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**Retrospective Analysis of Vestibular Dysfunction in Service  
Members: Demographic and Clinical Factors**



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## INTRODUCTION

Military personnel exposed to blast, inner ear injury, neurotoxins, or traumatic brain injury (TBI) may develop symptoms of vestibular dysfunction including dizziness, vertigo, and loss of balance (Akin et al., 2022; Scherer & Schubert, 2009; Swan et al., 2020). A study of more than 570,000 post-9/11 Veterans found that 2,560 (0.45%) had been diagnosed with vestibular dysfunction and 13,537 (2.57%) with non-specific dizziness (Swan et al., 2020), diagnoses that have been linked to poorer outcomes after head trauma (Chamelian & Feinstein, 2004; Lau et al., 2011; Yang et al., 2007). An unpublished study of more than 5.5 million TRICARE Military Health System (MHS) beneficiaries found that 52,878 (0.95%) had been diagnosed with at least one vestibular disorder in 2018-2019 (Sayegh et al., in preparation).

Unfortunately, the true prevalence and burden of vestibular injury among Service members is unknown and likely underestimated due to the complexity and time demands of clinical diagnosis. A thorough differentially diagnostic vestibular evaluation involves multiple vestibular function tests administered by qualified clinicians with advanced training. If there are not enough appropriately trained providers to meet the need in military treatment facilities, an unknown number of Service members with vestibular disorders may be left undiagnosed, uncounted, and untreated. Symptoms associated with vestibular dysfunction can limit military readiness, and are potentially hazardous to military operational and occupational performance. Vestibular rehabilitation has demonstrated value in reducing vestibular symptoms, including in military and civilian TBI patient populations (Gottshall, 2011; Park et al., 2018; Scherer & Schubert, 2009; Whitney et al., 2015).

The purpose of this retrospective study was (1) to observe the distribution of clinically-diagnosed vestibular dysfunction among active-duty Service members receiving care through MHS from the beginning of fiscal year 2016 through fiscal year 2020, based on vestibular diagnostic and treatment codes, and (2) to assess for the use of evidence-based clinical care in active-duty Service members diagnosed with benign paroxysmal positional vertigo (BPPV).

## METHODS

We conducted a preparatory-to-research analysis of vestibular diagnoses in active-duty military Service members between fiscal years 2016 and 2020, inclusive, using the DOD Hearing Center of Excellence (HCE) Joint Hearing Loss & Auditory System Injury Registry (JHASIR). JHASIR is a congressionally-mandated data registry under the purview of the HCE that combines clinical care encounters from both the DOD and VA for Service members with auditory and vestibular systems injuries from 2001 to present. JHASIR includes audiograms, demographic information, deployment and theater trauma, and non-trauma data.

Patient information from the Comprehensive Ambulatory/Professional Encounter Record (CAPER) combined with DEERS demographic information data was utilized from JHASIR. The initial dataset was selected using ICD-10 and CPT codes (**TABLES 1 and 2**) for encounters

between fiscal years 2016 and 2020, inclusive (World Health Organization, 2016; American Medical Association, 2021). This resulted in a dataset of 748,013 encounters. To deidentify patient data, patients' social security numbers and electronic data interchange personal identifier numbers were encrypted, and service and DOD occupation codes were masked. To further deidentify patients, sponsor pay grades were grouped into officer/enlisted, junior/senior, cadet, and warrant officer categories. The deidentified data were provided to HCE researchers in the form of a password- secured text file.

