Corticosteroids in the Treatment of Pediatric Retropharyngeal and Parapharyngeal Abscesses

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abstract

BACKGROUND AND OBJECTIVES: Treatment of retropharyngeal abscesses (RPAs) and parapharyngeal abscesses (PPAs) includes antibiotics, with possible surgical drainage. Although corticosteroids may decrease inflammation, their role in the management of RPAs and PPAs is unclear. We evaluated the association of corticosteroid administration as part of initial medical management on drainage rates and length of stay for children admitted with RPAs and PPAs.

METHODS: We conducted a retrospective study using administrative data of children aged 2 months to 8 years discharged with RPAs and PPAs from 2016 to 2019. Exposure was defined as systemic corticosteroids administered as part of initial management. Primary outcome was surgical drainage. Bivariate comparisons were made between patients in the corticosteroid and noncorticosteroid groups by using Wilcoxon rank or χ^2 tests. Outcomes were modeled by using generalized linear mixed-effects models.

RESULTS: Of the 2259 patients with RPAs and PPAs, 1677 (74.2%) were in the noncorticosteroid group and 582 (25.8%) were in the corticosteroid group. There were no significant differences in age, sex, or insurance status. There was a lower rate of drainage in the corticosteroid cohort (odds ratio: 0.28; confidence interval: 0.22–0.36). Patients in this group were more likely to have repeat computed tomography imaging performed, had lower hospital costs, and were less likely to have opioid medications administered. The corticosteroid cohort had a higher 7-day emergency department revisit rate, but there was no difference in length of stay (rate ratio 0.97; confidence interval: 0.92–1.02).

CONCLUSIONS: Corticosteroids were associated with lower odds of surgical drainage among children with RPAs and PPAs.

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WHAT'S KNOWN ON THIS SUBJECT: Treatment of retropharyngeal abscesses (RPAs) and parapharyngeal abscesses (PPAs) includes antibiotics, with possible surgical drainage. Adjuvant corticosteroid use may decrease inflammation and play a role in medical management. However, its role in pediatric RPAs and PPAs is not well defined.

WHAT THIS STUDY ADDS: Through administrative data from 46 children's hospitals in the United States, we demonstrate that adjuvant corticosteroid use for treatment of pediatric RPAs and PPAs is associated with lower surgical drainage rates without impacting length of stay.

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Retropharyngeal abscesses (RPAs) and parapharyngeal abscesses (PPAs) are serious, potentially life-threatening deep neck infections in children. RPAs and PPAs may arise from pharyngeal trauma or after an upper respiratory infection. Nontraumatic RPAs and PPAs result from the inflammation and suppuration of retropharyngeal lymph nodes, which are generally present in young children and involute with increasing age. The rising incidence of RPAs and PPAs over the past 20 years[1–3] has been attributed to more cases of predisposing tonsillitis, due to a shift away from tonsillectomies,[4] as well as the changing epidemiology of methicillin-resistant *Staphylococcus aureus*.[1]

Treatment of deep neck infections can include medical management alone, or in combination with surgical drainage. Medical management includes antibiotics, analgesia, and hydration. Over the past 40 years, surgical drainage rates for RPAs and PPAs have decreased from 60% to 80%[5,6] to 40% to 50%.[2,7] Medical management without surgical drainage confers both patient-level benefits (eg, avoidance of the risks of surgery and anesthesia, postoperative pain, and other complications) and system-level benefits (eg, lower hospital charges).[7]

Corticosteroids have been used as adjunct therapy in an attempt to decrease rates of medical treatment failure. Corticosteroids inhibit transcription of the proinflammatory mediators in human airway endothelial cells, which cause pharyngeal inflammation, an effect that, in theory, could reduce symptoms of pain.[8] However, corticosteroids may also mask important features of worsening infection, such as fever and pain, making the clinical examination less reliable and resulting in delayed management of the disease process. The objective of this study is to understand the association of systemic corticosteroid use with the primary outcome of surgical drainage in hospitalized children with RPAs and PPAs.

