

# **Design and Evaluation of Sleep MAPP: A Decision Support Tool for Guideline-Concordant Sleep Disorder Management in the Polytrauma/Traumatic Brain Injury System of Care**

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## Abstract

**Background:** Sleep disorders, including insomnia and obstructive sleep apnea (OSA), are prevalent among Veterans receiving Veterans Health Administration (VHA) Polytrauma/Traumatic Brain Injury System of Care (PSC) services. Poor sleep secondary to these conditions undermines recovery from traumatic brain injury and other service-related injuries and contributes to poor health. The VA/DoD Clinical Practice Guideline for Insomnia and OSA outlines evidence-based recommendations for managing these sleep disorders, from screening symptomatic patients using standardized assessments to empirically supported follow-up care. However, gaps in implementing these recommendations in the PSC persist. Specific barriers to implementation are amenable to clinical decision support tools, which offer a promising strategy to enhance the delivery of guideline-concordant sleep disorder care in the PSC.

**Objective:** First, to summarize the development of Sleep Disorder Management Assistance for Providers and Patients (Sleep MAPP)—a novel web-based decision support tool that leverages electronic medical record (EMR) data to facilitate guideline-concordant sleep disorder screening and follow-up. Second, to assess the tool's usability, acceptability, and feasibility among VHA clinicians.

**Methods:** First, we leveraged stakeholder input and subject matter expertise to identify the scope and design of the tool. Second, we engaged in an iterative process of developing the Sleep MAPP prototype, including its measures (i.e., algorithm evaluating receipt of guideline-concordant care), data (i.e., sources for measures), and display (i.e., design elements such as charts). Finally, a convergent parallel mixed methods design was employed to gather feedback on the prototype from VHA clinicians (n = 7). To evaluate the prototype, clinicians participated in semi-structured interviews and completed standardized instruments of usability (System Usability Scale), acceptability (Acceptability of Intervention Measure), and feasibility (Feasibility of Intervention Measure). Qualitative interview data were analyzed using descriptive and interpretive methods, while quantitative survey data were summarized with descriptive statistics. A joint display table was used to synthesize data from both strands and to derive overall conclusions.

**Results:** Clinicians found Sleep MAPP easy to use, highlighting its intuitive functionality, but suggested increased

customizability to maximize its usability. Sleep MAPP was seen as acceptable, facilitating time-efficient assessment and treatment of sleep disorders with the potential to improve care quality and clinical outcomes. Changes to EMR-based measures were recommended to increase acceptability. Sleep MAPP was considered feasible to implement due to its alignment with the PSC clinical workflow. Conducting educational meetings and developing a detailed plan for implementation were perceived to promote successful implementation, while facility resources (e.g., staffing levels) was identified as a potential barrier.

**Conclusions:** Sleep MAPP was considered usable, acceptable, and feasible to implement. Provider feedback will guide revisions to the tool and the development of an implementation blueprint to integrate Sleep MAPP into routine PSC services, enhancing sleep disorder care quality and outcomes among this high-risk population of Veterans.

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## Original Manuscript

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**Objective:** First, to summarize the development of Sleep Disorder Management Assistance for Providers and Patients (Sleep MAPP)—a novel web-based decision support tool that leverages electronic medical record (EMR) data to facilitate guideline-concordant sleep disorder screening and follow-up. Second, to assess the tool's usability, acceptability, and feasibility among VHA clinicians.

**Methods:** First, we leveraged stakeholder input and subject matter expertise to identify the scope and design of the tool. Second, we engaged in an iterative process of developing the Sleep MAPP prototype, including its measures (i.e., algorithm evaluating receipt of guideline-concordant care), data (i.e., sources for measures), and display (i.e., design elements such as charts). Finally, a convergent parallel mixed methods design was employed to gather feedback on the prototype from VHA clinicians ( $n = 7$ ). To evaluate the prototype, clinicians participated in semi-structured interviews and completed standardized instruments of usability (System Usability Scale), acceptability (Acceptability of Intervention Measure), and feasibility (Feasibility of Intervention Measure). Qualitative interview data were analyzed using descriptive and interpretive methods, while quantitative survey data were summarized with descriptive statistics. A joint display table was used to synthesize data from both strands and to derive overall conclusions.

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suggested increased customizability to maximize its usability. Sleep MAPP was seen as acceptable, facilitating time-efficient assessment and treatment of sleep disorders with the potential to improve care quality and clinical outcomes. Changes to EMR-based measures were recommended to increase acceptability. Sleep MAPP was considered feasible to implement due to its alignment with the PSC clinical workflow. Conducting educational meetings and developing a detailed plan for implementation were perceived to promote successful implementation, while facility resources (e.g., staffing levels) was identified as a potential barrier.

**Conclusions:** Sleep MAPP was considered usable, acceptable, and feasible to implement. Provider feedback will guide revisions to the tool and the development of an implementation blueprint to integrate Sleep MAPP into routine PSC services, enhancing sleep disorder care quality and outcomes among this high-risk population of Veterans.

**Keywords:** Brain Injuries, Traumatic; Veterans; Sleep; Sleep Initiation and Maintenance Disorders; Sleep Apnea, Obstructive; Guideline Adherence; Decision Support Systems, Clinical.

## Introduction

The prevalence of sleep disorders, particularly insomnia and obstructive sleep apnea (OSA), has increased dramatically among Veterans, posing a significant public health challenge.<sup>1</sup> When left untreated, these conditions lead to poor sleep quality, in turn compromising brain health, cardiometabolic functioning, and mental wellbeing.<sup>2-4</sup> Underscoring the urgency of this public health issue, the Support the Resiliency of Our Nation's Great (STRONG) Veterans Act was signed into law in 2022, including provisions intended to improve sleep disorder assessment and treatment within the Veterans Health Administration (VHA).<sup>5</sup> A key focus of the STRONG ACT is to enhance the adoption of the Departments of Veterans Affairs and Defense (VA/DoD) Clinical Practice Guideline (CPG) for Insomnia and OSA, which outlines evidence-based recommendations for each step of the sleep disorder care pathway, from initial screening to empirically supported treatments.<sup>6</sup> According to the CPG, guideline-concordant sleep disorder care begins with screening at-risk Veterans using standardized assessments for insomnia disorder (Insomnia Severity Index [ISI]) and OSA (Snoring, Tiredness, Observed apnea, Pressure [high blood pressure; STOP] questionnaire).<sup>7,8</sup> Screening results are used to inform evidence-based follow-up practices for probable insomnia disorder (Cognitive Behavioral Therapy for Insomnia [CBT-I]) and OSA (diagnostic sleep study, such as a home sleep apnea test or a lab-based polysomnography test).<sup>6</sup> As the standard of care for sleep disorder management in the VHA, widespread implementation of the VA/DoD CPG for insomnia and OSA is

expected to substantially enhance Veterans' sleep quality and overall health.

Efforts aimed at increasing implementation of guideline-concordant sleep disorder care should target settings which serve Veterans at high risk for insomnia and OSA. The VHA Polytrauma/Traumatic Brain Injury System of Care (PSC) is a prime target for such initiatives. As a national network of interdisciplinary teams with expertise in traumatic brain injury (TBI) and related conditions, the PSC treats Veterans with service-related injuries such as TBI, posttraumatic stress disorder (PTSD), depression, and chronic pain, all of which are associated with elevated risk for insomnia disorder and OSA.<sup>9-11 12-15</sup> By effectively managing these disorders and enhancing sleep quality, the delivery of guideline-concordant care to Veterans in the PSC can produce substantial downstream benefits, including corresponding improvements in cognitive performance, mental health, and pain.<sup>1,16</sup>

While delivering guideline-concordant sleep disorder care to Veterans receiving PSC services is expected to yield significant clinical benefit, decision support tools are likely needed to overcome implementation barriers. Decision support tools enhance care delivery by delivering filtered information regarding patients at appropriate times, thereby augmenting the clinical decision-making process.<sup>17</sup> Such tools have demonstrated positive impacts on care quality and patient outcomes in a variety of clinical populations (e.g., cardiovascular risk).<sup>17</sup> In our prior work investigating determinants of implementing guideline-concordant care for sleep problems in the PSC, we revealed barriers that were amenable to decision support tools, including limited availability of recommendations at appropriate times in the workflow. Moreover, PSC providers specifically recommended decision support as a strategy capable of increasing implementation of guideline-concordant sleep care.<sup>18</sup> To date, however, a decision support tool designed to promote guideline-concordant sleep disorder care has not been available in the PSC.

