



## Introduction

Viral croup, or laryngotracheitis, is a common cause of stridor in children, and is characterized by subglottic inflammation, secondary to viruses like *Parainfluenza* and *Influenza*. Presentation is variable but usually slow in onset, characterized by stridor, hoarseness, and a barking cough. Symptoms typically last for 3-7 days but can extend 14 days in atypical cases.<sup>1</sup>

While most children are managed as outpatients, some require admission or airway intervention. Treatment typically consists of steroids, racemic epinephrine, heliox, and rarely intubation. If symptoms do not improve in 48-72 hours, the possibility of tracheitis or other airway pathology must be entertained. Tracheitis, or bacterial croup, is a bacterial superinfection characterized by formation of thick, purulent secretions that are difficult to clear and potentially life-threatening. Classically, the patient with tracheitis appears toxic and is febrile with leukocytosis.<sup>2</sup> Conversely, the patient with viral croup is non-toxic, has variable fever, and variable white blood cell count.<sup>3</sup> Tracheitis presentation is often acute but can also be insidious. If a patient is not responding to medical management for presumed viral croup, otolaryngology may be consulted for direct laryngoscopy and bronchoscopy (DLB) to rule out tracheitis or other airway pathology. However, risks of DLB during acute croup include worsening the respiratory status from general anesthesia and instrumentation of an already edematous subglottis. This can result in intubation or transfer to a higher level of care, increasing cost, complications, and admission length. While the benefits of diagnosing tracheitis outweigh the risks of worsening the respiratory status during acute croup, the risk-benefit ratio of diagnosing a concurrent airway pathology in acute croup is uncertain.

The goal of this pilot study is to evaluate if performing DLB in hospitalized croup is safe, has sufficient yield in identifying tracheitis or unexpected pathology, and to guide practitioners in management of hospitalized croup patients. Additionally, we sought to identify if preoperative physiologic signs predict operative findings.

## Methods and Materials

- Retrospective chart review was performed at Texas Children's Hospital (2003-2011).
- ICD-9 coding search criteria included admitting diagnoses for acute tracheitis, acute laryngotracheitis, and croup.
- The initial search revealed 521 admissions. These did not include patients discharged from the emergency department or placed in prolonged observation status.
- Patients with prior tracheostomy tubes were excluded.
- 18 patients underwent inpatient DLB with an ICD-9 admitting diagnosis of croup (17) and tracheitis (1).
- Hospitalization dates, time to operation, age, gender, comorbidities, complications within 72 hours of operation, and pre-operative and post-operative level of care within 72 hours of DLB were recorded.
- Preoperative vitals including maximum and mean temperature, heart rate, systolic blood pressure, maximum and mean respiratory rate, and blood oxygen saturation per pulse oximetry were recorded.
- Operative findings were reviewed. Patients were assigned to one of three groups: standard croup (n=7), concurrent airway anomaly (n=7), or tracheitis (n=4). Patients in the concurrent airway anomaly group all had concomitant croup.
- Univariate analysis was performed using the Kruskal-Wallis Test to correlate vital signs with operative findings.

## Results

**Table 1. Patient Characteristics**

Gender		Comorbidities	
Male	61.1% (n=11)	GERD	27.8% (n=5)
Female	38.9% (n=7)	Prior Intubation	22.2% (n=4)
Age (mean in years)		Prematurity	16.7% (n=3)
Croup (n=7)	0.98 years	Asthma	11.2% (n=2)
Tracheitis (n=4)	1.51 years		
Other Airway Anomalies (n=7)	1.41 years		
Recurrent Croup (n=6)	1.86 years		

**Table 2. Operative Findings and Interventions**

Finding	Intervention
Tracheitis (n=4)	Debridement
Tracheal xanthogranuloma(n=1)	Subsequent open resection
Bilateral subglottic cyst (n=1)	CO2 laser marsupialization
Hypertrophic subglottic mucosa (n=1)	CO2 laser removal
Irregularity of distal trachea/left bronchus (n=1)	Pulmonary consultation
Supraglottic thrush (n=1)	Initiation of anti-fungal treatment
Posterior glottic web (n=1)	Observation
Type 1 laryngeal cleft (n=1)	Observation
Laryngomalacia (n=2)	Observation

- Of the four children with prior intubations, all had concurrent airway anomalies (RR 4.67; P=.0026).
- Four of the five children with GERD had airway anomalies (RR 3.47; P=.0247).
- Four of the six children with recurrent croup had concurrent airway anomalies.
- Nine of the 13 abnormalities required intervention, seven of which were operative interventions.
- There were no significant complications within 72 hours of DLB.