METHODS

Study Design and Data Source

We conducted a multicenter, retrospective study using administrative data from the Pediatric Health Information System (PHIS). The PHIS database contains clinical and resource use data from 46 tertiary care pediatric hospitals that are affiliated with the Children's Hospital Association (Lenexa, KS), and accounts for ~15% of all pediatric hospitalizations in the United States (excluding normal newborns). Participating hospitals provide patient-level data, including demographics, diagnoses, and procedures, as well as billing data for medications, laboratory tests, and radiology studies. Patient data are deidentified before inclusion in the database, although consistent encryption of patient identifiers allows for tracking of individual patients across multiple hospital visits. Data quality and reliability are assured through the Children's Hospital Association and participating hospitals. This study was not considered human subjects research by the Northwell Health Institutional Review Board.

Study Population

Inclusion Criteria

Children aged 2 months to 8 years who were admitted to a PHIS-participating hospital between January 1, 2016, and December 31, 2019, with an *International Classification of Diseases, 10 Revision* (ICD-10)–coded primary discharge diagnosis of RPAs and PPAs (J39.0) were eligible for inclusion. Although RPAs and PPAs have been described in children aged <2 months, evaluation of fever, irritability, or neck pain in this population necessitates a comprehensive infectious evaluation, and management is unique because of their immature immune system. We excluded patients aged >8 years because of potential overlap with other deep neck infections, such as peritonsillar abscesses. This age range is consistent with prevalence previously reported literature.[2,6]

Exclusion Criteria

We excluded children who were transferred from another institution and those from hospitals with incomplete data. To identify otherwise healthy children with RPAs and PPAs, we excluded patients with complex chronic conditions[9] and congenital airway malformations. Children with trauma were excluded because those deep neck infections are managed according to the extent of trauma and presence of other concurrent injuries. To allow for accurate examination of corticosteroid impact, children with comorbid conditions that require corticosteroid therapy (eg, adrenal insufficiency and nephrotic syndrome) and those with diagnoses that may require use of corticosteroids (eg, allergic reaction, sinusitis, and respiratory failure) were excluded, as were patients on inhaled corticosteroid medication (Supplemental Table 4).

Main Exposure

The primary exposure was systemic corticosteroid administration as part of initial medical management before any surgical procedure (if performed). Corticosteroids of interest included dexamethasone, prednisone, prednisolone, or methylprednisolone, administered parenterally or orally. The noncorticosteroid group did not receive initial corticosteroids for medical management. Patients who started corticosteroids on the day of or after surgery were included in the noncorticosteroid group because corticosteroids in this context may have been used primarily for perioperative or postoperative care and unlikely to have impacted decision for surgical drainage (Supplemental Table 5).

Outcomes

Our primary outcome was surgical drainage. Surgical status was determined by ICD-10 procedure codes. All procedure codes present in our cohort were inspected, and those that represented efforts to drain the primary site of infection or extension into adjacent anatomic sites (eg, mediastinum) were used to define drainage (Supplemental Table 6).

Our secondary outcomes included those related to diagnostic evaluation, medical management, and health care use. Our diagnostic evaluation outcome was repeat imaging with computed tomography (CT). Medical management outcomes included the use of intravenous hydration and analgesia. Pain medications evaluated included opioids given orally or intravenously, as well as other pain medication provided intravenously (eg, acetaminophen, ibuprofen, and ketorolac). Health care use outcomes included length of stay (LOS) (defined as date and time of discharge minus date and time of admission), hospital cost (estimated from charges by using annual hospital-specific cost-to-charge ratios), all-cause 7-day emergency department (ED) return visits, and all-cause 30-day hospital readmissions.