The purpose of this study was twofold. First, we summarized the design of Sleep Disorder Management Assistance for Providers and Patients (Sleep MAPP), a novel clinical decision support

tool aimed at facilitating guideline-concordant sleep disorder management in the VHA PSC. Second, we elicited feedback from a small group of VHA clinicians regarding prototype usability, acceptability, and feasibility.

## Methods

Our efforts were guided by Coulter et al.'s model, which describes a systematic process by which clinical decision support tools are developed and tested: 1) Identify the scope and design; 2) Develop a prototype; 3) Elicit feedback on the prototype from a small number of users; 4) Test the prototype under real-world conditions; and, 5) Finalize the development of the tool.<sup>19</sup> Phase 1 of the current study includes identifying the scope and design of Sleep MAPP as well as the development of the Sleep MAPP prototype. Phase 2 includes eliciting feedback on the prototype. Testing the prototype under real-world conditions and finalizing the tool will be the subject of future work.

### Phase 1: Design of the Sleep MAPP Prototype

#### *Identifying the Scope and Design*

The scope and design of Sleep MAPP was informed by our prior work gathering input from PSC providers, who reported that guidelines such as the VA/DoD CPG for Insomnia and OSA should be considered the standard of care for managing sleep problems in the PSC.<sup>18</sup> As previously mentioned, however, PSC providers directly requested decision support capable of delivering filtered information regarding Veterans at appropriate times in the decision-making process.<sup>18</sup> Accordingly, we embarked on designing a decision support tool intended to operationalize select recommendations within the VA/DoD CPG for Insomnia and OSA,<sup>6</sup> transforming raw electronic medical record (EMR) data and delivering actionable recommendations to PSC providers at appropriate times in the workflow.<sup>17</sup>

We next selected the specific CPG recommendations that would be the target of decision support. We selected target recommendations by assembling subject matter experts on the study team, including those with expertise in the clinical management of TBI and sleep medicine

specialists (AK, LB, NB, RNR, CU). Potential target recommendations were evaluated in light of two criteria: 1) the strength of the recommendation in the VA/DoD CPG; and, 2) the degree to which the recommendation was within the scope of direct PSC service delivery. The list of guideline recommendations was first narrowed to those with a “weak for” and “strong for” designation within the VA/DoD CPG. Next, because the guideline spans the entire continuum of sleep disorder care from screening to specialized treatment, we eliminated recommendations outside the scope of practice for members of the PSC interdisciplinary team. For example, the CPG includes recommendations for OSA treatment based on Veterans’ clinical presentation (e.g., positive airway pressure; mandibular advancement devices). Such treatment decisions are made by a sleep medicine specialist after a comprehensive evaluation, including interpretation of a diagnostic sleep study. Because sleep medicine specialists are not integrated into PSC interdisciplinary teams, such recommendations were considered outside the scope of PSC direct service delivery and thus did not serve as decision support targets. See **Table 1** for a final list of target recommendations, as well as a description of measures capable of evaluating adherence to recommendations within the CPG (see more below).

**Table 1. Target recommendations outlined in the VA/DoD Clinical Practice Guideline for the management of insomnia disorder and OSA**

| Sleep Disorder Management       | Recommendation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Sleep MAPP Measure Description                                                                                      |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| Screening for Insomnia Disorder | For evaluating patients suspected of having insomnia disorder, we suggest using the Insomnia Severity Index (ISI) or Athens Insomnia Scale as part of a comprehensive sleep assessment.                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Proportion of those with documented sleep problems who receive the ISI.                                             |
| Management of Insomnia Disorder | We recommend offering CBT-I for the treatment of chronic insomnia disorder.<br><br>For patients diagnosed with chronic insomnia disorder, we suggest CBT-I over pharmacotherapy as first-line treatment.                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Proportion of those with a provisional diagnosis of insomnia disorder (ISI ≥ 11) who receive CBT-I.                 |
| Screening for OSA               | For patients who report sleep complaints, we suggest using the STOP questionnaire to stratify the risk of obstructive sleep apnea.<br><br>We suggest that providers assess for sleep disordered breathing in patients with a history of cardiovascular or cerebrovascular events, congestive heart, and chronic prescription opioid use.                                                                                                                                                                                                                                                                                                                    | Proportion of those with a documented sleep problem and/or an OSA risk factor who receive the STOP.                 |
| Management of OSA               | Among patients with a high pretest probability for obstructive sleep apnea, we suggest a manually-scored type III home sleep apnea test (unattended portable monitor) using an event index (i.e., respiratory disturbance index, apnea-hypopnea index) ≥15 events per hour to establish the diagnosis of moderate to severe obstructive sleep apnea.<br><br>For patients with a high pretest probability for obstructive sleep apnea and a non-diagnostic home sleep apnea test (i.e., technically inadequate or apnea-hypopnea index <5), we recommend repeat (home sleep apnea testing or lab-based polysomnography) testing for obstructive sleep apnea. | Proportion of those with a high pretest probability of OSA (STOP ≥ 2) who receive a diagnostic sleep study for OSA. |

**Note.** VA = Department of Veterans Affairs; DoD = Department of Defense; OSA = obstructive sleep apnea; Sleep MAPP = Sleep Disorder Management Assistance for Providers and Patients; ISI = Insomnia Severity Index; CBT-I = cognitive behavioral therapy for insomnia; STOP =

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Snoring, Tiredness, Observed apnea, Pressure (high blood pressure).

## Design and Evaluation of Sleep MAPP

With respect to the format of the Sleep MAPP decision support tool, we elected to design a web-based dashboard using ©Microsoft Power Business Intelligence (BI). ©Microsoft Power BI was chosen because it is a VHA-approved business analytics software that enables secure data storage and display in accordance with clinicians' documentation privileges. We opted to design a web-based dashboard because access via an internet browser would enable data display during various points in the clinical workflow without integration with the documentation platform itself, circumventing technical challenges. Further, similar web-based dashboards have been used to enhance implementation of CPG recommendations within the VHA by transforming raw EMR data into clinically actionable insights.<sup>20</sup>

Given a key focus on increasing implementation of guideline-concordant sleep disorder screening (**Table 1**), we integrated the web-based dashboard with Behavioral Health Laboratory (BHL) Touch, a VHA-approved service that interfaces with VHA documentation platforms and EMR to facilitate measurement-based care. BHL Touch enables asynchronous administration of standardized assessments to Veterans' phone or email, including the ISI and STOP questionnaire, which are recommended within the VA/DoD CPG for determining risk for insomnia disorder and OSA, respectively.<sup>6</sup> Once Veterans complete the assessments, BHL Touch generates reports that can be reviewed by clinicians and uploaded to the EMR, after which results can be incorporated into Sleep MAPP measures designed to identify unmet need for sleep disorder management practices (see below).