<b>TABLE 1: ICD-10 CODES USED FOR INITIAL DATA ANALYSIS</b>	
<b>ICD-10 Code</b>	<b>Affiliated Diagnosis</b>
T753XXA	MOTION SICKNESS, INITIAL ENCOUNTER
T753XXD	MOTION SICKNESS, SUBSEQUENT ENCOUNTER
T753XXS	MOTION SICKNESS, SEQUELA
R42	DIZZINESS AND GIDDINESS
G450	VERTEBRO-BASILAR ARTERY SYNDROME
H8101	MENIERE'S DISEASE, RIGHT EAR
H8102	MENIERE'S DISEASE, LEFT EAR
H8103	MENIERE'S DISEASE, BILATERAL
H8109	MENIERE'S DISEASE, UNSPECIFIED EAR
H8110	BENIGN PAROXYSMAL VERTIGO, UNSPECIFIED EAR
H8111	BENIGN PAROXYSMAL VERTIGO, RIGHT EAR
H8112	BENIGN PAROXYSMAL VERTIGO, LEFT EAR
H8113	BENIGN PAROXYSMAL VERTIGO, BILATERAL
H8120	VESTIBULAR NEURONITIS, UNSPECIFIED EAR
H8121	VESTIBULAR NEURONITIS, RIGHT EAR
H8122	VESTIBULAR NEURONITIS, LEFT EAR
H8123	VESTIBULAR NEURONITIS, BILATERAL
H81311	AURAL VERTIGO, RIGHT EAR

H81312	AURAL VERTIGO, LEFT EAR
H81313	AURAL VERTIGO, BILATERAL
H81319	AURAL VERTIGO, UNSPECIFIED EAR
H81391	OTHER PERIPHERAL VERTIGO, RIGHT EAR
H81392	OTHER PERIPHERAL VERTIGO, LEFT EAR
H81393	OTHER PERIPHERAL VERTIGO, BILATERAL
H81399	OTHER PERIPHERAL VERTIGO, UNSPECIFIED EAR
H8141	VERTIGO OF CENTRAL ORIGIN, RIGHT EAR
H8142	VERTIGO OF CENTRAL ORIGIN, LEFT EAR
H8143	VERTIGO OF CENTRAL ORIGIN, BILATERAL
H8149	VERTIGO OF CENTRAL ORIGIN, UNSPECIFIED EAR
H818X1	OTHER DISORDERS OF VESTIBULAR FUNCTION, RIGHT EAR
H818X2	OTHER DISORDERS OF VESTIBULAR FUNCTION, LEFT EAR
H818X3	OTHER DISORDERS OF VESTIBULAR FUNCTION, BILATERAL
H818X9	OTHER DISORDERS OF VESTIBULAR FUNCTION, UNSPECIFIED EAR
H8190	UNSPECIFIED DISORDER OF VESTIBULAR FUNCTION, UNSPECIFIED EAR
H8191	UNSPECIFIED DISORDER OF VESTIBULAR FUNCTION, RIGHT EAR
H8192	UNSPECIFIED DISORDER OF VESTIBULAR FUNCTION, LEFT EAR
H8193	UNSPECIFIED DISORDER OF VESTIBULAR FUNCTION, BILATERAL
H821	VERTIGINOUS SYNDROMES IN DISEASES CLASSIFIED ELSEWHERE, RIGHT EAR
H822	VERTIGINOUS SYNDROMES IN DISEASES CLASSIFIED ELSEWHERE, LEFT EAR
H823	VERTIGINOUS SYNDROMES IN DISEASES CLASSIFIED ELSEWHERE, BILATERAL
H829	VERTIGINOUS SYNDROMES IN DISEASES CLASSIFIED ELSEWHERE, UNSPECIFIED EAR
H8301	LABYRINTHITIS, RIGHT EAR

H8302	LABYRINTHITIS, LEFT EAR
H8303	LABYRINTHITIS, BILATERAL
H8309	LABYRINTHITIS, UNSPECIFIED EAR
H8311	LABYRINTHINE FISTULA, RIGHT EAR
H8312	LABYRINTHINE FISTULA, LEFT EAR
H8313	LABYRINTHINE FISTULA, BILATERAL
H8319	LABYRINTHINE FISTULA, UNSPECIFIED EAR
H832X1	LABYRINTHINE DYSFUNCTION, RIGHT EAR
H832X2	LABYRINTHINE DYSFUNCTION, LEFT EAR
H832X3	LABYRINTHINE DYSFUNCTION, BILATERAL
H832X9	LABYRINTHINE DYSFUNCTION, UNSPECIFIED EAR
H838X1	OTHER SPECIFIED DISEASES OF RIGHT INNER EAR
H838X2	OTHER SPECIFIED DISEASES OF LEFT INNER EAR
H838X3	OTHER SPECIFIED DISEASES OF INNER EAR, BILATERAL
H838X9	OTHER SPECIFIED DISEASES OF INNER EAR, UNSPECIFIED EAR
H933X1	DISORDERS OF RIGHT ACOUSTIC NERVE
H933X2	DISORDERS OF LEFT ACOUSTIC NERVE
H933X3	DISORDERS OF BILATERAL ACOUSTIC NERVES
H933X9	DISORDERS OF UNSPECIFIED ACOUSTIC NERVE

