



IN THE NAME OF GOD



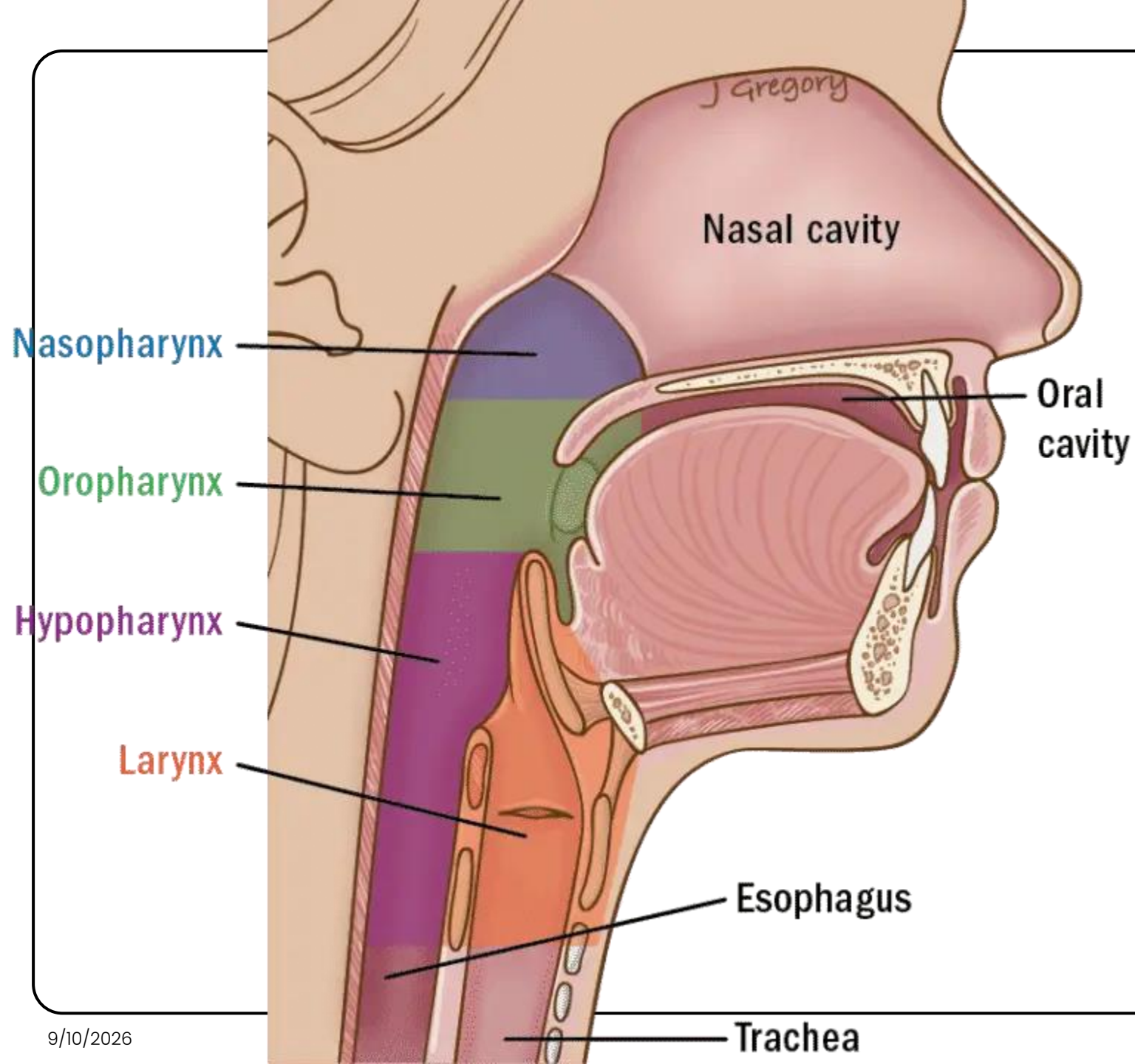
CROUP (LARYNGOTRACHEITIS) IN PEDIATRIC PRACTICE

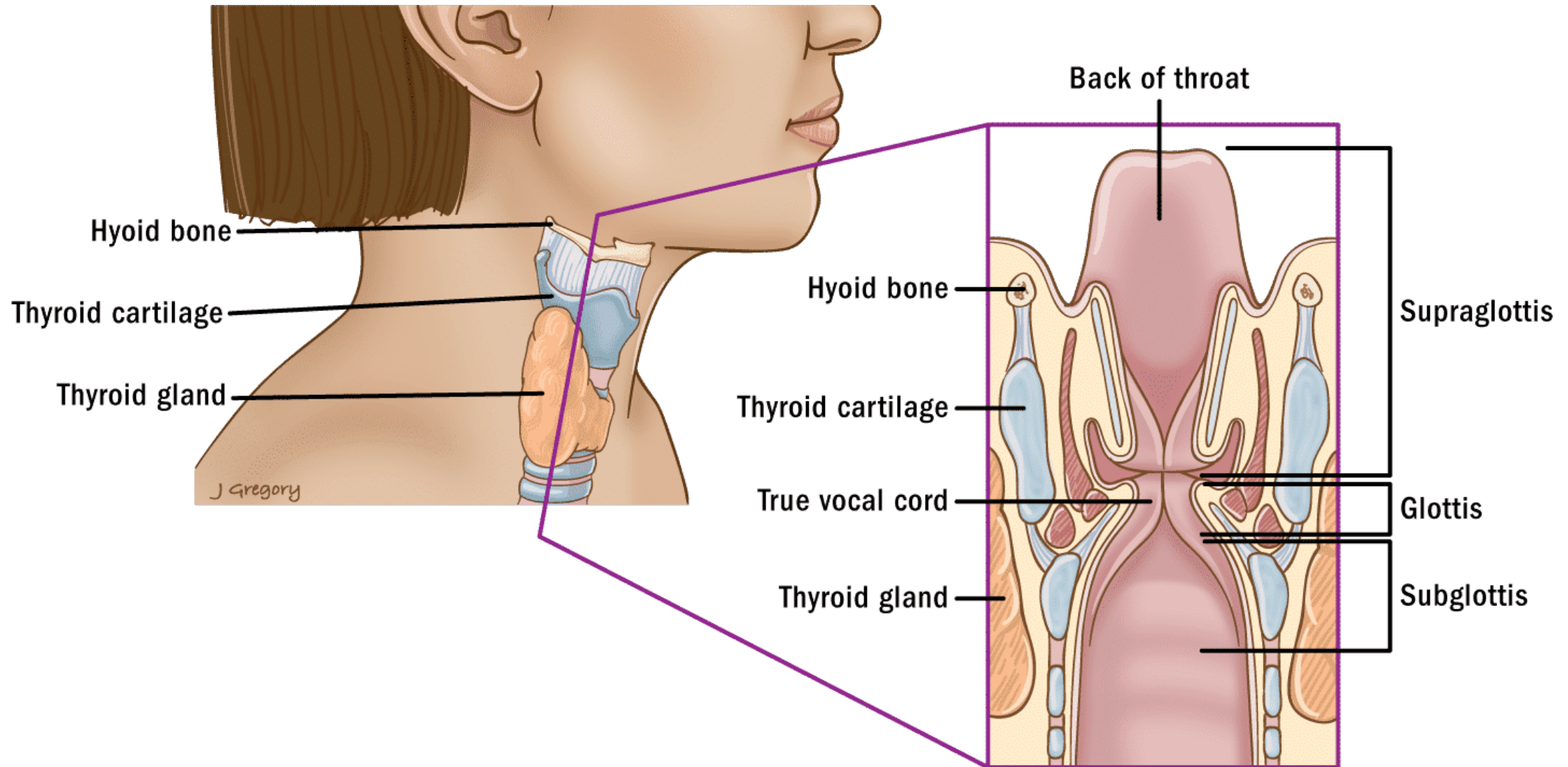
F.SH MD
PROFESSOR OF PEDIATRIC INFECTIOUS DISEASES

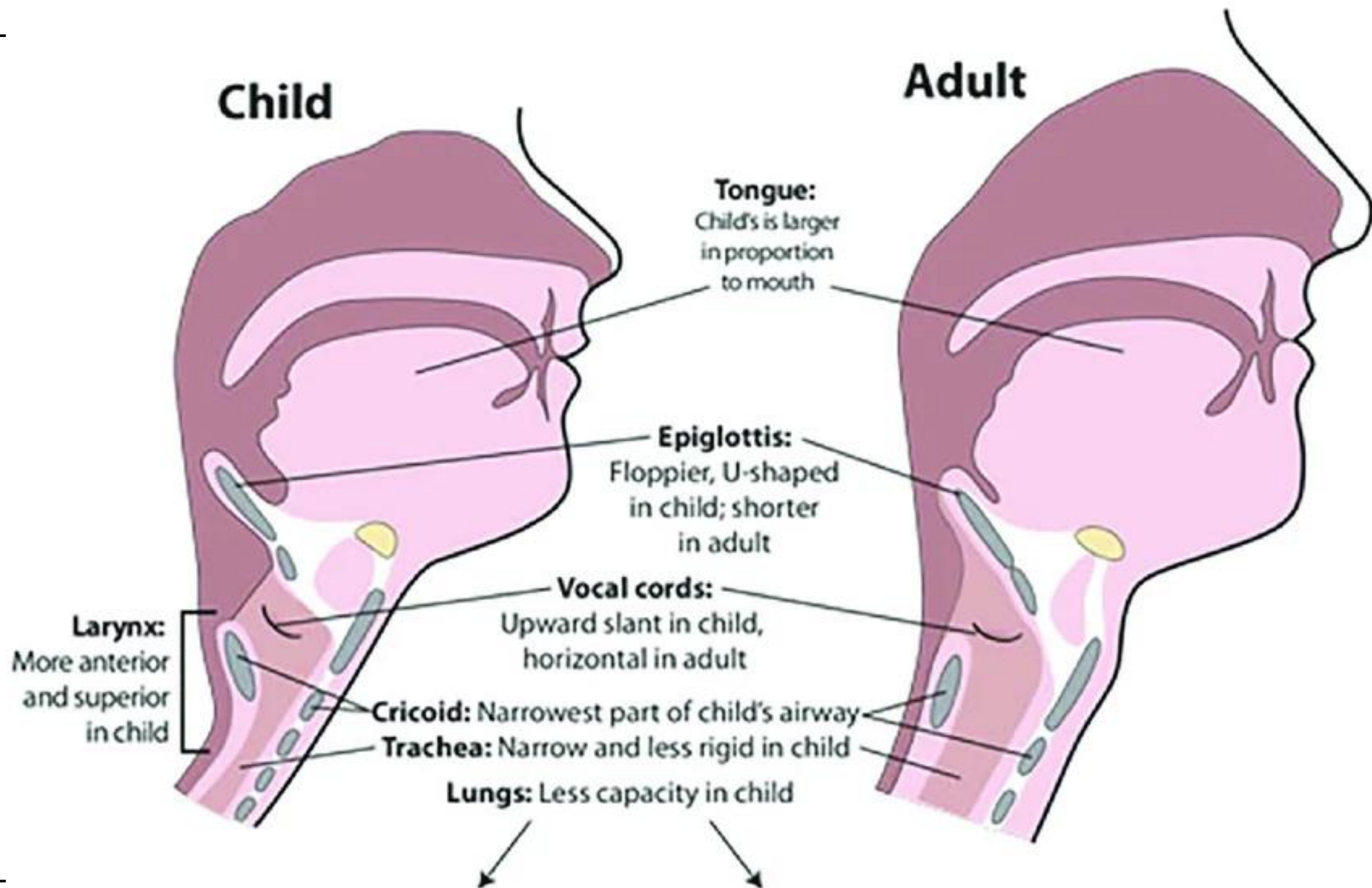
CROUP



 **"Croup"** refers to acute Laryngitis (Voice Box), Laryngotracheitis (Voice Box) and) and (Wind Pipe) Trachea and Laryngotracheobronchitis









Pathophysiology & Airway Fluid Mechanics

- **Anatomical Vulnerability:**

- The **subglottis** (encircled by the complete, rigid cricoid ring) is the **narrowest** portion of the pediatric upper airway.

- **Poiseuille's Law in the Subglottis:**

$$\text{Resistance} \propto 1/r^4$$

- The **resistance to flow is inversely related to the radius of the airway raised to the fourth power**, a small amount of narrowing (due to edema, inflammation, etc.,) in the already small pediatric airway could have severe consequences on respiratory function



Pathophysiology & Airway Fluid Mechanics

. Clinical Consequences:

- Mucosal inflammation, edema, and fibrinous exudate lead to dynamic inspiratory collapse (**inspiratory stridor**).
- Vocal cord edema results in classic **hoarseness/aphonia**.
- High-velocity airflow across narrowed subglottis creates the resonant, **barking cough**.

IMPORTANT SYMPTOMS

Inspiratory stridor,
barking cough, and
hoarseness





Epidemiology & Seasonality

. Demographics:

- **Peak incidence:** 6 months to 36 months (peak at 1–2 years).
- **Male-to-female ratio:** ~1.4 : 1.
- **Rare** in infants <3 months (consider anatomical subglottic stenosis or vascular rings) and **children >6 years**.

