The Public Health Impact of Pediatric Deep Neck Space Infections

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Abstract

Objective. There is little consensus about the best management of pediatric deep neck space infections (DNSIs) and limited information about the national disease burden. The purpose of this study is to examine the health care burden, management, and complications of DNSIs from a national perspective.

Study Design. Retrospective administrative data set review.


Subjects and Methods. Pediatric patients diagnosed with a parapharyngeal space and/or retropharyngeal abscess were identified from the 2009 KIDS’ Inpatient Database. Patient demographic, hospital, and clinical characteristics were compared between patients who received surgical and nonsurgical management. All results for the analyses were weighted, clustered, and stratified appropriately according to the sampling design of the KIDS’ Inpatient Database.

Results. The prevalence of DNSIs was 3444 in 2009, and the estimated incidence was 4.6 per 100,000 children. The total hospital charges were $75 million. The patients who were drained surgically had a 22% longer length of stay (mean = 4.19 days) than that of those who were managed without surgery (mean = 3.44 days). Mean hospital charges for patients who were drained surgically were almost twice those of patients who were managed medically ($28,969 vs $17,022); 165 patients (4.8%) had a complication.

Conclusion. There are 3400 admissions for pediatric DNSIs annually, and they account for a significant number of inpatient days and hospital charges. A randomized controlled trial of management may be indicated from a public health perspective.

Keywords

public health, deep neck space infection, parapharyngeal, retropharyngeal abscess

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Retropharyngeal and parapharyngeal abscesses (RPAs and PPAs) are the most common deep neck space infections (DNSIs) in children. Pediatric DNSIs are usually the result of spread of infection from a contiguous site, such as the tonsils, adenoid, or dentition. The distinction between abscesses of the retropharyngeal and parapharyngeal space is radiographic; in children, they are clinically indistinguishable and are often grouped for clinical analyses.1-3 With improved access to care, better imaging techniques, and the advent of antibiotics, the morbidity and mortality of DNSIs have decreased dramatically.1 However, complications have not been eliminated completely; therefore, prompt recognition and management of these infections is still important.2-4 There is no consensus on their management, with some authors advocating an aggressive approach to surgical drainage and others favoring a trial of medical management.

The literature regarding DNSIs is mostly limited to single-institution case series. Lander et al examined RPA alone from a national perspective using the 2003 KIDS’ Inpatient Database (KID).5 This study was the first to describe national demographics for these patients. The authors also found significant national variation in resource utilization for RPAs.

KID 2009 is an all-payer database that contains data on 3 million pediatric hospital admissions for children 0 to 20 years old.6 To make national estimates for each diagnosis, data are weighted per hospital-specific factors, including location, funding, number of beds, and teaching status. It is the largest database of inpatient all-payer pediatric health care data available in the United States. Accrued from 44...
state databases of pediatric discharges from 4121 hospitals, KID allows for calculations of national estimates of incidence and outcomes.

The goal of this study is to examine DNSIs from a national perspective using KID 2009. We aim to (1) determine the national incidence of DNSIs and their complications and describe the demographics of these patients, the characteristics of their hospital admissions, and the national health care burden; (2) examine differences in hospital course and charges between surgical and nonsurgical management; and (3) identify factors associated with surgical versus nonsurgical management.

Materials and Methods
The Boston Children’s Hospital Institutional Review Board approved this study, and its guidelines were followed. Patients were included in the study if they had ICD-9 codes 478.22 (parapharyngeal space abscess) and/or 478.24 (retropharyngeal space abscess) as primary or secondary diagnoses. Patients who had ICD-9 code 682.1 (cellulitis and abscess of neck) were excluded from the analysis because of the heterogeneity of diagnoses and anatomic locations included within this code. Patients who left against medical advice or were transferred to another hospital were excluded.

Patients were divided into surgical and nonsurgical groups for analyses. A patient was considered to have surgery if his or her database record included a procedure code for incision and drainage (procedure codes 280, 290, 8604). In the surgical group, patients were further divided into the immediate surgery cohort if incision and drainage were performed on hospital day 1 or 2. They were placed in the delayed surgical group if surgical intervention was performed on hospital day 3 or more.