<b>TABLE 2: CPT CODES USED FOR INITIAL DATA ANALYSIS</b>	
<b>CPT CODES</b>	<b>Description of Procedure</b>
92537	Caloric vestibular test with recording; bilateral; bithermal (i.e., one warm and one cool irrigation in each ear for a total of four irrigations)
92538	Caloric vestibular test with recording, bilateral; monothermal (i.e., one irrigation in each ear for a total of two irrigations)

92540	Basic vestibular evaluation, including spontaneous nystagmus test with eccentric gaze fixation nystagmus, with recording, positional nystagmus test, minimum of four positions, with recording, optokinetic nystagmus test, bidirectional foveal & peripheral stimulation, with recording & oscillating tracking test, with recording
92541	Spontaneous nystagmus test, including gaze and fixation nystagmus, with recording
92542	Positional nystagmus test, minimum of 4 positions, with recording
92544	Optokinetic nystagmus test, bidirectional, foveal or peripheral stimulation, with recording
92548	Computerized dynamic posturography sensory organization test (CPD-SOT), 6 conditions (described below), including interpretation and report
92549	With motor control test (MCT) and adaptation test (ADT)
92351	Spontaneous nystagmus, including gaze, without recording
92352	Positional nystagmus test, without recording
92700	NEW CODE – Unspecified otolaryngology procedure, to account for Video Head Impulse Test (vHIT)
95992	Canalith repositioning procedure(s) (e.g., Epley maneuver, Semont maneuver), per day
92517	NEW CODE – VEMP testing, with interpretation and report; cervical (cVEMP)
92518	NEW CODE – VEMP testing, with interpretation and report; ocular (oVEMP)
92519	NEW CODE – VEMP testing, with interpretation and report; cervical (cVEMP) and ocular (oVEMP)
92545	Oscillating tracking test, with recording
92546	Sinusoidal

### **Vestibular Diagnostic and Procedural Codes**

There are 61 ICD-10 codes and sub-codes pertaining to vestibular disorders, any one or more of which might appear in Service members' medical records. For example, H8111 and H8112 are the ICD-10 sub-codes that are used to designate BPPV involving the right ear and left ear, respectively. For the purposes of our inquiry, it was unnecessary to identify sub-code level diagnoses. There are 17 vestibular-related CPT codes that were used to determine if any

vestibular evaluation had been performed during the data time window of interest (FY16 - FY20, inclusive). For example, a Service member would be identified in this dataset because they had an encounter coded as CPT code 92548, indicating they underwent computerized dynamic posturography (CDP), which is commonly performed by a physical therapist to evaluate vestibular disorders. We elected to identify vestibular patients based on ICD-10 codes by diagnostic category as depicted in **TABLE 1**, or by at least one CPT vestibular procedural code as depicted in **TABLE 2**.

### **Sociodemographic and Clinical Factors**

Service members' characteristics included military rank, branch of service, and beneficiary category. Military ranks were categorized as cadet, junior enlisted (E1-E4), senior enlisted (E5-E9), junior officer (O1-O3), senior officer (O4-O11), and warrant officer (W1-W5). Branches of service were identified as Army, Air Force, Navy, Marines, and Coast Guard. Beneficiary categories were derived by matching eligibility as registered in Defense Enrollment Eligibility Reporting System (DEERS) files at the time of care. Service members were excluded from the analysis if they were coded as retirees, inactive Guard/Reserve, or dependents.

Clinical factors were fiscal year of the patient encounter and military treatment facility name.