### ***Developing a Prototype***

Design efforts followed recommended practices for dashboard design, including development of measures (i.e., algorithm defining the eligible population and receipt of guideline-concordant care practices), data (i.e., sources and data elements therein), and display

(i.e., design elements such as charts and colors).<sup>21</sup>

**Measures and Data Sources.** Measures identifying unmet need for guideline-concordant sleep disorder screening and follow-up were designed using best practices for the development of electronic clinical quality measures, which extract routinely collected data from the EMR to generate insights regarding care processes.<sup>22</sup> First, conceptualization of measures was informed by VA/DoD and American Academy of Sleep Medicine (AASM) clinical practice guidelines for the clinical management of insomnia disorder and OSA.<sup>6 23-26</sup> Subsequently, technical specifications for each measure were developed, informed by existing quality measure specifications,<sup>27</sup> published literature describing validated algorithms (e.g., identifying CBT-I encounters),<sup>28</sup> and input from subject matter experts on our study team. Technical specifications included the: 1) measure name; 2) measure description; 3) description of the eligible population; 4) exclusions and exceptions; 5) data sources; 6) key data elements and codes (e.g., operational definition of recommended practices using clinical codes from the EMR); 7) unit of measurement/analysis and sampling procedures; 8) time intervals for data extraction; and 9) the calculation algorithm used to assess results.<sup>29</sup>

Access to EMR data to facilitate Sleep MAPP development was approved by local regulatory bodies as a non-research quality improvement project, consistent with criteria specified in the Department of Veterans Affairs Office of Research and Development Program Guide 1200.21.<sup>30</sup> Veterans eligible to be queried by Sleep MAPP measures included those who received PSC care after 6/1/2021 and/or those with a scheduled PSC appointment. Past receipt of PSC services and scheduled PSC encounters were identified using 500-series Decision Support System Identifier (“clinic stop codes”) in the primary or secondary position. The primary data source was the Corporate Data Warehouse (CDW), which stores EMR data associated with VHA

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care, including diagnostic and clinical procedure codes, pharmaceutical records, referral information, and unstructured data from clinical notes. We also retrieved relevant diagnostic and clinical procedure codes associated with VA-purchased care delivered outside the VHA system from the VHA Office of Integrated Veteran Care Consolidated Data Sets (IVC CDS), the most comprehensive source for VA community care data.<sup>31</sup> Specifications were refined iteratively based on manual chart review and input from subject matter experts on our study team until no further changes were recommended. See **Figures 1 and 2** for a visual illustration of measure specifications.<sup>32-35</sup>

*[INSERT FIGURES 1 & 2 HERE]*

**Development of the Display.** The Sleep MAPP display was comprised of three main components: 1) a landing page; 2) aggregated data regarding receipt of guideline-concordant care stratified by clinic locations; and, 3) fallout reports for sleep disorder screening and/or treatment. The landing page was designed to orient the user to the purpose of Sleep MAPP, to provide instructions for its use, and to offer reference materials, including details regarding technical specifications for measures used to generate fallout reports. Separate pages leveraged the measure specifications and VHA clinic location filters to aggregate results summarizing the extent of unmet need for sleep disorder care across VHA facilities. These pages were intended to summarize clinic performance and to inform quality improvement efforts. Fallout reports were displayed on separate pages and were comprised of specific patients with unmet need for 1) insomnia disorder and OSA risk screening; 2) CBT-I; and/or, 3) an OSA diagnostic study. Fallout reports included additional features designed to assist clinical decision-making and quality improvement efforts, such as customizable report filters based on clinic location, date of completed/scheduled appointments, as well as information regarding sleep disorder treatment

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history and dates of upcoming appointments.

Integration with BHL Touch software was facilitated by an embedded button on the fallout report page. Clicking the corresponding button enables the user to asynchronously administer the ISI and/or STOP questionnaire. Once Veterans complete the screens, providers upload results into the EMR and the Sleep MAPP measure algorithms automatically retrieve the results to determine Veterans' eligibility for fallout reports focused on unmet need for guideline-concordant management of insomnia disorder ( $ISI \geq 11$ ) and OSA ( $STOP \geq 2$ ). See **Table 2** for a summary of Sleep MAPP components, informed by select characteristics from Sim & Berlin's taxonomy of clinical decision support systems.<sup>36</sup> See supplemental material for exemplar components of the Sleep MAPP display.

**Table 2. Description of Sleep MAPP components**

| <b>Taxonomy Component</b> | <b>Description</b>                                                               |
|---------------------------|----------------------------------------------------------------------------------|
| <b>Content</b>            |                                                                                  |
| Clinical setting          | Outpatient Polytrauma/Traumatic Brain Injury System of Care sites within the VHA |
| Clinical task             | Screening and follow-up for insomnia disorder and OSA                            |

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|                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Unit of optimization                        | Patient outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Relation to point of care                   | May be used prior to or during a shared clinician-patient encounter                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Knowledge and Data Source</b>            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Clinical knowledge source                   | VA/DoD CPG for Insomnia and OSA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Data source                                 | <ul style="list-style-type: none"> <li>• <b>Corporate Data Warehouse:</b> Data associated with VHA care, including diagnostic and clinical procedure codes, pharmaceutical records, referral information, and unstructured data from clinical notes</li> <li>• <b>Office of Integrated Veteran Care Consolidated Data Sets:</b> Data associated with VA-purchased care occurring in the community, including diagnostic and clinical procedure codes</li> </ul>                                                                             |
| Data coding                                 | Widely used schema (e.g., CPT codes), free text, local coding scheme (i.e., structured data elements reflecting responses to standardized assessments)                                                                                                                                                                                                                                                                                                                                                                                      |
| Update mechanism                            | Updates to target recommendations and corresponding measure algorithms will be updated manually based on revisions to the VA/DoD CPG for Insomnia and OSA                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Characterization of Decision Support</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Reasoning method                            | Rule-based                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Clinical urgency                            | Non-urgent                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Recommendation explicitness                 | <p>Explicit recommendations:</p> <ul style="list-style-type: none"> <li>• “Consider administering the [ISI/STOP] to detect high risk of [insomnia/OSA].”</li> <li>• “This Veteran has elevated insomnia symptoms but has not received behavioral treatment for insomnia, which is recommended as first-line treatment for insomnia. Consider a referral to a specialist.”</li> <li>• “This Veteran has a high probability of OSA and would likely benefit from evidence-based treatment. Consider a referral to sleep medicine.”</li> </ul> |
| Response requirement                        | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Information Delivery</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Delivery format                             | Online via web-based dashboard                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Delivery mode                               | Pull: Delivered once a member of the clinical team generates reports                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

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|                                                        |                                                                                                                                                                                                                                                                                            |
|--------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Action integration                                     | Integrated for target actions corresponding to sleep disorder screening via embedded BHL Touch functionality                                                                                                                                                                               |
| Delivery<br>interactivity/<br>Explanation availability | Brief explanation automatically available to referring provider (e.g., "This Veteran has elevated insomnia symptoms but has not received behavioral treatment for insomnia, which is recommended as first-line treatment for insomnia")                                                    |
| <b>Workflow</b><br>System user                         | Conditional on site-specific needs, but likely requires non-physician staff to generate fallout reports and asynchronously administer screens. Referring providers (e.g., physicians/nurse practitioners) will be required to conduct follow-up practices consistent with local procedures |
| Target decision maker                                  | Patient, referring provider                                                                                                                                                                                                                                                                |
| Output intermediary                                    | Conditional on site-specific needs, but likely requires non-physician staff to generate fallout reports and to incorporate fallout reports into existing interdisciplinary care planning                                                                                                   |
| Degree of workflow integration                         | Moderately to well-integrated, allows for workflow flexibility                                                                                                                                                                                                                             |

**Note.** VA = Department of Veterans Affairs; DoD = Department of Defense; CPG = clinical practice guideline; OSA = obstructive sleep apnea; VHA = Veterans Health Administration; CPT = Current Procedural Terminology; Sleep MAPP = Sleep Disorder Management Assistance for Providers and Patients; BHL = Behavioral Health Laboratory.

## Phase 2: Evaluation of the Sleep MAPP Prototype

### *Participants and Procedures*

A convergent parallel mixed methods design was used to evaluate the Sleep MAPP prototype, comprised of in-depth semi-structured interviews and standardized assessments of usability, acceptability, and feasibility administered using an online survey.<sup>37</sup> Recruitment and

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study procedures were approved by local regulatory institutions. Participants included clinicians who had previously engaged in study procedures eliciting perspectives regarding factors shaping implementation of guideline-concordant sleep disorder treatment in the PSC.<sup>38</sup> In the previous study, clinicians were selected using criterion and snowball sampling, and were eligible if they identified as providers and/or administrators who are involved in care delivered in the PSC or specialized sleep disorder settings in the VHA nationwide.<sup>39</sup> Seven clinicians participated in semi-structured interviews, five of whom completed standardized assessments of Sleep MAPP usability, acceptability, and feasibility.

