Pain research using Veterans Health Administration electronic and administrative data sources

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Abstract—Health services researchers are using Veterans Health Administration (VHA) electronic health record (EHR) data sources to examine the prevalence, treatment, and outcomes of pain among Veterans in VHA care. Little guidance currently exists on using these data; thus, findings may vary depending on the methods, data sources, and definitions used. We sought to identify current practices in order to provide guidance to future pain researchers. We conducted an anonymous survey of VHA-affiliated researchers participating in a monthly national pain research teleconference. Thirty-two researchers (89%) responded: 75% conducted pain-focused research, 78% used pain intensity numeric rating screening scale (NRS) scores to identify pain, 41% used International Classification of Diseases-9th Revision codes, and 57% distinguished between chronic and acute pain using either NRS scores or pharmacy data. The NRS and pharmacy data were rated as the most valid pain data sources. Of respondents, 48% reported the EHR data sources were adequate for pain research, while 45% had published peer-reviewed articles based on the data. Despite limitations, VHA researchers are increasingly using EHR data for pain research, and several common methods were identified. More information on the performance characteristics of these data sources and definitions is needed.

Key words: administrative data, computerized medical records, data collection, data interpretation, data mining, electronic health records, information storage and retrieval, pain, pain management, Veterans.

INTRODUCTION

The Veterans Health Administration (VHA) uses an electronic health record (EHR) to collect clinical and administrative data. Because the VHA is a national

integrated healthcare system that serves a diverse population of over 8 million Veterans per year in more than 140 facilities [1], EHR-based data can potentially provide valuable information on a variety of healthcare-related issues.

Researchers have successfully used EHR and administrative data in different ways. Such data have been used to create condition-specific registries [2], conduct data quality evaluations [3], differentiate the severity of mental health and medical conditions [4], describe longitudinal health services utilization [5], study outcomes [6], and improve the quality of care [7]. Within VHA, researchers have used EHR and administrative data to examine a diverse array of issues [8] such as mental health [9–11], human immunodeficiency virus [12–13], women's Veterans health [14], sex differences [15–16], diabetes [17–18], and stroke [19–20].

Pain is one of the most common reasons for seeking medical care [21], and health services researchers are using VHA EHR data sources to examine the prevalence, treatment, effect, and pain management practices among Veterans in VHA care. For example, Sinnott et al. evaluated several methods for identifying individuals with neck and back pain [22]. They identified seven unique published algorithms and outlined the similarities and differences in the structure and definitions of the algorithms. They then assessed and compared the algorithms by applying them to VHA administrative data (e.g., Patient Treatment Files [PTFs] for inpatient data and the National Patient Care Database [NPCD] for outpatient data). Lisi et al. compared VHA administrative data and structured chart review and identified and tested methods to distinguish between acute and chronic nonacute lower back pain among Veterans [4]. Models they constructed included several variables in addition to International Classification of Diseases-9th Revision (ICD-9) codes (e.g., prescriptions, consultations, and imaging orders). Variables were extracted from several Veterans Health Information System and Technology Architecture (VistA) databases and files (VistA stores EHR data).

Haskell et al. evaluated sex differences in the prevalence of overall pain, moderate to severe pain, persistent pain, and pain assessment in a cohort of Operation Iraqi Freedom/Operation Enduring Freedom (OIF/OEF) Veterans seen at an outpatient VHA clinic in the first year after their last deployment [15]. The researchers obtained demographic and military service information from the OIF/OEF roster, a database of Veterans who have separated from military service and have enrolled in VHA healthcare. The source of the roster is the Defense Manpower Data Center [23]. Visit information, ICD-9 codes, and pain intensity numeric rating screening scale (NRS) scores were obtained from the Corporate Data Warehouse (CDW).

Goulet et al. examined the degree of agreement between EHR-based and patient survey-based NRS scores and examined factors that could explain discrepancies [24]. Finley et al. studied the association of the polytrauma clinical triad (the co-occurrence of posttraumatic stress disorder [PTSD], traumatic brain injury, and chronic pain) with suicide-related behavior risk among OIF/OEF Veterans [8]. They identified Veterans using the OIF/OEF roster and used administrative data (e.g., VHA inpatient and outpatient data) to identify baseline characteristics (e.g., ICD-9 codes) and outcomes (e.g., suicide ideation, attempted or self-inflicted injury) [8]. Using a cohort of OIF/OEF Veterans, Seal et al. investigated the association of mental health disorders, in particular PTSD, on patterns of opioid prescription use and adverse clinical outcomes such as overdose and accidents [25]. VHA data sources used included the OIF/OEF roster, clinical visit and diagnostic information, and pharmacy records.