. Temporal Patterns:

- Classic autumn/early **winter peaks** coincide with **Parainfluenza surges**.
- **Secondary late winter/spring peaks** associated with **RSV, Metapneumovirus, and Influenza**.

Etiology & Pathogen Profiles (Viral)



Pathogen	Frequency	Seasonality / Pattern	Clinical & Epidemiologic Features
Human Parainfluenza 1 (HPIV-1)	%70–80%	Biennial peaks (Autumn/Early Winter)	Causes classic epidemic croup ; major driver of ED visits.
Human Parainfluenza 2 (HPIV-2)	%5–10%	Alternate years to HPIV-1	Typically causes milder disease.
Human Parainfluenza 3 (HPIV-3)	%5–10%	Spring/Summer endemic	More often associated with bronchiolitis/pneumonia ; sporadic croup.
Influenza A & B	%5–10%	Winter epidemics	Severe presentations , higher fevers; higher risk of bacterial superinfection.
RSV / hMPV	<5%	Winter/Spring	Prominent lower airway involvement (wheezing, rales).
Adenovirus / SARS-CoV-2	Variable	Year-round	Exudative pharyngitis , conjunctivitis; prolonged viral shedding.



Bacterial causes:

Mycoplasma

Staphylococcus aureus, *Streptococcus pyogenes*,
and *Streptococcus pneumoniae*

Disease Stages:

- **Prodrome:** 12 to 72 hours of low-grade fever, rhinorrhea, and coryza.
- **Classic Triad:**
 - Barking ("seal-like") cough
 - Inspiratory stridor (worse during agitation)
 - Hoarseness
- **Natural Course:** Symptoms typically peak on nights 2–3 and resolve within 48–72 hours (overall duration ≈ approx 5–7 days).



CLINICAL STIGMA

As airway obstruction progresses, stridor develops **Biphasic stridor** (stridor heard on both inspiration and expiration) at rest is a sign of significant upper airway obstruction.

When airway obstruction becomes severe, suprasternal, subcostal, and intercostal retractions may be seen.

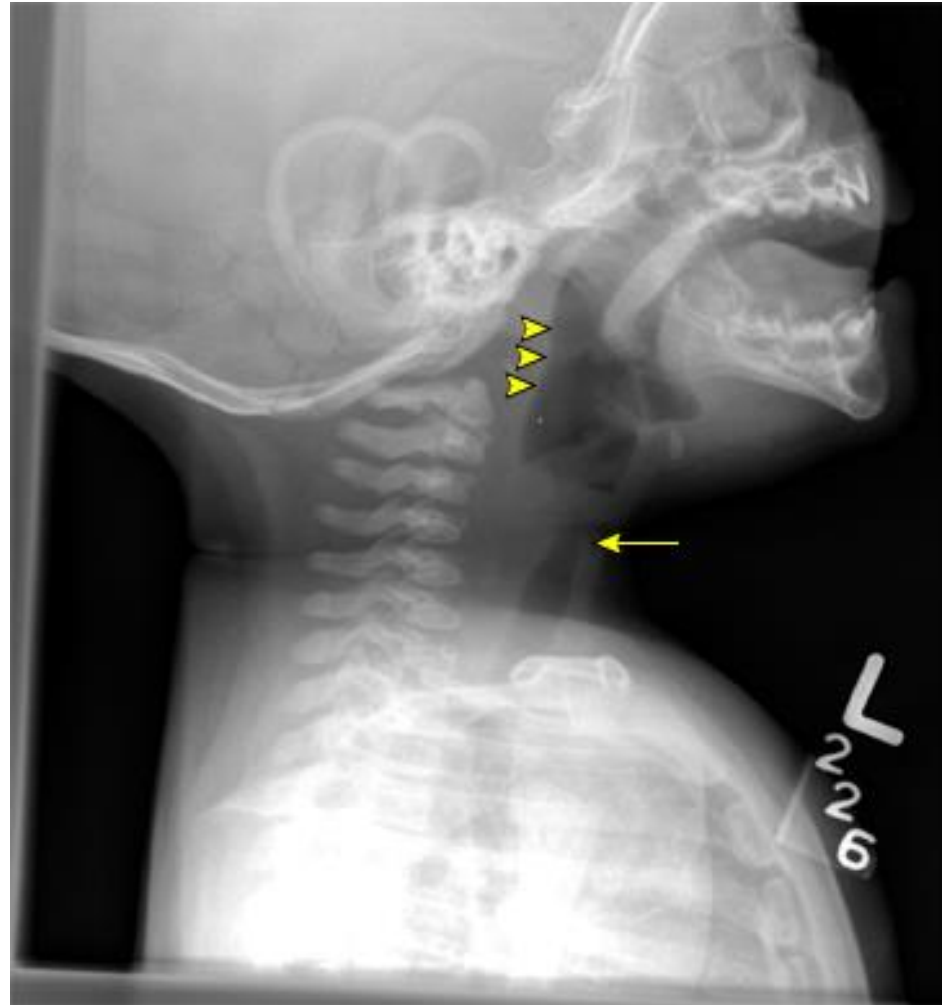
As upper airway obstruction progresses, the child may become restless or anxious.



