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# Pediatric Peritonsillar Abscess: Outcomes and Cost Savings From Using Transcervical Ultrasound

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**Objectives:** 1) To analyze clinical outcomes of children stratified by ultrasound into three diagnoses: acute tonsillitis, peritonsillar phlegmon, and abscess; and 2) To compare clinical outcomes and financial impact between children who underwent ultrasound protocol to those who did not.

**Study Design:** Retrospective analysis between two cohorts: ultrasound protocol group and control group.

**Methods:** Children with peritonsillar abscess (PTA) diagnosed in the emergency department (ED) were enrolled during a 2-year period for transcervical ultrasound evaluation of bilateral tonsillar fossae. Data from a cohort of patients with PTA prior to ultrasound screening were also collected from retrospective chart review. Outcome variables were analyzed using multivariate logistic regression.

**Results:** Seventy-eight children (mean 12.3 years) were enrolled in the ultrasound protocol, compared to 101 children (mean 13.6 years) evaluated using traditional methods of examination and/or computed tomography (CT) imaging. Demographics between the two groups were not significantly different.

Only one-third of patients presumed to have PTA by ED staff had ultrasound findings consistent with abscess. Overall treatment failure rate was 8%, requiring readmission or surgical intervention for abscess. Length of stay, surgical drainage, and radiation exposure from CT scans were reduced significantly in the ultrasound group ($P < 0.006$). Differences in readmission rates and mean charges between the two groups did not reach significance.

**Conclusion:** Peritonsillar abscess is a common infection in the pediatric population, but diagnosis can be challenging. Transcervical ultrasound is a safe, cost-effective, and accurate modality to help stratify patients into medical and surgical treatment arms.

**Key Words:** Ultrasound, peritonsillar abscess, CT, cost savings.

**Level of Evidence:** 3b.

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## INTRODUCTION

Peritonsillar abscess (PTA) is the most common infection found in the head and neck, formed in between the palatine tonsil capsule and the superior constrictor muscle fascia. Adolescents and young adults are particularly susceptible to developing PTA, with a cited incidence between 10 to 40 per 100 thousand person-years in patients less than 18 years of age.[1] Clinical signs include uvular deviation, *hot-potato* voice, trismus, and soft palate edema. However, clinical impression alone often poorly differentiates between true abscess and acute tonsillitis, with 78% sensitivity and 50% specificity.[2]

Over the last two decades, the introduction of ultrasound in the emergency room has proven to be an invaluable diagnostic tool. The application of ultrasound to the peritonsillar region was first described in Germany in the late 1980s. Numerous other studies have since discussed the utility of ultrasound in both the intraoral and transcervical approaches. Both methods have been highly sensitive and specific, with the transcervical approach being less invasive and better tolerated in children and in those with significant trismus.[3–6] Complications from untreated PTA are rare but may include sepsis, aspiration of purulent material, and subsequent airway compromise.

The objectives of this study are to examine the clinical course and compare outcomes between children stratified to medical and surgical treatment groups according to transcervical ultrasound findings and those who underwent traditional management based on clinical impression and computed tomography (CT) scan findings. We hypothesized that our transcervical ultrasound

