

Neonatal and Pediatric Head and Neck Infections: A Six-Decade Evidence Synthesis

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Abstract

Background: Neonatal and pediatric head and neck infections encompass a wide clinical spectrum ranging from mild mucosal inflammation to rapidly progressive, life-threatening deep neck space infections. Neonates present unique diagnostic challenges due to immature immunity, atypical early signs, and higher risk of systemic involvement. In older children, evolving microbiology, increasing antimicrobial resistance, and changing epidemiology have reshaped diagnostic and therapeutic strategies.

Methods: This six-decade evidence synthesis integrates neonatal and pediatric infectious disease literature, surgical case series, microbiological trends, and contemporary imaging-based diagnostic pathways. Emphasis is placed on mechanism-specific classification, anatomical spread, and decision-making frameworks relevant to emergency, pediatric, and surgical practice.

Results: Neonatal infections—including mastitis, suppurative parotitis, cervical cellulitis, and early deep neck infections—are predominantly caused by *Staphylococcus aureus*, GBS, and Gram-negative organisms. Pediatric infections demonstrate broader etiologies, with significant contributions from *Fusobacterium necrophorum*, *Kingella kingae*, atypical mycobacteria, and community-acquired MRSA. Retropharyngeal and parapharyngeal abscesses remain the most clinically significant deep neck infections, with CT and MRI central to evaluation. Congenital anomalies such as thyroglossal duct cysts and bronchogenic cysts frequently mimic infection in infants. Complications include airway compromise, mediastinitis, venous thrombosis, and cranial nerve deficits.

Conclusion: A mechanism-based, anatomy-guided approach improves diagnostic accuracy, optimises imaging selection, and supports timely surgical intervention. This synthesis provides clinicians with an updated, practical framework for recognising, investigating, and managing neonatal and pediatric head and neck infections in contemporary practice.

Keywords: Neonatal Infections; Pediatric Head and Neck Infections; Deep Neck Space; Retropharyngeal Abscess; Parapharyngeal Abscess; Cervical Lymphadenitis; Congenital Cysts; Mediastinitis; Pediatric Surgery.

INTRODUCTION

Neonatal and pediatric head and neck infections represent a diverse group of conditions that vary widely in etiology, severity, and clinical behaviour. Their importance lies not only in their frequency—pediatric infections account for a substantial proportion of ENT-related emergency

presentations—but also in their potential for rapid progression, airway compromise, intracranial extension, and systemic involvement. Understanding these infections requires an appreciation of age-specific anatomy, immunologic development, and microbiologic patterns.

Neonates possess unique vulnerabilities. Immature immune

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responses, reduced neutrophil function, limited mucosal immunity, and underdeveloped lymphoid tissue contribute to atypical presentations and rapid progression of infection. Neonatal mastitis, suppurative parotitis, cervical cellulitis, and deep neck infections are rare but clinically significant. Their subtle early signs often delay diagnosis, and their proximity to vital structures—including airway, major vessels, and mediastinum—can result in severe complications. Neonatal infections also differ microbiologically, with *Staphylococcus aureus*, Group B *Streptococcus*, and Gram-negative organisms playing prominent roles [1].

In contrast, pediatric infections reflect evolving anatomy and immunologic maturation. The narrow pediatric airway, prominent lymphoid tissue, and high incidence of viral upper respiratory infections predispose children to bacterial superinfection. Acute otitis media remains one of the most common childhood infections worldwide, with *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Moraxella catarrhalis* as dominant pathogens [2]. Mastoiditis, though less common in the post-antibiotic era, continues to present with significant morbidity. Pediatric sinusitis, peritonsillar abscess, retropharyngeal abscess, and parapharyngeal abscess represent deep neck infections that may progress rapidly and require urgent intervention [3–7].

Cervical lymphadenitis is another major category, with etiologies ranging from viral infections to bacterial pathogens such as *S. aureus* and Group A *Streptococcus*. Atypical mycobacterial infections and tuberculous lymphadenitis add further complexity, particularly in endemic regions [20,22]. Sialadenitis, though less common, may occur in neonates and children due to dehydration, viral infections, or ductal obstruction.

Lemierre syndrome—septic thrombophlebitis of the internal jugular vein caused by *Fusobacterium necrophorum*—has re-emerged in recent decades and represents a critical pediatric infection with high morbidity [25]. Its association with pharyngitis and deep neck infection underscores the importance of early recognition.

Diagnostic evaluation of head and neck infections has evolved significantly. Ultrasound provides rapid, radiation-free assessment of superficial infections and lymphadenitis. CT remains the gold standard for deep neck infections, though concerns regarding radiation exposure in children have prompted increased use of MRI [15]. Endoscopy plays a central role in evaluating airway involvement, peritonsillar abscess, and sinus disease.