Radiology



Steeple sign



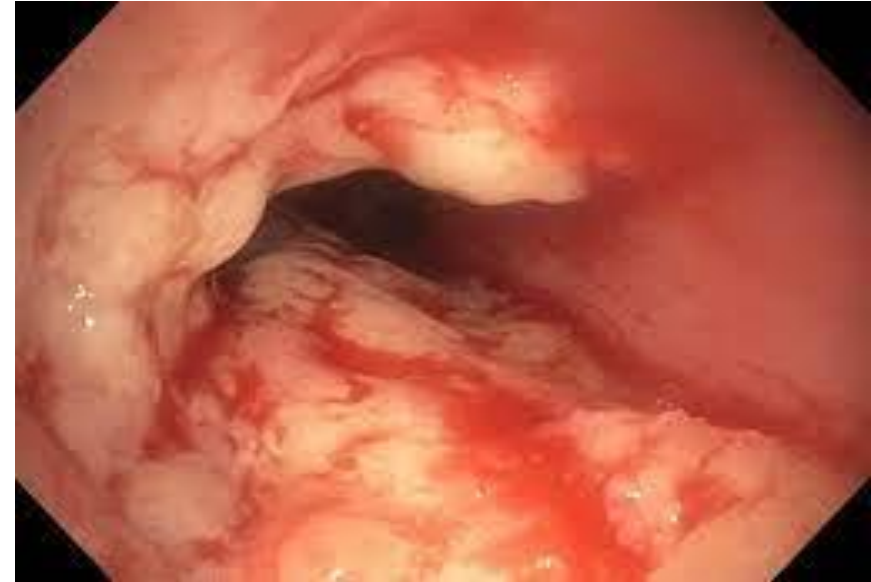
Lateral neck radiograph showing subglottic narrowing (arrow) and distended hypopharynx (arrowheads) consistent with acute laryngotracheitis.



Differential Diagnosis of Acute infectious Upper Airway Obstruction

Feature	Viral Croup	Bacterial Tracheitis	Acute Epiglottitis	Foreign Body Aspiration
Etiology	Parainfluenza 1–3	<i>S. aureus</i> (incl. MRSA), <i>S. pyog.</i>	<i>H. influenzae</i> type b, <i>S. pyog.</i>	Non-infectious foreign object
Onset / Prodrome	1–3 days URTI prodrome	Viral prodrome → → acute collapse	Rapid, fulminant (<12–24 h)	Sudden, witnessed choking/coughing
Fever & Toxicity	Low-grade; Non-toxic	High fever; Toxic / Moribund	High fever; Toxic / Ashen	Afebrile; Non-toxic
Cough & Voice	Barking cough; Hoarseness	Severe croupy cough; Purulent spit	Absent cough; Muffled (" hot potato ")	Paroxysmal coughing; Aphonia
Posture & Drooling	Normal; Drooling rare	Variable; Secretions prominent	Tripod , neck hyperextended; Drooling	Variable; distress depending on site
X-ray Findings	Subglottic tapering (Steeple)	Irregular tracheal shadow / membranes	"Thumbprint" sign, arytenoid edema	Normal / Air-trapping / Radio-opaque
Response to Epinephrine	Good / Rapid	Poor / Transient	No response	No response