**Data Collection**

**Qualitative Data Collection.** Before interviews, participants completed an online survey via Research Electronic Data Capture (REDCap)<sup>40</sup> designed to collect sociodemographic and professional characteristics (e.g., discipline). Hour-long semi-structured interviews were conducted using ©Microsoft Teams and were recorded and transcribed verbatim. Prior to interviews, each participant was sent a link to the web-based dashboard. Interview questions were anchored to Sleep MAPP and included questions designed to elicit perspectives regarding Sleep MAPP usability (e.g., *“In what ways would this dashboard be easy to use to identify Veterans who needed to be assessed for insomnia and/or OSA?”*), acceptability (e.g., *“In what ways would this dashboard be helpful to you regarding the assessment and treatment of sleep disorders?”*), and feasibility (e.g., *“What, if anything, would make it difficult to implement the dashboard in routine care?”*).

**Quantitative Data Collection.** After completing the semi-structured interview, participants were sent an online survey including standardized assessments of usability, acceptability, and feasibility. Survey questions were anchored to Sleep MAPP. *Usability* was

measured using the System Usability Scale (SUS), a widely utilized instrument for evaluating the usability of clinical tools, such as computerized clinical decision support systems.<sup>41</sup> It consists of a 10-item questionnaire that assesses subjective usability perceptions, with responses rated on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). We opted to interpret SUS items separately rather than consolidating item scores into a summary score, collecting item scores and identifying the proportion of respondents who indicated a positive response to each discrete item (i.e., “agree” or “strongly agree”).

The Acceptability of Intervention Measure (AIM) was used to evaluate the *acceptability* of Sleep MAPP.<sup>42</sup> AIM is a psychometrically sound measure of the extent to which stakeholders perceive a clinical innovation to be agreeable, satisfactory, and consistent with their expectations and needs. Sleep MAPP *feasibility* was measured using the Feasibility of Intervention Measure (FIM), a validated tool which evaluates the extent to which stakeholders believe that an innovation can be successfully implemented in a particular setting, including perceptions of practicality, resource availability, and alignment with current workflows.<sup>42</sup> AIM and FIM are comprised of four items, each of which is rated on a scale of one (“completely disagree”) to five (“completely agree”).<sup>42</sup> We collected discrete item scores and calculated the proportion of respondents rating each item positively (i.e., “agree” or “completely agree”).

## Data Analysis

**Qualitative Data Analysis.** Descriptive and Interpretive Analysis was used to analyze semi-structured interviews.<sup>43</sup> An analytic memo was created at the conclusion of each interview to summarize key concepts, or ‘meaning units,’ identified by the interviewer. These initial meaning units were leveraged to develop a preliminary codebook which was refined through group discussions. A primary coder who possesses expertise in the management of sleep

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disorders in the PSC (AK)<sup>44</sup> applied the codebook to interview transcripts and a secondary reviewer (MN) independently verified the coding for reliability. In the event of discrepant coding across the two coders, resolution was achieved through negotiated consensus.<sup>45</sup> Upon confirming the coding of all transcripts, meaning units were consolidated into themes and subcategories based on the corresponding construct of interest (usability, acceptability, or feasibility). For each theme, illustrative quotes were identified to strengthen interpretations and conclusions. ATLAS.ti v.23 software was used to conduct analysis.

**Quantitative Data Analysis.** We performed a descriptive analysis of each discrete item of the SUS, AIM, and FIM, calculating the median, interquartile range, and prevalence and proportion of participants endorsing a positive response. All analyses were conducted using R Version 4.3.1.<sup>46</sup>

**Synthesis of Qualitative and Quantitative Data.** Consistent with recommendations for mixed methods research, we created a joint display table to compare and contrast quantitative and qualitative results.<sup>47</sup> Based on interpretations of the merged data, the first author (AK) derived meta-inferences, or conclusions regarding the similarities and differences between the qualitative and quantitative data strands.<sup>47</sup> Meta-inferences were reviewed by co-authors to achieve consensus on conclusions.

## Results

### Participant Characteristics

Clinicians were evenly distributed according to clinical expertise, with 57% specializing in TBI rehabilitation within the PSC. Most participants were physicians (71%) with the remaining 29% identifying as psychologists. 57% reported more than 20 years of experience. See supplementary material for detailed clinician characteristics.

## Qualitative Strand

### *Usability*

Interviews revealed insights into positive aspects of Sleep MAPP usability, particularly its *intuitive design*. Clinicians further shared that *increased customization* would enhance the usability of Sleep MAPP. See **Table 3** for a detailed summary of qualitative results, including illustrative quotes.

Table 3. Summary of Qualitative Feedback on Sleep MAPP (n = 7)

| Domain        | Theme                   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                              | Illustrative Quote                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Usability     | Intuitive design        | Clinicians reported that navigating the tool, administering assessments, and interpreting data was user-friendly and structured consistently with the workflow specified in the VA/DoD clinical practice guideline.                                                                                                                                                                                                                                      | <i>“One of the problems with [these tools sometimes] is that you have to know Power BI. And you have to know how to search by different fields and all that. But you’ve kind of made it easier by creating buttons that will get you where you want to go. Like, ‘I want to see all my patients [who haven’t received STOP].’ So, you have a button for that. You don’t have to go through Power BI jiu-jitsu to find that out.”</i>                                                                                                                                                                             |
|               | Increased customization | Clinicians emphasized the need for enhanced customizability through the integration of additional data filters. Specifically, clinicians advocated for the capability to stratify data displays using sociodemographic factors (e.g., race/ethnicity). Additionally, clinicians highlighted the value of incorporating clinical filters to identify patients at more severe risk for sleep disorders, facilitating more targeted implementation efforts. | <i>“Because I know, so you can sort [the list of patients based on] who’s coming in and whatnot. But are you able to adjust that? So as a site might start to use it, could you adjust [the algorithm to identify those who report severe sleep problems]? So, you’re kind of really targeting a fewer number of individuals, but those with a higher likelihood they would benefit. I’m thinking about this from an implementation standpoint; that might give some flexibility to kind of start a little more at the extreme to not overwhelm your referral sources.”</i>                                      |
| Acceptability | Time efficient          | Sleep MAPP facilitates asynchronous administration of sleep disorder assessments, streamlining this aspect of clinical care and making it a more efficient process. This is critical given time constraints and provider workload.                                                                                                                                                                                                                       | <i>“Sometimes you get so bogged down in other things you don’t have a chance to do an assessment in the clinic, you know? So, I think this does a good job by making it very easy. Look at the recommendation. If it says you need to do it, the buttons are down below, they’re accessible.”</i>                                                                                                                                                                                                                                                                                                                |
|               | Improves care quality   | Sleep MAPP enhances care quality by 1) enabling the identification of Veterans with unmet need for guideline-concordant sleep disorder care; and, 2) providing actionable recommendations concerning such care.                                                                                                                                                                                                                                          | <i>“As a health care system, we are trying to get our providers to utilize validated assessment tools more consistently. And to follow clinical practice guidelines. I think [decision support tools] are great ways for an individual provider to recognize, ‘wow, I’m seeing people who I know have sleep problems, but I’m not formally assessing that. I’m kind of just interviewing them, or it’s popping on another measure, but I’m not using more formalized measures, and we really should be.’ So, I like it that way, to kind of keep a check on if they are following evidence-based practices.”</i> |
|               | Algorithm modifications | Clinicians suggested changes to the algorithms that transformed raw                                                                                                                                                                                                                                                                                                                                                                                      | <i>“So, I think there’s a lot missing here. […] The traditional screenings are like, people are at risk if they’re obese, they have hypertension, they have diabetes. Like,</i>                                                                                                                                                                                                                                                                                                                                                                                                                                  |