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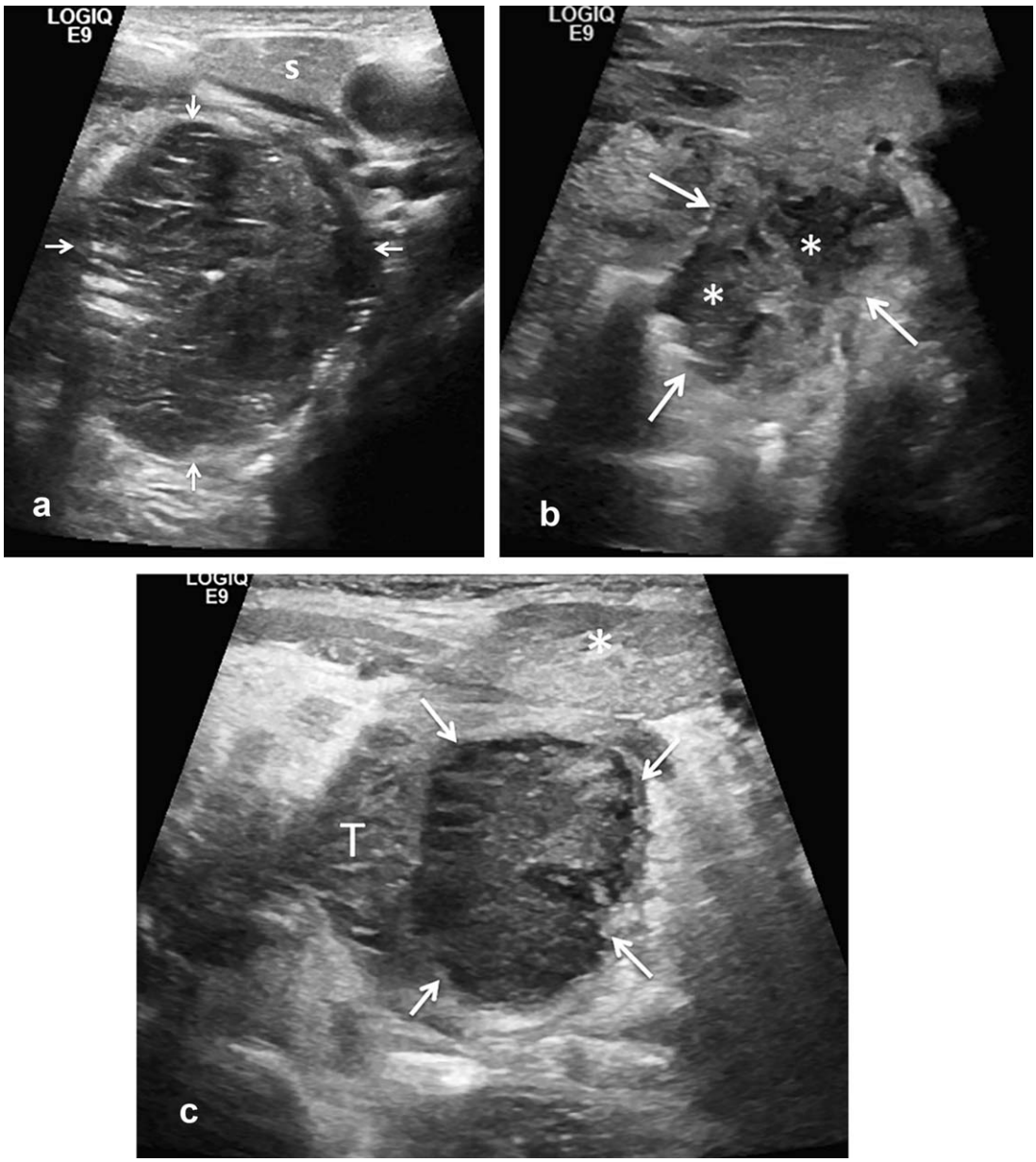


Fig. 1. (a) Transcervical ultrasound showing an example of left acute tonsillitis. Arrows delineate periphery of the tonsil. (b) Transcervical ultrasound showing an example of left peritonsillar phlegmon with developing small intratonsillar abscesses (*). Arrows show ill-defined margins and markedly increased echogenicity of surrounding soft tissues that suggests significant inflammatory change. (c) Transcervical ultrasound showing an example of left peritonsillar abscess, which is lateral relative to the T and deep to the submandibular gland (*).
S = submandibular gland; T = tonsillar tissue.

protocol is cost-effective for diagnosis and an option for reducing radiation exposure in the pediatric population.

## MATERIALS AND METHODS

Institutional review board approval was obtained, and children with possible PTA diagnosed in the emergency department (ED) were enrolled prospectively during a 2-year period from 2013 to 2015 for transcervical ultrasound evaluation of bilateral tonsillar fossae. Diagnosis was determined by a board-certified physician in the ED based on physical exam findings such as tonsillar asymmetry, uvular deviation, and trismus. Children less than 2 years of age, and/or any suspicion for retropharyngeal or parapharyngeal abscesses, or those with hemodynamic instability or respiratory distress were excluded from the study. Age, gender, ethnicity, ultrasound findings, and treatment course were then collected. Of note, all enrolled children in the protocol were able to complete the ultrasound exam, and hence all imaging was adequate for analysis.