### **Data Analysis**

The initial dataset was entered into SPSS. ICD-10 codes were categorized by diagnosis type as: BPPV, central diagnoses, fistula, Meniere's disease, motion sickness, non-specific dizziness diagnoses, and vestibular nerve disorders. Descriptive statistics were calculated for total encounters, total unique patients, beneficiary status, rank, and diagnostic category. The dataset was then reduced to include only active-duty Service members who met inclusion criteria. Visits per beneficiary were calculated for each vestibular diagnosis. Finally, the file was reduced again by patients' unique pseudo-identification numbers to account for patients who appeared multiple times within the dataset (i.e., multiple encounters for the same condition). Counts and percentages were calculated for sociodemographic variables and vestibular condition categories. The average numbers of visits were calculated for each diagnosis category.

To assess accurate coding and evidence-based clinical care for vestibular patients, we chose to analyze patterns in patients who were coded with a diagnosis of BPPV, to determine what percentage of their encounters included a canalith repositioning maneuver (CRM) CPT code. BPPV was the diagnosis of choice because it is the most commonly occurring vestibular diagnosis in adults and is one of the few diagnoses that warrant a specific maneuver for diagnosis and treatment (Ahn et al., 2011; Chau et al., 2015; Neuhauser, 2016). We also investigated what types of practitioners performed CRM on patients with the diagnosis of BPPV.

## RESULTS

The original data pull from JHASIR yielded 748,013 patient encounters that included either a vestibular/balance diagnosis (ICD-10) or vestibular procedure code (CPT). These records represented 337,676 individual patients. After selecting for patients who were active-duty Service members or activated Guard/Reserve military members, the dataset consisted of 345,025 encounters involving 130,123 unique individuals.