Variables

Patient demographics included age, sex, and payer. Diagnostic testing was identified by using billing codes. Laboratory measures included complete blood cell count, C-reactive protein, erythrocyte sedimentation rate, blood cultures, and cerebrospinal fluid cultures. Radiology studies included CT scan and MRI. Empirical antibiotics were defined as antibiotics used within the first 2 days of hospitalization and were grouped into categories: clindamycin monotherapy, β-lactam and/or β-lactamase inhibitor monotherapy, or other antibiotic regimen. Illness severity was assessed by using admission to the PICU, defined as any child who incurred charges for critical care, and severity index by using the Hospitalization Resource Intensity Scores for Kids (H-RISK).[10] The H-RISK is a resource intensity weight derived from the 2012 Healthcare Cost and Utilization Project Kids' Inpatient Database. The weight for a particular All-Patient Refined Diagnostic Group (3M Health Information Systems, St Paul, MN) and severity of illness is calculated as the mean cost of all patients in this group divided by the mean cost of all hospitalized patients. An H-RISK score of 1.0 would mean that the child's All-Patient Refined Diagnostic Group severity of illness was the same as the average resource intensity of all pediatric hospitalizations nationwide.

Statistical Analysis

Continuous variables were summarized with medians and interquartile ranges (IQRs), whereas categorical variables were summarized with frequencies and percentages. Bivariate comparisons were made between patients receiving corticosteroids and those not receiving corticosteroids by using Wilcoxon rank tests or χ^2 tests, as appropriate. To account for clustering of patients within hospitals, outcomes were modeled by using generalized estimating equations with binomial distributions or normal distributions after log transforming continuous outcomes, and factors found to be significant at $P < .10$ on bivariate analyses or factors a priori thought to be clinically important were adjusted for with fixed effects. Results are presented as odds ratios (ORs) or rate ratios (RRs) with 95% confidence intervals (CIs). All statistical analyses were performed by using SAS v.9.4. (SAS Institute, Inc, Cary, NC), and P values $< .05$ were considered statistically significant.

RESULTS

Study Population

We identified 2259 patients who met inclusion criteria (Fig 1). Median age was 3 years (IQR 2–5), with 57.4% of patients between age 1 and 4 years. There was a significant male predominance (61.4%). PICU stay was required for 3.2% of our cohort, most (94.4%) of whom were admitted directly to the PICU.

There were 1677 patients (74.2%) in the noncorticosteroid group and 582 patients (25.8%) in the corticosteroid group. Corticosteroid use across the study hospitals varied significantly, with a median (IQR) of 20.5% (11.1%–39.4%) ($P < .001$) (Fig 2) and with significant differences based on geographic region (Supplemental Table 7). Among patients with corticosteroid use, 52.3% started it on hospital day 1 and 26.3% on hospital day 2. The type and route of corticosteroid used in our cohort is as follows: parenteral dexamethasone (85.4%), oral dexamethasone (12.2%), parenteral methylprednisolone (1.9%), and oral prednisone (0.5%). There were no differences in age, sex, payer, or severity index (H-RISK) between patients in the corticosteroid and noncorticosteroid groups (Table 1).