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|             |                                  |                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------------|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|             |                                  | medical record data into lists of Veterans with unmet need for guideline-concordant sleep disorder care. For instance, some advocated for broadening the STOP questionnaire eligibility criteria beyond the OSA risk factors outlined in the VA/DoD guidelines.                                                    | <i>there are a whole host of medical conditions that are associated with a very high prevalence of sleep apnea.”</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Feasibility | Aligned with workflow            | Providers highlighted that the tool is easy to access, enabling integration into the existing clinical workflow.                                                                                                                                                                                                   | <i>“Yeah, I do think it’s [feasible to use in routine care]. I think it’s easy to pin to your dashboard, you know? And... pull up quickly. [...] There are dashboards that I’ve kind of integrated and use routinely, and those are the exact features that I need.”</i>                                                                                                                                                                                                                                                                                                                                                                                                                |
|             | Conduct educational meetings     | Clinicians reported that some providers are unaware of guideline recommendations for sleep disorder assessment and treatment. To overcome this challenge, clinicians recommended that education and training on this topic, in addition to Sleep MAPP functionality, was delivered prior to Sleep MAPP deployment. | <i>“...some additional targeted education on, ‘here are the CPGs’ and a push to get people to be more aware of them and to utilize the CPGs to guide decision making about patient care. It’s a little hit or miss right now whether people have awareness of the CPGs and the recommendations.”</i>                                                                                                                                                                                                                                                                                                                                                                                    |
|             | Facility resources               | Clinicians indicated that variation in facility resources, such as staffing and time constraints, may influence implementation. Clinicians noted that the limited time available beyond their existing clinical duties may challenge Sleep MAPP’s integration into routine care.                                   | <i>“...I think every VA is a little different. And every VA has a different number of [...] providers. Here, [...] we have sections with our own supervised, like, middle management, essentially. And that would be a good fit, because they’re supposed to be running numbers like that; making sure consults are getting closed out and suicide screens are getting done. Things like that. That’s part of their job [and] they get some of their clinical responsibilities removed so they can do that. Another VA that’s smaller, I don’t know if they have those kinds of people.”</i>                                                                                            |
|             | Develop implementation blueprint | an Clinicians highlighted the need for a standardized scheme outlining the sequence of tasks needed to integrate Sleep MAPP into the everyday workflow of Polytrauma/TBI System of Care teams.                                                                                                                     | <i>“Like I said, this is a step in the process, and it’s a good step. You’ve done a lot of the pre-work. And so, how does my... how does my case manager know who I’ve sent these [assessments] to, you know? [...For example,] me and my case manager sit down and say, on every, on, on Mondays I’m gonna open this up and I’m going to click on upcoming Polytrauma appointments. I’m gonna slide that bar for the next 5 days, and so I’m going to send it out to all the people coming in this week or something like that, you know? So, I guess I’m trying to decide if that’s something for your team to do, or something that would be inherent to the process of the team</i> |

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*that's gonna be using this; the clinical team.”*

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**Note.** Sleep MAPP = Sleep Disorder Management Assistance for Providers and Patients; VA/DoD = Departments of Veterans Affairs and Defense; CPG = clinical practice guideline; BI = Business Intelligence; OSA = obstructive sleep apnea; TBI = traumatic brain injury; STOP = Snoring, Tiredness, Observed apnea, Pressure (high blood pressure).

### ***Acceptability***

Interviews similarly revealed positive appraisals of Sleep MAPP acceptability. Clinicians reported that the prototypes made the delivery of guideline-concordant sleep disorder care more *time efficient* and generally *improved care quality*. Notably, clinicians recommended *algorithm modifications* to improve the ability of Sleep MAPP to detect Veterans with unmet need for guideline-concordant sleep disorder care. See **Table 3**.

### ***Feasibility***

Clinicians reported that Sleep MAPP would be feasible to implement, highlighting that it was *aligned with the workflow*. Clinicians further shared insights into factors that would shape future incorporation into real-world PSC delivery. While *conducting educational meetings* and *developing an implementation blueprint* were perceived to promote successful implementation, the availability of *facility resources* was identified as a potential barrier. See **Table 3**.

## **Quantitative Strand**

### ***Usability***

The vast majority of clinicians (80%-100%) endorsed a positive appraisal of usability characteristics based on items rating the ease with which users navigate and utilize Sleep MAPP functions. Regarding items for which a higher score (i.e., agreement) indicates favorable usability (e.g., “I would be very confident using Sleep MAPP”), the median response was 4 (“Agree”) across items. With respect to items for which a lower score (i.e., disagreement) indicates favorable usability (e.g., “I found Sleep MAPP unnecessarily complex”), median responses ranged from 1 (“Strongly Disagree”) to 3 (“Neither Agree or Disagree”). See **Table 4**.

Table 4. Clinician ratings of Sleep MAPP usability, acceptability, and feasibility (n = 5)

| Item Language                                                                            | Median (IQR) <sup>a</sup> | n (%) Endorsing Agree/Strongly or Completely Agree <sup>a</sup> |
|------------------------------------------------------------------------------------------|---------------------------|-----------------------------------------------------------------|
| Usability: System Usability Scale                                                        |                           |                                                                 |
| I think that I would like to use Sleep MAPP frequently                                   | 4 (4 – 5)                 | 4 (80%)                                                         |
| I found Sleep MAPP unnecessarily complex                                                 | 2 (2 – 2)                 | 0 (0%)                                                          |
| I thought Sleep MAPP was easy to use                                                     | 4 (4 – 4)                 | 4 (80%)                                                         |
| I think I would need the support of a technical person to be able to use Sleep MAPP      | 3 (2 – 3)                 | 1 (20%)                                                         |
| I found the various functions in Sleep MAPP were well integrated                         | 4 (4 – 4)                 | 5 (100%)                                                        |
| I found there was too much inconsistency between the design and navigation of Sleep MAPP | 1 (1 – 1)                 | 0 (0%)                                                          |
| Most would learn to use Sleep MAPP very quickly                                          | 4 (4 – 4)                 | 4 (80%)                                                         |
| I found Sleep MAPP very cumbersome to use                                                | 2 (2 – 2)                 | 0 (0%)                                                          |
| I would be very confident using Sleep MAPP                                               | 4 (4 – 4)                 | 4 (80%)                                                         |
| I would need to learn a lot of things before I could get going with Sleep MAPP           | 2 (2 – 3)                 | 1 (20%)                                                         |
| Acceptability: Acceptability of Intervention Measure                                     |                           |                                                                 |
| Sleep MAPP meets my approval                                                             | 4 (4 – 5)                 | 4 (80%)                                                         |
| Sleep MAPP is appealing to me                                                            | 5 (4 – 5)                 | 5 (100%)                                                        |
| I like Sleep MAPP                                                                        | 5 (4 – 5)                 | 4 (80%)                                                         |
| I welcome Sleep MAPP                                                                     | 5 (4 – 5)                 | 5 (100%)                                                        |
| Feasibility: Feasibility of Intervention Measure                                         |                           |                                                                 |
| Sleep MAPP seems implementable                                                           | 5 (4 – 5)                 | 4 (80%)                                                         |
| Sleep MAPP seems possible                                                                | 4 (4 – 5)                 | 5 (100%)                                                        |
| Sleep MAPP seems doable                                                                  | 4 (4 – 5)                 | 5 (100%)                                                        |
| Sleep MAPP seems easy to use                                                             | 4 (4 – 5)                 | 4 (80%)                                                         |

Note. Sleep MAPP = Sleep Disorder Management Assistance for Providers and Patients; IQR = interquartile range

<sup>a</sup> System Usability Scale: 1 = strongly disagree, 5 = strongly agree; Acceptability and Feasibility of Intervention Measures: 1 = completely disagree, 5 = completely agree



### ***Acceptability***

Between 80% and 100% of clinicians endorsed a response to AIM items indicating a positive appraisal of Sleep MAPP acceptability (e.g., “Sleep MAPP is appealing to me”). Three of four items received a median response of 5 (“Completely Agree”), with the remaining item receiving a median response of 4 (“Agree”). See **Table 4**.

### ***Feasibility***

Most clinicians (80%-100%) endorsed a response to FIM items reflecting a positive perception of the feasibility of incorporating Sleep MAPP into routine PSC delivery (e.g., “Sleep MAPP seems implementable”). Three of four items received a median response of 4 (“Agree”), with the remaining item receiving a median response of 5 (“Completely Agree”). See **Table 4**.