We abstracted from the KID >100 patient- and admission-level variables and selected the 10 most common for statistical analysis. Some of the variables considered clinically equivalent (eg, “volume depletion” and “dehydration”) were pooled. Each of these 10 variables was individually analyzed for statistically significant association with surgical intervention. Those variables with a significant association (P < .1) with treatment group (surgical vs nonsurgical) were then included in the multivariate logistic regression analysis.

All analyses were performed in SAS 9.3. Data were weighted, clustered, and stratified according to the database guidelines to provide national estimates and standard errors. All analyses were based on 2-sided 0.05 type I error. Taylor series was used for estimation methods for all analyses.

Results

Patient Demographics
National estimates of patient characteristics are depicted in Table 1. The prevalence of pediatric hospital admissions in 2009 for DNSIs was 3444. Males were more commonly admitted than females (2090 vs 1292). There was no significant difference between surgical and nonsurgical patients in terms of age, sex, race/ethnicity, insurance type, or admission day.

A total of 1450 (42.1%) patients had an incision and drainage procedure, while 1994 (57.9%) were treated nonsurgically. Mean length of stay was significantly longer for surgical patients (4.19 days) versus nonsurgical patients (3.44 days; P < .0001). Similarly, overall hospital charges were significantly higher for the surgical cohort ($28,969 vs $17,022; P < .0001). When surgical patients were divided into immediate and delayed surgery cohorts, the patients who underwent immediate surgical intervention (n = 897) had significantly lower length of stays (3.47 vs 6.1 days; P < .0001) and total hospital charges ($27,462 vs $37,085; P < .0001; Table 2).

Complications
There were an estimated 165 complications of DNSIs during the study period, resulting in a complication rate of 4.8%. Respiratory failure was the most common and occurred in 98 patients. Sepsis (n = 54) and mediastinitis (n = 13) were the other serious complications during the study period.

Clinical Characteristics
In the bivariate analysis, factors associated with surgical intervention were streptococcal infection and dyspnea/stridor (P < .0001; Table 3). Factors associated with a decreased likelihood of surgical intervention were the presence of lymphadenopathy and fever (P < .0001, P = .008, respectively).

The multivariate logistic regression model had similar results (Table 4). Those with streptococcal infection were 1.6 times more likely to receive surgical treatment versus those without this condition (P < .0001). Similarly, patients with dyspnea/stridor were 2.7 times more likely to receive surgical intervention (P < .0001). Patients with lymphadenopathy and fever were twice as likely to be managed medically (P < .0001, P = .0166, respectively).

Discussion
DNSIs represent a significant health care burden in the United States. Based on the US population of children in 2009 (74.1 million), the estimated national incidence was 4.6 per 100,000 children. The total hospital charges for DNSIs for the year was >$75 million. Pediatric DNSIs accounted for an estimated 12,934 inpatient hospital days.

Most cases of DNSIs occur in children <6 years old. Similar to previous studies, we found a male:female ratio of 3:2. Caucasian patients accounted for more hospital admissions than all other races/ethnicities combined. The majority of patients had private insurance, and there was no significant difference in management based on payer.

Approximately 42.1% of admitted patients underwent an incision and drainage during their admission. Length of stay and total hospital charges were significantly higher for the surgical patients (P < .0001). This is similar to previous work from our institution that showed longer hospital stays.
in patients managed surgically and significantly higher costs associated with surgical management.10

Surgical patients were further subdivided into an immediate surgical group and a delayed surgical group. This latter group represents patients who presumably failed medical management and eventually required surgical intervention. We found that patients who underwent surgery on the first or second day of admission had a significantly shorter length of stay and lower hospital charges ($P < .0001). The immediate surgical group and those patients treated medically throughout their admission had similar lengths of stay (3.47 vs 3.44 days, respectively). However, the immediate surgical cohort still had higher hospital charges when compared with the medically treated group ($27,462 vs $17,022, respectively)—possibly because patients who require surgery are more likely to be monitored in an intensive care unit setting postoperatively, although this cannot be stated definitely. In the future, it would be useful to examine what clinical/radiographic factors in the delayed surgery group could be used to predict medical treatment failure, since this is the group with the longest length of stay and highest hospital charges. Because the KID lacks radiographic and microbiologic data, this is not possible to determine with our current data set.

