

ORIGINAL RESEARCH—PEDIATRIC OTOLARYNGOLOGY

# Airway management in pediatric epiglottitis: A national perspective

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**OBJECTIVES:** The purpose of this study was to describe current demographics and resource utilization in the treatment of pediatric epiglottitis.

**STUDY DESIGN:** Case series from a national database.

**SUBJECTS AND METHODS:** The Kids' Inpatient Database was systematically searched to extract patients under 19 years old admitted with a diagnosis of epiglottitis and undergoing an airway intervention.

**RESULTS:** Three hundred forty-two sampled admissions were for epiglottitis; 40 of these patients were under the age of 19 and had an airway intervention (intubation or tracheotomy). On average, patients were 4.3 years old (SD = 6.0 years). The average length of stay was 15.6 days (SD = 33.9 and range = 0-199) with average total charges of \$74,931 (SD = \$163,387, range = \$3342-\$938,512). Multivariate analysis revealed that admission to a children's facility, admission other than via the emergency room, and nonemergent admission were associated with increased total charges. Twenty-two states reported an admission for pediatric epiglottitis that required airway intervention.

**CONCLUSIONS:** In our sample, only 40 patients were identified who were under the age of 19 years and required an airway intervention for the treatment of epiglottitis. Epiglottitis is a rare, expensive, and protracted disease to treat in the postvaccine era. The unique nature of this disease has implications for training future surgeons on proper management of this potentially fatal disease.

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Since the introduction of the *Haemophilus influenzae* (HiB) vaccine in 1985, the incidence of epiglottitis has rapidly changed. After the introduction of the vaccine, the rate of epiglottitis, as would be expected, dropped precipitously. In Australia, the rate of epiglottitis in children under 5 years of age decreased to 3.3 per 100,000, from a rate of 6.6 per 100,000.<sup>1</sup> A 1990 Canadian study by Wurtele<sup>2</sup> suggested a postvaccination incidence of 6 per 100,000 in children and 1 per 100,000 in adults, as well as a relative

increase in the ratio of adult to pediatric cases, a finding echoed in another Australian series by Wood et al.<sup>3</sup> Changes have also been described in the United States, as noted by Shah et al,<sup>4</sup> who described an increase in the average age of pediatric epiglottitis patients in Boston, MA, which was largely attributed to the HiB vaccine. Although the literature clearly describes an overall decrease in the incidence of epiglottitis, several authors have been cautious to point out that this does not represent elimination of this disease.<sup>4,5</sup> Despite advances in therapy, epiglottitis remains relevant, and the otolaryngologist continues to be instrumental in the management of this disease.

There have been reported changes in the epidemiology of epiglottitis, but there are currently no national studies describing the demographics of pediatric epiglottitis in the post-HiB era. More specifically, no studies exist describing the demographic of patients requiring airway intervention in the treatment of epiglottitis, a topic of interest to the otolaryngologist. These changing demographics may have significant implications for resident training, patient triage, and treatment algorithms.

Of interest, there are also no studies describing resource utilization in the treatment of this disease process. Resource utilization is a concept that is increasingly gaining momentum in the medical literature. It is based on the concept of a rigid analysis of the cost of treating a disease in relation to patient and hospital variables. This methodology has been used to broaden the knowledge regarding disease states in the otolaryngology literature as well as in cardiology and pediatrics.<sup>6-8</sup> To date, there are no studies describing either resource utilization or a national perspective in the management of pediatric epiglottitis.

## METHODS

Institutional review board approval was obtained. The source of the data used is the Kids' Inpatient Database (KID) from the Healthcare Cost and Utilization Project created by the Agency

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for Healthcare Research and Quality.<sup>9</sup> The KID is an all-payer national database of inpatient pediatric admissions, encompassing 36 states in the year 2003. The KID includes 3,428 hospitals and 2,984,129 pediatric discharges. The KID was systematically searched using the *International Classification of Disease, Ninth Revision (ICD-9)* diagnosis codes 464.30 (acute epiglottitis without mention of obstruction) and 464.31 (acute epiglottitis with mention of obstruction). From this subset of patients, the incidence at varying ages from 0 years old to 19 years old was examined.