### **Synthesis of Qualitative and Quantitative Strands**

Upon merging the qualitative and quantitative strands of data, meta-inferences revealed areas of *convergence* (i.e., inferences drawn from qualitative and quantitative data aligned), *expansion* (i.e., inferences drawn from the two strands of data aligned, but qualitative data offered a more nuanced depiction of Sleep MAPP feedback), and *emergent information* (i.e., qualitative data elicited information that was unavailable from quantitative data). See **Table 5** for a joint display table detailing similarities and differences between qualitative and quantitative findings as they pertain to Sleep MAPP usability, acceptability, and feasibility. Further, the joint display table summarizes planned actions regarding design and implementation.

Table 5. Joint Display Table Synthesizing Feedback on Sleep MAPP

| Domain        | Qualitative Theme                       | Quantitative Results Summary                                                                                                                                                                                                                                                         | Meta-Inference                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Planned Actions Regarding Design and Implementation                                                                                                                                   |
|---------------|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Usability     | Intuitive design                        | <b>System Usability Scale:</b> The vast majority of clinicians (80%-100%) endorsed a positive appraisal of usability characteristics based on items rating the ease with which users navigate and utilize Sleep MAPP functions (e.g., “I would be very confident using Sleep MAPP”). | <b>Expansion:</b> Overall, qualitative and quantitative results aligned, yet interviews with clinicians offered nuance with respect to the specific drivers of usability. Clinicians highlighted that navigating the tool, administering assessments, and interpreting data was perceived to be user-friendly and structured consistently with the workflow specified in the VA/DoD clinical practice guideline.                                                                                  | —                                                                                                                                                                                     |
|               | Increased customization                 | —                                                                                                                                                                                                                                                                                    | <b>Emergent information:</b> While Sleep MAPP was perceived to be easy-to-use, interviews revealed that increased customizability was recommended to maximize its usability.                                                                                                                                                                                                                                                                                                                      | Additional filters which stratify data displays based on sociodemographic (e.g., race/ethnicity) and clinical factors (e.g., severity of self-reported sleep problems) will be added. |
| Acceptability | Time efficient<br>Improves care quality | <b>Acceptability of Intervention Measure (AIM):</b> The vast majority of clinicians (80%-100%) endorsed a response to AIM items indicating a positive appraisal of Sleep MAPP acceptability (e.g., “Sleep MAPP is appealing to me”).                                                 | <b>Expansion:</b> Qualitative and quantitative results aligned with respect to the acceptability of Sleep MAPP, but qualitative findings shed light on the specific aspects of Sleep MAPP that clinicians perceived to have a positive impact on clinical practice. Specifically, clinicians perceived Sleep MAPP to be capable of 1) streamlining the delivery of guideline-concordant sleep disorder care; and, 2) enhancing the quality of sleep disorder assessment and treatment in the PSC. | —                                                                                                                                                                                     |
|               | Algorithm modifications                 | —                                                                                                                                                                                                                                                                                    | <b>Emergent information:</b> Despite quantitative results indicating positive appraisals of Sleep MAPP acceptability, qualitative interviews elicited slight modifications to the algorithms                                                                                                                                                                                                                                                                                                      | Algorithms will be revised to incorporate clinician feedback in the following ways: <ul style="list-style-type: none"><li>• Criteria identifying Veterans eligible</li></ul>          |

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designed to identify patients with unmet need for guideline-concordant sleep disorder care.

to receive the STOP questionnaire will be broadened to include additional OSA risk factors outlined in AASM guidance.

- In addition to documented management of insomnia disorder and OSA, referrals to CBT-I and sleep medicine will be incorporated into algorithms as appropriate.

Feasibility

Aligned with workflow

**Feasibility of Intervention Measure (FIM):** The vast majority of clinicians (80%-100%) endorsed a response to FIM items reflecting a positive perception of the feasibility of incorporating Sleep MAPP into routine PSC delivery (e.g., “Sleep MAPP seems implementable”).

**Convergence:** Qualitative and quantitative findings aligned with respect to Sleep MAPP feasibility, indicating that it could be seamlessly incorporated into existing clinical workflows.

—

Conduct educational meetings  
Facility resources  
Develop an implementation blueprint

—

**Emergent information:** Qualitative data elucidated potential factors shaping implementation of Sleep MAPP into routine care. While conducting educational meetings and developing a detailed plan for implementation were perceived to promote successful implementation, facility resources was identified as a potential barrier.

A Sleep MAPP implementation bundle will be designed, comprised of the Sleep MAPP decision support tool plus additional implementation strategies such as educational meetings. We will co-produce a detailed implementation plan with PSC leadership that will aim to enhance care quality while accommodating varying resources such as staffing levels and time constraints.

**Note.** Sleep MAPP = Sleep Disorder Management Assistance for Providers and Patients; American Academy of Sleep Medicine; OSA = obstructive sleep apnea; CBT-I = cognitive behavioral therapy for insomnia; STOP = Snoring, Tiredness, Observed apnea, Pressure (high blood pressure).

<sup>a</sup> See Table 3 for detailed descriptions of qualitative themes.  
<sup>b</sup> See Table 4 for detailed quantitative results regarding usability, acceptability, and feasibility.



## Discussion

In this study, we describe the design of Sleep MAPP, a novel decision support tool aimed at promoting guideline-concordant sleep disorder care in the VHA Polytrauma/TBI System of Care (PSC). Further, we elicited feedback from clinicians regarding the usability, acceptability, and feasibility of Sleep MAPP in preparation for its implementation in “real-world” care. Findings highlight that Sleep MAPP is easy-to-use, feasible to implement, and capable of improving the quality of sleep disorder care in the PSC. Nonetheless, clinicians offered recommendations for design changes and future implementation that will help facilitate its seamless integration into routine PSC services, ultimately improving sleep quality and overall health in this high-risk population.

Overall, findings indicated that Sleep MAPP was perceived as easy-to-use with respect to navigating the tool, administering assessments, and interpreting data to inform clinical decisions. Nonetheless, clinicians requested increased customization in the form of data filters which stratified the Sleep MAPP display based on sociodemographic and clinical factors. These recommendations to improve the usability of Sleep MAPP will be critical to implement prior to deploying the tool in the PSC, given evidence that decision support tools with greater usability have higher rates of clinician acceptance, in turn enabling their successful integration into routine service delivery.<sup>48</sup> Filters displaying unmet need for guideline-concordant sleep disorder care across different sociodemographic subgroups would enable the detection of systematic differences in the distribution of sleep disorder care, and Sleep MAPP could be used to guide implementation activities aimed at eliminating such gaps. Indeed, prior work has identified racial and ethnic differences in access to CBT-I among Veterans receiving PSC services, highlighting the potential need for such implementation activities.<sup>49</sup> Further, as highlighted by clinicians,

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filters enabling the identification of Veterans at highest risk for sleep disorders and adverse outcomes could enable efforts which prioritize the delivery of services to those in greatest need. Given the noted gap between growing Veteran demand for sleep disorder care and the capacity of the VHA system to offer services, the use of such filters could facilitate more targeted use of scarce sleep disorder care resources in the VHA.<sup>50</sup> Importantly, we also echo previous calls to bolster the supply of trained sleep providers in the VHA to increase the system's capacity to satisfy demand, thereby distributing services to all Veterans who would benefit.<sup>50</sup>