**FIGURE 1:**

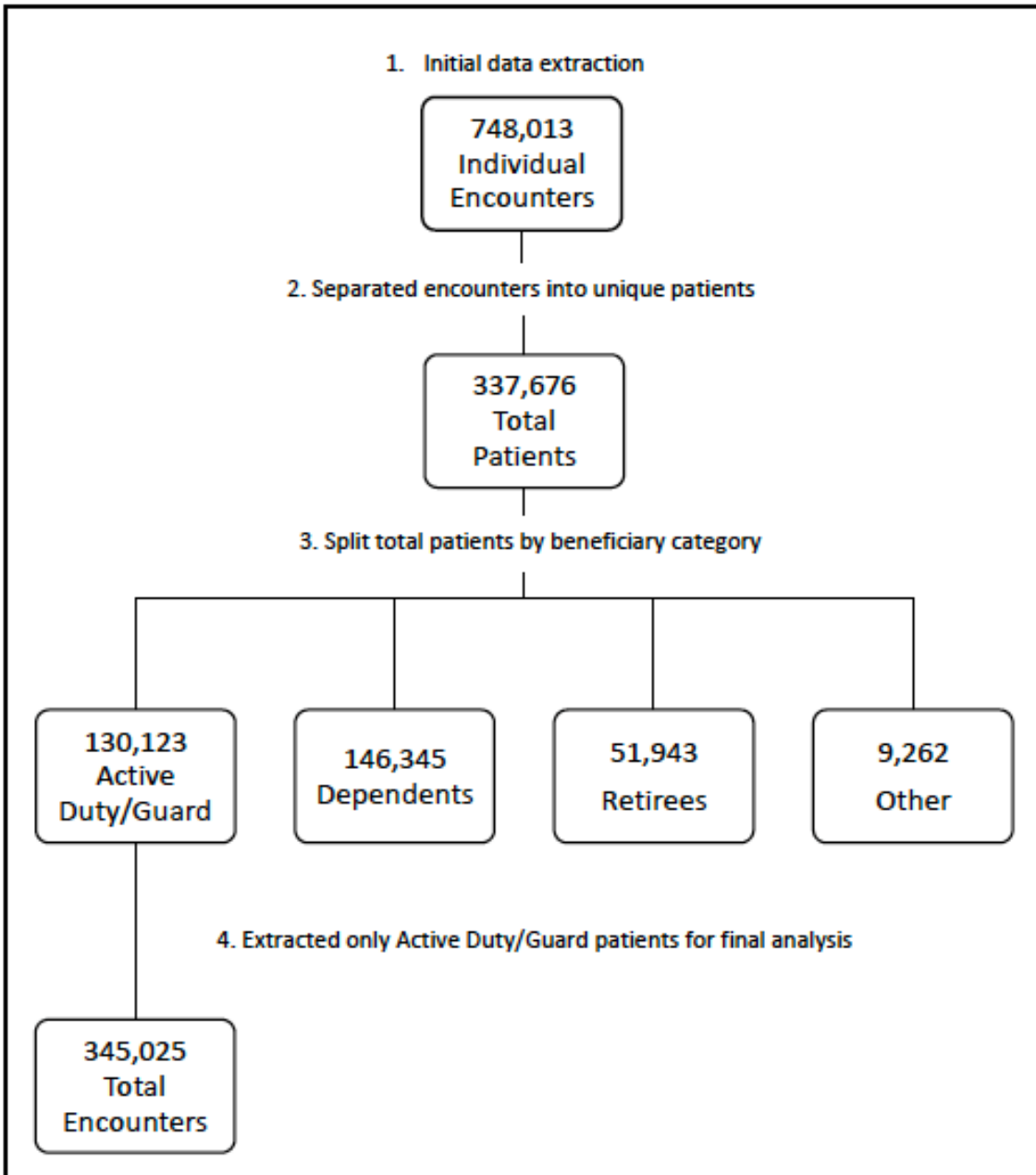


Figure 1: Illustrates the process used to determine the final sample for analysis.

Final study sample members' military status, branch, and rank descriptors are presented in **TABLE 3**. Nearly half (45.6%) were Army members, followed by Air Force, Navy, Marines, and other service branch members. Nearly half (49.6%) of the sample were senior enlisted military members, followed by junior enlisted and other ranks. Military officers comprised 18.5% of the study sample.

**TABLE 3** presents the sociodemographic characteristics of the final study sample.

<b>TABLE 3: SOCIODEMOGRAPHIC DESCRIPTORS</b>		
		% of Sample
Military Status	Active Duty	91.6%
	Guard/Reserve on Active Duty	8.4%
Branch	Army	45.6%
	Air Force	22.9%
	Navy	18.9%
	Marines	11.4%
	Other	<1%
Rank	Cadet	0.3%
	Junior Enlisted	28.2%
	Senior Enlisted	49.6%
	Junior Officer	9.6%
	Senior Officer	8.9%
	Warrant Officer	2.9%
	Other	0.4%

The most common diagnosis was non-specific dizziness, which was associated with more than three-quarters (78.8%) of all medical encounters. Just 6.6% of medical visits were associated with BPPV diagnoses. (**TABLE 4**)

**TABLE 4** presents ICD-10 code category frequencies and average numbers of encounters by diagnosis.

<b>TABLE 4: MEDICAL UTILIZATION BY DIAGNOSIS CATEGORY</b>		
Diagnosis Category	% of Visits	Average # of Visits/Person
BPPV	6.6%	3
Central Diagnoses	0.9%	7.5
Fistula	1%	11
Meniere's Disease	1.3%	7.5
Motion Sickness	5.9%	2
Non-Specific Dizziness Diagnoses	78.8%	2.5
Vestibular Nerve Disorders	2%	4

Between fiscal years 2016 and 2020, 22,646 encounters were coded for BPPV. Among these encounters, only 8.7% (n = 1,986) also had an accompanying CRM CPT code. Practitioners who coded for a CRM most frequently were physical therapists (47.5%), otolaryngologists (14.4%), physicians (13.4%), or audiologists (12.9%) and 11.8% other types of providers.