BACTERIAL TRACHEITIS



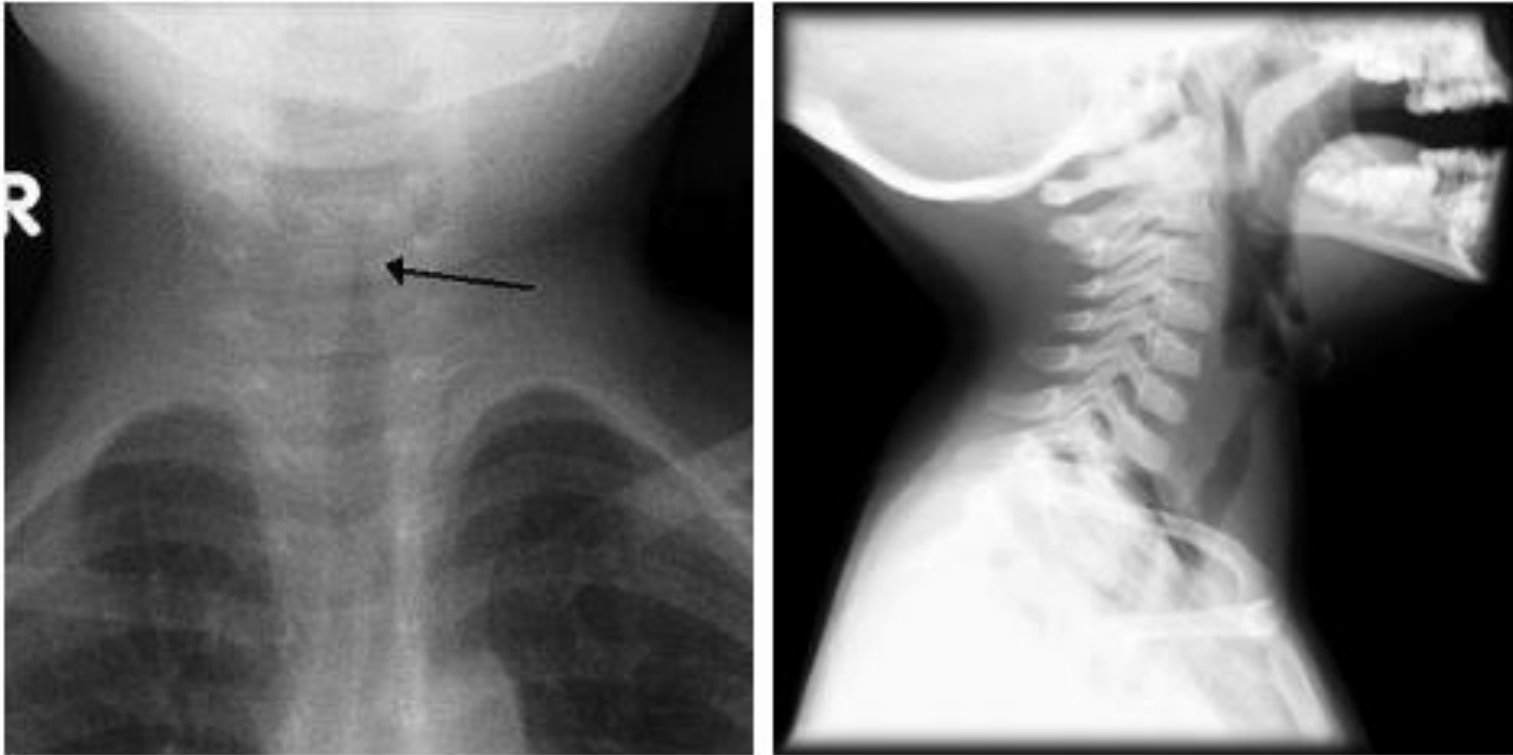
Invasive exudative bacterial infection of the soft tissues of the trachea

1-extension to the subglottic laryngeal structures or the upper bronchial tree.

2- primary infection or as a complication of viral croup.

3-Fever, Toxic Appearance





Bacterial Tracheitis

Ant and Lateral neck radiograph showing intraluminal membranes and tracheal wall irregularity consistent with bacterial tracheitis.



Epiglottitis

Lateral neck radiograph demonstrating **swollen epiglottis (arrow)** and **aryepiglottic folds (asterisks)** in a child with **epiglottitis** due to *Haemophilus influenzae* type b. The swollen epiglottis is often called a "**thumb sign**."



Recurrent/Atypical Croup & Special Populations

- Recurrent Croup Workup:
 - If a child presents with >2-3 episodes per season or episodes outside typical age boundaries:
 - Consider direct laryngotracheobronchoscopy (DLB) if needed to rule out:
- Congenital subglottic stenosis
- Subglottic hemangioma
- Laryngeal cleft or vascular ring
- Severe gastroesophageal reflux disease (GERD) / Eosinophilic esophagitis.



Recurrent/Atypical Croup & Special Populations

- Recurrent Croup Workup:
- Immunocompromised Host Considerations :
 - Prolonged viral shedding (especially Parainfluenza and Adenovirus).
 - Higher propensity for atypical/opportunistic pathogens and severe lower respiratory progression (bronchiolitis obliterans or giant cell pneumonia).



