

## Epidemiology of Meningitis and Encephalitis in the United States from 2011-2014

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Rodrigo Hasbun, MD, MPH  
Rodrigo.Hasbun@uth.tmc.edu**Abstract****Background**

Meningitis and encephalitis can be caused by several infectious and non-infectious pathogens but large epidemiological studies evaluating etiologies, management decisions and outcomes in the United States are lacking.

**Methods**

Adult patients (age  $\geq 18$  years) with an admission or discharge diagnosis of meningitis or encephalitis by ICD-9 codes available in the Premier Healthcare Database from 2011-2014 were analyzed.

**Results**

A total of 26,429 patients with meningitis or encephalitis were identified. The median age was 43 years; 53% were female. The most common etiology was viral (16152, 61%); followed by unknown (4944, 18.7%), bacterial (3692, 13.9%), non-infectious (921, 3.4%), and fungal (720, 2.7%). Empirical antibiotics, antivirals and antifungals were administered in 85.8%, 53.4%, and 7.8%, respectively and varied by etiologies. Adjunctive steroids were utilized in 15.85% of all patients and in 39.33% of patients with pneumococcal meningitis with an associated decrease in mortality (6.67% vs. 12.5%,  $P=.0245$ ). The median length of stay was 4 days; with the longest duration in those with fungal (13 d), arboviral (10 d), and bacterial meningitis (7 d). Overall inpatient mortality was 2.9% and was higher in those with bacterial (8.2%), fungal (8.2%), or arboviral (8.9%) disease. Overall readmission rates at 30 days was 3.2%. Patients with arboviral (12.7%), bacterial (6.7%) and fungal (5.4%) etiologies had higher readmission rates.

**Conclusion** Viruses most commonly cause meningitis and encephalitis in the United States; management decisions and clinical outcomes vary by etiology and adjunctive steroids are associated with a decrease in mortality in pneumococcal meningitis.

**INTRODUCTION**

Meningitis and encephalitis can be caused by a wide variety of infectious and non-infectious etiologies creating diagnostic and treatment challenges to clinicians.

The majority of patients continue to have unknown etiologies with some pathogens requiring urgent antimicrobial therapy for cure and survival.

Adjunctive steroids decrease mortality in pneumococcal meningitis but data from the US is lacking.

The purpose of our study was to evaluate the epidemiology, management and outcomes of adults with all types of meningitis and encephalitis in the United States.

**METHODS**

Adult patients (age  $\geq 18$  years) with an admitting or discharge diagnosis (primary and/or secondary) of meningitis or encephalitis determined by ICD-9 diagnostic codes that were discharged between January 1, 2011 and December 30, 2014 were eligible for the study.

**Premier Healthcare Database (PHD)** currently contains data of approximately 20% of all hospital discharges in the United States.

**SUMMARY**

- Viruses caused 61% of meningitis and encephalitis.
- Management decisions, outcomes, length of stay and mortality vary by etiology.
- Empiric antibiotic therapy is given to the majority of patients with viral etiologies.
- Adjunctive steroids decrease mortality in pneumococcal and viral meningitis.
- Adjunctive steroids showed a trend towards an increase mortality in fungal meningitis and lower mortality in those with unknown etiologies.

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**RESULTS**

**Table 1: Frequency and duration of antibiotic, antiviral and antifungal use in adults with Meningitis and Encephalitis in the United States between 2011-2014. [(n,%); median duration in days (IQR<sup>a</sup>)]**

