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TITLE: Does Evidence-Based PTS Treatment Reduce PTS Symptoms and Suicide in Iraq and Afghanistan Veterans Seeking VA Care?

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14. ABSTRACT

Enter a brief (approximately 200 words) unclassified summary of the most significant finding during the research period.

We identified a cohort of OEF/OIF/OND Veterans who had a diagnosis of PTS after the end of their last deployment(N=308,556). This PTS+ cohort had a mean age of 35.9 years (SD=8.8 years), was 89.6% male, and was comprised of those who were 57.5% white, 13.9% black, 11.4% Hispanic, 3.9% other and 13.9% unknown. We identified 5.7 million psychotherapy visits made by these Veterans in the study period and linked these to approximately 8 million psychotherapy notes. We completed a standardized annotation guide specifying each category of psychotherapy to be identified and then four study team members annotated a set of 650 notes. We used a bag of words and support vector machine (SVM) approach to generate a classifier for irrelevant notes, which had a classification accuracy of 88%. This allowed us to remove irrelevant documents and generate an enriched pool of 4 million psychotherapy notes to be used for ongoing rounds of annotation. Also during this period, we identified 30,884 (10%) Veterans in our PTS cohort with three (or more) PCLs within an 18 week period, and, separately, 101,761 (33% of PTS cohort) members of the PTS cohort with two or more suicide screenings during the post-deployment period.

15. SUBJECT TERMS
Key words or phrases identifying major concepts in the report.
Posttraumatic Stress, Cognitive Processing Therapy, Prolonged Exposure Therapy, Evidence Based Therapy, Comparative Effectiveness, Natural Language Processing

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1. **INTRODUCTION:**

    Posttraumatic stress (PTS) is among the most common mental health problems among Service Members and Veterans returning from recent deployments, and despite the availability of evidence-based treatments (EBT), many of those with mental health problems do not seek or postpone seeking EBT for PTS, defined here as Prolonged Exposure Therapy (PE) and/or Cognitive Processing Therapy (CPT). This study will improve clinical care for the large number of Warfighters and Veterans who suffer from PTS by determining if Veterans receiving EBT outside of research trials actually demonstrate PTS symptom improvement in a clinical setting, whether these EBTs for PTS impact suicidality in a clinical setting, what factors are associated with PTS symptom improvement in those that benefit from EBT, and whether all Veterans benefit equally from EBTs for PTS.

2. **KEYWORDS:**

    Posttraumatic stress

    Cognitive Processing Therapy

    Prolonged Exposure Therapy

    Evidence based treatment

3. **ACCOMPLISHMENTS:**

▪ **What were the major goals of the project?**

    The major goals of this project are to determine the effectiveness of evidence-based therapies for posttraumatic stress (PTS) applied naturalistically in a clinical setting; factors associated with PTS symptom improvement; and optimal treatment trajectories for Veterans with PTS and complex comorbidities.

    The project work has been divided into four main tasks:

    TASK 1. Update and Merge Existing Data and Datasets—100% completed
    TASK 2. Use NLP to Evaluate Clinical Notes—37.5% completed.
    TASK 3. Data Analysis—0% completed
    TASK 4. Finalize study requirements, prepare for future funding, and dissemination of findings—0% completed

Progress on subtasks is described in detail in the following section.

- **What was accomplished under these goals?**

To date, several milestones identified in the SOW were achieved to support the major goals. The following are subtasks that have been achieved as specified in Task 1 (Update and merge existing data and datasets): IRB protocols were approved (subtask 1a), scientific approvals were obtained (subtask 1b),study staff were hired (subtask 1c), VA OEF/OIF/OND Roster was obtained from VA Central Office (subtask 1d), Roster was merged with VA National Patient Care Database and Corporate Data Warehouse (CDW) (subtasks 1g, 1e), study sample was identified based on eligibility criteria (subtask 1f). This subtask (1f) also included checking for quality of the record linkage, which was an important quality control measure. We have also obtained updated PCL measures and suicide measures (subtask 1g), and identified those with at least 3 PCL measures within 18-weeks and at least two suicide measures. Further, we identified all Veterans with a PCL at baseline and at least one other PCL within the five years of seeking mental healthcare, and suicide screens at two time points also within the first five years (subtask 1k). Based on the sample identified in task 1f, subtask 1i has been modified to include all psychotherapy notes for all PTS visits. The reason for this is that to account for potential bias, we need to determine the propensity for treatment regardless of level of utilization, or documentation of mental health measures/symptoms.