Red Flags & Evaluation of Recurrent Croup

Presentation	Suspected Pathology	Diagnostic Modality of Choice	Management Focus
Onset <3 months of age	Congenital Subglottic Stenosis, Vascular Ring	Direct Laryngoscopy / Bronchoscopy (DLB) ± CTA	ENT referral, airway calibration, surgical repair.
Frequent recurrent episodes (>3/year)	Subglottic Hemangioma, Laryngeal Web	Flexible/Rigid Endoscopy	Propranolol (for hemangioma), laser/surgical dilation.
Sudden nocturnal onset without fever	Spasmodic Croup (Allergic/Hyperreactive)	Clinical diagnosis	Cold night air/humidity at home; low-dose Dexamethasone.

SPASMODIC CROUP "FREQUENTLY RECURRENT CROUP."



Children six months to three years of age

- Always occurs at night.
- Clinical symptoms:
 - abrupt,
 - short duration,
 - Fever is typically absent,
 - Coryza may be present but less common,
 - Episodes can recur the same night and for two to four successive evenings,
 - familial predisposition,
 - more common in children with a family history of allergy "allergic croup."





Severity Stratification (Modified Westley Croup Score)

Clinical Feature	0 Points	1 Point	2 Points	3-4 Points	5 Points
Inspiratory Stridor	None	With agitation	At rest	—	—
Chest Retractions	None	Mild (intercostal)	Moderate	Severe (suprasternal/ sternal) (3 pts)	—
Air Entry	Normal	Decreased	Markedly decreased	—	—
Cyanosis	None	—	—	With agitation (4 pts)	At rest (5 pts)
Consciousness	Normal	—	—	—	Altered / Depressed (5 pts)



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• Clinical Scoring (Modified Westley Score):

- Evaluates: 1-Inspiratory Stridor, 2-Retractions, 3-Air Entry, 4-Cyanosis, and 5-Level of Consciousness.
- Mild (≤ 2): No stridor at rest, Occasional Barking cough, no/mild retractions.
- Moderate (3–7): Stridor at rest, Frequent barking cough, Mod intercostal/substernal retractions, No cyanosis, No or little distress or agitation
- Severe (8–11): Prominent stridor at rest, Frequent barking cough, Marked sternal/suprasternal retractions, air hunger, Significant agitation.
- Impending Respiratory Failure (≥ 12): Altered mental status, exhaustion, Severe sternal/suprasternal retractions, cyanosis or pallor, **diminished breath sounds**.



Severity Categories & Disposition Matrix

Total Score	Severity Class	Clinical Profile	Primary Action
≤2	Mild	Barking cough, no resting stridor, no retractions	Single-dose Dexamethasone; safe for outpatient management.observe
3 – 7	Moderate	Stridor at rest, mild/moderate retractions, no cyanosis	Dexamethasone + Nebulized Epinephrine;/Budesonide observe ≥2–4 hours
8 – 11	Severe	Loud stridor, severe retractions, agitation, air hunger, lethargy	Dexamethasone + Nebulized Epinephrine;/Budesonide admit to inpatient unit.
≥12	Impending Failure	Altered mental status, exhaustion, cyanosis, poor air entry	Urgent PICU/ENT involvement; repeated Epinephrine; prepare for intubation.



Medication	Formulation & Dose	Route	Onset & Duration	Clinical Pearls & Comments
Dexamethasone	0.15–0.60 mg/ kg (Max: 16 mg)	PO / IV / IM	Onset: 1–2 h Duration: 36–72 h	0.15 mg/ is clinically non-inferior to 0.6 mg/kg in mild-moderate disease.
Nebulized Budesonide	2 mg (single dose)	Inhaled	Onset: 1–2 h \ Duration: 24 h	Equivalent efficacy to Dexamethasone; preferred if severe vomiting is present.
L-Epinephrine (1:1,000)	0.5 mL/ undiluted (Max: 5 ml)	Inhaled via jet nebulizer	Onset: 10–30 min Duration: 90–120 min	Safe, effective, and readily available global alternative to racemic formulation.
Racemic Epinephrine (2.25%)	0.05 mL/ in 3 mL NS (Max: 0.5 mL)	Inhaled via jet nebulizer	Onset: 10–30 Duration: 90–120 min	Monitor heart rate during delivery. Observe minimum 2–4 hours for rebound stridor.



When to use nebulized budesonide in croup?

First choice

Dexamethasone is preferred for essentially all severities of croup, including mild croup.

Dexamethasone 0.6 mg/kg PO is the commonly used dose.

Oral administration is preferred when possible.



Budesonide: when is it useful?

