Epilepsy in Active Component Service Members, 1998-2012

Epilepsy is defined as a disorder of the brain characterized by an enduring predisposition to generate epileptic seizures without any immediate identified cause. During the surveillance period there were 11,295 incident cases of epilepsy among active component service members (incidence rate: 52.8 per 100,000 person-years). Incidence rates increased 23 percent from 1999 to 2006, increased 52 percent from 2006 to 2010, and then decreased 38 percent from 2010 to 2012. Epilepsy incidence rates were higher among females, in the youngest age group (<20), and among white, non-Hispanics. A majority (85.8%) had no predisposing condition identified in their medical record. The number of epilepsy cases with a traumatic brain injury preceding their epilepsy diagnosis could not account for the increases in epilepsy during the period. However, the upward trend may be attributable to increased screening and evaluation of service members with possible head injuries, with subsequent detection of epileptic seizures.

Epilepsy is defined as a disorder of the brain characterized by an enduring predisposition to generate epileptic seizures without any immediate identified cause. An epileptic seizure is a transient disruption of normal brain function due to abnormal excessive or synchronous neuronal activity in the brain.[1,2] Epileptic seizures are classified into partial (i.e., localized to one area of the brain) and generalized seizures (i.e., affecting the entire brain). The intensity of an epileptic seizure ranges from benign – no alteration of consciousness or brief absences – to severe – loss of consciousness and/or full body muscle spasm.[1,2]

The etiology of epilepsy is multifactorial and, often, the cause is unknown. Known risk factors include family history or brain insults such as head trauma, brain tumor, cerebrovascular disease, or central nervous system (CNS) infections (e.g., meningitis, encephalitis).[3] The prognosis depends on several factors including etiology, age at onset, number of seizures at onset, the natural history of the condition, and response to the use of antiepileptic drugs (AEDs).[4,5] In severe cases, epilepsy cannot be controlled by AEDs – known as intractable epilepsy – and more aggressive measures must be taken to control the seizures.

For civilian applicants to military service, Department of Defense policies and regulations allow individual consideration to applicants with epilepsy only if the applicant has been seizure-free without medication for the five years immediately prior to the application and has had recent normal electroencephalography (EEG) results.[6-10] Each Service has different policies regarding the retention of individuals who develop epilepsy while on active duty. In general, a service member diagnosed with epilepsy is assessed by a Medical Review Board which then makes recommendations ranging from no restrictions or restricted military duties and assignments (e.g., if the epilepsy is fully controlled medically) to a full medical discharge.[8,9] In select occupations, such as aviation, any seizure is immediately disqualifying.

The objectives of this analysis were to determine the incident counts, incidence rates, and trends of epilepsy in active component service members and the potential predisposing factors for epilepsy.

METHODS

The surveillance period was January 1998 through December 2012. The surveillance population included all U.S. service members of the Army, Navy, Air Force, Marine Corps, and Coast Guard who served in the active component of the Armed Forces any time during the surveillance period. Cases were identified from standardized records of all hospitalizations and outpatient medical encounters during the surveillance period in fixed (e.g., not deployed or at sea) military and nonmilitary (purchased care) medical facilities.

For surveillance purposes, a case of epilepsy was defined as 1) a hospitalization with an epilepsy ICD-9 code (ICD-9: 345.xx "epilepsy and recurrent seizures" or 649.4x "epilepsy complicating pregnancy, childbirth, or the puerperium") in the primary or secondary diagnostic position (diagnoses coded as 345.6x "infantile spasms" were excluded); or 2) two outpatient encounters with an epilepsy ICD-9 code in the primary diagnostic position. Individuals were counted as an incident case only once during the surveillance period.

If an epilepsy case (as defined above) had an encounter with ICD-9: 780.39 "other convulsions" prior to any of the case defining encounters, the date of the first "other convulsions" encounter was considered the incident date of his/her epilepsy. This determination was based on the coding practices that are standard for coding seizures and epilepsy. Epilepsy is generally coded when seizures occur on more than one occasion (e.g., after a first seizure episode generally coded by ICD-9: 780.39).[11] An individual did not qualify as an epilepsy case if his/her medical record contained only the ICD-9 code 780.39; this specific code was used only to assign the incident date.

