Original Article

Trends in Outcomes and Hospitalization Charges of Infant Botulism in the United States: A Comparative Analysis Between Kids' Inpatient Database and National Inpatient Sample

Tamara Opila BSN, MPH [a], Asha George MS [a], Mohammad El-Ghanem MD [b], Nizar Souayah MD [b],*

[a] Innovative Research Associates, Philadelphia, Pennsylvania
[b] Department of Neurology and Neurosciences, New Jersey Medical School, Newark, New Jersey

ABSTRACT

BACKGROUND: New therapeutic strategies, including immune globulin intravenous, have emerged in the past two decades for the management of botulism. However, impact on outcomes and hospitalization charges among infants (aged ≤1 year) with botulism in the United States is unknown. METHODS: We analyzed the Kids' Inpatient Database (KID) and National Inpatient Sample (NIS) for in-hospital outcomes and charges for infant botulism cases from 1997 to 2009. Demographics, discharge status, mortality, length of stay, and hospitalization charges were reported from the two databases and compared. RESULTS: Between 1997 and 2009, 504 infant hospitalizations were captured in KID', and 340 hospitalizations from NIS, for comparable years. A significant decrease was observed in mean length of stay for 'KID ($P < 0.01$); a similar decrease was observed for the NIS. The majority of patients were discharged to home. Despite an initial decrease after 1997, an increasing trend was observed for 'KID/NIS mean hospital charges from 2000 to 2009 (from \$57,659/\$56,309 to \$143,171/\$106,378; $P < 0.001$/ $P < 0.001$). A linear increasing trend was evident when examining mean daily hospitalization charges for both databases. In conducting a subgroup analysis of the 'KID database, the youngest patients with infantile botulism (≤1.9 months) displayed the highest average number of procedures during their hospitalization ($P < .001$) and the highest rate of mechanical ventilation ($P < .001$), compared with their older counterparts. CONCLUSION: Infant botulism cases have demonstrated a significant increase in hospitalization charges over the years despite reduced length of stay. Additionally, there were significantly higher daily adjusted hospital charges and an increased rate of routine discharges for immune globulin intravenous—treated patients. More controlled studies are needed to define the criteria for cost-effective use of intravenous immune globulin in the population with infant botulism.

Keywords: botulinum toxin, childhood diseases, hospitalization costs, patient outcomes, intravenous immunoglobulin, infant botulism

Introduction

Although rare, infant botulism is the most prevalent form of botulism in the United States, which accounts for the greatest number of cases worldwide. Children aged one to 12 months[1] are at risk, with the greatest incidence observed among children one to six months of age. Approximately 80 to 100 cases are reported by the Centers for Disease Control and Prevention annually.[2]

Since its first recognition in 1976, the mortality rate of infant botulism has decreased to less than 2%,[3] which correlates with the improvement in mechanical ventilation

* Communications should be addressed to: Dr. Souayah; Department of Neurology; Rutgers New Jersey Medical School; 90 Bergen Street; DOC 8100; Newark, NJ 07103.
E-mail address: souayani@njms.rutgers.edu

TABLE 1.
Demographics, Clinical Characteristics, and In-hospital Outcomes Among Infants Hospitalized With Botulism in the United States (KID & NIS)

HCUP Database	Year				
	1997		2000		2003
	KID	NIS	KID	NIS	KID
n	130	68	126	84	78
Age (months)					
Mean ± S.D.	3.2 ± 2.0	2.5 ± 1.5	3.4 ± 1.8	3.8 ± 1.6	4.0 ± 2.5
Sex (%)					
Male	46.2	41.2	52.0	71.4	46.2
Female	53.8	58.8	48.0	28.6	53.8
Race (%)					
White	54.6	63.2	46.3	53.6	41.8
Other[†]	45.4	36.8	53.7	46.4	58.2
Disposition status (%)					
Routine	67.7	70.6	73.8	82.4	80.8
Other[‡]	32.3	29.4	26.2	17.6	19.2
Length of stay (days)					
Mean ± S.D.	19 ± 23	18 ± 18	16 ± 15	10 ± 9	13 ± 9
Unadjusted Hospitalization Charges ($)					
Mean ± S.D.	57,659 ± 64,642	56,309 ± 63,449	50,944 ± 43,968	48,889 ± 43,052	52,743 ± 49,690
Adjusted Hospitalization Charges ($)					
Mean ± S.D.	77,073 ± 86,407	75,269 ± 84,812	63,471 ± 54,780	60,910 ± 53,639	61,498 ± 57,939