We received approval from ORD and NDS to access the national data sources needed for this project. We were then able to work with VINCI staff to create views of national data sources based on linkage to the Veterans listed in the OEF/OIF/OND Roster. We built a preliminary cohort of OEF/OIF/OND Veterans who had a diagnosis of PTS after the end of their last deployment (N=308,556; subtask 1f). This PTS+ cohort had a mean age of 35.9 years (SD=8.8 years), was 89.6% male, and was comprised of 57.5% white, 13.9% black, 11.4% Hispanic, 3.9% other and 13.9% unknown.

We identified all outpatient and inpatient PTS psychotherapy visits made by these Veterans in the study period: there were total of 5,693,721 visits, with a median of 9 visits per patient (IQR=20). Ninety-five percent of these PTS psychotherapy visits linked directly to at least one clinical note (a corpus of 7,841,634 notes in total; subtasks1i, expanded to include all PTS+ cohort from subtask 1f and subtask 2a). The clinical notes for these visits will be analyzed using natural language processing (NLP) to classify each visit as evidence-based therapy (expanded to include CPT, PE, group CPT, and group PE), other psychotherapy (individual or group), or not psychotherapy. Building a classifier with good performance requires using human-annotated notes (gold standard) to train and test different machine learning algorithms.

We completed a standardized annotation guide specifying each category of psychotherapy to be identified. From our corpus of approximately 8 million psychotherapy notes (subtask 2a) we randomly selected 5 documents from each of 130 VA facilities (650 documents). Using the standardized annotation guide, the notes were doubly annotated (task 2c) within each of two sites (SF and SLC) and adjudication was performed at each site (task 2d). The clinician annotation team (SF) had a high level of agreement (K=0.92), and the professional annotation team (SLC) reached fair level of agreement

(K=0.79). The between site agreement was good (K=.84). The SLC team then reviewed all cases where they disagreed with the SF team's adjudicated judgements and collaborated to improve the annotation guide for use in subsequent rounds. Consistent without our pilot data, our first round of annotation showed that half of the documents were irrelevant (not psychotherapy) and that some of the key evidence-based therapy classes contained an insufficient number of documents for algorithm creation. Given this finding, we have taken advantage of improved methods of performing large scale NLP developed at the SLC site.

To enrich our corpus, we created an NLP system to filter out the "Not psychotherapy" notes for ongoing rounds of annotation. Using a training set of notes from the first round of annotation that all four reviewers agreed were "Not Psychotherapy," we used a bag of words and support vector machine (SVM) approach to generate a classifier for irrelevant notes that has a classification accuracy (TP+TN/Total) of 88%. This has allowed us to remove irrelevant documents and generate an enriched pool of approximately 4 million psychotherapy notes. This will greatly increase the efficiency of our annotation process.   We will no longer be using ARC (task 2b), and have instead switched to a semi-supervised platform that has improved machine learning performance and fewer systematic delays, as recommended by Drs. DuVall and Patterson at the SLC site. This platform will also vastly improve the speed of document classification once the NLP system is finalized.

Also during this period, we identified 30,884 (10%) Veterans in our PTS cohort with at least one instance of three (or more) PCLs within an 18 week period (subtask 1h). We compared these Veterans to those members of the PTS cohort without that level of data on demographic and military characteristics (date of last deployment, age, gender, race, rank, and number of deployments) and found no substantial differences. We aligned the PCL data with the patients' outpatient psychotherapy billed visits in order to get an estimate of number of psychotherapy visits with corresponding (within one week) PCL data (task 1j, 1k). The subset of 30,529 PTS patients who had both psychotherapy sessions and PCL data had a total of 1.51 million visits, with a median of 26 (IQR=12-53) psychotherapy visits per patient; and, 64,789 (4.3%) of these visits had a proximal PCL. We identified 101,761 (33% of PTS cohort) members of the PTS cohort with two or more suicide screenings during the post-deployment period (subtask 1h). We compared these Veterans to those with only 1 or no suicide screens on demographic and military characteristics (date of last deployment, age, gender, race, rank, and number of deployments) and found no substantial differences. There were 11,799 Veterans with a PCL at baseline and at least one other PCL within the five years of seeking mental healthcare, and suicide screens at two time points also within the first five years (task 1k).

During this period it became clear that ARC was not the tool best suited to meet our research goals (Task 2b: "Use the Automated Retrieval Console (ARC) algorithm designed to identify CPT and PE notes"). After consultation with the team, we have moved to an updated NLP platform that will improve performance and efficiency. Our team's deep expertise in informatics has allowed us to incorporate better and faster technologies into our work to as we encounter obstacles. This is a strength our multi-disciplinary research approach.

- **What opportunities for training and professional development has the project provided?**

    Nothing to report (not a goal of this study).

- **How were the results disseminated to communities of interest?**

    Nothing to report (not yet at dissemination phase).