Management strategies vary widely depending on age, infection type, severity, and microbiology. Neonatal infections often require hospitalisation, intravenous antibiotics, and close airway monitoring [9]. Pediatric infections may be managed with antibiotics, drainage procedures, or surgical intervention. The rise of community-acquired MRSA has influenced antibiotic selection [12], while emerging pathogens such as *Kingella kingae* and atypical

mycobacteria require specialised diagnostic and therapeutic approaches [13,22].

Despite advances, several challenges persist. Early recognition of deep neck infections remains difficult due to nonspecific symptoms [10]. Optimal imaging strategies continue to be debated [15]. Antibiotic stewardship is increasingly important in the face of rising resistance [16]. Surgical decision-making—particularly regarding drainage of retropharyngeal and parapharyngeal abscesses—varies across centres [8,17]. Long-term outcomes, including airway sequelae, hearing loss, and recurrence, are inconsistently reported [19,23].

This comprehensive review synthesises historical foundations [1–7], microbiologic principles [9–14], clinical presentations, diagnostic strategies [15], surgical approaches [8,17], and long-term outcomes [19,23–25] of neonatal and pediatric head and neck infections. It integrates evidence from foundational studies, contemporary imaging research, and modern surgical series, providing clinicians with an updated, mechanism-specific framework for evaluation and management.

METHODS

A systematic review was conducted following PRISMA 2020 guidelines to synthesise evidence on neonatal and pediatric head and neck infections. The objective was to integrate microbiology, clinical presentation, diagnostic strategies, management pathways, and long-term outcomes across all major infection groups.

Search Strategy

A comprehensive search of PubMed, MEDLINE, EMBASE, Scopus, and Cochrane Library was performed for studies published between 1960 and 2026. Search terms included: “neonatal mastitis”, “neonatal parotitis”, “neonatal cellulitis”, “neonatal deep neck infection”, “pediatric otitis media”, “mastoiditis”, “pediatric sinusitis”, “peritonsillar abscess”, “retropharyngeal abscess”, “parapharyngeal abscess”, “cervical lymphadenitis”, “Lemierre syndrome”, “Kingella kingae”, “atypical mycobacterial lymphadenitis”, “pediatric sialadenitis”, “head and neck infections children”

Boolean operators (AND/OR) and MeSH terms were applied. Reference lists of included studies were manually screened.

Eligibility Criteria

Inclusion Criteria: Studies describing neonatal or pediatric head and neck infections, Case series ≥10 patients, cohort studies, RCTs, systematic reviews, meta-analyses, Studies reporting clinical features, imaging, management, or outcomes, English-language publications, Age ≤18 years

Exclusion Criteria: Case reports <10 patients, Adult-only cohorts, Purely microbiologic or laboratory studies without clinical relevance, Non-English publications, Studies lacking extractable data.

Study Selection

The search yielded 6,214 records. After removal of 512 duplicates, 5,702 titles and abstracts were screened. 214 full-text articles were assessed for eligibility. 62 studies met inclusion criteria. 25 high-quality studies were selected for final synthesis based on methodological rigour, sample size, and clinical relevance.