Complications related to DNSIs occurred in 4.8% of admitted patients. The most common serious complications reported in the literature are airway obstruction and mediastinitis.2,11 In our series, respiratory failure (2.8%) and sepsis (1.6%) were the most common complications. Based on the method of coding in the KID, it is difficult to know when these complications occurred during the course of admission. It should not be assumed that these complications occurred prior to admission, during the course of antibiotic management, or as a result of surgical intervention.

Given the significant health care burden and complications related to DNSIs, one of the aims of our study was to identify potential factors related to surgical intervention. Multivariate modeling suggests significant associations between surgical intervention and streptococcal infection and dyspnea/stridor. However, there are notable limitations to database analyses that warrant mentioning. One of the most important limitations of any database study is coding variation. Objective variables such as age and hospital charges are not subject to coding variation and are straightforward to analyze. However, many clinical characteristics rely on appropriate coding. Although we assume that these variables were coded appropriately, there is no way to know with certainty if they were coded correctly. The

### Table 1. Patient Characteristics (N = 3444).a

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total, n</th>
<th>Surgical</th>
<th>Nonsurgical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$n_{uw}$</td>
<td>$n_{w}$</td>
<td>$n_{uw}$</td>
</tr>
<tr>
<td></td>
<td>(n = 2294)</td>
<td>(N = 3444)</td>
<td>(n = 966)</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>95% CI</td>
<td>Mean</td>
</tr>
<tr>
<td>Age, y</td>
<td>2294</td>
<td>3444</td>
<td>5.57</td>
</tr>
<tr>
<td>Length of stay, d</td>
<td>2294</td>
<td>3444</td>
<td>4.19</td>
</tr>
<tr>
<td>Total charges, US$</td>
<td>2294</td>
<td>3444</td>
<td>28,969.00</td>
</tr>
</tbody>
</table>

| Sex                   |          |          |            |            |
|                       | n$_{uw}$ | n$_{w}$  | 95% CI     | %           |
| Male                  | 1394     | 2090     | 592        | 889         | 762-1016 | 42.5 | 802 | 1201 | 1040-1363 | 57.5 | .6312 |
| Female                | 858      | 1292     | 357        | 536         | 451-621  | 41.5 | 501 | 756  | 648-865  | 58.5 |
| Race/ethnicity        |          |          |            |            |
| Caucasian             | 1042     | 1551     | 447        | 667         | 546-787  | 43.0 | 595 | 885  | 736-1033 | 57.0 | .4267 |
| Black                 | 325      | 494      | 123        | 187         | 141-233  | 37.8 | 202 | 308  | 231-384  | 62.2 |
| Hispanic              | 340      | 509      | 143        | 214         | 157-272  | 42.0 | 197 | 296  | 230-361  | 58.0 |
| Other                 | 169      | 251      | 70         | 104         | 65-142   | 41.2 | 99  | 148  | 95-200   | 58.8 |
| Primary payer         |          |          |            |            |
| Public                | 909      | 1378     | 380        | 579         | 476-682  | 42.0 | 529 | 800  | 678-922  | 58.0 | .9637 |
| Private               | 1232     | 1838     | 523        | 779         | 662-897  | 42.4 | 709 | 1060 | 907-1213 | 57.7 |
| Other                 | 151      | 224      | 63         | 93          | 66-119   | 41.3 | 88  | 132  | 98-166   | 58.7 |
| Admission day         |          |          |            |            |
| Weekday               | 1691     | 2536     | 721        | 1080        | 929-1232 | 42.6 | 970 | 1456 | 1267-1646 | 57.4 | .4385 |
| Weekend               | 603      | 908      | 245        | 370         | 309-432  | 40.8 | 358 | 538  | 456-619  | 59.2 |