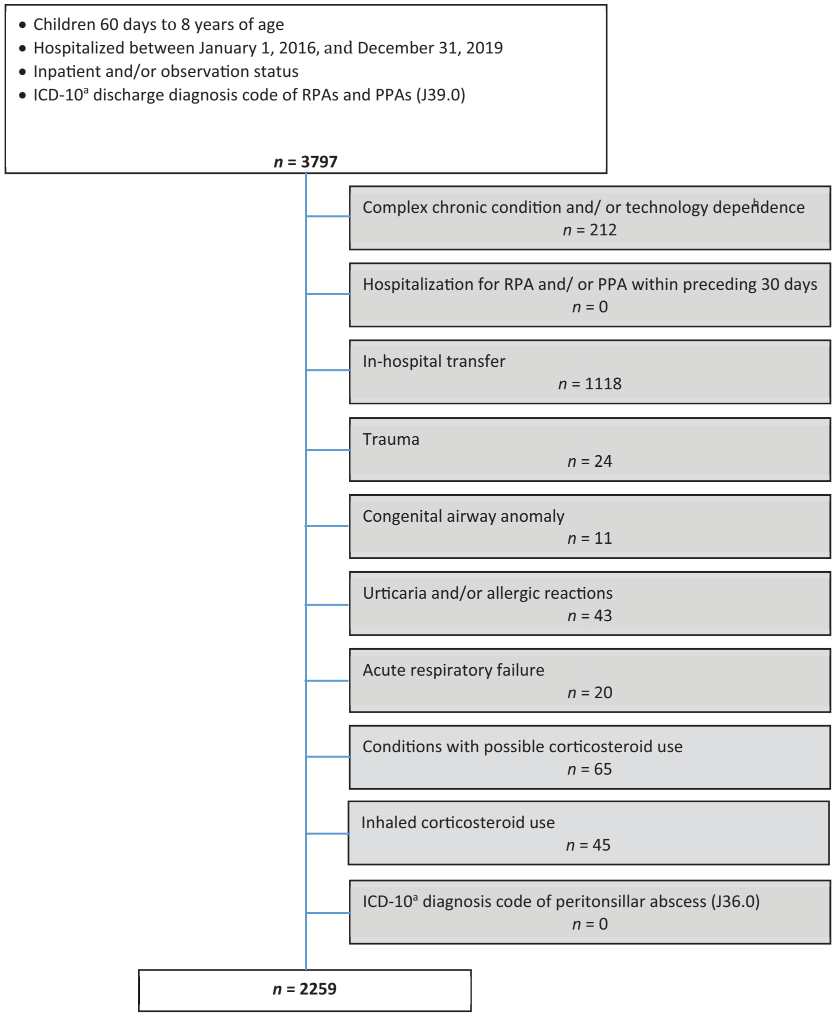

FIGURE 1
Study population. [a] ICD-10. [b] See reference Feudtner et al.[9]

Primary Outcome: Surgical Management

Surgical drainage occurred less frequently in the corticosteroid group, as compared with the noncorticosteroid group (22.2% vs 51.5%; $P < .001$; Table 2), with a significantly lower odds of surgery for the corticosteroid group (OR: 0.28; 95% CI 0.22–0.36; Table 3). Among the 44% who underwent surgery, approximately equal numbers of patients had surgical drainage on days 1, 2, and 3. However, more patients in the corticosteroid group had delayed surgery (ie, surgery on hospital day 3 or later), as compared with those in the noncorticosteroid group (59.7% vs 29.4%; $P < .001$).

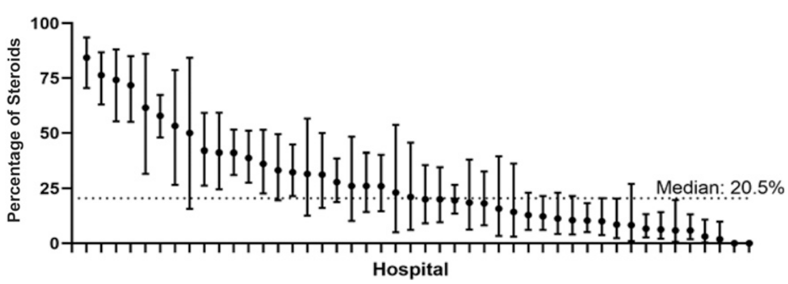

FIGURE 2
Corticosteroid use among PHIS hospital sites. Comparison of the percentage of patients with RPAs and PPAs who had corticosteroid use across PHIS hospitals.

Diagnostic Evaluation

Most patients had a complete blood cell count (83.5%) and C-reactive protein (66.4%) performed, whereas

