of medication adherence, whereas a score of 10 is suggestive of a good likelihood of adherence (Sowunmi & Onifade, 2019). Questions one-to-four represent behaviors that contribute to medication adherence; questions five-to-eight represent attitudes about taking medications; and questions nine and ten represent attitudes about psychotropic medication and the negative side-effects associated with psychotropic use (Sowunmi & Onifade, 2019).

While 18 MARS questionnaires were administered, six (33.3%) were missing data for at least one question. Figure 2 and Figure 3 below indicates the breakdown of the "yes" and "no" responses for each MARS question for completed and incomplete MARS, respectively.

Figure 2: Responses from Completed MARS

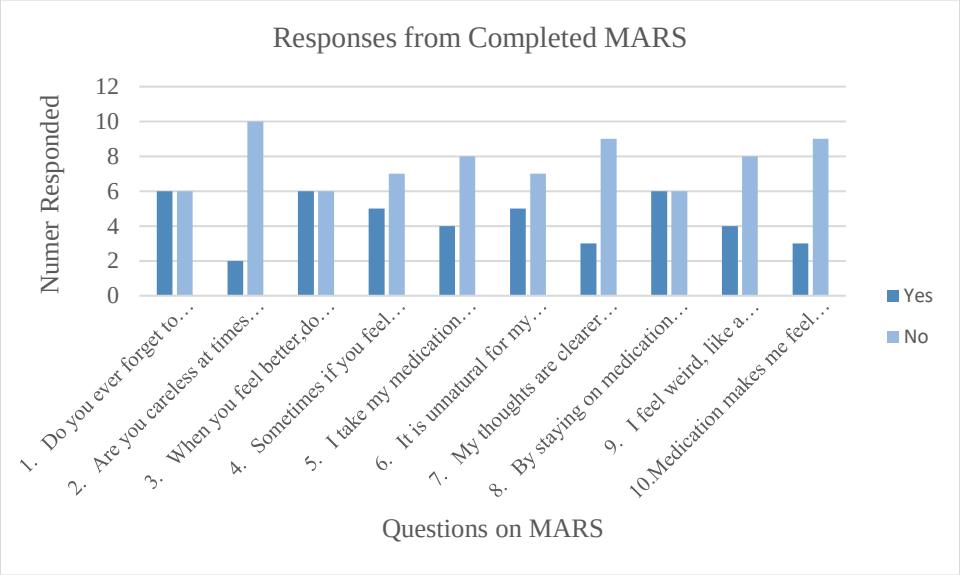
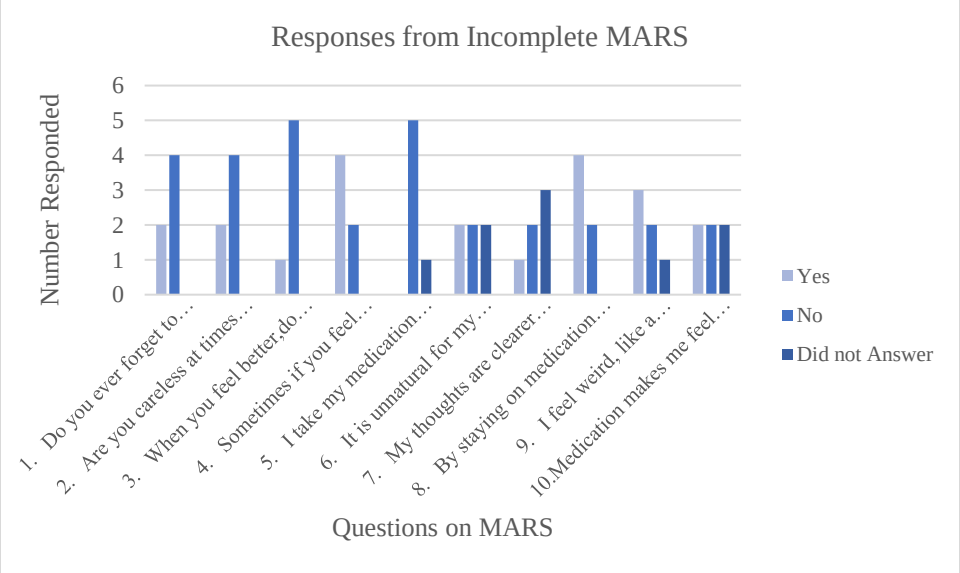