These studies highlight the variety of methods, definitions, and data sources used in pain-related research. While there are different approaches to using VHA EHR and administrative data, factors such as the inherent structure of VHA data (i.e., the large number of available data sources and data elements) and the existence of different relevant data owners and procedures to gain access to data sources can affect research results. Thus, research findings can vary depending on the methods and sources of data that researchers use to identify samples of patients and to define outcomes. For example, some may approach the identification of patients with pain through pharmacy dispenses of opioid medications, by NRS scores of a certain threshold (e.g., ≥4 to indicate moderate to severe pain), by ICD-9 code, or through a combination thereof. Different definitions can contribute to pain researchers arriving at very different conclusions.

The use of EHR data, originally collected for clinical and administrative purposes and not research purposes, highlights the importance of establishing how best to use the available data to conduct pain-related research. As a first step toward establishing best practices to leverage optimal use of VHA EHR data, we conducted an anonymous survey of VHA-affiliated pain researchers. The survey results were intended to serve as a basis for future

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efforts to derive a consensus about recommended data sources, definitions, and methods to aid researchers in conducting studies that are comparable and consistent and ultimately to help improve healthcare services for Veterans.

The survey asked about respondents' research focuses, how they defined certain concepts (e.g., pain, acute and chronic pain), and whether they used a comparison or control group in their most recent research. We asked which specific national data sources they used in their pain research, which sources they used to identify the presence of pain, and how valid they felt the sources were. We inquired about potential barriers to data use, whether VHA data were adequate for pain research, and whether the respondents would be willing to participate in an expert panel to discuss issues and recommendations for pain research using VHA data.

METHODS

Participants

In 2012, all active members ($n = 36$) of the national VHA Pain Research Working Group (PRWG) were invited to participate in a voluntary, one-time, online survey about their use of VHA EHR and administrative data in pain-related research. The PRWG was created to support a key objective of the VHA National Pain Management Strategy: "Identifying research opportunities and priorities in pain management and facilitating collaborative research efforts" [26]. Members of the group include VHA investigators as well as collaborating investigators outside of the VHA. The Department of Veterans Affairs (VA) Connecticut Healthcare System Human Subjects Subcommittee approved this investigation.

The study principal investigator (J.G.) sent an email announcement to the group using a preexisting email distribution list as a source for names. Email messages were sent once a month for 3 mo (totaling three emails) to all group members, inviting respondents' voluntary and anonymous participation in an online survey. Respondents used REDCap (Research Electronic Data Capture) [27], a secure, Web-based application designed to support data capture for research studies, to complete the survey. No names or personally identifying information about either respondents or VHA patients were collected. Rather, the survey asked about primary affiliation, professional discipline, primary service department, pain

research focus, and use and opinions of VHA EHR and administrative data.

Survey Questions

See the **Appendix** (available online only) for the survey questions used in this study.

Data Source Use and Validity

We asked survey respondents to indicate whether they used any of eight EHR and administrative data sources that have been used in other areas of research and to rate their opinion of the validity of the source on a scale of 1 (not valid) to 7 (valid).

Most Recent Research

We asked seven questions about respondents' most recent research, including several dichotomous "yes/no" questions, such as whether they distinguished between chronic and acute pain, used a comparison or control group, or examined recurrence of pain. We then asked open-ended questions about how they defined pain and chronic pain and asked them to identify the geographic area (e.g., national or local VHA facility only) of their most recent research. Finally, we asked whether respondents had ever published any pain-focused peer-reviewed articles.

Barriers to Data Source Use

We asked respondents about barriers to their use of VHA electronic and administrative data. We provided a list of 10 known barriers (plus an option for "none"). We compiled the list of barriers based on the combined experience of authors (J.G., C.B.) who have developed three large VHA data cohorts. Respondents could also add any additional barriers not listed. We also asked them to rate each barrier, including ones the respondents added, as a "minor barrier," "major barrier," or "not a barrier."