TABLE 1 Demographic and Clinical Characteristics

	Overall	Noncorticosteroid	Corticosteroid	P
No. discharges	2259	1677 (74.2)	582 (25.8)	
Age, y				
<1	144 (6.4)	110 (6.6)	34 (5.8)	.26
1–4	1297 (57.4)	976 (58.2)	321 (55.2)	.26
5–8	818 (36.2)	591 (35.2)	227 (39)	.26
Sex				
Male	1386 (61.4)	1028 (61.3)	358 (61.5)	.93
Season				
Spring	729 (32.3)	541 (32.3)	188 (32.3)	.90
Summer	437 (19.3)	319 (19)	118 (20.3)	.90
Fall	392 (17.4)	291 (17.4)	101 (17.4)	.90
Winter	701 (31)	526 (31.4)	175 (30.1)	.90
Payer				
Government	1018 (45.1)	740 (44.1)	278 (47.8)	.31
Private	1148 (50.8)	866 (51.6)	282 (48.5)	.31
Other	93 (4.1)	71 (4.2)	22 (3.8)	.31
Illness severity				
PICU stay	72 (3.2)	57 (3.4)	15 (2.6)	.33
H-RISK,a mean (SD)	0.35 (0.17)	0.35 (0.15)	0.34 (0.21)	.34
Imaging studies				
CT scan	1807 (80)	1326 (79.1)	481 (82.6)	.063
MRI	31 (1.4)	27 (1.6)	4 (0.7)	.099
Disposition				
Home	2244 (99.3)	1663 (99.2)	581 (99.8)	.23

[a] H-RISK.

less than half had erythrocyte sedimentation rate (29.4%) and blood cultures (44.7%) done. Laboratory testing and radiographic imaging did not differ between the corticosteroid and noncorticosteroid groups. Most patients underwent CT imaging (80%). Multiple CT scans were performed in 7.3% of patients and occurred more often in the corticosteroid group (9.8% vs 6.4%; $P = .006$).

Medical Management

The most common empirical antibiotic in our cohort was β-lactam and/or β-lactamase inhibitor monotherapy (32.2%), followed by clindamycin monotherapy (28.3%). Antibiotic use differed between our cohorts, with β-lactam and/or β-lactamase inhibitor more frequently used in the noncorticosteroid group (36.3%) and clindamycin in the corticosteroid group (35.1%) ($P < .001$). Use of intravenous hydration and intravenous analgesia was noted in 85.7% and 63.1%, of our overall cohort, respectively; rates did not differ between the corticosteroid and noncorticosteroid groups. Opioid analgesia was required in 52% overall and was used less frequently among patients in the corticosteroid group (45.2% vs 54.4%; $P < .001$).

Health Care Use

The median LOS was 64 hours (IQR 44–86). On bivariate analysis, the LOS was 4 hours shorter for patients in the corticosteroid group, as compared with the noncorticosteroid group ($P = .02$); there was no significant difference in LOS in the risk-adjusted analysis. Hospital costs were lower in the corticosteroid group, as compared with the noncorticosteroid group (RR: 0.92; 95% CI: 0.88–0.97; $P < .001$). After hospital discharge, 2.3% of patients returned to the ED within 7 days for evaluation. Patients in the corticosteroid group had 2.2-times greater odds (95% CI: 1.24–4.05) of having a 7-day ED revisit ($P = .009$). The most common reasons for the ED return visits were for upper respiratory tract diagnoses (30%), fever (14%), or gastrointestinal complaints (14%).

Rates of 30-day hospital readmission did not differ between our 2 cohorts (3% in the noncorticosteroid group versus 4% in corticosteroid group; $P = .29$). Among the 74 patients who were readmitted, the most common reason was for upper respiratory tract diagnoses (65.3%). There were 16 patients who were medically managed during the index admission and then underwent surgical drainage during the readmission; 8 patients were in the noncorticosteroid group (0.5%) and 8 were in the corticosteroid group (1.3%). When including procedures performed during the index admission and/or readmission, the surgical drainage rate remained significantly lower in the corticosteroid group (23.5% vs 52%; $P < .001$).

DISCUSSION

In this multicenter, retrospective study of children with RPAs and PPAs, corticosteroid use during initial medical management was associated with lower rates of surgical drainage, less opioid use, and lower hospital costs. Although corticosteroid use was associated with more 7-day ED revisits, there was no difference in LOS or 30-day hospital readmissions. Our results suggest that corticosteroids may have a role as adjuvant therapy in managing pediatric RPAs and PPAs.