For each epilepsy case identified, all medical records prior to the incident seizure or epilepsy event were searched to identify possible predisposing conditions for epilepsy **(Table 1)**. In order to qualify as a predisposing condition, an individual had to have one hospitalization with one of the ICD-9-CM codes of interest in any diagnostic position or two or more outpatient encounters with an ICD-9-CM of interest in the first diagnostic position. An individual could have more than one condition identified.

TABLE 1. ICD-9-CM codes for predisposing factors for epilepsy

Predisposing factors	ICD-9-CM
Traumatic brain injury	800.xx, 801.xx, 803.xx, 804.xx, 850.xx-854.xx, 310.2, 907.0, 959.01, V15.52[a]
Brain tumor	191.x, 198.3, 225.0, 237.5, V10.85,[a] V12.41[a]
Non-injury-related brain hemorrhage	430-432.x
Cerebrovascular disease	433.xx-438.xx, 997.02, V12.54[a]
Meningitis (any type)	003.21, 036.0, 049.0, 049.1, 053.0, 054.72, 072.1, 090.42, 091.81, 094.2, 098.82, 100.81, 112.83, 114.2, 115.01, 115.11, 115.91, 321.x, 013.0x, 045.xx, 047.x, 320.x, 322.x
Encephalitis (any type)	013.6, 036.1, 045.0, 049.8, 049.9, 052.0, 054.3, 055.0, 056.01, 058.2x, 066.2, 066.41, 071, 072.2, 090.41, 094.81, 130.0, 136.2, 139.0, 046.xx, 062.x, 063.x, 064.x, 323.xx
Other infectious diseases	060.x, 061, 065.x, 066.3, 084.x, 121.2, 123.1, 128.0, 647.4
Other seizures	780.31, 780.32, 780.33
Other brain disease	348.xx
Evidence of chronic alcohol abuse	291.9, 303.9x, 357.5, 425.5, 535.3x, 571.0-571.3, V11.3[a]
Personal/family history of neurologic disease	333.2, V12.49, V17.2

[a]These codes indicate a personal or family history of the predisposing factor

TABLE 2. Incident counts and incidence rates of epilepsy, active component, U.S. Armed Forces, 1998-2012

	No.	Rate[a]	IRR[b]
Total	11,295	52.8	.
Inpatient	1,862	8.7	Ref
Outpatient	9,433	44.1	5.1
Type of seizure			
Intractable epilepsy	341	1.6	Ref
Other epilepsy	5,670	26.5	16.7
Other convulsions[c]	5,284	24.7	15.5
Sex			
Male	9,082	49.7	Ref
Female	2,213	71.7	1.4
Age			
<20	1,470	92.7	2.8
20-24	4,527	65.0	2.0
25-29	2,383	51.0	1.5
30-34	1,227	38.5	1.2
35-39	951	34.6	1.0
40+	736	33.1	Ref
Race/ethnicity			
White, non-Hispanic	7,640	56.8	1.8
Black, non-Hispanic	1,871	50.3	1.6
Hispanic	935	44.0	1.4
Asian/Pacific Islander	262	32.0	1.0
American Indian/ Alaskan Native	78	31.1	Ref
Other	509	50.5	1.6
Service			
Army	5,512	72.5	1.9
Navy	2,112	40.2	1.1
Air Force	1,965	37.8	Ref
Marine Corps	1,458	53.1	1.4
Coast Guard	248	42.7	1.1
Rank			
Enlisted	10,382	58.1	2.2
Officer	913	26.1	Ref
Military occupation			
Combat-specific[d]	1,706	64.6	1.5
Armor/motortransport	658	70.0	1.6
Repair/engineering	2,799	44.5	Ref
Comm/intel	2,394	49.4	1.1
Healthcare	982	56.2	1.3
Other	2,756	56.0	1.3

[a]Rate per 100,000 person-years
[b]Incidence rate ratio
[c]These individuals were first identified as epilepsy cases (ICD-9-CM:345); this reflects their incident seizure encounter.
[d]Infantry, artillery, combat engineering

Medical evacuations from Operations Enduring Freedom (Afghanistan), Iraqi Freedom, and New Dawn (Iraq) for epilepsy were included if they had a medical encounter with an epilepsy defining ICD-9-CM code diagnosed from 5 days prior to 10 days after a reported medical evacuation from the U.S. Central Command (CENTCOM) to locations other than CENTCOM.[12] Epilepsy medical evacuations were summarized separately from the epilepsy cases identified in this report; in addition, both active and reserve component individuals were included in this calculation.

