

# Identification of Resource Use And Associated Costs for Viral Meningitis

*Using database analysis, this study documents various resources consumed as part of routine management of suspected meningitis, culminating with a discharge with a diagnosis of viral meningitis.*

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## ABSTRACT

**Purpose:** This study involved identifying resource use and assigning monetary value to the diagnostic work-up and management of viral meningitis.

**Methodology:** Using a previously established decision analytic framework, various resources were identified as part of routine management of viral meningitis. Secondary database analyses were used to quantify resources and assign a monetary value as a part of routine management of viral meningitis requiring use of the resource units identified in the decision analytic framework. Discharge data sources from the states of California, Florida, and Illinois, and Medicaid data sources from the state of Pennsylvania, were used for the purpose of analysis.

**Principal Findings:** Physician visits, emergency room visits, hospital admissions, procedures, and medications were identified as the major resources used. Lumbar punctures, CT scans, and antibiotics were identified as the major procedures and medications utilized. No significant difference was found in the major resources used between the states' discharge data and the Medicaid data sources. The mean total charges for

patient admissions with CT scans were significantly higher than for patient admissions without CT scans (\$11,531.80 vs. \$7,841.30,  $P < 0.05$ ). The mean lengths of stay for patients with CT scan were significantly higher than for patient admissions without CT scans (4.71 days vs. 3.88 days,  $P < 0.05$ ). The patient readmission rate was 10.7 percent, while the readmission rate for episodes with more than one hospitalization was 11.1 percent. The mean charge associated with readmission was \$12,200.

**Key words:** Viral meningitis, resource utilization, decision analysis, Medicaid, state discharge data.

## INTRODUCTION

Viral meningitis is the most common cause of aseptic meningitis, and is described as an "inflammatory disorder involving the leptomeninges without evidence of a bacterial or fungal etiology," usually with no evidence of parenchymal involvement.<sup>1</sup> The characteristic features typically include fever, moderate to severe headache, malaise, stiff neck, photophobia, nausea, and vomiting.<sup>2</sup>

Management of viral meningitis imposes a sizable economic burden from both payer and societal perspectives. Reports on the incidence of viral meningitis vary from approximately 50,000 hospitalized cases to over 2 million cases of aseptic meningitis per year.<sup>3,4</sup> Based on 300,000 annual cases of aseptic meningitis in the United States, the economic impact is estimated to be \$1.5 billion in direct costs alone.<sup>5</sup> Viral meningitis is a challenge to the scientific community because of the

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complexity involved in differentiating it from the treatable forms of aseptic meningitis and bacterial meningitis. Although aseptic meningitis is a disease of short duration, with a typical course lasting approximately two weeks, it can place a significant economic and humanistic burden on patients and the health care system. For example, the direct medical cost of the 1991 outbreak of aseptic meningitis in Rhode Island has been estimated in excess of \$500,000.<sup>6</sup>

Physicians have traditionally treated suspected viral meningitis with pain medication and antibiotics to avoid missing a bacterial case.<sup>1</sup> However, because of the rising costs of medications and hospitalizations, and the potential of antibiotic resistance, there is an increasing demand to minimize the use of inappropriate and unnecessary medications, hospital procedures, and other related expensive resources.

Various cost-containment strategies, including formulary restrictions for medications, are in place at several managed care organizations. In contrast, there is a trend for new and highly effective medications to be available at significant premiums.

Thus, it is increasingly important to identify the resource units that could be affected by the introduction of new technology. Although effective antiviral therapy is currently not available for acute enteroviral infection, new antiviral compounds are under investigation.<sup>7</sup> This agent, if proven effective and safe, will ultimately affect the pharmacy budget and overall cost of managing viral meningitis.

The objective of this study was to identify resource use and associated costs for viral meningitis.

#### METHODS

The research methodology used in this study involved reviewing a previously established decision analytic framework (DAF) to identify various resources used in routine management of viral meningitis and secondary database analyses to quantify resources and assign a monetary value.

##### *Decision Analytic Framework*

As part of estimating the economic impact of suspected meningitis, a DAF representing current clinical management was developed.<sup>8</sup> The development and vali-

dation of the DAF for suspected meningitis is discussed elsewhere.<sup>5,8</sup> Briefly, the process of developing the DAF included extensive search of medical literature and review and analysis of all pertinent literature. An expert panel comprising seven physicians (four pediatric/infectious disease specialists, one neurologist, one family practitioner, and one emergency medicine physician) developed and validated the DAF. The integrative group process, a modified Delphi technique, was used with the expert panel. Seed algorithms based on a literature review were provided to facilitate the discussion. The integrative group process included a step-by-step procedure in which each panelist confirmed structural validity, and then estimated probability ranges anonymously. After the first probability ranges had been identified, the baselines were determined and complementary branches were computed and confirmed. Consensus on the probability ranges was achieved over two rounds of discussion. Finally, a post-meeting follow-up questionnaire confirmed agreement with all captured probability estimates. The schematic employed in the final construction of the DAF is presented in Figure 1.