## Vital Signs (Table 3)

- Mean temperature and change in mean temperature were both significantly elevated in the tracheitis group (p=0.016), but the maximum temperatures were not significantly different between groups.

**Table 3. Mean Preoperative Vital Signs by Operative Findings**

Vital Signs	Croup (n=7)	Other (n=7)	Tracheitis (n=4)	P
Maximum Temperature (mean)	99.5 ± 0.52	99.1 ± 0.59	100 ± 2.25	0.58
ΔMaximum Temperature (mean)	2.24 ± 0.52	1.83 ± 0.59	2.75 ± 2.25	0.58
Temperature (mean)	98.1 ± 0.6	97.5 ± 0.48	98.6 ± 0.22	0.016
Δ Temperature (mean)	0.8 ± 0.6	0.17 ± 0.48	1.3 ± 0.22	0.016
Heart Rate (mean)	129 ± 8.79	126 ± 17.9	131 ± 4.79	0.59
ΔHeart Rate (mean)	-0.69 ± 16.3	3.27 ± 10.8	5.57 ± 9.98	0.38
Maximum Respiratory Rate (mean)	49.4 ± 9.22	48.7 ± 13	49 ± 10	0.88
Δ Maximum Respiratory Rate (mean)	12.3 ± 5.77	14.9 ± 11.3	13.8 ± 11.1	0.93
Respiratory Rate (mean)	33.3 ± 4.56	36.1 ± 8.98	33.2 ± 3.1	1.00
ΔRespiratory Rate (mean)	-3.85 ± 2.24	2.22 ± 5.23	-2.08 ± 3.07	0.047
Oxygen Saturation (mean)	98.2 ± 0.78	97.9 ± 1.5	97.8 ± 1.57	0.97
Δ Oxygen Saturation (mean)	-1.77 ± 0.78	-2.07 ± 1.5	-2.17 ± 1.57	0.97
Systolic Blood Pressure (mean)	106 ± 6.72	112 ± 12.4	114 ± 10.6	0.35
Δ Systolic Blood Pressure (mean)	23.7 ± 7.37	27.4 ± 12	30.2 ± 9.35	0.63

Δ indicates change relative to the established age-related normals.<sup>4-6</sup>

± indicates 1 standard deviation

P-values for univariate analysis

## Level of Care

- Non-ICU Patients were unlikely to be transferred to a higher level of care or intubated after DLB.
- There was only one escalation in level of care in the immediate post-operative period.
- All patients who were intubated during DLB were in the ICU setting pre-operatively. Preoperative ICU level of care correlates with intubation, as 66% (4/6) of ICU patients were intubated in the operating room.

## Discussion

- There is paucity of literature examining DLB in the inpatient croup population.<sup>1,7,8</sup> Tan<sup>1</sup> looked predominantly at the inpatient croup population (n=18). Jabbour<sup>7</sup> and Delaney<sup>8</sup> looked at predominantly outpatient recurrent croup populations with small numbers of inpatients (n=16 and n=12 respectively). These two studies show inpatient consultation (relative to outpatient) is significantly associated with positive DLB findings in the recurrent croup population (RR 5.3-6.1).
- However, there is little objective data regarding the risk-benefit ratio of performing inpatient DLB in hospitalized croup.
- Beneficially, diagnosis of tracheitis can be made, cultures taken, and treatment employed via endoscopic debridement, intravenous antibiotics, and possibly intubation. Likewise other airway anomalies may be diagnosed and addressed.

## Comorbidities (Table 1)

- Increased suspicion for concurrent airway anomaly should be present in patients with prior intubations, GERD, or recurrent croup.