Deaths with epilepsy as underlying cause of death (UCOD) were identified from casualty records (UCOD code for epilepsy:1500). The records of these individuals were searched to identify those who had any epilepsy or seizure-related encounter in their history (i.e., other seizure or personal/family history of neurologic diseases **[Table 1]**) or had an encounter for a predisposing condition in their history.

RESULTS

During the surveillance period there were 11,295 incident cases of epilepsy among active component service members (incidence rate: 52.8 per 100,000 person-years [p-yrs]) **(Table 2)**. Incidence rates increased 23 percent from 1999 (40.1 per 100,000 p-yrs) to 2006 (49.3 per 100,000 p-yrs), increased 52 percent from 2006 to 2010 (75.1 per 100,000 p-yrs), then decreased 38 percent from 2010 to 2012 (46.5 per 100,000 p-yrs) **(Figure 1)**.

Most cases of epilepsy were diagnosed for the first time (incident event) in the outpatient setting (83.5%); the remaining 16.4 percent were identified during an inpatient hospital stay. Most incident cases of epilepsy were identified as "other" epilepsy (i.e., not intractable) or as "other" convulsions. Three percent of incident cases (n=341) were considered intractable epilepsy at the incident diagnosis **(Table 2)**.

Overall and during every year of the period, the epilepsy incidence rates were higher in females (overall: 71.7 per 100,000 p-yrs) than males (overall: 49.7 per 100,000 p-yrs) **(Table 2; Figure 1)**. Rates among females increased 21.8 percent during the period; rates among males increased 13.7 percent during the period **(Figure 1)**. Incidence rates were highest in the youngest (under 20 years of age: 92.7 per 100,000 p-yrs) and decreased with increasing age. In service members under age 20 incidence rates increased 130 percent from 1998 (63.1 per 100,000 p-yrs) to 2009 (144.5 per 100,000 p-yrs), and then decreased 56 percent from 2009 to 2012 (62.4 per 100,000 p-yrs). Similar trends (with lower rates) were demonstrated in every age category **(Figure 2)**.

Among racial/ethnic groups, incidence rates of epilepsy were highest in white, non-Hispanic service members (56.8 per 100,000 p-yrs, respectively) **(Table 2)**. Compared to their respective counterparts, rates of epilepsy were highest among service members in the Army (72.5 per 100,000 p-yrs); among enlisted service members (58.1 per 100,000 p-yrs); and

FIGURE 1. Incidence rates of epilepsy by gender, active component, U.S. Armed Forces, 1998-2012

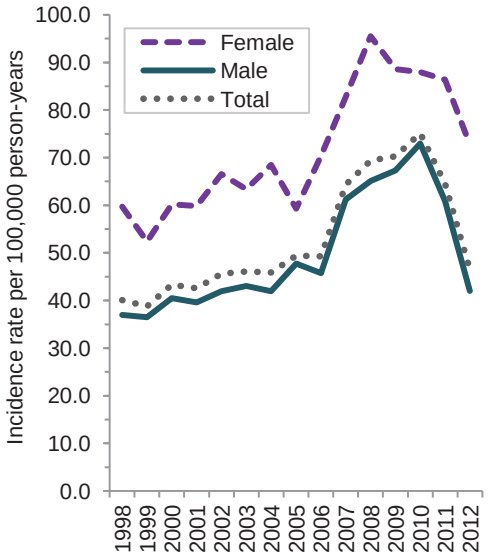


FIGURE 2. Incidence rates of epilepsy by age, active component, U.S. Armed Forces, 1998-2012