Adequacy of Data for Pain Research

Survey respondents were asked the following question to ascertain their opinion of the adequacy of data sources for pain research: "Do you think VHA electronic and administrative data are adequate for pain research?" Single questions were then asked to elicit feedback about (1) how respondents would improve VHA electronic and administrative data for pain research and (2) whether respondents would be interested in participating in an expert panel to discuss issues in pain research using VHA data.

Data Sources and Definitions

There are approximately 139 data sources within VHA [28]. Given this sizeable number of data sources potentially available to conduct pain research, we felt it would be useful to identify and ask respondents about a subset of those sources often used in pain research. We relied on our prior experience conducting pain research and the prior publications of VHA pain-related researchers to identify the subset and describe them here for clarity and informational purposes. Hynes provides information about many of these resources and gaining access to them [28].

Corporate Data Warehouse

The CDW is a national repository of VHA clinical and administrative data [29]. Data include national clinical, enrollment, financial, administrative, utilization, and benefits information consolidated from multiple VHA data sources. The CDW allows for a standardized database structure and facilitates analysis and reporting.

Veterans Health Administration Medical SAS Inpatient and Outpatient Data Sets

The Medical SAS (MedSAS) inpatient and outpatient data sets consist of national VHA healthcare encounter data, specifically workload information at the encounter, visit, or stay level, for inpatient and outpatient healthcare encounters. MedSAS inpatient data are obtained from the PTF and both the outpatient and inpatient encounter MedSAS data are taken from the NPCD [30]. The NPCD is a centralized database of integrated patient care data from VistA.

Department of Veterans Affairs Managerial Cost Accounting System

The Managerial Cost Accounting (MCA) system (formerly known as the Decision Support System) is a cost allocation system that can generate the costs of healthcare use for hospital stays and outpatient care at an individual patient level. Examples of data reported include costs of ordering chest X-rays, clinic visits, and inpatient visits [31].

Beneficiary Identification and Records Locator System Death File

The Beneficiary Identification and Records Locator System death file is a Veterans Benefits Administration-extracted death file database that contains cumulative information about Veterans' deaths. This database is compiled from multiple sources such as VHA hospitals, family members applying for benefits, the VA National Cemetery Administration, and the Social Security Administration.

National Surgical Quality Improvement Program

The National Surgical Quality Improvement Program includes risk-adjusted data extracted from patient charts and provides preoperative to postoperative patient outcomes.

Pharmacy Benefits Management

Pharmacy Benefits Management is a comprehensive national database containing information about all prescriptions dispensed at a VHA pharmacy or consolidated mail outpatient pharmacy since fiscal year 1999. Data include "medication dispensing utilization information for prescription fills in VHA pharmacies" [32], dosing instructions, National Drug Code identifiers, cost, and provider information.

Survey of Healthcare Experiences of Patients

The Survey of Healthcare Experiences of Patients (SHEP) is a VHA survey program that assesses patient experiences with inpatient and outpatient healthcare with the overall goal of improving the quality of VHA healthcare. In 2010, the SHEP program began using the Agency for Healthcare Research and Quality's Consumer Assessment of Healthcare Providers and Systems (CAHPS) family of survey instruments. As developed, these surveys are standardized and thus comparable across settings, and their psychometric properties are well-documented [33]. The SHEP program implements additional CAHPS survey instruments in accordance with VHA priorities.

Health Analysis and Information Group Pain Management Survey Data

The Health Analysis and Information Group (HAIG) pain management survey data include a comprehensive field-based survey of pain management in all VHA facilities conducted in 2009 by the HAIG in collaboration with the Pain Management Program Office. All facilities responded, and the role of respondents varied by facility (e.g., pain management point of contact or not). Available data include adherence to VHA pain management directive, clinical care characteristics, pain management

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stepped care model implementation, and focused review of specific priority areas.

Bar Code Medication Administration

The Bar Code Medication Administration is a VistA module that provides inpatient medication dispensing safety and control to reduce inpatient medication errors. It does so by electronically validating and documenting medications for patients. The system visually alerts clinicians when medication-dispensing conditions are not met.