##### *Secondary database analyses*

Two databases were analyzed to quantify and assign a monetary value to the resources consumed as part of routine management of viral meningitis:

- State-level inpatient billing records provided by individual state agencies in Florida, California, and Illinois — three populous states; and
- Federal Medicaid inpatient and provider billing records provided by Pennsylvania.

The state and Medicaid databases were analyzed separately and for different results.

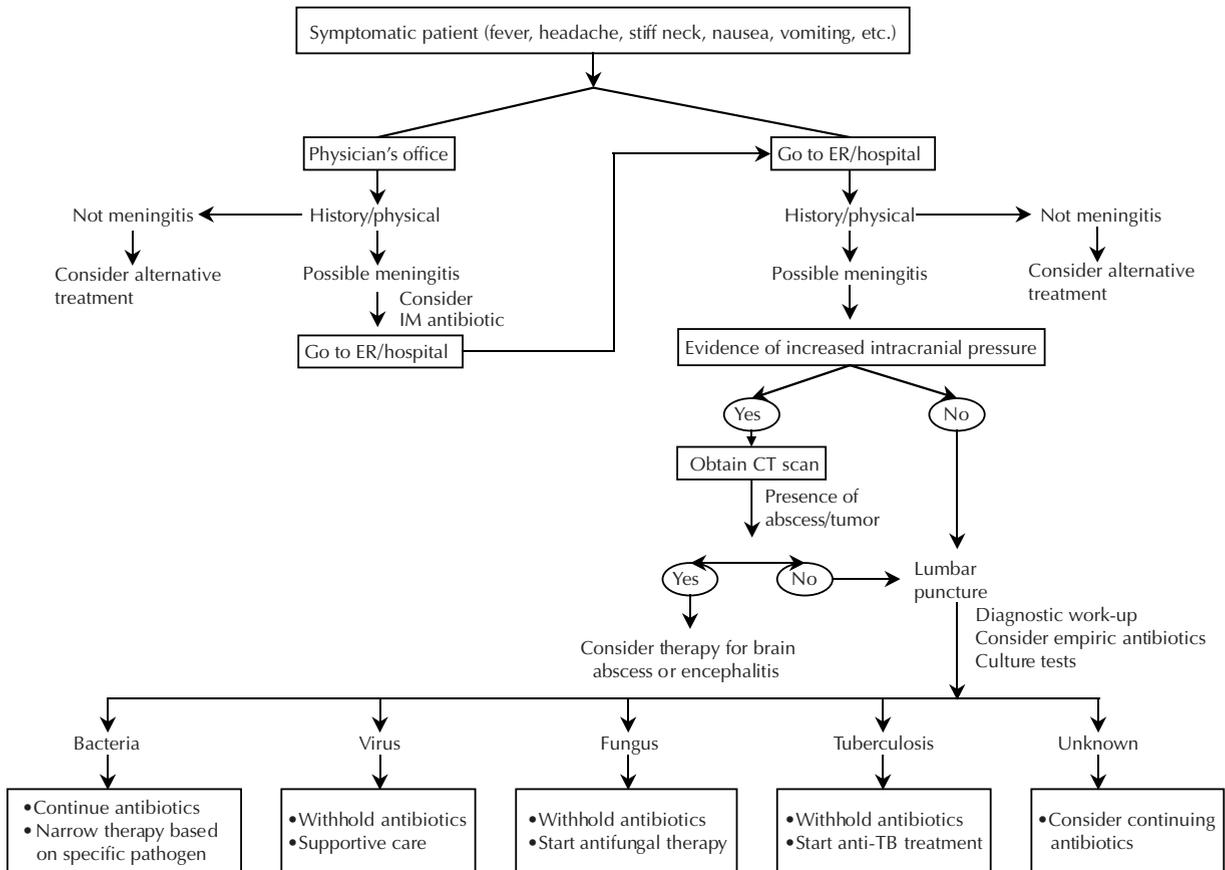
A brief description of these databases and operational definitions used in the study are provided in Appendix A.