To reduce the potential for coding inconsistencies and to select for the patients with an acute airway, the additional inclusion criterion of airway intervention was applied. This was accomplished using the *ICD-9 Classification of Procedure code* for either intubation (96.04) or tracheotomy, temporary or permanent (31.1 and 31.29). A final sample of patients who met both inclusion criteria was evaluated in this study. No exclusion criteria were applied. Total charges were used as a surrogate for resource utilization. A *P* value of <0.05 was used to indicate a significant predictor of increased total charges. Univariate and multivariate regression models were fit to determine which factors were associated with increased total charges.

## RESULTS

In the KID 2003, 342 patient admissions were identified with a diagnosis of epiglottitis. Of these, 40 patients were identified who required either intubation or tracheotomy and were under the age of 19. The mean age of these patients was 4.3 years, with 63 percent under the age of 2. Sex distribution was roughly equal; 53 percent of patients were male. The racial breakdown showed that 48 percent of patients were white. The mean length of stay was 15.6 days, with a range of 0 to 199 days. Univariate analyses of clinical variables that are associated with increased total charges are presented (Table 1). Seasonal variation was noted, with January and August being the most common months for admission. Regional variations were also noted; Texas, Massachusetts, and New York had the most inpatient admissions. The average total charges were \$74,931, with a range from \$3,343 to \$938,512. Private insurance companies were the primary payers in 45 percent of admissions. Academic institutions bore the brunt of management of these complex patients, with 55 percent of patients managed at teaching hospitals.

In a univariate analysis, only the National Association of Children's Hospitals and Related Institutions hospital type revealed statistically significant differences in total charges.

**Table 1**  
Univariate analysis of predictors of increased total charges in the airway management of pediatric epiglottitis

Variable	Number of patients	Total charges (mean, SD)	<i>P</i> value
Sex			0.1871
Male	20	\$ 41,981 (46,495)	
Female	17	\$113,697 (233,546)	
Race			0.3914
White	14	\$ 57,879 (104,523)	
Other	15	\$117,235 (233,868)	
Median income quartile			0.4131
1st	15	\$ 49,285 (56,001)	
2nd-4th	21	\$ 95,836 (211,558)	
Source of admission			0.4957
ER	18	\$ 55,791 (94,608)	
Other	19	\$ 93,065 (210,295)	
Type of admission			0.8307
Emergent	21	\$ 48,649 (87,769)	
Other	16	\$ 54,154 (53,593)	
Discharge quarter			0.7958
1st or 2nd	16	\$ 83,063 (228,839)	
3rd or 4th	21	\$ 68,736 (93,182)	
Primary payer			0.3515
Medicaid	16	\$105,590 (227,643)	
Private	18	\$ 50,477 (91,982)	
Urban/rural patient			0.1094
Large metropolitan	17	\$121,697 (231,608)	
Other	20	\$ 35,181 (42,287)	
Children's specialty			0.0299
Children's hospital or ward	14	\$151,272 (249,024)	
Nonchildren's	20	\$ 24,089 (31,837)	
Teaching status			0.3614
Teaching	22	\$ 96,490 (205,870)	
Nonteaching	12	\$ 39,733 (62,951)	

**Table 2**  
**Indicators for increased total charges for epiglottitis admissions in a multivariate analysis of admission characteristics of patients**

Variable	Regression coefficient (95% CI)	P value	Partial R <sup>2</sup>
Age	−2,051.4 (−6,874.5, 2,771.7)	0.3833	0.0425
Sex	−3,100.1 (−66,610, 60,410)	0.9195	0.0006
Type of admission	102,884 (12,162, 193,606)	<b>0.0284</b>	0.2398
Source of admission	−168,837 (−268,910, −68,765)	<b>0.0023</b>	0.4111
Month of admission	−5,452.1 (−16,266, 5,362.0)	0.3035	0.0587
Admission day is a weekend	−40,526 (−111,615, 30,563)	0.2466	0.0738
NACHRI hospital type	144,698 (72,534, 216,861)	<b>0.0005</b>	0.4965
Teaching hospital	−60,737 (−125,515, 4,041.2)	0.0644	0.1773
Median household income quartile	70,498 (−4,878.8, 145,874)	0.0650	0.1766
Primary payer	6,023.1 (−34,569, 46,615)	0.7588	0.0053
Patient location	−4,115.9 (−81,065, 72,833)	0.9118	0.0007

NACHRI, National Association of Children's Hospitals and Related Institutions.