- **What do you plan to do during the next reporting period to accomplish the goals?**

Currently, the SF and SLC annotation teams are working through another 650 documents from the enriched corpus using the improved annotation guide. If agreement within and between sites is high and sufficient numbers of each psychotherapy class are identified, subsequent rounds of annotation will be completed by the SLC annotation team only, with consultation from the clinical experts on the SF annotation team as needed. We anticipate that this second round of annotation will be completed in the next two weeks. As rounds of annotation are completed, Drs. DuVall and Patterson will create evidence-based psychotherapy classifiers, asking for additional rounds of annotation when performance is limited by insufficient examples. We anticipate finalization of the evidence-based psychotherapy classifier and application of the classifier to the corpus by the end of next quarter.

4. **IMPACT:**

- **What was the impact on the development of the principal discipline(s) of the project?**

    Nothing to report.

- **What was the impact on other disciplines?**

    Nothing to report.

- **What was the impact on technology transfer?**

    Nothing to report. Once the project is complete we will be able to share our algorithms to further research in this area.

- **What was the impact on society beyond science and technology?**

    Nothing to report.

5. **CHANGES/PROBLEMS:**

There were some delays in acquiring the OEF/OIF/OND Roster, but this issue has been resolved and we are still on track, given that we left extra time for this task.

Our first round of annotation showed that the majority of documents were irrelevant (not psychotherapy) and that some of the key evidence-based therapy classes had too few documents to learn from. Therefore, we developed an NLP classifier to remove irrelevant documents in order to enrich our text corpus. It became clear that ARC was not tool best suited to our research task. Therefore, we have moved to an updated NLP platform that will improve performance and efficiency.

Poor computing infrastructure in VINCI caused delays in creation of database of psychotherapy visits and corresponding clinical notes as well as delays in extracting and cleaning mental health measures data (PCL and suicide screens).   Given significant delays in VINCI Windows desktop, we transferred the bulk of analytical work to the Vinci (Linux) SAS/GRID. In addition, we received permission to access to our Vinci extracts from a secure local server at the SFVA, which provides an alternate system for data processing and analysis in the event of future problems on the Vinci desktop.

6. **PRODUCTS:**

In this period, we created a database of PTS+ OEF/OIF/OND Veterans and their demographic characteristics and medical record data, their PTS psychotherapy visits and corresponding clinical notes, as well as their PCL and suicide measures. We completed, tested, and improved a standardized annotation guide specifying each category of treatment to be annotated. We created a classifier to separate irrelevant documents from psychotherapy notes, allowing us to distill our text corpus to the most important documents.

7. **PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS**
- **What individuals have worked on the project?**

Name:	*Shira Maguen*
Project Role:	*Principle Investigator, San Francisco VAMC*
Researcher Identifier (e.g. ORCID ID):	*N/A*
Nearest person month worked:	*3.5*
Contribution to Project:	*Dr. Maguen has provided coordination, oversight, and management of all tasks outlined in the research plan, working closely with her co-investigators.*

Name:	Brian Shiner
Project Role:	Co-investigator, White River Junction VAMC
Researcher Identifier (e.g. ORCID ID):	N/A
Nearest person month worked:	4
Contribution to Project:	Dr. Shiner has helped the team use his natural language processing algorithms to identify the use of evidence-based psychotherapy for PTS. He has also assisted with methods related to this project, given his prior experience with NLP.

Name:	Erin Madden
Project Role:	Statistician
Researcher Identifier (e.g. ORCID ID):	N/A
Nearest person month worked:	5
Contribution to Project:	Ms. Madden has worked to acquire the data sources used for this project, built the initial cohort and derived administrative-based datasets for the cohort.

Name:	Scott Duvall/Olga Patterson/Corinne Halls
Project Role:	NLP Expert, Salt Lake City VAMC
Researcher Identifier (e.g. ORCID ID):	N/A
Nearest person month worked:	4
Contribution to Project:	Drs. Duvall and Patterson advised the study team on NLP methods and are starting to test and modify the algorithm. Ms. Halls is overseeing annotation and coding for NLP team.

Name:	Kristine Burkman
Project Role:	Clinical Psychologist Coder
Researcher Identifier (e.g. ORCID ID):	N/A
Nearest person month worked:	2
Contribution to Project:	Dr. Burkman is a clinical psychologist who has coded clinical notes during the performance evaluation phase of the study.

Name:	Lisabeth Goldstein
Project Role:	Clinical Therapist Coder
Researcher Identifier (e.g. ORCID ID):	N/A
Nearest person month worked:	2
Contribution to Project:	Dr. Goldstein is a postdoctoral fellow who has coded clinical notes during the performance evaluation phase of the study.