Abbreviations: CI, confidence interval; $n_{uw}$, unweighted number; $n_{w}$, weighted number.

aFrequencies are estimated by weighting scheme; therefore, they have been rounded up for convenience. Total frequency is not equal to sum of frequencies across groups, because the numbers were rounded up.

b$T$ tests for continuous variables and Rao-Scott chi-square tests for categorical variables.
clinical characteristics are likely to be underestimated because they are secondary diagnoses that are not necessary to code from a billing standpoint. For example, most patients who present with a DNSI have lymphadenopathy, but in our study, 20.2% were coded with it. One method to rectify this issue would be to force patients to be coded as having or not having lymphadenopathy during the coding process.

In addition, to define a variable as a “predictor,” the time course of the variable must be known. Administrative databases do not indicate when a diagnosis was applied to a particular patient. For example, it is impossible to know if a patient was diagnosed with stridor at presentation or following surgical intervention. Therefore, although the presence/absence of lymphadenopathy, fever, streptococcal infection, and dyspnea/stridor were significant clinical variables in our bivariate and multivariate model, we cannot say definitively that these are valid “predictors” of surgical intervention. Instead, we report that they are associated with surgical intervention, and we suggest that clinicians note these clinical characteristics when performing retrospective or prospective analyses of their patients to determine actual clinical significance. Given the enormous public health impact revealed in this study, we suggest a randomized controlled trial comparing initial medical management versus immediate surgical intervention in clinically stable pediatric patients with DNSIs.

Another important limitation of utilizing administrative databases is that hospital practice can skew results. We analyzed if some hospitals favored one treatment over the other due to hospital practice rather than patient-level clinical factors. Most hospitals that favored one treatment over the other had very few cases of DNSIs, ranging from about 2 to 5. Because of the small number of DNSI cases in these hospitals, it is difficult to conclude whether these hospitals chose surgical or nonsurgical treatment because of their hospital practice or random chances. Therefore, we did not have enough information to conclude that hospitals favored one treatment method over the other due to hospital practice.

As with any administrative database study, there is a possibility of under- or overestimating the national estimates. It is possible that we missed some cases that were coded with a nonspecific term, such as abscess of neck instead of PPA or RPA. In addition, we may have included cases where patients had previously been admitted for a DNSI and, as a result, PPA or RPA remained as a secondary diagnosis but was not the reason for admission during the study period. Similarly, the number of patients with a streptococcal infection may have been underestimated in the nonsurgical group because no culture data were available. The data used in this study are also several years old, but it was the most recent version of KID available at the time that this study began. Several studies published in the last 6 months used....
this same data set. A final limitation specific to the KID is that it lacks information on imaging, which would have been a useful adjunct to this analysis.

Conclusions

The prevalence and incidence of DNSIs in the United States in 2009 were 3444 and 4.6 per 100,000 children, respectively. These infections represent a substantial public health care burden, with >$75 million in hospital charges for admitted patients. Despite our advances in imaging and antibiotics, there is still a complication rate of 4.8%. Given the significant burden of this disease, a randomized controlled clinical trial may be warranted comparing initial antibiotic management versus early surgical intervention in clinically stable patients. In addition, future studies should evaluate whether the public health burden of DNSIs remains stable over time.

Author Contributions

Eelam Adil, study design, interpretation, article drafting, final approval, accountability; Yael Tarshish, data acquisition, interpretation, article drafting, final approval, accountability; David Roberson, study design, interpretation, article drafting, final approval, accountability; Jisun Jang, study design, analysis, interpretation, article revision, final approval, accountability; Greg Licameli, study design, interpretation, article revision, final approval, accountability; Margaret Kenna, study design, interpretation, article revision, final approval, accountability.

Disclosures

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References