Etiology (n)	Antibiotic Therapy		Antiviral Therapy		Antifungal Therapy	
	N (%)	Median Days (IQR)	N (%)	Median Days (IQR)	N (%)	Median Days (IQR)
<b>Number of Patients</b>						
	22648 (85.8)	4 (5)	14109 (53.4)	3 (3)	2055 (7.8)	4 (7)
<u>Enterovirus</u> (13463)	11106 (82.5)	3 (2)	6859 (51.0)	3 (2)	416 (3.1)	2 (3)
Unknown Etiology (4944)	4198 (84.5)	5 (6)	2608 (52.3)	4 (4)	47 (9.6)	4 (6)
Bacterial Meningitis (3692)	3656 (99.0)	8 (7)	1535 (41.6)	2 (3)	370 (10.0)	4 (6)
Herpes simplex virus (2184)	1841 (84.3)	3 (3)	2062 (94.4)	5 (5)	101 (4.6)	3 (4)
Fungal meningitis (720)	635 (88.2)	6 (10)	233 (32.4)	3 (5)	588 (81.7)	9 (12)
<u>Arboviruses</u> (291)	269 (92.4)	7 (8)	216 (74.2)	4 (3)	35 (12.0)	5 (7)
Other viruses (214) <sup>b</sup>	185 (86.5)	5 (7)	193 (90.2)	6 (7)	30 (14.0)	4 (6)
Non-ME diagnosis (921) <sup>c</sup>	794 (86.2)	3 (2)	403 (43.8)	2 (2)	39 (4.2)	3 (3)

**Table 3: Length of stay, inpatient mortality and readmission rates<sup>a</sup> in adults with Meningitis and Encephalitis in the United States between 2011-2014.**

Etiology (n)	N (%)	Median length of stay (IQR)	Inpatient Mortality n (%)	Readmission Rate n (%)
<u>Enterovirus</u>	13463 (51.6)	3 (2)	65 (0.5)	164 (1.2)
Unknown Etiology	4944 (21.4)	5 (7) <sup>b</sup>	247 (5.1) <sup>b</sup>	253 (5.1) <sup>b</sup>
Bacterial Meningitis	3692 (14.1)	7 (8) <sup>b</sup>	302 (8.2) <sup>b</sup>	245 (6.7) <sup>b</sup>
Herpes simplex virus	2184 (8.3)	5 (5) <sup>b</sup>	45 (2.1) <sup>b</sup>	79 (3.6) <sup>b</sup>
Fungal meningitis	720 (2.7)	13 (12) <sup>b</sup>	59 (8.2) <sup>b</sup>	39 (5.4) <sup>b</sup>
<u>Arbovirus</u>	291 (1.1)	10 (11) <sup>b</sup>	26 (8.9) <sup>b</sup>	37 (12.7) <sup>b</sup>
Other viruses	214 (0.8)	8 (9) <sup>b</sup>	25 (11.7) <sup>b</sup>	13 (6.1) <sup>b</sup>
Noninfectious	921 (3.5)	3 (3) <sup>b</sup>	7 (0.8)	15 (1.6)

**Table 2: Frequency, duration and impact on inpatient mortality of adjunctive intravenous steroids in adults with Meningitis and Encephalitis in the United States between 2011-2014.**

Etiology (n)	Adjunctive Steroids <sup>a</sup>		Mortality <sup>c</sup> with steroids	Mortality <sup>c</sup> without steroids	P value	
	N (%)	Median Days (IQR)				
<b>Number of Patients</b>						
	26429	4190 (15.85)	2 (3)	130/4190 (3.10)	643/22239 (2.89)	0.5105
Viral etiology (16152)	2216 (13.72)	1 (2)	12/2216 (0.54)	149/13787 (1.07)	0.0202	
Unknown Etiology (4944)	638 (12.90) <sup>b</sup>	3 (4) <sup>b</sup>	22/638 (3.45)	225/4306 (5.23)	0.0545	
Bacterial Meningitis (3692)	1121 (30.36) <sup>b</sup>	4 (3) <sup>b</sup>	84/1121 (7.49)	215/2571 (8.36)	0.3734	
Pneumococcal (572)	225 (39.33) <sup>b</sup>	4 (2) <sup>b</sup>	15/225 (6.67)	43/344 (12.5)	0.0245	
Fungal meningitis (720)	73 (10.14)	2 (5) <sup>b</sup>	10/73 (13.70)	49/647 (7.57)	0.0705	
Non-ME diagnosis (921) <sup>a</sup>	142 (15.41) <sup>b</sup>	1 (2)	2/142 (1.41)	5/779 (0.64)	0.2950	