Department of Veterans Affairs Resource Centers

We included in the survey four of the eight national VA resource centers that are commonly used by VHA pain researchers. We selected these four sources by drawing on our experience as pain researchers.

Serious Mental Illness Treatment Resource and Evaluation Center

The Serious Mental Illness Treatment Resource and Evaluation Center is a VA Health Services Research and Development Service (HSR&D) research center that develops and maintains two national data repositories: the National Psychosis Registry and the National Registry for Depression [34].

Health Economics Resource Center

The Health Economics Resource Center (HERC) is an HSR&D resource center that provides data about VHA facility, departmental, and individual healthcare costs, specifically inpatient and outpatient costs along with fee basis or costs related to outside care with a provider contracted with VHA. HERC also produces several resources, including MCA cost data [35].

Department of Veterans Affairs Information Resource Center

The VA Information Resource Center (VIReC) is an HSR&D resource center that develops and disseminates knowledge about data resources and provides guidance and assistance to researchers [31]. VIReC also provides access to VA and Centers for Medicare and Medicaid Services data, including United States Renal Data System data.

Northeast Program Evaluation Center

The Northeast Program Evaluation Center (NEPEC) is the evaluation division of the National Center for PTSD [36]. NEPEC is responsible for evaluating Office of Mental Health services programs, including PTSD clinical programs.

RESULTS

Of 36 researchers contacted, 32 (89%) respondents completed the survey. Nearly all (94%) identified their primary affiliation as VHA. Respondents included psychologists (33%), physicians (25%), epidemiologists (13%), and statisticians (13%). Seventy-two percent reported conducting research in an outpatient setting, and 44 percent identified chronic pain as their primary area of research. The majority of respondents (75%) had been a principal investigator or coinvestigator on pain-focused studies. Two-thirds (67%) reported they had received VHA funding for their most recent pain-related research, 25 percent reported they had received funding from "other" sources, and 8 percent reported they had received National Institutes of Health funding. No respondents reported Department of Defense funding.

As shown in **Table 1**, more respondents endorsed using NRS scores (78%), ICD-9 codes for pain (66%), and/or Computerized Patient Record System (CPRS) progress notes (41%) to identify the presence of pain than other data sources. Respondents' impressions of the validity of the sources of pain data were highest for

Table 1.
Sources of pain data.

Source	Percent[*]	Impression of Data Validity (median score)[†]
NRS Scores	78	5
ICD-9 Codes for Pain	66	4
CPRS Progress Notes	41	4
Pharmacy	39	5
CPT Codes	38	4
CPRS Problem List	38	3.5
Other (e.g., patient self-report, RAI/MDS)	24	5.5
Clinic Stop Codes	22	4
CPRS Discharge Summary	16	4

[*]Individuals could endorse multiple sources and thus numbers do not sum to 100%.

[†]Range = 1 (not valid) to 7 (valid).

CPRS = Computerized Patient Record System, CPT = Current Procedural Terminology, ICD-9 = International Classification of Diseases-9th Revision, NRS = pain intensity numeric rating screening scale, RAI/MDS = Resident Assessment Instrument/Minimum Data Set.

"other" (including patient self-report and the Resident Assessment Instrument/Minimum Data Set [RAI/MDS]), NRS scores, and pharmacy sources.

In their most recent research, 41 percent of respondents reported they relied on ICD-9 codes only and 21 percent of respondents used NRS scores only to define pain. More than half of the respondents (57%) distinguished between chronic and acute pain.

Among those who reported how they defined chronic pain, most reported using NRS scores of ≥4 during some interval of time. Nearly one-third of the respondents (32%) constructed a comparison or control group, 25 percent had a national focus, 13 percent had a Veterans Integrated Service Network focus, and 16 percent had a local facility focus. Less than half (45%) reported they published pain-focused peer-review articles using VHA electronic and administrative data.

We ascertained respondents' perceived barriers to the use of VHA electronic and administrative data for pain-related research. As shown in **Table 2**, "insufficient level of detail in data" received the greatest percentage of endorsements as a major barrier (33%). The other identified major barriers included "data management issues (e.g. cleaning data)" and "data quality (e.g. completeness, lack of validation)" (both 27%) and "privacy/Health Insurance Portability and Accountability Act concerns" (23%). Two factors received the greatest percentage of endorsements as "not a barrier": "timeliness of data" (77%) and "lack of hardware to house data (e.g., computer storage)" (73%).