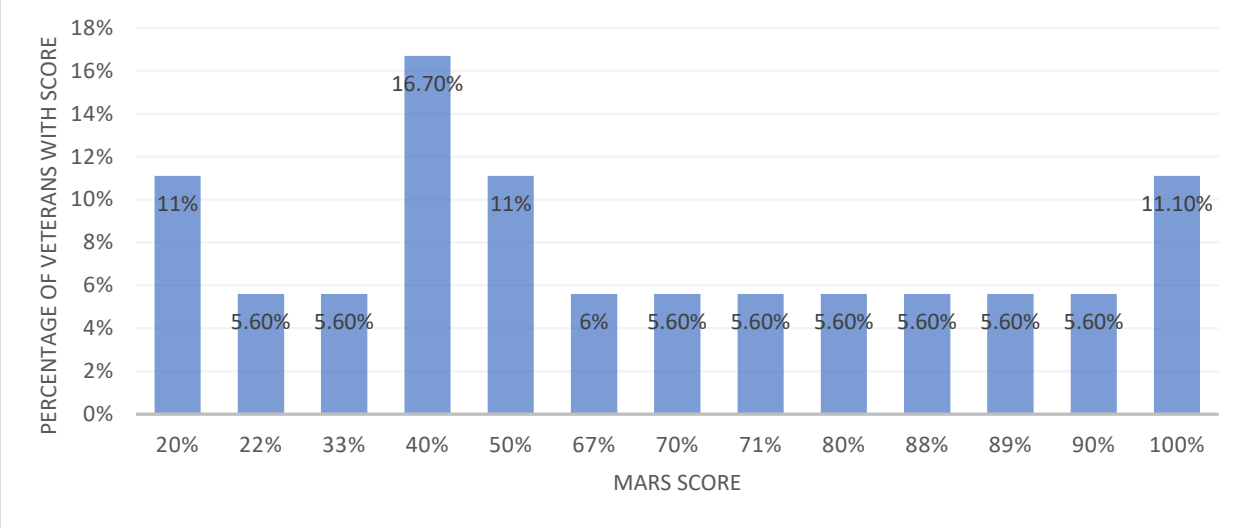
Figure 3: Responses from Incomplete MARS



As a result of the missing data for six of the MARS, all the MARS scores were adjusted to percentages that were calculated as "percentage of positive responses"- higher percentages equaled higher adherence and positive attitudes regarding psychotropic medication. For example,

a Veteran answered 9 out of the 10 questions; therefore, the percentage of positive responses was calculated based on those nine answered questions. The Veteran's MARS score was a three based on the nine answered questions, giving him a percentage score of 33% (3/9). Using this scoring method, MARS scores ranged from 20% to 100%. The most common score was 40% (n=3). The percentage at each score was calculated by adding the total number at that score (i.e. 20%, 22%, 33%, 40%, 50%, 67%, 70%, 71%, 80%, 88%, 89%, 90%, & 100%) and dividing it by the total number of MARS (n=18). For example, two Veterans scored a 100% on the MARS based on the adjusted values: therefore 2/18= 11.10%. The percentage of Veterans at each score for both completed and incomplete MARS are displayed in Figure 4 below.

Figure 4: Percentage of Positive Responses

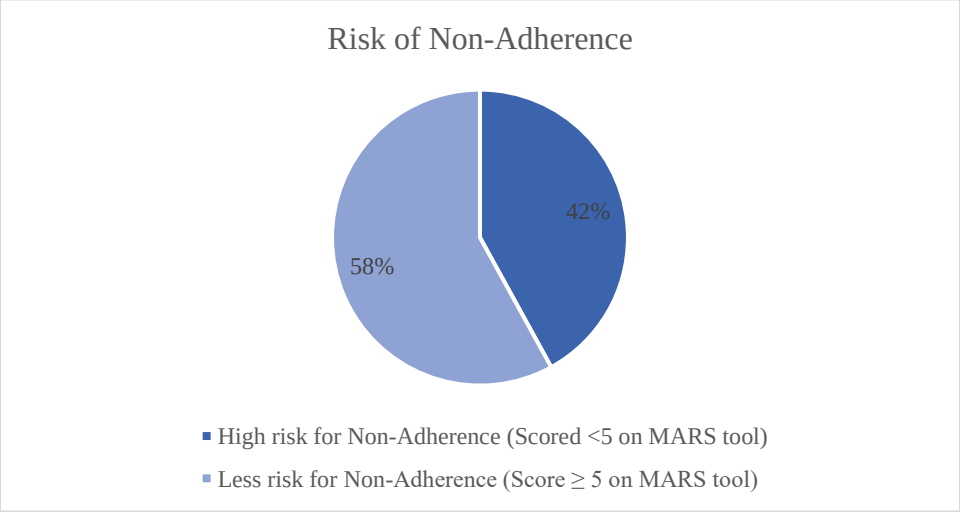


Reasons for missing data from the six Veterans who did not complete all ten questions were: one Veteran could not answer questions # 7, 9, and 10 (statement(s) about side effect of medication) because he had only taken antibiotics. Another Veteran did not state a reason as to why he did not answer question #6 (statement: it is unnatural for medication to control one's