- **Has there been a change in the active other support of the PD/PI(s) or senior/key personnel since the last reporting period?**

    Nothing to report.

- **What other organizations were involved as partners?**

    Nothing to report.

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JW140056

PI: Shira Maguen, Ph.D.

Org: Northern California Institute for Research and Education (NCIRE)   **Award Amount:** $517,760 (directs) + $275,967 (F&A)
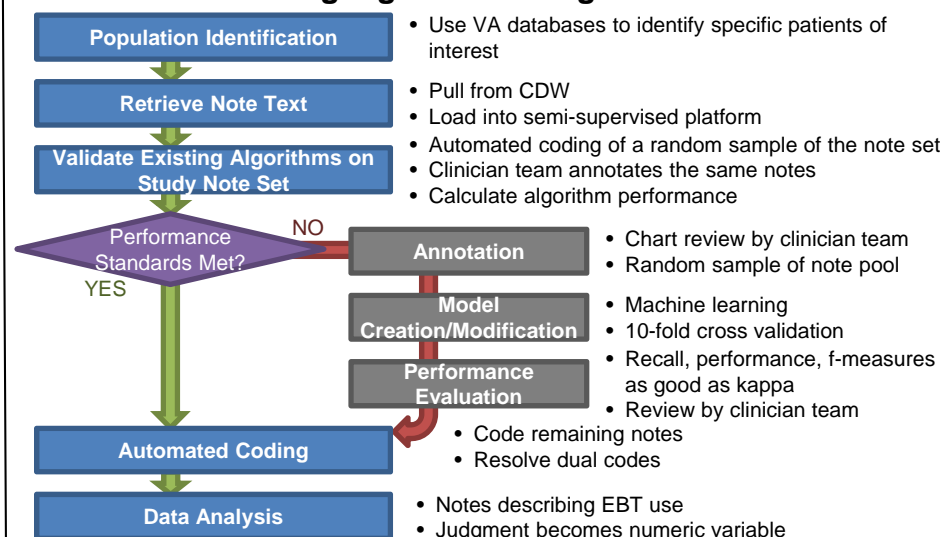
Study/Product Aim(s)

•**Aim 1**: Determine whether Iraq and Afghanistan Veterans that receive EBT for PTS across the entire Veterans Administration (VA) demonstrate improvement in PTS and suicide symptoms.

•**Aim 2**: Determine what percentage of Veterans with PTS complete a minimally-adequate dose of EBT for PTS, as well as factors associated with treatment completion.

•**Aim 3**: Determine the association between treatment profiles (early, delayed, and no EBT) and symptom improvement in Veterans with PTS, including those with complex comorbidities (depression, TBI, substance use disorders, and/or pain disorders).

Approach

Retrospective cohort study using multiple sources of VA data from 2007 to 2014. Sample will include Iraq and Afghanistan Veterans with PTS who are new users enrolled in the VA health care system.
Natural Language Processing (NLP) will be used to determine receipt of evidence-based psychotherapy for PTS.

Natural Language Processing Methods

- Use VA databases to identify specific patients of interest
- Pull from CDW
- Load into semi-supervised platform
- Automated coding of a random sample of the note set
- Clinician team annotates the same notes
- Calculate algorithm performance
- Chart review by clinician team
- Random sample of note pool
- Machine learning
- 10-fold cross validation
- Recall, performance, f-measures as good as kappa
- Review by clinician team
- Code remaining notes
- Resolve dual codes
- Notes describing EBT use
- Judgment becomes numeric variable

Timeline and Cost

Activities CY	15	16	17
Update and Merge Existing Data and Datasets	▮		
Use NLP to Evaluate Clinical Notes		▮	
Data Analysis		▮	
Finalize Study Requirements, Prepare for Future Funding, and Disseminate Findings			▮
Estimated Budget ($780,491 directs)	246,365	279,653	254,473

Updated: April 2016 (SFVAMC – San Francisco, CA)

Goals/Milestones

CY15 Goals – *Update and Merge Existing Data and Datasets*
- ☑ Update and merge multiple VA datasets
- ☑ Population identification
- ☑ Retrieve note text
- ☑ Begin developing standardized annotation guide

CY16 Goals – *Use NLP to Evaluate Clinical Notes*
- ☑ Complete creation of standardized annotation guide
- ☑ Quadruple annotation of 650 psychotherapy notes
- ☑ Build classifier to remove irrelevant notes
- ❑ Annotation of enriched set of 650 notes
- ❑ Build NLP model for types of EBT
- ❑ Automated coding

CY17 Goals – *Complete Data Analysis and Disseminate Findings*
- ❑ Complete data analysis
- ❑ Finalize study requirements
- ❑ Prepare for future funding
- ❑ Disseminate findings