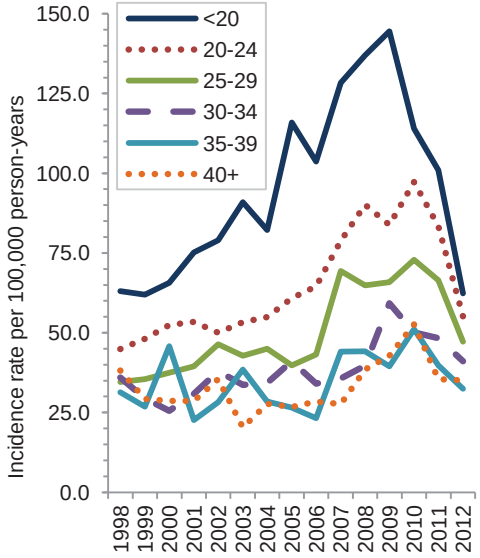


TABLE 3. Number of epilepsy cases with a predisposing condition prior to epilepsy, active component, U.S. Armed Forces, 1998-2012

Predisposing condition	No.	% total
Traumatic brain injury	875	7.8
Evidence of chronic alcohol abuse	375	3.3
Cerebrovascular disease	243	2.2
Other brain disease	198	1.8
Brain tumor	129	1.1
Noninjury-related brain hemorrhage	70	0.6
Meningitis (any type)	63	0.6
Encephalitis (any type)	31	0.3
Personal/family history of neurologic disease	28	0.3
Other seizures	11	0.1
Other infectious diseases	9	0.1
Multiple risk factors identified	322	2.9
Any risk factor (deduplicated)	1,605	14.2
No risk factor identified	9,690	85.8

among service members in "armor/motor transport" and "infantry/artillery/combat engineering" occupations (70.0 and 64.6 per 100,000 p-yrs, respectively) **(Table 2)**.

During the period the number of medical encounters, individuals affected, hospital bed days, and lost work time associated with epilepsy diagnoses increased –particularly after 2006 **(Figure 3)**. Despite a decrease in medical encounters and individuals affected in 2011 and 2012, hospital bed days and lost work time continued to increase through 2011. Overall, there were 0.8 bed days per individual affected **(data not shown)**.

Predisposing conditions for epilepsy

Of the 11,295 incident cases of epilepsy, a majority (85.8%) had no predisposing condition identified in their medical record; the remaining 14.2 percent (n=1,605) had at least one possible predisposing condition identified preceding their incident seizure/epilepsy encounter **(Table 3)**. The most common condition identified was traumatic brain injury (n=875; 7.8% total). The next most common conditions were evidence of chronic alcohol abuse (n=375) and cerebrovascular disease (n=243) which accounted for 3.3 and 2.2 percent of total cases, respectively. Each of the remaining conditions accounted for less than 2 percent of all cases **(Table 3)**.

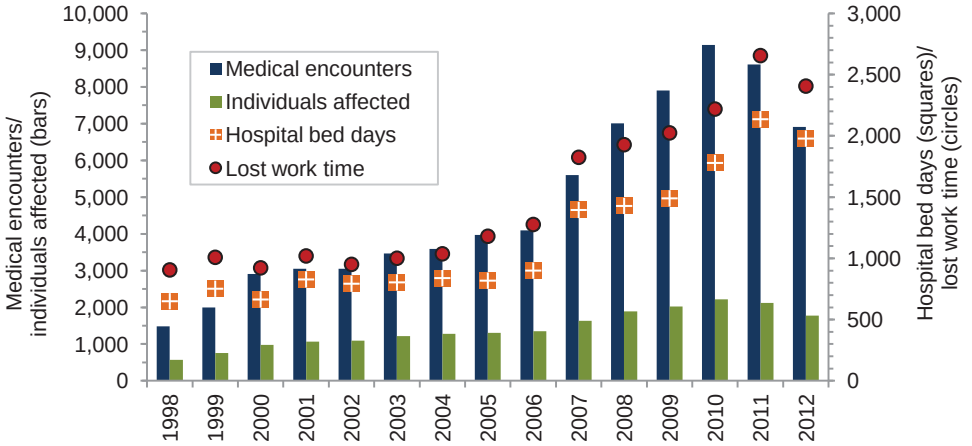
Medical evacuations from OEF/OIF/OND

From 7 October 2001 through 31 December 2012 there were 438 medical evacuations from OEF/OIF/OND (i.e., Afghanistan/Iraq) that resulted in a medical encounter for epilepsy. Nearly two-thirds of epilepsy medical evacuations (65.3%; n=286) were evacuated from OIF/OND (Iraq) **(Figure 4)**. A majority occurred in males (n=87.4%) **(data not shown)**.