mind and body). One Veteran stated he did not know the answer for question #5 (statement: I take my medication only when I am sick). One Veteran did not answer question #6 (statement: it is unnatural for medication to control one's mind and body) because he thought the question was vague. This Veteran's response to the question was that it is "relative to the type of medication and how it affects the body." One Veteran did not answer questions #7 and 10 (statements about side effects) because he was unsure how to answer. The last Veteran did not answer question #4 (statement asked if you feel worse as a result of taking medication) because it "depends on how I feel." This same Veteran did not answer question #7 because he stated did not know how to answer it.

Figure 5 below displays results related to the likelihood of adherence based on data collected from the completed MARS tools. A score of five was identified as the median point. Veterans who scored < 5 (5/12=42%) were at high risk for lower adherence to their antidepressant regimen and Veterans who scored ≥ 5 (7/12=58%) had a lower risk of poor adherence to their antidepressant regimen.

Figure 5: Likelihood of Adherence



Qualitative data were gathered between each PDSA cycle. Previously established semi-structured questions that were developed from the evidence were used to elicit feedback from the implementation team members about their perceptions of the implementation process and to identify any barriers they encountered. Solutions were determined for any identified barriers. At the conclusion of the implementation process, post-implementation semi-structured questions were used to facilitate debriefing of the implementation of the practice change and to discuss the feasibility of sustaining use of the MARS screening tool in this clinic.

PDSA Between Cycle Debriefing Questions

The purpose of the PDSA between cycle debriefings (Table E1 in Appendix E) was to identify barriers to implementation of the MARS tool and to discuss solutions to improve the practice change in real time before the start of the next cycle.

After the completion of cycle 1, the psychologist (team champion) suggested revising the electronic template to make it easier to score the MARS tool. This change was implemented before the start of cycle 2. The updated MARS template was emailed to all implementation team members.

After completion of cycle 2, the psychologist suggested having implementation team members submit the completed MARS to the DNP project lead or place them in a designated mailbox by the end of the week. A significant increase in tele-mental health appointments as a result of COVID-19, with team members teleworking, resulted in decreased ability to collect the completed MARS tool in person. Furthermore, it was recommended to revise the MARS cover sheet to include the date and the name of the provider administering the MARS tool. Both changes were implemented before the start of cycle 3 and an email was sent to the implementation team members to communicate the change.

After completion of cycle 3, the psychologist recommended to allow the option for team implementation members to email the completed MARS to the DNP project lead. An email was sent to the implementation team members to communicate the change before the start of cycle 4.

After completion of cycle 4, the social worker inquired about including additional information such as Veteran's thoughts and comments about the MARS tool. The social worker was informed Veteran's thoughts and comments could be included on the MARS tool. This information was emailed to the team implementation members before the start of cycle 5.

After the completion of cycle 5, the social worker cited a preference for keeping the MARS questions consistent with respect to the form of pronouns used in the questions. The MARS questions used both first and second person pronouns throughout the tool. The MARS tool is a standardized and validated tool that cannot be changed by an individual. As this suggestion is more about personal preference than about barriers to MARS administration, the DNP project leader suggested the social worker could change the pronoun when asking the question. The PMHNP resident suggested adding the PHQ-9 score to the MARS electronic template. It was explained the PHQ-9 template is already added to the Veteran's electronic record and adding the PHQ-9 score to the MARS electronic template would be redundant.

Post-implementation Questions

The purpose of the post-implementation questions (Table E2 in Appendix E) at the completion of the intervention were to focus on the practice change process in its entirety to include overall perceptions, attitudes, barriers, facilitators, and suggestions for future implications for use of the MARS tool in this clinic; as well as other clinics in the VA system.

Overall, the team members agreed the MARS tool administration was feasible and easy to administer in the clinical setting, with administration time between 2-10 minutes. All agreed the

MARS questions were relevant to the Veteran population, who were receiving mental health treatment. Two team members mentioned the MARS may be irrelevant to Veterans who have never taken and/or not currently on a psychotropic medication. Others mentioned the MARS questions could be modified to increase clarity and make it more generalizable.