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## IDENTIFICATION OF RESOURCE USE AND ASSOCIATED COSTS FOR VIRAL MENINGITIS



**Figure 1. Schematic representation of management of suspected meningitis**

From the state discharge databases, all discharges reflecting a discharge diagnosis of viral meningitis (ICD-9-CM code 047.XX) were selected. These diagnoses occurred as primary or secondary diagnosis. Due to limits in the availability of discharge data, information regarding lumbar puncture was not used for analysis in the state databases. From the Medicaid data set, all patients in the provider database were identified if they had a diagnosis of viral meningitis and had a lumbar puncture (CPT code 62270) performed in the emergency room (Place of Service code 14). Further, all hospital discharges with a diagnosis of viral meningitis were also extracted for further analyses. If the patient identifiers extracted from the ER Medicaid data set matched those from the hospital discharge Medicaid data set, the records were merged and counted as

a single episode for longitudinal analysis.

Patient records from the state discharge data set were used to compute the frequency and charges associated with discharges with and without antibiotic use, and to contrast hospital length of stay and charges with the Medicaid population. Patient records from the Medicaid databases were used to compute the frequency and charges associated with physician visits, lumbar punctures, ER admissions, procedures, hospital admissions, and rehospitalizations due to viral meningitis. Charges were used as a proxy to value the resources identified in the analysis. Hospital charges reflect those amounts generally submitted for reimbursement to third-party payers such as HMOs. Consumer price index adjustments were not included in the analysis.

## RESULTS

The major resource use categories identified were physician visit, ER visit, procedure, and hospital admission (Table 1).

Spinal tap or lumbar puncture was identified as a major procedure associated with viral meningitis, constituting 71.8 percent of the total procedures. Computed tomography (CT) scan of the head and magnetic resonance imaging (MRI) of the brain, constituting about 14.5 percent, follow as the next most common procedures (Table 2).

There was no statistically significant difference in the mean hospital charges between the states' discharges and the Medicaid data set. The mean hospital charges were \$8,826.21, \$8,177.56, and \$6,887.37, for California, Florida, and Illinois, respectively (Table 3).

There was no statistically signifi-

**Table 1. Description of major resource categories identified**

Resource	Description
<b>Physician visit</b>	A patient's visit to a physician's office or clinic
<b>ER visit</b>	Admission to ER for suspected viral meningitis
<b>Hospital admission</b>	Admission to hospital for suspected viral meningitis
<b>Medication</b>	Outpatient IM ceftriaxone or IV ceftriaxone
<b>Procedure</b>	Includes lumbar puncture, CT scan of the head, MRI of the brain, injection of antibiotic, electroencephalogram, and other procedures performed at the physician's office, ER, or hospital
<b>Rehospitalization</b>	Readmission of a patient to the hospital
<b>Follow-up physician visits</b>	Visit of a patient to the physician's office after an initial office visit, ER visit, or hospitalization due to viral meningitis

**Table 2. Procedures\* associated with hospital admission for viral meningitis**

Procedure	Percentage
Lumbar puncture	71.8
CT scan of the head	11.5
MRI of the brain	3.0
Antibiotic injection	2.5
Electroencephalogram	2.1
Electrocardiograph monitoring	1.0
Diagnostic ultrasound — heart	1.0

\* Procedures were truncated at a frequency of less than 1 percent.

cant difference in the mean length of stay between the states' discharges and the Medicaid data set. The mean lengths of stay for hospital admission were 3.89, 4.19, and 3.95 days for California, Florida, and Illinois, respectively (Table 3).

There was no significant difference in mean physician charges for patients with and without lumbar puncture or between adult and pediatric patients (Table 4).

Similarly, there was no significant difference between the mean ER charges for patients with lumbar puncture and without lumbar puncture or between adult and pediatric patients (Table 5).

The mean total charges for patient admissions with CT scans were significantly higher than for patient

admissions without CT scans (\$11,531.80 vs. \$7,841.30,  $P < 0.05$ , Table 6). The mean lengths of stay for patients with CT scans were significantly higher than for patient admissions without CT scans (4.71 days vs. 3.88 days,  $P < 0.05$ , Table 6). The patient readmission rate was 10.7 percent, while the readmission rate for episodes with more than one hospitalization was 11.1 percent. The mean charge associated with readmission was \$12,200.

Although not delineated in this paper, a linear relationship was observed for length of stay, age, number of diagnoses associated with hospital admission for the diagnosis of viral meningitis, and total charges. As expected, with an increase in the number of diagnoses, there was a corresponding linear increase in the total charges, length of stay, or age associated with hospital admissions for viral meningitis.