Clinicians perceived the Sleep MAPP decision support tool to be capable of enhancing the management of sleep disorders in the PSC, in turn improving clinical outcomes among this high-risk population of Veterans. Clinicians reported that Sleep MAPP has significant potential to improve care quality because it facilitates the identification of Veterans with unmet need for sleep disorder screening and follow-up care, offering actionable recommendations that shape care decisions in a beneficial manner for the Veteran. The prevailing consensus is that improving sleep is a cornerstone of effective treatment for Veterans receiving PSC services because: 1) sleep challenges are amenable to treatment; and, 2) improved sleep has a "ripple effect," such that enhancing sleep quality produces a concomitant improvement in other priority treatment targets, including cognitive performance, mental health, and pain.<sup>16,51</sup> Because VA/DoD CPG recommendations rest upon empirical support for the impact of each care practice upon clinical outcomes,<sup>6</sup> it is expected that incorporating Sleep MAPP into routine PSC care delivery will not only increase adherence to guideline-concordant sleep care, but that this improvement in care quality will likewise enhance clinical outcomes among Veterans. Of course, this hypothesis needs to be empirically tested in a future effectiveness-implementation hybrid trial designed to evaluate the effect of Sleep MAPP deployment on changes in sleep disorder care quality and

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Veteran outcomes.<sup>52</sup>

Clinicians also reported that Sleep MAPP could make the delivery of sleep disorder care in the PSC more time efficient, largely due to embedded BHL functionality, which streamlines sleep disorder screening by asynchronously administering assessments to eligible Veterans. Time constraints are among the most cited barriers to implementing CPG recommendations across a variety of patient populations and settings,<sup>53-55</sup> including for sleep disorder treatment in the PSC.<sup>56,57</sup> Our findings indicate that Sleep MAPP can overcome this implementation challenge by moving screening tasks outside the shared encounter through asynchronous administration. This feature enables guideline-concordant sleep disorder screening while unlocking more time during appointments to address follow-up care for sleep disorders and other clinical concerns.<sup>57</sup> Importantly, this and other Sleep MAPP features should be carefully pilot tested upon introduction into the PSC workflow, enabling continued refinements to the processes by which it is deployed.<sup>58,59</sup> Such information can optimize the efficiency with which guideline-concordant sleep disorder care is delivered to this high-risk population of Veterans and can facilitate the sustained adoption of Sleep MAPP, producing long-term improvements to care delivery and Veteran outcomes.

Clinicians highlighted that Sleep MAPP can be easily integrated into routine PSC care delivery. Nonetheless, they also provided important insights into the factors affecting its implementation and the strategies needed to address such challenges. As such, a Sleep MAPP implementation bundle, comprised of the Sleep MAPP decision support tool plus additional implementation strategies, is likely needed to address the multi-faceted barriers to guideline-concordant sleep disorder care in the PSC. Our findings align with evidence that deploying clinical decision support in the VHA tends to be more successful when additional

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implementation strategies, such as facilitation, are incorporated.<sup>60,61</sup> With respect to strategies identified in the current study, clinicians suggested that educational meetings and a detailed implementation plan would enhance deployment of Sleep MAPP in the PSC. Educational meetings assemble providers and other relevant stakeholders to deliver targeted content that increases understanding of clinical innovations.<sup>62</sup> Such meetings are among the most utilized implementation strategies in TBI rehabilitation settings and while education is typically delivered in conjunction with other strategies, educational efforts have improved care quality in TBI rehabilitation settings when delivered in isolation.<sup>63,64</sup> Regarding clinicians' recommendation that a detailed plan for implementation is developed, implementation blueprints are a promising strategy. Implementation blueprints are formal plans that guide implementation efforts, including specific action steps, timelines, and requisite personnel.<sup>62,65</sup> Blueprints are foundational to successful implementation efforts, and co-producing them with stakeholders can successfully tailor initiatives to the local clinical context, thereby maximizing the effectiveness of strategies.<sup>66,67</sup> Our future work will include the co-production of an implementation blueprint with PSC providers and other relevant stakeholders to facilitate the deployment of the Sleep MAPP decision support tool, educational meetings, and other beneficial implementation activities. Importantly, clinicians highlighted the variable level of resources across PSC facilities, including staffing levels. As such, when developing the implementation blueprint, we will develop processes that minimize resource utilization to accommodate varying levels of staffing and other resources across PSC sites.

### Study Limitations

One limitation of the current study was that we gathered input from a small number of clinicians regarding feedback on the Sleep MAPP prototype, and as such, the extent to which

findings are transferable to perceptions of Sleep MAPP after it is embedded in routine clinical care is unclear. Evaluating the usability, acceptability, and feasibility of Sleep MAPP once the tool is incorporated into the PSC workflow is an essential next step, and continued refinement of Sleep MAPP will likely be indicated as a result.<sup>19</sup> Further, we were unable to gather Veteran perspectives in the current study. Future research should gather Veteran perspectives regarding patient-facing components of Sleep MAPP (e.g., process by which sleep disorder screens are administered). Finally, EMR-based measures which facilitate the generation of lists of Veterans with unmet need for sleep disorder care have yet to be validated due to the need for clinician feedback on measure specifications, which was gathered in the current study. This feedback yielded important modifications to measures, and upon finalization of measure specifications, results will be compared to manual chart review to evaluate their accuracy and determine whether additional modifications are required prior to Sleep MAPP deployment.

### Conclusion

In this study, we summarized the development of Sleep MAPP, a novel decision support tool designed to facilitate guideline-concordant management of insomnia disorder and OSA among Veterans receiving PSC services, gathering feedback regarding its usability, acceptability, and feasibility. The evaluation of Sleep MAPP highlighted its intuitive design, streamlined workflow integration, and capacity to identify and address gaps in sleep disorder screening and follow-up. Further, clinicians offered valuable suggestions for Sleep MAPP design changes and implementation efforts. Our findings will directly inform future pilot testing of Sleep MAPP in “real-world” PSC service delivery, ultimately improving care quality and Veterans’ clinical outcomes.

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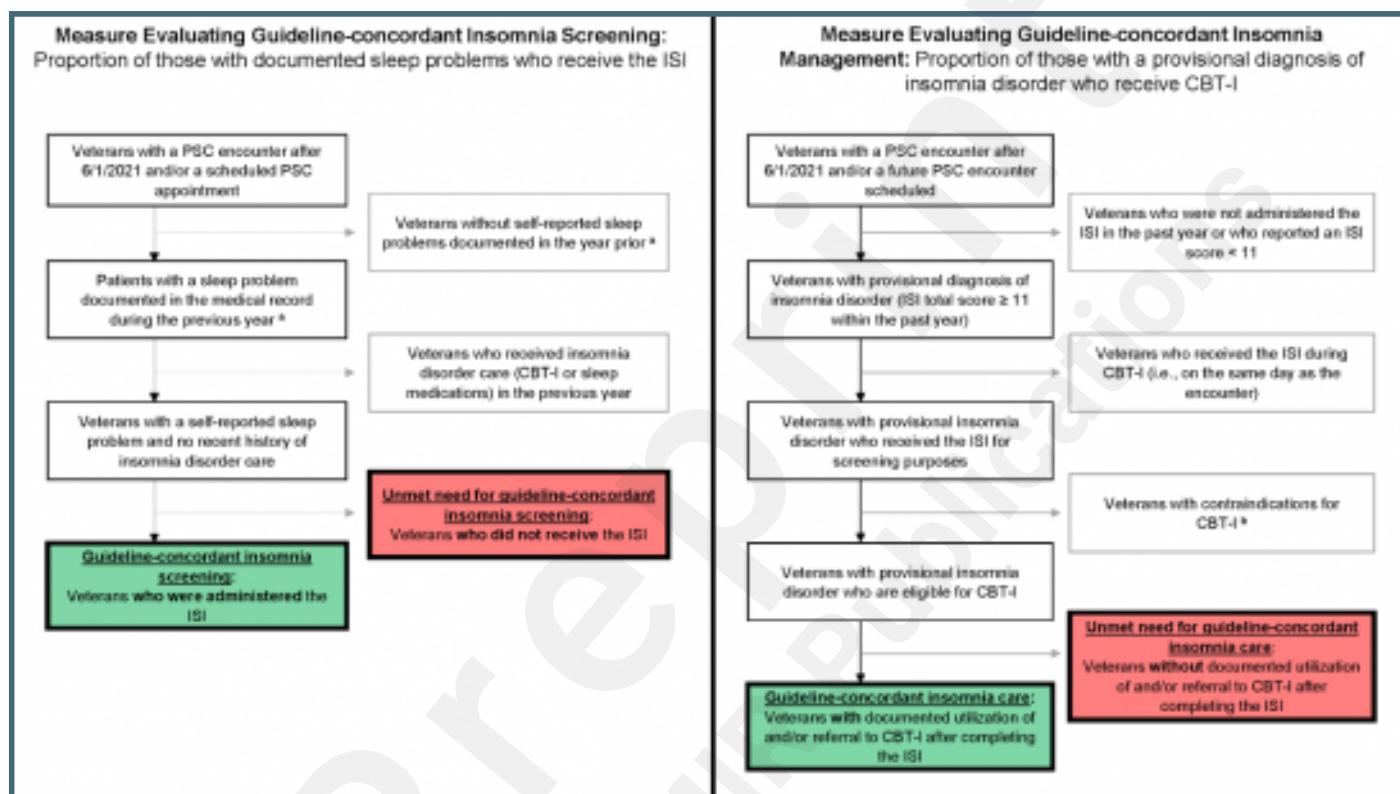
### List of Abbreviations