All five of the team members agreed the MARS tool would be beneficial for the treatment of depression in the Veteran population. While all agreed on the benefits of the tool, two team members suggested implementation of the MARS tool in the clinic setting be done by nurse care managers to assist with routine medication monitoring rather than by psychologists, social workers, and prescribers. One team member stated the MARs tool could serve as a "great starting point for discussion surrounding medication/medication adherence." Another team member stated it could be beneficial to track the Veteran's attitudes or beliefs about taking an antidepressant. Lastly, one team member agreed the MARS tool would allow for the clinician to have an idea if the Veteran will adhere to the antidepressant. Contrastingly, this same team member felt the MARs tool was a very subjective screening tool and sometimes a Veteran may answer the MARS questions based on how they perceive clinician wants the Veteran to answer the question.

Emerging Themes

Throughout the practice change, team member's comments were documented during between-cycle debriefing and post-implementation debriefing questions. Three themes emerged at the conclusion of the six-week implementation period.

Theme one was *Veteran barriers.* Seven of the 25 Veterans who met criteria for MARS administration declined the MARS tool. In general, refusals of administration of screening tools are to be expected by a small number of Veterans. Additional barriers included hearing and

cognition concerns, Veterans who were loquacious and using up time in the appointment, and lack of applicability of the MARS tool to the individual Veteran. For the seven Veterans that did not receive the MARS, reasons are displayed in Table 2 below.

Table 2: Reasons for Non-Administration of MARS

Reason	n (%)
Refused	3 (42.9%)
Hearing/Cognition concerns	1 (14.3%)
Not on a psychotropic	1 (14.3%)
Not enough time	2 (28.6.3%)

Theme two was *process of implementation considerations.* The PDSA model allowed consideration of the process and changes in "real time." Communication with implementation team members occurred early Monday morning before Veteran's appointments began. It was during this time that feedback was elicited from team members involved in the previous week's cycle. Shortly after the discussion, most suggestions were implemented. Changes made to the implementation process were conveyed to implementation team members via an email. Data such as numbers of MARS administered vs. number of Veterans eligible and reasons why MARS were not administered to eligible Veterans, were collected from the implementation team members.

The third, and final theme, was *making meaning of Veterans' responses.* It was frequently reported by implementation team members that Veterans' comments about MARS questions included, inapplicability, lack of clarity for what the question(s) was asking, and lack of understanding about psychotropic medications. Some based their answers on previous trials of sleep medications (trazodone & zolpidem). Others did not answer a question because it asked about a specific type of medication the Veteran was not taking. One Veteran did not answer three

questions because he had never taken a psychotropic and currently was taking an antibiotic. Team members conveyed they did not know what to document based on the Veterans' responses; therefore, the question was left blank.

CHAPTER 8: DISCUSSION

The overall outcomes of the practice change initiative in the PCMHI setting supports the use of the MARS as a screening tool to assess for medication-taking behaviors. Although the overall actual provider compliance adherence rate (72%) was lower than the targeted provider compliance adherence rate (90%), the compliance rate demonstrated engagement by the implementation team members. The integration of the MARS tool generated discussion by the implementation team members about medication compliance factors among the Veterans they treat. The consensus was adoption of the practice change initiative, administration of the MARS tool to eligible Veterans, was sustainable at this clinic.

A factor that affected adherence rates was team member participation. Although all five team members consented to participate in the practice change, one implementation team member did not participate during cycle 3. There was a miscommunication between the implementation team member and the DNP project leader. The implementation team member did not receive the reminder email about their role in cycle 3. The process was later discussed and reviewed with this implementation team member, who was then able to move forward with participation in cycles 4,5,6. Clear, effective communication was identified as a critical factor for the success of the practice change initiative. A strategy to help mitigate participation errors in this type of implementation process would be to ensure an email reply confirmation from all implementation team members. If no confirmation reply occurred, then an additional method of communication (telephone or in-person) could occur to clarify understanding of next steps.

The implementation team members' comments from the post-implementation debriefing suggested a high likelihood of adopting the MARS tool in the clinic setting, with the consideration of nurse care managers' involvement. Monitoring a Veteran's medication regimen is a component of the nurse care manager's role; therefore, they are ideally placed to administer the MARS tool. Additionally, the process of screening for medication behaviors facilitates conversations with Veterans about their knowledge, attitude, and beliefs regarding psychotropic medications. Most importantly, this conversation promotes opportunities for clinicians to provide psychoeducation to address knowledge deficits that become apparent during the conversation.