## DISCUSSION

Our results indicate that physician visits, hospital admissions, ER visits, medications, procedures including lumbar punctures and CT scans, rehospitalizations, and follow-up physician visits are the major resources used in managing patients discharged with viral meningitis.

The results of our analyses indicate an average length of stay for hospitalizations to be 3.99 days, with a corresponding charge of \$8,292.32. While the lengths of stay for hospi-

talizations are comparable to those reported by Rice et al (61 ± 34 hours, with 44-hour mean presentation time), the monetary value of hospitalizations is higher than the costs reported by Rice et al (\$1,757 per admission) or the charges reported by Wall et al (\$2,824 per admission).<sup>6,9</sup> These differences may be attributable to differing methods for ascertaining the monetary value. The current study utilized charges from the 1995 Pennsylvania Medicaid hospital discharge abstracts supplemented with inpatient hospital discharge abstracts from three populous states (California, Illinois, Florida). In contrast, the Rice et al study employed costs (using cost-to-charge ratios) of viral meningitis that were derived from a sample of inpatient admissions to a single institution (Memorial Hospital of Rhode Island), while the Wall et al study deflated the charge estimate to reflect 1990 estimates and primarily included patients who are under 12 months of age.

While under certain circumstances, CT scans or MRI of the brain are performed,<sup>10</sup> they may not be needed routinely for management of viral meningitis.<sup>6</sup> However, CT scans or MRI of the brain have been reported to be performed on patients discharged with a diagnosis of viral meningitis.<sup>2,6</sup> For instance, Rice et al reported 26.5 percent and 68 percent of admissions with viral meningitis to teaching hospitals and non-teaching hospitals to have received a CT scan,<sup>6</sup> while Elmore et al reported physicians conducting cranial imaging in 49 percent of aseptic meningitis cases presenting in an emergency department.<sup>2</sup>

Our results indicate CT scans or MRI to be associated with 14.5 percent of hospital admissions, an average length of stay for hospitalizations to be 4.71 days, and corresponding charges of \$11,531 for patients who received a CT scan. For patients who did not receive a CT scan, our data indicate an average length of stay of 3.88 days and corresponding charges of \$7,841. Since our analysis included data from several years, as

compared to management during outbreaks, and included all hospital discharges from the states of California, Illinois, and Florida, the number of CT scans or MRI of the brain may be conservative for resource estimation in viral meningitis.

In our study, readmission for viral meningitis following an admission for viral meningitis occurred for approximately 11 percent of the admissions, for a mean charge of \$12,200 per readmission. Readmission rates and associated charges have not been reported previously. We were able to track patients, as our data source reflected comprehensive hospital discharges for three states and the 1995 Pennsylvania Medicaid data. Previous studies in this area utilized a single institution or a small group of affiliated hospitals, which may have limited the ability to track readmissions at the patient level.

A limitation of our study is its retrospective inspection. We employed only those discharges with an ICD code of 047.XX, which may not have captured all cases of aseptic meningitis. To this end, our analysis may be conservative. However, there were no differences in hospital charges between the state discharge data and the Medicaid population in our study. From a payer perspective, it may be appropriate to identify the overall resources used, and then apply the institution-specific charges to estimate the economic impact of viral meningitis.

Clearly, hospitalizations (and re-hospitalizations) and diagnostic procedures are the largest cost drivers

**Table 3. Mean (± SD) lengths of stay and mean (± SD) charges for hospital discharges due to viral meningitis by data source**

Source	N*	Length of stay Mean (± SD)	Charges <sup>a</sup> Mean (± SD) (\$)
California	15,559	3.89±4.72	8,826.21±17,341.50
Florida	9,382	4.19±4.14	8,177.56±11,391.30
Illinois	5,146	3.95±3.63	6,887.37±10,766.80
Pooled <sup>b</sup>	30,087	3.99±4.37	8,292.32±14,690.38

\*The numbers reflect specific codes for viral meningitis (047.XX), which may not reflect the true incidence of viral meningitis in a typical health care system.

<sup>a</sup>P > 0.05 California versus Florida versus Illinois.

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<sup>b</sup>Data for the three states were pooled to obtain summary information.

**Table 4. Mean (± SD) charges for physician visit of adult and pediatric Medicaid patients by lumbar puncture status**

Lumbar puncture status	N*	Adult (\$)	N*	Pediatric (\$)
With lumbar puncture <sup>a</sup>	2	174.00±3,676.96	6	121.17±3,181.46
Without lumbar puncture <sup>a</sup>	45	40.84±2,000.56	5	34.20±204.93

\*The numbers reflect specific codes for viral meningitis (047.XX), which may not reflect the true incidence of viral meningitis in a typical health care system.