The transcervical ultrasound technique utilizes a high-frequency probe placed underneath the mandible to visualize the submandibular gland followed by the tonsil and peritonsillar space. The transcervical ultrasound was performed by licensed ultrasound technicians who followed guidelines put forth by an

TABLE I.
Patient Demographics Between Pre- and Post-ultrasound Groups.

| | Pre-ultrasound Use | | | Post-ultrasound Use | | | |
|---|---|---|---|---|---|---|---|
| | N (%) | Mean ± SD | Median (min., max.) | N (%) | Mean ± SD | Median (min., max.) | *P* Value |
| Age | 101 | 13.6 ± 4.5 | 15.0 (1.3, 20.0) | 78 | 12.3 ± 5.2 | 14.0 (1.8, 20.0) | 0.22 |
| Gender | | | | | | | |
| Female | 56 (55.4%) | | | 40 (51.3%) | | | 0.65 |
| Male | 45 (44.6%) | | | 38 (48.7%) | | | |
| Race | | | | | | | |
| African American | 82 (81.2%) | | | 57 (73.1%) | | | 0.23 |
| White | 11 (10.9%) | | | 10 (12.8%) | | | |
| Hispanic | 8 (7.9%) | | | 8 (10.3%) | | | |
| Asian | 0 (0.0%) | | | 3 (3.9%) | | | |

max. = maximum; min. = minimum; SD = standard deviation.

experienced radiology attending. Our protocol for transcervical ultrasound can be performed in 10 minutes or less. Ultrasound images were then analyzed by a blinded radiologist and categorized as 1) abscess, 2) phlegmon, or 3) tonsillitis. See Figures 1a through 1c for examples of each.

Additionally, corresponding data from a cohort of patients with PTA prior to the use of transcervical ultrasound were collected as a control group from the years 2011 to 2012. This was conducted using Oracle Endeca Information Discovery platform (Oracle Corporation, Redwood Shores, CA) to identify International Classification of Diseases-Ninth Revision diagnosis code 475 for peritonsillar abscess. Outcome variables such as length of stay, readmission, and/or medical treatment failure requiring surgical intervention were then tabulated from both the ultrasound and control groups. The charges for CT scans and transcervical ultrasounds were also obtained and compared. Additionally, charges for an average night of inpatient stay; ear, nose, and throat (ENT) consultation; and procedures, if any, were added to the imaging fee to result in a total charge. These charges were obtained from hospital billing data from 2014 to 2015. Emergency department charges, facility fee, medications, radiologist and anesthesiology charges for sedation associated with CT scans were not included in the total charges.

Comparisons of outcomes were performed using several statistical tests and Stata V14 (College Station, TX). Normality of continuous outcomes (age and total cost) was assessed using a Shapiro-Wilk normality test, and it was determined that neither outcome satisfied the assumption of normality. The comparison of gender and race between the pre- and post-ultrasound groups used a $\chi^2$ test. The comparison of age and total cost used a Wilcoxon rank sum test. The association between ultrasound group and several outcomes (whether or not a CT scan was ordered, performance of a procedure, a length of stay $>$ 23 hours, an ENT consultation in the ER, and readmission within 30 days) was tested using logistic regression analysis, for which each outcome listed was the dependent variable and ultrasound group was the independent predictor. Odds ratios and 95% confidence intervals are presented along with $P$ values. In addition, all five of these outcomes were assessed in a multiple variable logistic regression as predictors to assess their combined predictive effect on the outcome of inclusion in an ultrasound group. Lastly, the type of procedure performed was assessed in only those undergoing a procedure using a Fisher's exact test. All $P$ values $\leq$ 0.05 were considered statistically significant.