Barriers to the effective, sustained use of the MARS tool were identified throughout the implementation process. The first key point is to consider additional methods about how to administer the MARS tool for Veterans with hearing and cognition impairments. Provision of a hard copy of the MARS tool prior to or upon arrival to the clinic may improve the Veteran's ability to complete the tool. This could alleviate concerns about time constraints for MARS tool administration during the actual appointment. If time is limited, the Veteran could complete the MARS tool after the appointment and email or physically mail it back to the provider. Perhaps nurse care managers can assist with this process of supplying a copy of the tool to the Veteran before/after their appointment.

The second key point for consideration is to streamline the administration guidelines for the MARS tool. Rather than administering the MARS tool to all Veteran who score ≥ 5 on the PHQ-9, it would be helpful to inquire if the Veteran has ever taken an antidepressant or confirm if Veteran is currently on an antidepressant. A negative response to either question would indicate the MARS tool would not be offered.

Incomplete data from 6 of the 18 MARS questionnaires revealed MARS questions that require clarification or did not apply to this Veteran population. Of the six incomplete questionnaires, questions #6 (n=2), #7 (n=3), and #10 (n=2) were the most frequently left unanswered. Question #6 stated "Is it unnatural for my mind and body to be controlled by medication." Question #7 stated "my thoughts are clearer on medication." Question #10 stated "medication makes me feel tired and sluggish." Plausible solutions include provider education about the outcomes of this practice change initiative to administer the MARS tool with training about how the provider can clarify what the Veteran does not understand in these questions. For example, the Veteran may not have a history of taking a psychotropic, therefore doesn't understand the meaning of questions 6 and 7. The provider might ask, "Have you ever taken a medication for your mental health" and list names of psychotropics to help the Veteran understand what the question is asking. Ultimately, this difficulty with the tool may be effectively managed by streamlining the inclusion criteria for MARS administration to include Veterans who have a history of taking an antidepressant and/or are currently taking an antidepressant.

Results from Figure 5 reflect 42% of Veterans who were administered the MARS tool, are at high risk for non-adherence with an antidepressant medication. The added benefit of the MARS screening tool is clinicians can pinpoint specific MARS questions to identify barrier(s) leading to non-adherence. For example, if a Veteran answered yes (score=0) on question #1, "do you ever forget to take your medication," the clinician can develop an intervention to assist with remembering to take medications, such as a pill box.

Barriers

A potential barrier was the novelty of this medication adherence assessment tool within the clinic of this hospital system. No other clinic within the hospital utilized a medication adherence assessment tool, resulting in possible resistance to being the first adopters. Other potential barriers included perception of a lack of time to administer the tool during the appointment and/or a belief the tool would not be helpful for the Veteran population. These barriers were addressed during a scheduled team meeting. Dissemination of evidence supporting the significance of this clinical problem, the high rate of antidepressant nonadherence, psychometric properties of the MARS screening tool, and purpose of the practice change were discussed. Evidence supporting a high level of acceptability of the MARS tool in a clinical setting, combined with a completion time of less than < 5 minutes were emphasized (Fond, 2017). Additionally, implementation team members received a copy of the schedule outlining their role during each of the PDSA cycles.

Another potential barrier to implementation of the practice change was concern for maintaining fidelity of the tool's administration. A solution to alleviate concern about inconsistency in administration was education to each team member, one-on-one, about how and when to administer the MARS. A flow chart was provided to the implementation team member as a visual graphic for the steps in the implementation process (Appendix F).

Limitations

A limitation of the project included lack of precedent for implementation of a screening tool to assess medication-taking behaviors. No clinic in the system had an established protocol for this practice change initiative. The time constraints for implementation may have contributed to insufficient data to demonstrate to all providers and clinic leadership the practice change could

be sustainable. Another limitation was that paper and electronic entry of data created additional workload for the implementation team members. Lastly, nurse care managers were not recruited to participate in this practice change initiative. Inclusion of an additional disciplinary role may have helped to generate additional insights and suggestions to improve the practice change initiative process.

Strengths and Facilitators

Strengths of this practice change initiative included stakeholder investment, ease-of-use of the screening tool, and creation of an opportunity for the clinic to be an early adopter of a screening tool that may improve Veteran medication adherence. Use of the PDSA Model promoted close communication with the implementation team members and quick real-time revisions to address barriers. Earlier, lack of precedent for implementation of a screening tool to assess medication-taking behaviors was identified as a limitation. On the contrary, this can be identified as a strength. One can argue, the practice change initiative sets a precedent for implementing screening tools to assess medication-taking behaviors.

Facilitators to the project included buy-in and approval from the Director and the clinic coordinator of PCMHI clinic. Most importantly, a team champion was identified to help lead the change and assist with implementation. The team champion had significant influence due to their expertise and experience in the clinic.