P > 0.05 adult versus pediatric.

<sup>a</sup>P > 0.05 with lumbar puncture versus without lumbar puncture.

**Table 5. Mean (± SD) charges for ER visit of adult and pediatric Medicaid patients by lumbar puncture status**

Lumbar puncture status	N*	Adult (\$)	N*	Pediatric (\$)
With lumbar puncture <sup>a</sup>	21	742.11±607.39	4	985.96±928.07
Without lumbar puncture <sup>a</sup>	40	505.68±429.60	9	931.81±1,256.90

\*The numbers reflect specific codes for viral meningitis (047.XX), which may not reflect the true incidence of viral meningitis in a typical health care system.

P > 0.05 adult versus pediatric.

<sup>a</sup>P > 0.05 with lumbar puncture versus without lumbar puncture.

**Table 6. Total mean (± SD) charges and lengths of stay for hospital admission for viral meningitis for patients diagnosed with and without a CT scan**

	Without CT scan		With CT scan	
	N*	Mean (± SD)	N*	Mean (± SD)
Total charges (\$)	26,410	7,841.30±14,291.70	3,677	11,531.80±17,053.40
Length of stay <sup>a</sup>	26,844	3.88±4.32	3,806	4.71±4.67

\*The numbers reflect specific codes for viral meningitis (047.XX), which may not reflect the true incidence of viral meningitis in a typical health care system.

P < 0.05 without CT scan versus with CT scan.

<sup>a</sup>P < 0.05 without CT scan versus with CT scan.

among the resources identified. Our previous work indicates that there are

## APPENDIX A

### State Database

The state inpatient billing records used for the study span 4 years of hospitalizations in 3 states, totaling 12 years of combined data. The state databases employed for the analysis include Florida (1993–1996), California (1993–1996), and Illinois (1992–1995).

### Medicaid Database

The 1995 Pennsylvania Medicaid database comprises two data sets, the provider billing records database and the inpatient billing records database. Each has a unique patient identifier, making it possible to track patients.

### Operational Definitions

- *Complicated* is a discharge with a length of stay greater than or equal to two days for adults and greater than or equal to three days for pediatric patients.
- *Antibiotic* is an inpatient stay from state data only with ICD-9-CM Procedure code 99.21, which is listed as “injected with antibiotic.”
- *Lumbar Puncture* is determined differently for the state data and the Medicaid data. In the state databases, ICD-9-CM Procedure code 03.31 is listed as “spinal tap.” For the Medicaid database, CPT Procedure code 62270 is listed as “lumbar puncture.”
- *Diagnosed with Viral Meningitis* is a billing record (ER, Medicaid inpatient, state inpatient) with ICD-9-CM Diagnosis code 047.XX listed as a primary diagnosis or as any secondary diagnosis.
- *Readmission* is an admission to a hospital facility within one calendar month of initial hospital admission due to viral meningitis.

primarily two drivers of the decision to hospitalize patients presenting for medical management: 1) rule out bacterial infection and 2) patient dehydration (caused by excessive nausea and/or vomiting).<sup>5,8</sup> Potential direct medical cost savings may result from the use of an effective agent during “watchful monitoring” prior to referral to ER or after hospital admission. This stems from reduction in severity and duration of symptoms and length of stay. Potential indirect medical cost savings will stem from reductions in time to return to work, school, and normal leisure activities.

The availability of an effective antiviral agent might affect the overall costs of management of viral meningitis. For instance, from our previous analyses, an efficient and economical way to manage patients with viral meningitis may be to provide an effective oral antiviral agent to those patients presenting to the ER or hospital with a confirmed or suspected diagnosis of viral meningitis.<sup>5,8</sup> This pattern of management might reduce the need for hospitalization, procedures, and rehospitalization, thereby effecting cost savings.

In summary, the diagnosis and management of viral meningitis imposes a significant economic burden on the health care system. Reports on the incidence of viral meningitis vary from approximately 50,000 hospitalized cases to over 2 million cases of aseptic meningitis per year.<sup>3,4</sup> Based on 300,000 annual cases of aseptic meningitis in the United States, the economic impact is estimated to be \$1.5 billion in direct costs alone.<sup>5</sup> The availability of an effective antiviral agent could positively influence the clinical outcome and economic effect of viral meningitis, resulting in a valuable improvement in patient care. An effective antiviral agent might also improve the morbidity associated with viral meningitis, in terms of reduction in symptomatology and return to normal activities, and reduce costs associated with these factors.

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