Statistical significance  $P < 0.05$  indicated by bold typeface. Model  $R^2 = 0.61$ ,  $P < 0.036$ .

Total charges with admission to a children's hospital or ward were approximately 6 times as high as total charges for admissions to nonchildren's hospitals (\$151,272 vs \$24,089,  $P < 0.05$ ). The length of stay at nonchildren's facilities was much shorter (mean 7.45 days; range, 0-73 days) than at children's facilities (mean 28.53 days; range, 3-199 days;  $P = 0.07$ ). Although large differences were noted for other variables (Table 1), none met statistical significance ( $P < 0.05$ ).

In a multivariate analysis (Table 2), admission to a children's specific facility was associated with a statistically significant increase in total charges. Admission source and admission type were also associated with significant increases in total charges. The source of admission refers to admission via the emergency room in comparison to another source (ie, transfer from another hospital). Admission from a source other than the emergency room was associated with an increase in total charges. Nonemergent admission was also associated with increased total charges.

## DISCUSSION

Per the KID data-use agreement, it is not permissible to use patient identifiers for reasons of patient confidentiality. Furthermore, with the KID data-use agreement, we are prohibited from discussing in greater detail when the sample size of variable is less than 10 patients (which limits subgroup analysis in patients undergoing airway intervention). Despite these limitations, several interesting findings were evident in our results. In this national database of inpatient pediatric admissions encompassing an entire year, there were 342 admissions for epiglottitis. Of these, 40 were children under the age of 19 requiring an airway intervention for the treatment of epiglottitis. Although these low numbers show that the HiB vaccine has made epiglottitis an exceedingly rare disease process, it shows that this disease

has not been eliminated. Also, it must be appreciated that with such relative infrequency will come a lack of familiarity, not only among otolaryngologists but also among emergency room physicians, pediatricians, and anesthesiologists. As the foremost experts on the airway, it is incumbent on the otolaryngologist to be facile in the treatment of this disease. Although rare, this disease process will persist among the nonvaccinated as well as in those with vaccine failure (a well-documented occurrence).<sup>4</sup> It is imperative to continue to teach medical students, residents, and emergency room physicians to maintain a high index of suspicion for epiglottitis.

This sample of patients was slanted toward younger patients, with 63% being age 2 or younger, increasing the acuity of the airway situation. Other studies have suggested that older patients may be treated more conservatively; this younger patient sample would suggest that aggressive airway management may be necessary in many cases.

The majority of patients was initially seen at nonchildren's facilities. Significant cost differentials at children's facilities indicate that perhaps the majority of the management may have occurred at children's facilities. We surmise this as the length of stay at the children's hospitals is much longer than that at the nonchildren's hospitals. It is also reasonable to assume that the majority of pediatric patients with severe diseases or complicated cases are managed at pediatric facilities as opposed to community hospitals.

Several weaknesses exist in our study methodology. First, it is a retrospective study. This lends less weight than a prospective study and introduces the possibility of selection bias. Unfortunately, it would be extremely challenging to perform a prospective study for this disease process, and on a national scale this would be essentially impossible. Second, ICD-9 codes were used, introducing the possibility of coding errors. We attempted to mitigate this as a source of error by also using the codes of patients that required airway intervention. Finally, we were limited by restrictions

set forth in the data-use agreement for the KID, which prohibits analysis of variables in which the sample size is fewer than 10 patients.

## CONCLUSION

In the post-HiB era, epiglottitis has become an exceedingly rare entity. Only 40 children required an airway intervention for epiglottitis (from 22 of the 36 states sampled in 2003). Airway intervention for epiglottitis was associated with both high total charges and prolonged hospitalization. Despite large variances in total charges, only hospital type (pediatric vs nonpediatric facilities), admission source, and admission type were significantly associated with increased total charges. Epiglottitis is a very rare, expensive, and protracted disease to treat in the HiB vaccine era. The infrequency of this disease has significant implications for resident education and training.

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## AUTHOR CONTRIBUTIONS

**Jason Acevedo**, study design, writer; **Lina Lander**, study design, data collection; **Sukgi Choi**, study design, writer; **Rahul Shah**, study design, writer.

## FINANCIAL DISCLOSURE

None.

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