Sustainability

Sustainability of the MARS tool utilization could enhance identification of barriers to adherence to a prescribed antidepressant medication regimen, as well as elicit information about Veterans' perceptions and beliefs about psychotropic medications. Information from the evaluation of the MARS tool utilization, combined with additional mental health assessment

data, can provide comprehensive information to address the mental health needs of the Veteran more adequately. Inclusion of the MARS data into the electronic health record can increase the accessibility of this information over the course of treatment for all providers involved in the Veteran's care. Overall, this tool facilitates QI of mental health care treatment, through identification of barriers and development of solutions to assist with increasing antidepressant adherence.

As discussed earlier, the implementation team members' comments from the post-implementation debriefing suggested a high likelihood of sustainability for the use of the MARS tool in the clinic setting, with the consideration of nurse care management involvement. Key actions to assist with sustainability include dissemination of the results to both the clinic coordinator and the director of the PCMHI clinic. It will be important to stress to the Leadership Team the beneficial value, feasibility, and relevance of administrating the MARS tool to the Veteran population. Emphasis on incorporation of the practice change into the standard of care is important. Some steps have already been taken to assist with the transition into clinical practice, such as creation of an electronic template for the MARS tool in the electronic documentation system. Additionally, informal education sessions can be provided to new staff members, who are unfamiliar with utilization of the MARS tool.

Lastly, each year at this hospital system, recognition is given to the department or clinic who demonstrated an effective practice change that resulted in positive outcomes for the Veteran. Emphasis on the importance of the sustainability of the MARS tool can be promoted as a QI initiative for the PCMHI clinic to increase Veterans' health outcomes to make this clinic competitive to receive the award.

CHAPTER 9: RECOMMENDATIONS

As a result of the data collected from this practice change initiative, key recommendations were identified. The first recommendation is to expand this practice change initiative into other PCMHI clinics within the VA system. Replication would beneficially facilitate evaluation of the impact of this QI practice change initiative across a variety of clinics. Extension into other clinics is feasible given interest and buy-in from both the PCMHI Clinic Coordinator and the Clinic Director.

The second recommendation is to consider nurse care management involvement, particularly during medication follow-up appointments. Administration of the MARS tool by nurse care managers will assist the care managers to identify barriers to nonadherence. Identification of these barriers can highlight the process for nurse care managers to develop individualized interventions that assist with increasing compliance. Through discussion generated by administration of the MARS tool, benefits of additional mental health interventions that can support medication adherence may become apparent, such a group or individual psychotherapy, utilization of pill boxes, and/or pill reminder alarms on electronic devices.

The last recommendation is to change the inclusive criteria of administering the MARS tool to Veterans who score ≥ 5 on the PHQ-9 questionnaire and have previously and/or currently taking an antidepressant.

APPENDIX A: DSM-5 CRITERIA FOR MDD & MARS QUESTIONNAIRE

Table A1: DSM-5 Criteria for Major Depressive Disorder

Five or more of the following symptoms are present within the past two weeks and are not related to a medical condition. One of the symptoms must include (1) anhedonia and/or (2) depressed mood. 1. Depressed mood 2. Diminished interest or pleasure in activities 3. Significant changes in appetite or weight 4. Problems with sleep, hypersomnia, or insomnia 5. Psychomotor retardation or agitation 6. Low energy or fatigue 7. Feelings of low self-worth, or guilt 8. Problems with concentration 9. Recurrent passive or active suicidal ideation

American Psychiatric Association, 2013

Table A2: Medication Adherence Rating Scale (MARS) questions

Questions	
1. Do you ever forget to take your medications?	Yes/No
2. Are you careless at times about taking your medication?	Yes/No
3. When you feel better, do you sometimes stop taking your medication?	Yes/No
4. Sometimes if you feel worse when you take your medication, do you stop taking it?	Yes/No
5. I take my medication only when I am sick	Yes/No
6. It is unnatural for my mind and body to be controlled by medication	Yes/No
7. My thoughts are clearer on medication	Yes/No
8. By staying on medication, I can prevent getting sick	Yes/No
9. I feel weird, like a ‘zombie’ on medication	Yes/No
10. Medication makes me feel tired and sluggish	Yes/No

Thompson, Kulkarni, & Sergejew, 2000

APPENDIX B: APPROVAL MEMO

Department of Veterans Affairs

Memorandum

Date: January 21, 2020

From: Division Chief, Behavioral Medicine; Clinic Coordinator- Primary Care Mental Health Integration

Subj: QI Project Approval

To: Bich-Tuyen Nguyen

1. Ms. Bich-Tuyen Nguyen, PMHNP, has my approval to conduct a QI project focused on exploring the utility of administering a medication adherence measure to Primary Care patients.