Abbreviations:
HCUP = Healthcare Cost and Utilization Project
KID = Kids' Inpatient Database
NA = Not applicable
NIS = National Inpatient Sample

* *P* values for continuous variables were determined using analysis of variance. *P* values for linear trend and association of dichotomized categorical variables were determined using Mantel−Haenszel chi-square analysis.

† "Other" race category includes: Asian, Native American, Hawaiian, all other non-Caucasians, and missing categories.

‡ "Other" disposition status includes: other transfers including skilled nursing facility, intermediate care and another type of facility, home health care, discharges against medical advice, discharged alive but destination unknown, and unknown dispositions.

techniques, intensive supportive care, and the development of Botulism Immune Globulin Intravenous (BabyBIG).[4] Over the past decade, advanced therapeutic strategies have been more widely implemented for the management of infant botulism. In addition to the introduction of immune globulin intravenous in 2003, hospital interventions include specialized intensive care units, nutritional supplementation via enteral feedings, noninvasive bilevel ventilation (BiPAP), and positive-pressure mechanical ventilation.[5] The aim of this study is to assess the impact of therapeutic strategies on patient outcomes, and hospital charges among infant botulism hospital admissions in the United States. Two administrative databases were selected to study a 12-year time period, which encompassed six years prior to and following the approval of immune globulin intravenous; Kids' Inpatient Database (KID) and National (Nationwide) Inpatient Sample (NIS) covariates have previously been used as a surrogate measure for determining costs of illness, efficacy of interventions, and trend analysis of health-related outcomes.[6]

Methods

Patient population selection

Data from KID and NIS were extracted for analysis; both of these databases are part of the Healthcare Cost and Utilization Project (HCUP), sponsored by the Agency for Healthcare Research and Quality (AHRQ)[7] The KID database randomly samples and stratifies pediatric discharges, including 80% of pediatric patients from a sampling frame of community, nonrehabilitation hospitals. It includes all-payers and restricts age to discharges less than or equal to 18 years. In contrast, the NIS is the largest publicly available all-payer inpatient health care database in the United States, which systematically samples 20% of US community hospitals in greater than 40 states, for patients of all ages. Combined, these databases capture data to identify, track, and analyze national trends in health care utilization, access, charges, quality, and outcomes. They contain both clinical and nonclinical data elements for each hospital stay, including primary and secondary diagnoses/procedures, patient demographic characteristics, hospital characteristics, expected payment source, total charges, discharge status, length of stay (LOS), and severity/comorbidity measures.[7]

KID data are available every three years, whereas NIS data are available annually. The NIS was selected for assessments at matched intervals for best comparison. The data were filtered within the respective databases with the use of botulism primary diagnosis codes (040.41, 040.42, 005.1) from the International Classification of Disease, 9th Revision, Clinical Modification (ICD-9), to include all forms of the disease that may lead to flaccid paralysis. Subgroup analyses were conducted using ICD-9 codes (99.14, 99.57) for immune globulin intravenous and mechanical ventilation (96.71, 96.72). We reviewed the hospitalization characteristics of infants diagnosed with botulism for 1997, 2000, 2003, 2006, and 2009; analysis was conducted for demographic characteristics (age, race, sex), number of admissions, patient disposition, and total/daily charges incurred.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics, Version 22.0, IBM Corporation, Armonk, NY. Weights were provided by NIS and KID to generate national discharge estimates. A variable standardizing age in months was established to obtain an analysis population consisting of infant patients (≤12 months). The age in months at the time of