|            |                                                                    |
|------------|--------------------------------------------------------------------|
| AASM       | American Academy of Sleep Medicine                                 |
| ADAPT      | Accelerate Discovery and Practice Transformation                   |
| AIM        | Acceptability of Intervention Measure                              |
| BHL        | Behavioral Health Laboratory                                       |
| BI         | Business Intelligence                                              |
| CBT-I      | Cognitive Behavioral Therapy for Insomnia                          |
| CPG        | Clinical Practice Guideline                                        |
| EMR        | Electronic medical record                                          |
| FIM        | Feasibility of Intervention Measure                                |
| ISI        | Insomnia Severity Index                                            |
| IVC CDS    | Office of Integrated Veteran Care Consolidated Data Sets           |
| MIRECC     | Mental Illness Research, Education and Clinical Center             |
| NSI        | Neurobehavioral Symptom Inventory                                  |
| OSA        | Obstructive sleep apnea                                            |
| PCL-5      | Posttraumatic Stress Disorder Checklist                            |
| PSC        | Polytrauma/Traumatic Brain Injury System of Care                   |
| PTSD       | Posttraumatic stress disorder                                      |
| Sleep MAPP | Sleep Disorder Management Assistance for Providers and Patients    |
| SPiRE      | Small Projects in Rehabilitation Research                          |
| STOP       | Snoring, Tiredness, Observed apnea, Pressure (high blood pressure) |
| STRONG     | Support the Resiliency of Our Nation's Great                       |
| SUS        | System Usability Scale                                             |
| TBI        | Traumatic brain injury                                             |
| VA/DoD     | Departments of Veterans Affairs and Defense                        |
| VHA        | Veterans Health Administration                                     |

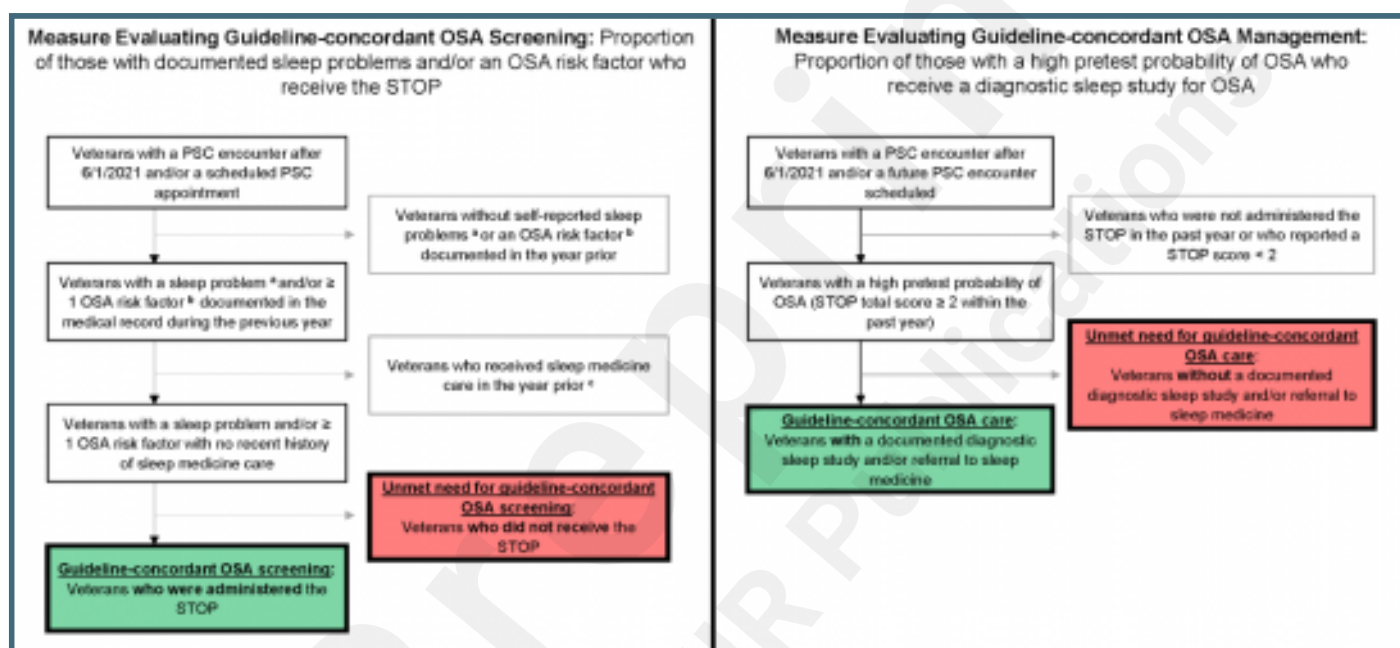
## Supplementary Files

## Figures

Visual illustration of insomnia disorder measure specifications. PSC = Polytrauma/TBI System of Care; CBT-I = cognitive behavioral therapy for insomnia; ISI = Insomnia Severity Index. a Determined using: Neurobehavioral Symptom Inventory (NSI) item #18 ? 2; Patient Health Questionnaire measuring depressive symptoms (PHQ-9) item #3 ? 2; Posttraumatic Stress Disorder Checklist (PCL-5) item #20 ? 2; and/or VHA TBI screening item endorsing recent sleep problems.32-35 b Contraindications for treatment include active alcohol or other use disorder and/or exposure-based therapy for posttraumatic stress disorder, defined as documentation of contraindications within the 30 days prior.



Visual illustration of obstructive sleep apnea measure specifications. PSC = Polytrauma/TBI System of Care; OSA = obstructive sleep apnea; STOP = Snoring, Tiredness, Observed apnea, Pressure (high blood pressure). a Determined using: Neurobehavioral Symptom Inventory (NSI) item #18 ? 2; Patient Health Questionnaire measuring depressive symptoms (PHQ-9) item #3 ? 2; Posttraumatic Stress Disorder Checklist (PCL-5) item #20 ? 2; and/or VHA TBI screening item endorsing recent sleep problems.<sup>32-35</sup> b OSA risk factors include: congestive heart failure; myocardial infarction; stroke; chronic prescription opioid use; obesity; nocturnal dysrhythmias; atrial fibrillation; hypertension; pulmonary hypertension; Type 2 diabetes or prediabetes; coronary artery disease; or arrhythmia. c Sleep medicine care includes a referral to sleep medicine; a diagnostic sleep study; and/or receipt of first-line OSA treatment, positive airway pressure or an oral appliance.



## **Multimedia Appendixes**

Sleep MAPP landing page.

URL: <http://asset.jmir.pub/assets/276bf1b038118a4bfc8f97998d5409a0.pdf>

Sleep MAPP page aggregating measure results.

URL: <http://asset.jmir.pub/assets/d1348487d9b0d7644c7f412f03a27df8.pdf>

Sleep MAPP fallout report example.

URL: <http://asset.jmir.pub/assets/99d44b1819105d02ea474633475e6aa0.pdf>

Clinician characteristics.

URL: <http://asset.jmir.pub/assets/7d3b54bb57022fc07c783709f9916d59.docx>