2. This proposed incorporation of a medication adherence measure may assist in identifying patients who have barriers to medication adherence, and for clinicians to intervene with those patients with elevated risk for nonadherence.

Cindy D. Greenlee, PhD
Division Chief, Behavioral Medicine
Clinic Coordinator, Primary Care- Mental Health Integration
Durham VA Health Care System

Automated VA FORM 2105

APPENDIX C: CONSENT INFORMATION FORM FOR TEAM MEMBERS

To: Implementation Team Member

Re: Practice Change to Implement the Medication Adherence Rating Scale

In a recent study done at three VA medical centers (Ann Arbor, Detroit, & Battle Creek, Michigan) nearly one-third of Veterans were nonadherent with their antidepressant at the fourth and twelfth-month follow-up visit. Locally, through conducted chart reviews, the findings are similar. Antidepressant nonadherence leads to poor healthcare outcomes. Because there is often a high prevalence of multiple medical comorbidities with depression, untreated depression can lead to non-compliance with other medical interventions. The American Psychiatric Association guidelines for Major Depressive Disorder recommend an individual take the antidepressant beyond six months after remission of symptoms to prevent relapse.

Currently, clinicians at the VA clinics are not utilizing a screening tool to assess for medication-taking behaviors. I am proposing a practice change in which clinical staff administers the Medication Adherence Rating Scale (MARS) to Veterans who score at least ≥ 5 on the PHQ-9 at their primary care appointment and are interested in taking an antidepressant. Strong evidence exists in the literature to support the use of the MARS tool to assess medication-taking behaviors.

This proposed practice change will facilitate identification of barriers to adherence to an antidepressant medication regimen. This will allow clinical staff to develop individualized interventions to increase antidepressant adherence. A John Hopkins School of Public Health research publication about policy on risk management and healthcare, discussed findings to support that medication adherence not only improves healthcare outcomes but also saves billions of dollars. With that being said, additional potential long-term outcomes benefiting both the Veteran and the hospital include an overall potential decrease in costs for the Veteran and the hospital.

The target start date for implementation is June 1, 2020 and will run until July 10, 2020. My aim for the practice change is to have 90% clinician utilization rate of the MARS within the inclusive criteria. I have secured approval from Dr. Cindy Greenlee, the clinic coordinator for PCMHI Clinic.

I would greatly appreciate your cooperation in helping to implement this practice change. Your signature on this document constitutes your consent to participate.

Implementation Team Member Signature: _____
Date: _____

Sincerely,

Bich-Tuyen Nguyen, MSN, PMHNP-BC, UNC DNP graduate student

APPENDIX D: PDSA CYCLE SCHEDULE

Week	Cycle number	Number of implementation team member involved	Implementation Team member who will administer the MARS	Days & times of the week the MARS will be administered	Time length of each Cycle
1	1 (June 1, 2020 to June 5, 2020)	1	**Psychologist**	Thursday PM & all-day Friday	One week
In between cycle debriefing questions implementation staff					
2	2 (June 8, 2020 to June 12, 2020)	2	Psychologist and **1st Psychology fellow**	Monday afternoon, all-day Thursday & Friday	One week
In between cycle debriefing to implementation staff					
3	3 (June 15, 2020-June 19, 2020)	3	Psychologist, Psychology Fellow, **and Social Worker**	All day Monday, Tuesday, Thursday, & Friday	One week
In between cycle debriefing to implementation staff					
4	4 (June 22, 2020 to June 26, 2020)	4	Psychologist, Psychology fellow, Social Worker, and **NP resident**	All day on Monday, Tuesday, Wednesday, Thursday, & Friday	One week
In between cycle debriefing to implementation staff					
5	5 (June 29, 2020 to July 3, 2020	5	Psychologist, Psychology fellow, Social Worker, NP resident, NP resident, and **2nd Psychology Fellow**	All day on Monday, Tuesday, Wednesday, Thursday, & Friday	One week
In between cycle debriefing to implementation staff					
6	6 (July 6, 2020 to July 10, 2020)	5	Psychologist, 1st Psychology fellow, Social Worker, NP resident, and 2nd Psychology fellow	All day on Monday, Tuesday, Wednesday, Thursday, & Friday	One week
Post-implementation debriefing to all members of implementation team					