Deaths from epilepsy

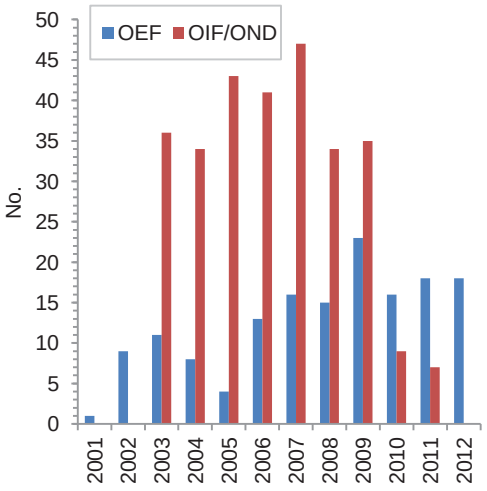
During the period there were 23 deaths with an underlying cause of death listed as epilepsy. Only one of these individuals had no documentation of an epilepsy or seizure medical encounter in his/her medical record prior to death **(data not shown)**. Of the 22 others with antecedent documentation of seizures, seven individuals had possible predisposing conditions prior to their incident epilepsy diagnosis.

FIGURE 3. Medical encounters,[a] individuals affected,[b] hospital bed days, and lost work time,[c] for epilepsy, active component, U.S. Armed Forces, 1998-2012



[a]Medical encounters: total hospitalizations + ambulatory visits for epilepsy (no more than one encounter/individual/day)
[b]Individuals with at least one hospitalizaiton or ambulatory visit for epilepsy per year
[c]A measure of lost work time due to bed days, convalescence, and one-half day for each ambulatory visit that resulted in limited duty

FIGURE 4. Number of medical evacuations from Operations Enduring Freedom (OEF), Iraqi Freedom, and New Dawn (OIF/OND) for epilepsy, active and reserve components, U.S. Armed Forces, 7 October 2001-31 December 2012



EDITORIAL COMMENT

This report summarizes the incident counts and incidence rates of epilepsy in the active components of the U.S. Armed Forces from 1998 to 2012. From 2006 to 2010 rates of incident epilepsy cases increased 52 percent. The increase was demonstrated across all demographic groups (e.g., in both males and females and in all age categories). This increase may be attributable, at least in part, to increases in moderate and severe traumatic brain injuries (prior to and during the same period) which are a well-documented predisposing factor for the development of epilepsy.[13-16] However, only 7.8 percent of all incident cases of epilepsy during the surveillance period had any documented diagnoses of traumatic brain injury prior to their first diagnosis of epilepsy. During the latter part of the surveillance period, commanders and medical personnel have given greatly increased attention to the frequency of traumatic brain injuries. In fact, in anticipation of an increase in epilepsy in service members with traumatic brain injuries, in 2008 Congress directed the Department of Veterans Affairs to establish the Epilepsy Centers of Excellence (ECoE).[17] The extent to which the screening and evaluation of service members with possible head injuries and exposures to concussive blasts have become much more thorough and commonplace may have resulted in an increased frequency of diagnoses of epilepsy.

These results should be considered in light of several limitations. This analysis relies upon ICD-9-CM coding of epilepsy in administrative data to estimate the incidence counts and rates of epilepsy. Historically, the definitions of seizures and epilepsy have been intermingled and used inconsistently.[18,19] Several iterations of the definition have been proposed, modified, and introduced by the International League Against Epilepsy (ILAE).[1,2,11,18,19] This analysis relies upon clinicians' interpretation of the definition of epilepsy which may vary based on their expertise and previous exposure to patients with seizures or epilepsy.

This report is limited to active component duty members. Moreover, some severely injured service members may receive care outside of the Military Health System (e.g., Veterans Health Administration hospitals) after they have left military service; in such cases, epilepsy – particularly posttraumatic epilepsy associated with traumatic brain injury – may not be documented on records used for this analysis.

Finally, the possible predisposing conditions identified here may or may not be actually associated with the diagnosis of epilepsy or may be part of a multifactorial process that triggered epileptic seizures. A majority (86%) of epilepsy cases do not have a predisposing condition listed in their available medical records. This finding corresponds with the observation that in most individuals with epilepsy, the etiology of their disease remains unknown.

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