Regarding use of VHA data sources, as shown in **Table 3**, less than half (44%) of the respondents reported using the VHA's integrated data warehouse (CDW) or the MedSAS data sets (47%). Of note, despite the evident use of VHA data sources by these researchers, only 48 percent thought that the data sources were adequate for pain research. More than half of respondents (58%) said they would be willing to participate in an expert panel to discuss issues in pain research using VHA data.

DISCUSSION

The results of this survey provide insight into how VHA pain researchers use VHA EHR and administrative data to conduct pain-related research. Nearly half of the respondents did not think VHA EHR and administrative data were adequate for pain research. Despite limitations in these data sources, pain researchers are using them and in different ways. The survey results also showed variations in key approaches to pain research, including which specific data sources were used, how chronic pain was defined, how chronic and acute pain were distinguished, whether a comparison or control group was used, and perceived barriers to using such data sources for pain research.

The majority of respondents endorsed using the NRS scores and/or ICD-9 codes. The NRS is a brief instrument, is easy to administer, correlates with other pain intensity measures, and is widely used in large healthcare settings and research. Thus, NRS scores may be relatively easier to obtain from EHR and administrative data relative to other pain data. While this survey result is similar to published literature, there are issues with reliance on NRS scores. They do not describe important

Table 2.

Barriers to use of Veterans Health Administration electronic and administrative data for pain research.

Barrier	Not a Barrier (%)	Major Barrier (%)	Minor Barrier (%)
Insufficient Level of Detail in Data	7	33	60
Data Management Issues (e.g., cleaning data)	10	27	63
Data Quality (e.g., completeness, lack of validation)	13	27	60
Privacy/HIPAA Concerns	27	23	50
Inability to Access Data	17	20	63
Lack of Expertise in Analyzing Data	53	17	30
Data Security	50	10	40
Timeliness of Data	77	7	17
Lack of Hardware to House Data (e.g., computer storage)	73	3	23
Lack of Standardization (e.g., site variation)	27	3	23

Note: Individuals could endorse multiple resources and thus numbers do not sum to 100%.
HIPAA = Health Insurance Portability and Accountability Act.

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Table 3.
Top five Veterans Health Administration resources used in pain research.

Resource	Percent
Medical SAS Data sets	47
Corporate Data Warehouse	44
Decision Support System	28
Beneficiary Identification and Records Locator System Death File	22
Survey of Healthcare Experiences of Patients	16

information (e.g., persistence of pain, level of impairment), and they may underestimate direct patient reports of pain [24].

ICD-9 codes are assigned to and available for most inpatient and outpatient encounters, are captured in EHR and administrative data, and thus are relatively easy to access. However, they are often used for purposes that are a departure from their original intent [37], and their accuracy in identifying patients with specific conditions is variable. Because of reliability and validity issues using ICD-9 codes to identify patients, including those with pain [38], researchers have developed identification algorithms to improve accuracy (e.g., using a specific number of inpatient and/or outpatient ICD-9 codes within a given time frame) [12,38]. Pain researchers have developed and evaluated identification algorithms that use ICD-9 codes (along with other data) to identify patients with pain [4,6–7,22].

Our survey results suggest that VHA pain researchers use EHR and administrative data sources and recognize and capitalize on their advantages for research. VHA EHR and administrative data sources contain information on a large and diverse sample of individuals, and much of the data are entered or stored in structured fields. Researchers may be able to evaluate treatment outcomes using observational designs across a wider range of clinical settings, geographical regions, and patients and have access to samples of patients in preparation for recruitment for clinical trials [2] and/or survey studies. Use of EHR and administrative data for research may also be less expensive and time-consuming than studies that require patient recruitment and/or data collection [39]. In addition, use of existing data may reduce participant risk (e.g., reduce study intervention risk) and participant burden (e.g., eliminate the burden or expense of traveling to participate in a research study or time needed to complete a protocol). The variability in the methods, data sources, and definitions used by survey respondents may also

reflect these advantages of EHR and administrative data, including the potential for greater flexibility in designing and executing research.