## RESULTS

Demographics of age, gender, and race between the pre- and post-ultrasound groups were not significantly different (Table I). The mean age was 13.6 years in the pre-ultrasound group versus 12.3 years in the post-ultrasound group ($P$ = 0.22). Gender was essentially evenly divided between males and females. Most children in both groups were African American. No major complications, for example, airway compromise requiring intubation or sepsis, occurred over the study period. The total number of patients enrolled in the ultrasound group was 78. Of these, eight (10%) had findings on ultrasound of phlegmon, 26 (33%) had peritonsillar abscess, and 44 (56%) had acute tonsillitis.

Table II describes the independent comparison of outcomes between the pre- and post-ultrasound groups. Those in the post-ultrasound group were significantly less likely to have a CT scan ordered (odds ratio [OR] = 0.34, 95% confidence interval [CI] 0.16 – 0.72; $P$ = 0.005). However, there was no significant difference in the proportion of negative CT scans between the pre-ultrasound and post-ultrasounds groups ($P$ = 0.79). Those in the post-ultrasound group were also less likely to have a procedure performed (OR = 0.38, 95% CI 0.20–0.71; $P$ = 0.002). Lastly, those in the post-ultrasound group were significantly less likely to have a length of stay longer than 23 hours (OR = 0.35, 95% CI 0.17–0.71; $P$ = 0.004). See also Figure 2 for a depiction of post-ultrasound outcome variables. The ORs of readmission within 30 days were not significantly different between the pre- and post-ultrasound groups ($P$ = 0.20). The type of procedure (in only those who had a procedure performed) was not significantly different in the pre- or post-ultrasound group ($P$ = 0.54), nor was an ENT consult in the ED ($P$ = 0.38).

Table III extends the analysis of outcomes to a multi-variable model assessing the predictive ability of all dichotomous outcomes in combination. Note that this model does not include the type of procedure because this was only applicable to a subset of the patients. When assessed in combination, having a procedure

TABLE II.
Outcomes Between Pre- and Post-ultrasound Groups.

| Outcome | | Pre-ultrasound Use | Post-ultrasound Use | Odds Ratio | 95% Confidence Interval | *P* Value |
|---|---|---|---|---|---|---|
| CT scans | No | 66 | 66 | 1.00 | | |
| | Yes | 35 | 12 | 0.34 | 0.16–0.72 | 0.005 |
| Procedure performed | No | 51 | 57 | 1.00 | | |
| | Yes | 50 | 21 | 0.38 | 0.20–0.71 | 0.002 |
| Type of procedure* | Needle | 11 | 6 | | | |
| | I&D | 32 | 14 | | | 0.54 |
| | Both needle and I&D | 2 | 1 | | | |
| | Quinsy tonsillectomy | 5 | 0 | | | |
| Length of stay > 23 hrs. | No | 64 | 65 | 1.00 | | |
| | Yes | 37 | 13 | 0.35 | 0.17–0.71 | 0.004 |
| ENT consult in ER | No | 32 | 20 | 1.00 | | |
| | Yes | 69 | 58 | 1.34 | 0.70–2.60 | 0.38 |
| Readmission within 30 days | No | 87 | 72 | 1.00 | | |
| | Yes | 14 | 6 | 0.52 | 0.19–1.42 | 0.20 |

*Analysis performed by Fisher's exact test on only those patients receiving a procedure.
CT = computed tomography; ENT = ear, nose, and throat; ER = emergency room; I&D = incision and drainage.

performed, length of stay over 23 hours, and ENT consultation in the ED were all significant predictors of whether a patient was in the pre- or post-ultrasound group. With all other predictors held constant, those patients who had procedures performed were less likely to be in the post-ultrasound group (OR = 0.28; $P$ = 0.001); those with a length of stay over 23 hours were less likely to be in the post-ultrasound group (OR = 0.34; $P$ = 0.010); and those with an ENT consult in the ED were more likely to be in the post-ultrasound group (OR = 2.98; $P$ = 0.009). Of note, there was no association between length of stay over 23 hours and having a procedure ($P$ = 0.28).

Finally, when total costs were compared between those in pre-ultrasound group to those in the post-ultrasound group, the median cost in the post-ultrasound group was lower at $296 compared to $510 in the pre-ultrasound group, but the difference did not reach statistical significance ($P$ = 0.4). Cost for CT scans ordered during the 2-year period prior to the establishment of our ultrasound protocol was $11,935, whereas the cost for CT scans during the study period was $4,092, with a cost savings in imaging fee alone of almost $8,000.