Consider nebulized budesonide 2 mg when:

1-The child has moderate/severe croup and corticosteroid treatment is required, but oral/IM/IV dexamethasone cannot be given effectively.

2-The child has persistent vomiting, making oral dexamethasone difficult.

3-There is significant respiratory distress where nebulized treatment is easier to administer.

4-*Dexamethasone is unavailable.*

Nebulized budesonide has demonstrated efficacy in croup, but oral dexamethasone is generally at least as effective and easier/less distressing to administer.

Important:

don't routinely combine them

Do not routinely give **budesonide + dexamethasone**.

Adding nebulized budesonide to oral dexamethasone has not demonstrated additional clinical benefit



Supportive Care & Ineffective Interventions

•Supportive Management:

- Minimize distress (allow the child to remain in parent's arms).
- Blow-by oxygen if $SpO_2 < 92\%$ or in severe distress.
- Hydration support (enteral if safe, IV if respiratory rate is markedly elevated).

•Interventions Lacking Evidence:

- **Mist Therapy / Cool Humidification:** Cochrane reviews and clinical trials show no measurable benefit over non-humidified room air.
- **Antitussives / Decongestants:** Ineffective and potentially dangerous in young children.
- **Antibiotics:** Ineffective for viral croup; strictly reserved for proven or suspected secondary bacterial tracheitis or concurrent otitis media.
- **Sedation: Strictly contraindicated** in acute upper airway obstruction.



Evidence-Based Appraisal of Ancillary Interventions

Intervention	Proposed Mechanism	Evidence Grade & Recommendations	Notes
Cool Mist / Humidification	Liquefies secretions, soothes mucosa	No proven clinical benefit (Cochrane)	Not recommended; causes unnecessary distress/separation.
Heliox (He/O ₂ : 70/30 or 80/20)	Decreases gas density → reduces turbulence	Weak / Inconclusive; transient relief	Consider in severe croup refractory to medical therapy in PICU.
Systemic Antibiotics	Antimicrobial coverage	Contraindicated in uncomplicated croup	Reserve strictly for confirmed secondary bacterial tracheitis.
Antitussives / Decongestants	Sympathomimetic mucosal constriction	Ineffective & Unsafe in young children	Contraindicated; risk of toxicity and respiratory depression.
Sedatives / Anxiolytics	Calming the patient	Strictly Contraindicated	Suppresses respiratory drive and masks clinical deterioration.



Management of Severe Croup & PICU Indications

•Indications for Admission:

- Persistent stridor at rest or significant retractions after glucocorticoids and ≥ 2 doses of nebulized epinephrine.
- Need for supplemental oxygen ($SpO_2 < 92\%$)
- Lethargy, poor oral intake, dehydration, or social factors.

•PICU Transfer & Intubation Criteria:

- Exhaustion, increasing hypercapnia, or impending respiratory arrest despite maximal medical therapy.

• Intubation Specifics:

- Performed by the most experienced specialist (anesthesiologist/PICU/ENT) with emergency surgical airway standby.
- Use an Endotracheal Tube (ETT) 0.5 to 1.0 size smaller than predicted for age due to subglottic stenosis.
- Uncuffed or low-pressure cuffed tubes with careful monitoring of leak pressures ($< 20-25$ cm H₂O).



Critical Airway Management in Croup-Induced Respiratory Failure

Step / Parameter	Clinical Action / Standard	Expert Rationale
Personnel	Most experienced operator available (Pediatric Anesthesiologist/ENT/PICU)	Subglottic edema distorts landmarks and increases risk of complete occlusion.
Tube Selection	Select 0.5 to 1.0 smaller than age-predicted ETT internal diameter	Compensates for fixed mucosal narrowing at the level of the cricoid ring.
Tube Type & Pressure	Cuffed tube with continuous monitoring of leak pressure (<20 – 25 cm H20)	



Key Summary Points & Clinical Pearls

1.Clinical Diagnosis: Avoid unnecessary diagnostics that agitate the infant.

2.Universal Steroid Utility: Single-dose dexamethasone (0.15–0.6 mg/kg) benefits *all* severities of croup, reducing return visits and hospitalizations.

3.Epinephrine Safety: L-epinephrine 1:1,000 is an effective, accessible alternative to racemic epinephrine; maintain a 2- to 4-hour post-nebulization monitoring window.

4.Maintain Vigilance for Bacterial Tracheitis: Re-evaluate immediately if the child appears toxic, develops high fever, or fails to respond to standard therapy.

5.Downsize ETT: Always select a smaller ETT size if advanced airway control becomes necessary.



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THANK YOU