Although in previous studies, researchers have reported corticosteroids as part of initial medical management of RPAs and PPAs, few have directly explored whether its use confers benefit. In a recent study, researchers examined dexamethasone use in deep neck infections.[11] Although in this study, researchers reported overall lower

TABLE 2 Unadjusted Outcomes

	Overall	Noncorticosteroid	Corticosteroid	*P*
Primary outcome				
Surgical drainage	993 (44)	864 (51.5)	129 (22.2)	<.001
Secondary outcomes				
Diagnostic evaluation				
>1 CT scan performed	164 (7.3)	107 (6.4)	57 (9.8)	.006
Medical management				
IV fluid hydration	1937 (85.7)	1446 (86.2)	491 (84.4)	.27
IV analgesia	1425 (63.1)	1071 (63.9)	354 (60.8)	.19
Opioid analgesia	1176 (52.1)	913 (54.4)	263 (45.2)	<.001
Health care use				
LOS, median (IQR), h	64 (44–86)	64 (45–86)	60 (42–85)	.022
Cost, median (IQR)	6685 (4551–9752)	6932 (4818–9910)	5896 (3849–9225)	<.001
7-d ED revisit	51 (2.3)	28 (1.7)	23 (4)	.001
30-d hospital readmission	74 (3.3)	51 (3)	23 (4)	.29

IV, intravenous.

rates of surgical drainage in patients who received dexamethasone, there was no difference in the RPA and PPA subgroups. Previously reported rates of corticosteroid use for RPA and PPA management have ranged from 27% to 100%.[12–14] This wide variation of corticosteroid use was also noted among the hospitals in our study, with rates of use within site ranging from 0% to 84% (median 20%). These data suggest that the decision to use corticosteroids may be driven by institutional and individual physician practices rather than by evidence.

There has been a general shift toward medical management alone for RPAs and PPAs, with researchers of more recent studies reporting drainage rates of ∼40%.[4,7,15] Consistent with these reports, the overall surgical drainage rate was 44% in our study. In addition, we found that corticosteroid use was associated with a lower surgical drainage rate. There was an almost twofold lower rate of drainage in the corticosteroid cohort, as compared with the noncorticosteroid group. This finding suggests a potential role for corticosteroids in the medical management of children with RPAs and PPAs to reduce rates of surgical drainage.

Although we found corticosteroid use was associated with lower rates of surgery, there is concern that it masks disease progression so that patients have initial symptomatic improvement with clinical worsening once corticosteroid effects wane. As such, the timing of surgical intervention is an important factor to consider. Delayed surgery (after 1–2 days of initial conservative treatment) often represents medical management failure. In previous studies, researchers have reported delayed surgical rates of 23% to 45%[15,16]; our data reveal a similar rate (33% in the overall cohort). Previously described factors associated with failed initial medical management and delayed surgery have included abscess diameter >20 to 25 mm on CT imaging,[15–18] as well as younger patient age.[18,19] In our surgical cohort, the use of corticosteroids was associated with higher odds of delayed surgery, possibly because of clinicians' monitoring for a longer period to determine if corticosteroids had adequate effect. Although this is an important association to consider, studies have revealed that in the absence of airway compromise or other complications, delayed surgery after initial medical management failure is safe and generally not associated with worse outcomes[12] or a longer LOS.[20]

The initial diagnostic evaluation did not differ between corticosteroid and noncorticosteroid groups. In a previous report, researchers found that 21% of pediatric patients with deep neck infection required a second CT study.[21] Although our rate of repeat CT imaging (7.3%) was lower than previously described, it was significantly higher in those patients with corticosteroid use. This supports the theory that although corticosteroids provide initial symptomatic improvement, a certain subset of patients may have clinical worsening once the

TABLE 3 Risk-Adjusted Outcomes[a]

	OR and/or RR (95% CI)	*P*
Primary outcome		
Surgical drainage	.28 (.22–.36)	<.001
Secondary outcomes		
Diagnostic evaluation		
>1 CT scan performed	1.7 (1.18–2.44)	.006
Medical management		
IV fluid hydration	.94 (.78–1.13)	.507
IV analgesia	.93 (.74–1.15)	.477
Opioid analgesia	.75 (.61–.92)	.008
Health care use		
LOS, h	.97 (.92–1.02)	.285
Cost	.92 (.88–.97)	.004
7-d ED revisit	2.24 (1.24–4.05)	.009
30-d hospital readmission	1.36 (.82–2.27)	.232

IV, intravenous.