APPENDIX E: INTERVENTION DEBRIEFING QUESTIONS

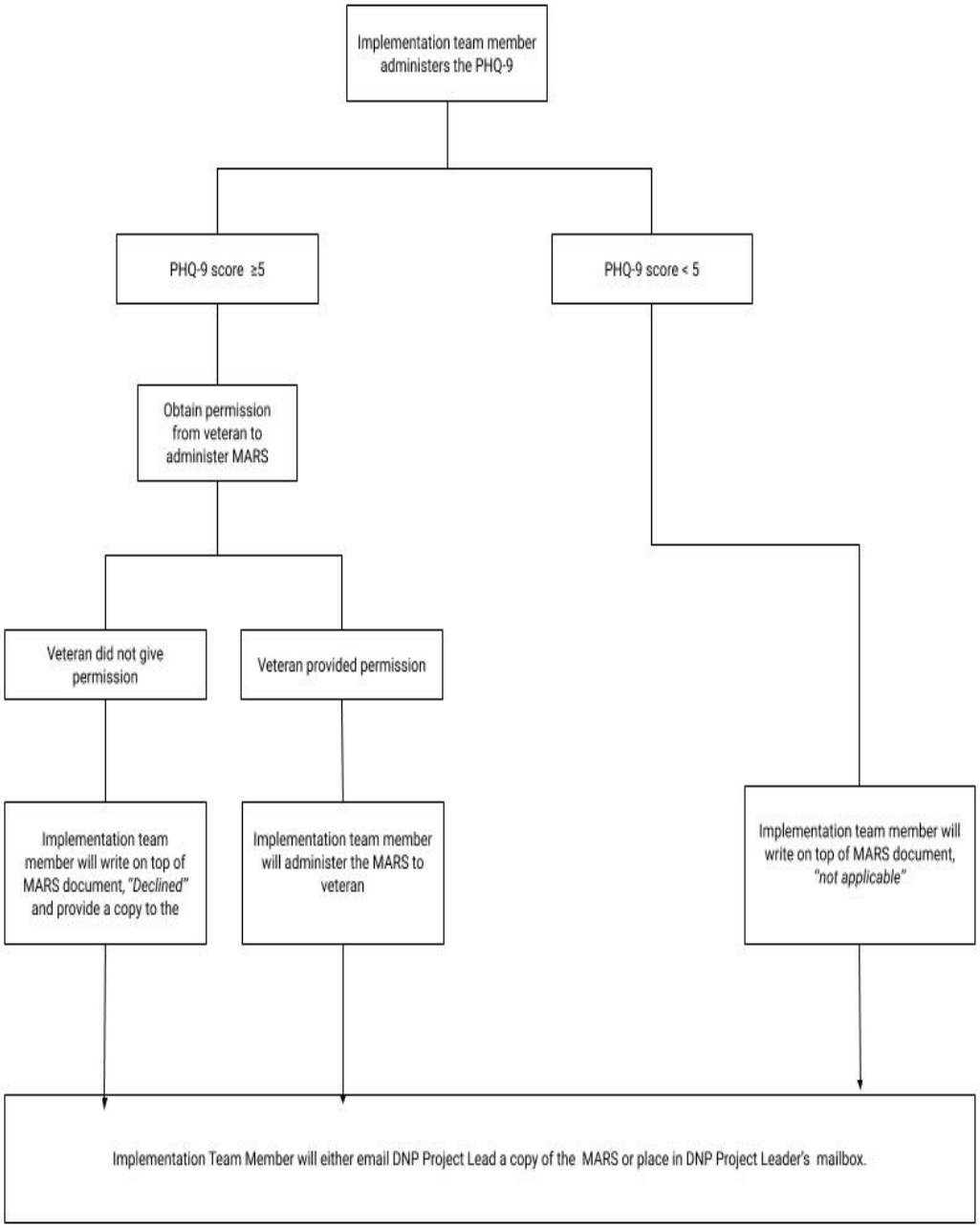
Table E1: Formal between cycles debriefing questions

1. Overall, how did this work for you? 2. Did administration of the MARS cause significant delays in your screening appointment? 3. Did Veterans share any additional information while completing the MARS? 4. Do you have any recommendations on how to improve/change the implementation process?

Table E2: Post-Implementation debriefing questions

1. How feasible was administration of the MARS in the clinical setting? 2. Overall, how much time did it take from start to finish, administering the MARS? 3. Do you feel the MARS is relevant to the population we are treating? 4. In the future, what are your thoughts on how the MARS could be beneficial to the Veteran population?

APPENDIX F: IMPLEMENTATION OF MARS PROCESS



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