This survey highlights some of the known limitations to using EHR and administrative data for research. Because these sources are designed and implemented to support patient care and clinical processes, not research [40], the data needed to accomplish research objectives may not be available, may lack the information and details needed, or may be hard to retrieve. For example, EHR and administrative data omit valuable information [2], such as the severity of a patient's illness [30] and degree of disability. In addition, important information and details may be embedded in text format (e.g., clinician progress notes, secure email messages, and texts from patients) and thus are harder to retrieve and analyze than structured data.

Survey respondents appear to recognize these limitations as evidenced in their endorsement of both "insufficient level of detail in data" and "data quality (e.g., completeness, lack of validation)" as two major barriers to use of VHA EHR and administrative data. These limitations may also explain why survey respondents endorsed greater usage of NRS scores, ICD-9 codes, and CPRS progress notes to identify the presence of pain. Respondents may be less likely to use data they consider to have the highest validity (i.e., patient self-report and RAI/MDS), because this information is not available, is difficult to ascertain on a large scale (e.g., patient self-report), or is available for a specific population such as patients in nursing homes (e.g., RAI/MDS) or a limited number of patients (e.g., study-specific surveys). Respondents appear to want more in-depth data about pain (such as the PEG instrument [41]) in VHA EHR and administrative data and may be using NRS scores, ICD-9 codes, and CPRS progress notes in the absence of more detailed and better data.

The lack of standardization over time of EHR and administrative data is another significant challenge. Specific databases may have been developed and implemented in response to distinct administrative, operational, quality improvement, or clinical needs and may be incompatible with national or organizational standards. The data rules, definitions, and structures may be unique to each legacy system [42], and the data may have been obtained, entered, and stored differently. Data may need to be merged, which may be an added challenge. The VHA has encountered these problems and has approached the

challenges presented by its legacy systems, unconsolidated data, and multiple databases by implementing the CDW because attempts to apply common standards across legacy systems were impractical. Essentially, it was more practical and efficient to create a vast, modern data structure and repository than to attempt to modernize or to redesign historic systems.

In addition to its focus on improving data and systems, VHA is increasingly focused on data users. There are valuable, user-focused resources such as the VHA data portal (an online gateway to VHA data information, resources, and training), VIReC (a resource center designated to provide guidance to VHA researchers using data), and VA Informatics and Computing Infrastructure (an environment that provides researchers access to analytical tools and clinical and administrative data sets). User-focused resources such as these facilitate practical access to data, knowledge about and use of available data sources, and project collaboration so that individuals can more efficiently and quickly produce information using VHA data.

Finally, although the VHA has several programs and services to help researchers, the ability to retrieve and use EHR and administrative data may depend on the researcher's technical knowledge and skills (e.g., knowledge of the data source structures, ability to conceptualize what data are available or can be utilized, knowledge of natural language processing or qualitative methodologies) or access to individuals with these skills.

There are several limitations to this study. The small sample size limits the ability to generalize findings to other VHA pain researchers. Because the survey relied on a convenience sample of PRWG members, this sample may not be representative of all those who use VHA EHR and administrative data for pain research. The use of nonstandardized questionnaires and tools as well as selection of data sources based on authors' pain research experience and familiarity with data sources may have affected the findings. It is possible that the survey excluded important and relevant questions and data sources.

CONCLUSIONS

As researchers continue to use VHA data for pain or other conditions, it is important to understand data sources and methods better so that protocols can be for-

mulated to help guide future researchers and studies. Data from this survey provided an opportunity to examine VHA researchers' use of and confidence in the reliability of EHR and administrative data. We assessed respondents perception of barriers to accessing data and the adequacy of the data sources for pain research. In spite of known limitations, VHA pain researchers are capitalizing on the advantages of using EHR and administrative data to conduct pain studies to help ultimately improve healthcare services for Veterans. The VHA National Pain Management Strategy, initiated on November 12, 1998, established pain management as a national priority. Since then (and coincident with greater awareness of prescription opioid-related adverse events), pain research in VHA has increased and findings are increasingly relevant to healthcare providers and policy makers. Thus, the methods used to identify Veterans with pain need to be shared between researchers in the field, and future work comparing, contrasting, and validating these methods against patient-reported outcomes would help us to better understand the accuracy of the data used.

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