## Operative Findings (Table 2)

- 61% of our patients had pathology outside croup, and two patients had multiple abnormalities. Clinical suspicion yielded a high rate of positive operative findings.
- Flexible laryngoscopy likely could have diagnosed the patient with supraglottic thrush, but at the minimum 39% of our patients required significant operative intervention.
- Selection bias plays a role in the findings as inpatient pediatricians consult otolaryngologists for airway evaluation when they suspect aberrant pathologies or the clinical course is not following the expected natural history.

## Vitals (Table 3)

- Elevated mean temperatures should increase suspicion for tracheitis, and lack of substantial fever does not rule out tracheitis.
- Increased respiratory rate should raise suspicion for concurrent airway anomalies (P=.047). We presume these concurrent respiratory lesions further increased airway resistance, decreased tidal volume, and required an elevated respiratory rate to maintain minute ventilation.

## Level of Care/Complications

- While we expect some increase in subglottic edema from DLB, the magnitude of this increase does not seem to be clinically significant in non-ICU patients.
- Families and pediatricians should understand the increased likelihood of intubation in ICU patients, and if circumstance allows, we recommend delaying DLB until patients are out of the ICU.

## Conclusions

Performing inpatient DLB in a hospitalized croup population is reasonably safe and has a sufficient yield of identifying tracheitis or other concurrent airway pathology. Elevated preoperative mean temperatures are correlated with tracheitis, whereas elevated respiratory rates are correlated with concurrent airway pathology. Recurrent croup and history of GERD or prior intubation increase the yield of DLB.

## Contact

Daniel P. Fox, MD  
 Baylor College of Medicine  
 Department of Otolaryngology—Head & Neck Surgery  
 Email: [df2@bcm.edu](mailto:df2@bcm.edu)

Acknowledgements:  
 We thank Dr. Wei Zhang, Ph.D. of Texas Children's Hospital for her statistical analysis of our data.

## References

- Tan AK, Manosian J. Hospitalized croup (bacterial and viral): the role of rigid endoscopy. *J Otolaryngol*. 1992;21:48-53.
- Mahajan A, Azeur D, Chang C, Warren WS, Varma RK. Bacterial tracheitis: diagnosis and treatment. *Int J Pediatr Otorhinolaryngol*. 1985;10:271-277.
- Baker SK. Laryngotracheobronchitis—a continuing challenge in child health care. *J Otolaryngol*. 1979;8:684-690.
- Fleming S, Thompson M, Stevens R, Hengstler C, Pflaumanna A, Macoschia L, et al. Normal ranges of heart rate and respiratory rate in children from birth to 18 years: a systematic review of observational studies. *Lancet*. 2011;377:1011-1018.
- Craig H, Sauerstein GA, Williams PK, Smith R. Temperature measured at the axilla compared with rectum in children and young people: systematic review. *BMJ*. 2002;325:1174-1178.
- Mackowiak PA, Wasserman SS, Levine MM. A critical appraisal of 98.6 degrees F, the upper limit of the normal body temperature, and other legacies of Carl Reinhold August Wunderlich. *JAMA*. 1992;268:1576-1580.
- Jabbour N, Parker W, Finkelman M, Linder TA, Samra D. Incidence of operative endoscopy findings in recurrent croup. *Otolaryngol Head Neck Surg*. 2011;144:596-601.
- Delany DL, Johnson DR. Role of direct laryngoscopy and bronchoscopy in recurrent croup. *Otolaryngol Head Neck Surg*. 2015;152:159-164.
- Polina DS, Jones RD, Pillsbury HC. Severe hospitalized croup: treatment trends and prognosis. *Laryngoscope*. 1984;94:1372-1375.
- Schulter DG, Brock HG. The safety of intubation in croup and epiglottitis: an eight-year follow-up. *Laryngoscope*. 1975;85:33-46.
- Segal AD, Orghian G, Moneishi R, Mandani M, Upshur RE. Croup hospitalizations in Ontario: a 14-year time-series analysis. *Pediatrics*. 2005;116:51-55.
- Casper T, Kuznetsov G, Prasad R, Elshahin H. Atypical croup: association with airway lesions, atopy, and epiglottitis. *Otolaryngol Head Neck Surg*. 2012;147:209-214.
- Thompson DM. Laryngomalacia: factors that influence disease severity and outcomes of management. *Curr Opin Otolaryngol Head Neck Surg*. 2010;18:564-570.