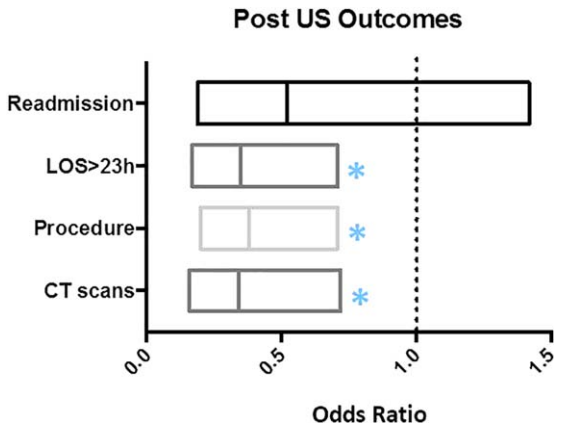


Fig. 2. Outcome variables with corresponding odds ratios in the post-US group as compared to the pre-US group.
*Significance with $P < 0.006$.
CT = computed tomography; h = hours; LOS = length of stay; US = ultrasound. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

## DISCUSSION

Transcervical ultrasound for diagnosis of peritonsillar abscesses can be an effective and cost-saving tool. This protocol has been particularly useful in the ED setting to triage patients: those who need ENT consultation and those who could benefit from surgical drainage. As shown in numerous other studies, the sensitivity and specificity of clinical impression is often poor and unreliable, particularly in the pediatric population where cooperation and examination may be difficult. Over half of patients enrolled in the study thought to have presumed PTA were found to have acute tonsillitis without abscess formation. Our previous study[4] showed that even otolaryngology evaluation is not sufficient to accurately differentiate between the presence or absence of PTA. The only independent variable that was significant in differentiating between the two was ultrasound. The transcervical ultrasound approach has been better tolerated and less limited by trismus and patient discomfort compared to an intraoral approach.[5,6]

Our management algorithm has been stratified to medical treatment for those with ultrasound findings of tonsillitis, phlegmon, or small abscesses and those with true abscess of at least 1.5 cm to surgical drainage at the bedside or in the OR with good treatment success. Overall treatment failure rate during the ultrasound protocol period was 8% requiring readmission or surgical intervention for abscess compared to 14% during the pre-ultrasound time frame. This difference was not

TABLE III.
Multi-variable Model of Predictors.

| Predictor | Odds Ratio* | 95% Confidence Interval | *P* Value |
|---|---|---|---|
| CT scans ordered | 0.56 | 0.25–1.25 | 0.16 |
| Procedure performed | 0.28 | 0.13–0.61 | 0.001 |
| Length of stay > 23 hours | 0.34 | 0.15–0.77 | 0.010 |
| ENT consult in ER | 2.98 | 1.32–6.75 | 0.009 |
| Readmission within 30 days | 0.54 | 1.32–1.64 | 0.28 |

*Represents the odds of being in the ultrasound cohort compared to the odds of being in the pre-ultrasound cohort.

CT = computed tomography; ENT = ear, nose, and throat; ER = emergency room.

significant. However, transcervical ultrasound did significantly reduce length of stay, number of procedures, and CT scans. The reduction in CT scans is beneficial in the pediatric population because their growing cells are particularly susceptible to the effects of radiation. Studies have found that the incidence of cancer such as leukemia or brain cancer are 24% higher in children between the ages of 0 and 19 years of age who were exposed to CT radiation versus children who were not exposed.[7]

Finally, despite the lack of difference in cost between the pre- and post-ultrasound time frame, the available fees analyzed was for imaging only; length of stay; ENT consultation; and procedures, if any, and do not include ED charges, facility fee, medications, radiologist and anesthesiology charges for sedation associated with CT scans. If all of the cost variables were tabulated, we anticipate that the cost will be significantly less in the ultrasound group. Future studies could further extrapolate such cost variables. Furthermore, ultrasound did not appear to significantly improve the proportion of negative CT scans because over 50% of these patients had been transferred with a CT scan performed at an outside hospital (OSH). These CT scans often are reflexively ordered by an OSH when ENT expertise is lacking, and they often are misinterpreted by less experienced radiologists as peritonsillar abscesses when in fact they are intratonsillar abscesses that do not require surgical intervention.