[a] Age, severity index (H-RISK), and antibiotic regimen were included in the risk-adjusted analysis.

anti-inflammatory effect of the corticosteroid wanes, thus prompting additional evaluation for disease progression.

The temporary relief from corticosteroids may also impact health care use, specifically postdischarge acute care visits. Our corticosteroid group had a higher rate of 7-day ED return visits, and the primary reason for returning to the ED was upper respiratory tract diagnoses, which may have been related to the initial diagnosis of RPAs and PPAs. The 30-day readmission rates were not significantly different between the groups. Although there was a higher rate of surgery in the corticosteroid group on readmission, the overall rate of drainage remained lower in this group. These data suggest that although corticosteroids may be part of a successful management regimen, the ideal timing of discharge may be harder to determine when corticosteroids are used.

Appropriate analgesia is an important component of RPA and PPA management, yet it has not been well studied. Despite its analgesic benefit, opioid use in children has been associated with adverse side effects, such as nausea, vomiting, and respiratory depression.[22–24] In addition, postdischarge pediatric opioid medications have led to accidental exposure, misuse, and diversion,[25] contributing to the current opioid epidemic. As such, there have been significant efforts to reduce opioid prescriptions for acute pain from oropharyngeal infections,[24] as well as during the perioperative period for otolaryngology surgeries.[23,26] We noted that opioid use during the hospitalization was higher in the noncorticosteroid group. Corticosteroid administration may decrease the need for opioid use, especially in younger children most affected by RPAs and PPAs, and for whom the potential for opioid-related adverse events is highest.[24]

There are several limitations to our study. This is an observational study, and causality cannot be determined. In addition, the PHIS database contains administrative and billing information, which did not permit assessment of details about corticosteroid administration, such as dosing and frequency. We were unable to determine if corticosteroids were given for medical management, perioperative care, or another medical condition. Because of the inability to determine the rationale for corticosteroid administration, there may be potential for residual confounding by indication. However, we accounted for potential confounding by defining corticosteroid exposure–based surgical status and by adjusting for patient severity. Information about the patient's physical examination findings or diagnostic results (such as imaging and microbiology results) was not available. Thus, we were unable to ascertain if corticosteroids were more frequently used in patients with imaging finding of phlegmon or abscess, although we suspect that corticosteroid use in this setting would be nondifferential by indication. For patients who had repeat CT imaging done, we were unable to determine if the repeat imaging resulted in a change in management (such as a drainage procedure). Previous studies have revealed that larger abscesses, leukocytosis, and methicillin-resistant *Staphylococcus aureus* on wound culture are independently associated with failure of medical management.[21] We were unable to ascertain this information from our data set. If patients in the noncorticosteroid group had a higher incidence of these features, our results would bias our study in favor of finding a benefit with corticosteroid use.

CONCLUSIONS

Treatment of pediatric RPAs and PPAs has largely shifted toward a trial of parenteral antibiotics alone, with surgical drainage in cases without improvement after 1 to 2 days. Optimizing this initial medical management regimen may decrease the need for surgery and reduce the associated surgical and anesthetic risks. In our study, we indicate that corticosteroids may play a significant role because we have observed lower rates of surgery, decreased opioid medication use, and lower hospital costs in the corticosteroid cohort. These findings underscore the need for further prospective studies to identify specific factors associated with medical management failure, for which the use of corticosteroids may provide significant benefit.

ABBREVIATIONS

CI: confidence interval
CT: computed tomography
ED: emergency department
H-RISK: Hospitalization Resource Intensity Scores for Kids
ICD-10: *International Classification of Diseases, 10th Revision*
LOS: length of stay
OR: odds ratio
PHIS: Pediatric Health Information System
PPA: parapharyngeal abscess
RR: rate ratio
RPA: retropharyngeal abscess

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