## DISCUSSION

Of the 130,123 individuals represented in the final dataset, nearly 50% were of senior enlisted ranks (**TABLE 3**), whose members are typically between 30 and 50 years old. Individuals in this age bracket are generally more susceptible to vestibular disorders than their younger (e.g., junior enlisted) counterparts (Agrawal et al., 2009; Liston et al., 2014). However, relatively lower numbers of junior Service members might also be attributable to military cultural stigma associated with seeking medical care. Junior Service members may be reluctant to report medical issues that might restrict their duty and/or military career advancement (Bookbinder et al., 2020; Chase et al., 2015; Chase & Nevin, 2015). There also remains a culture of mistrust and difficulty navigating the military health care system, which may discourage less seasoned soldiers to report their conditions (Bookbinder et al., 2020; Escolas et al., 2020; Hyatt et al., 2014). The disability rating system for military veterans seeking compensation and other benefits may incentivize delay in seeking care, and thus skew reporting and treatment to older, more senior military members.

More than three-quarters (78.8%) of our sample's encounters were coded for a diagnosis of non-specific dizziness (**TABLE 4**), which is surprising because we would have expected BPPV diagnoses to comprise the majority. BPPV is the most prevalent vestibular disorder among adults, characterized by head movement-induced episodic dizziness (Ahn et al., 2011; Chau et al., 2015; Neuhauser, 2016). Clinical practice guidelines instruct providers to perform a Dix-Hallpike maneuver for accurate diagnosis of BPPV, followed by CRM for those with positive diagnosis (Quatman-Yates et al., 2020; The Management and Rehabilitation of Post-Acute Mild Traumatic Brain Injury Work Group, 2021). However, in our findings, we noted that only 8.7% of the patient encounters involving a positive BPPV diagnosis code also included treatment with CRM. This is very surprising, given that BPPV is easily treatable with CRM. Physical therapists comprised nearly half (47.5%) of practitioners who administered CRM. Fewer than one out of six CRM procedures were administered by otolaryngologists (14.4%), other physicians (13.4%), or audiologists (12.9%). This may highlight a need for further training of these providers on proper management of BPPV, or perhaps on appropriate CRM coding.

Health care utilization for vestibular care is not consistent across diagnoses. The distribution of average visits can be attributed to the complexity of the diagnosis itself, with more complex diagnoses involving more visits and referrals. Based on our findings, individuals with fistulas, central causes of dizziness, and Meniere's disease had higher average numbers of medical encounters. On average, Service members with fistula received 11 encounters, likely due to the specialized care and surgical intervention typically associated with this diagnosis. Central

diagnoses and Meniere's disease involved 7.5 visits on average, which was more than twice the average number of visits associated with motion sickness or non-specific dizziness. Central and Meniere's disease diagnoses typically involve a visit to the emergency room or to primary care, and referral to audiology, ENT, or neurology. Contrarily, motion sickness and non-specific dizziness are commonly managed at the primary care level.

There is a paucity of literature that describes vestibular diagnoses within military Service members. Through this analysis, we were able to quantify diagnoses distribution and the average number of patient visits by diagnosis, which helps to illustrate diagnostic patterns of patient care. Future research may dive deeper to explore possible reasons for the frequent diagnosis of non-specific dizziness (vs. BPPV). It is possible that some or many diagnoses of dizziness of unknown origin reflect practitioners' lack of knowledge or experience recognizing and treating vestibular disorders generally. We also observed what appears as a lack of adherence to clinical practice guidelines for the assessment and treatment of patients diagnosed with BPPV; a majority of our BPPV-diagnosed sample were not treated with CRM. Taken together, these findings strongly suggest the need to further educate MHS providers on vestibular diagnostic practice, and on appropriate implementation of CPG guidance for the management of BPPV.

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## **ABBREVIATIONS AND ACRONYMS**

Benign Paroxysmal Positional Vertigo (BPPV)

Canalith Repositioning Maneuver (CRM)

Comprehensive Ambulatory/Professional Encounter Record (CAPER)

Computerized Dynamic Posturography (CDP)

Current Procedural Terminology (CPT)

Defense Enrollment Eligibility Reporting System (DEERS)

Department of Defense (DOD)

Hearing Center of Excellence (HCE)

International Classification of Diseases 10th Revision (ICD-10)

Joint Hearing Loss & Auditory System Injury Registry (JHASIR)

Medical Health System (MHS)

Traumatic Brain Injury (TBI)

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