Limitations of this study include its retrospective nature, as well as an inherent study bias during the study period when ENT consultation by the ED resulted in the enrollment of subjects for the ultrasound group and favoring ultrasound over CT imaging. These biases likely explain the significance found on multivariate analysis in the higher likelihood of ENT consultation and fewer CT scans during the post-ultrasound time frame. We also cannot account for provider differences in the management of abscesses. Nevertheless, transcervical ultrasound is well tolerated and does not expose children to unnecessary radiation or intravenous sedation, which sometimes is necessary for CT scans. We do not disregard a thorough physical examination and other clinical signs that are highly suggestive of PTA. In cases where examination is difficult or equivocal, we propose that our practice algorithm be utilized (Fig. 3). If a patient with suspected PTA presents with high certainty on physical examination, then proceed to gold standard of abscess drainage. However, if there is doubt or any inconsistencies on examination or history, then proceed to transcervical ultrasound and treat accordingly based on ultrasound findings. Based on previous analysis by Fordham et al.,[4] the false positive patients who had identification of abscess on ultrasound but no findings of purulence on I&D, or who were treated successfully with only antibiotics, had an abscess cavity with an average size of 15 mm (ranged from 11 mm to 21 mm). We followed the same treatment algorithm of medical treatment if the abscess size was less than 1.5 cm or if ultrasound shows tonsillitis or phlegmon. The caveat is that these are guidelines only; the final clinical decision should consider the whole picture of the patient, along with their course of illness as well as their parent's treatment preference. Additional sample size over a longer period of time can help further streamline this algorithm, and may even help facilitate ED evaluation in the adult

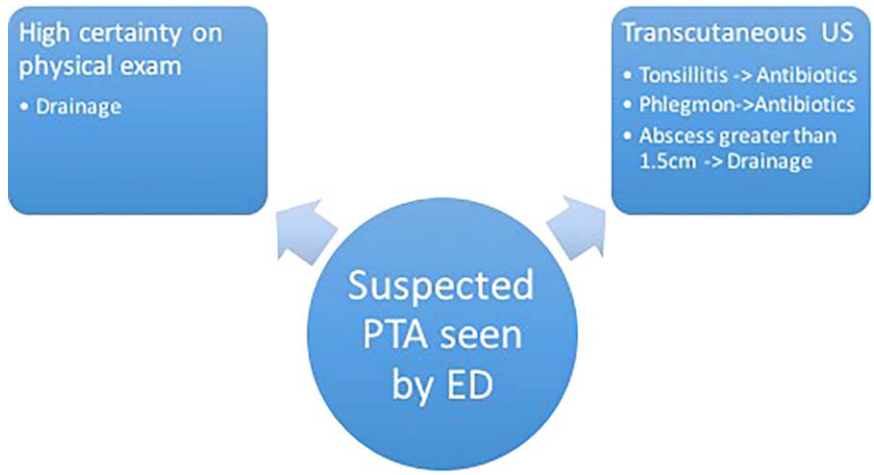


Fig. 3. Flowchart that shows our proposed practice algorithm for management of PTA in the ED.
ED = emergency department; PTA = pediatric peritonsillar abscess; US = ultrasound. [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

population as well as aid in treatment with potential ultrasound-guided real-time drainage.

## CONCLUSION

Peritonsillar abscess is a common infection in the pediatric population, but diagnosis can be challenging. Based on our findings, the ED was accurate in diagnosing true abscess in only one-third of the cases. The ultrasound group had significantly much lower length of stay, rate of procedures, and radiation exposure from CT scans compared to the pre-ultrasound group. No difference in readmission rates between the two groups was demonstrated. Hence, transcervical ultrasound is a safe, cost-effective, and accurate modality to help stratify patients into medical and surgical treatment arms, particularly in the ED setting.

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