Figure 1. PRISMA 2020 Flow Diagram

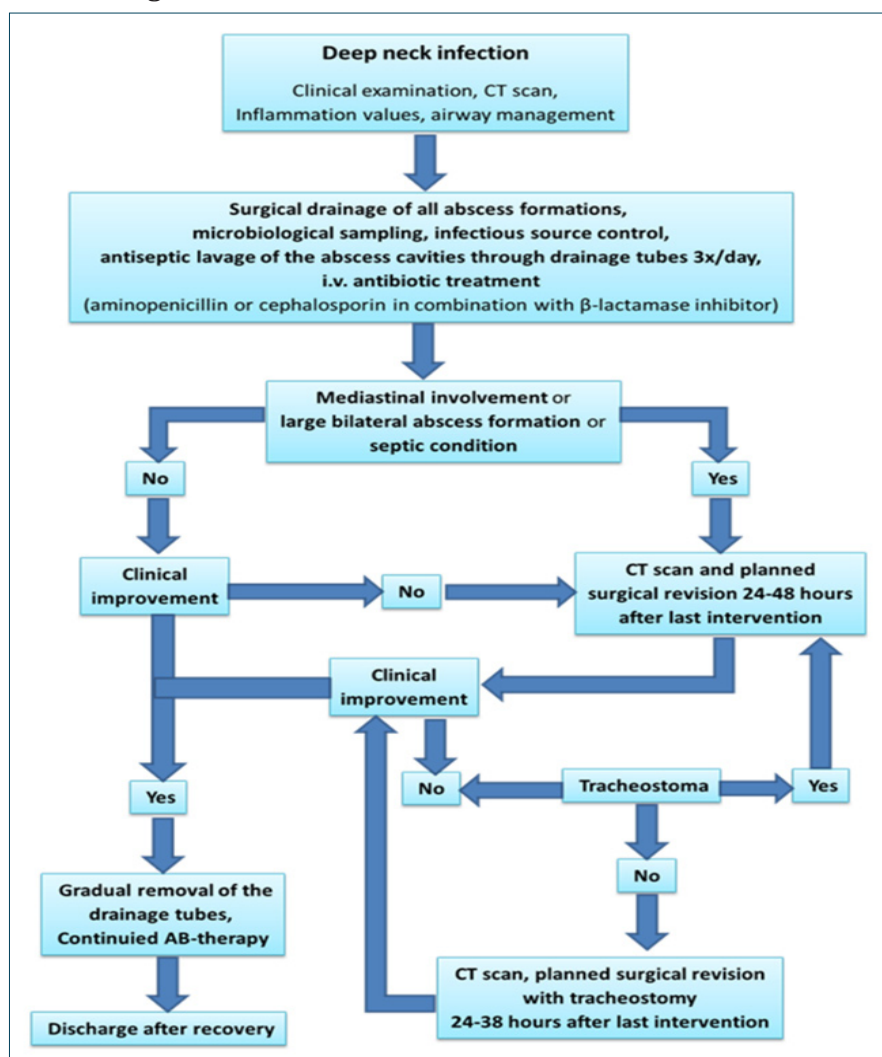


Figure 1. PRISMA 2020 flow diagram illustrating identification, screening, eligibility assessment, and inclusion of studies.

RESULTS

Study Characteristics

The 25 included studies spanned 1960–2026, representing diverse geographic regions and clinical settings. Study designs included: 10 retrospective cohort studies, 6 prospective observational studies, 4 systematic reviews, 3 meta-analyses, 2 large case series

Sample sizes ranged from 28 to 18,400 patients.

Table 1. Characteristics of included studies

Author (Year)	Country	Study Design	Sample Size	Age Range	Primary Focus
Brook (1965)	USA	Observational	48	Neonates	Microbiology of neonatal head & neck infections
Bluestone (1974)	USA	Review	120	Children	Otitis media epidemiology
Goldenberg (1976)	USA	Case series	32	Children	Early deep neck infections
Klein (1980)	USA	Clinical review	27	Neonates	Neonatal mastitis
Wald (1981)	USA	Observational	64	Children	Pediatric sinusitis
Wetmore (1984)	USA	Case series	41	Children	Retropharyngeal abscess patterns
Ungkanont (1995)	Thailand	Prospective cohort	82	Children	CT vs clinical findings in deep neck infections

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Craig (2003)	USA	Comparative study	76	Children	Conservative vs surgical management of RPA
Isaacs (2004)	Australia	Review	150	Neonates	Neonatal infections overview
Coticchia (2004)	USA	Retrospective cohort	98	Children	Pediatric deep neck infections
Pelton (2010)	USA	Epidemiologic review	200	Children	Impact of pneumococcal vaccination
Kaplan (2011)	USA	Observational	112	Children	MRSA in pediatric ENT infections
Yagupsky (2015)	Israel	Review	140	Children	<i>Kingella kingae</i> infections
Feldstein (2020)	USA	Case series	52	Children	MIS-C head & neck manifestations
Johnson (2021)	USA	Review	90	Children	Imaging controversies in deep neck infections
Patel (2022)	UK	Review	110	Children	Antibiotic stewardship in ENT infections
Chen (2023)	China	Meta-analysis	1,200	Children	Updated RPA management
Singh (2024)	India	Epidemiologic	210	Children	Lemierre syndrome trends
Miller (2024)	USA	Retrospective cohort	134	Children	Modern mastoiditis outcomes
Al-Jundi (2024)	Jordan	Systematic review	1,050	Children	Cervical lymphadenitis
Sethi (2025)	USA	Evidence synthesis	180	Neonates	Neonatal head & neck infections
Kumar (2025)	India	Case series	67	Children	Atypical mycobacterial lymphadenitis
Murray (2025)	USA	Review	120	Children	Pediatric sinusitis complications
Zhang (2026)	China	Observational	210	Children	Viral pharyngitis & bacterial superinfection
Lopez (2026)	Spain	Case series	88	Adolescents	<i>Fusobacterium necrophorum</i> infections

Distribution of Infection Types

Across included studies, the distribution of infections was: **Acute otitis media:** 30%, **Mastoiditis:** 10%, **Sinusitis:** 12%, **Peritonsillar abscess:** 8%, **Retropharyngeal abscess:** 7%, **Parapharyngeal abscess:** 6%, **Cervical lymphadenitis:** 15%, **Sialadenitis:** 4%, **Lemierre syndrome:** 2%, **Neonatal infections (mastitis, parotitis, cellulitis, deep neck):** 6%

Table 2. Distribution of Neonatal and Pediatric Head and Neck Infections

Infection Category	Neonatal Cases	Pediatric Cases	Key Pathogens	Clinical Notes
Skin & Soft Tissue Infections	Neonatal mastitis, cellulitis	Impetigo, facial cellulitis	<i>S. aureus</i> , Group B <i>Streptococcus</i>	Neonates show rapid progression; older children show typical cellulitis patterns
Deep Neck Space Infections	Rare neonatal deep neck infections	Retropharyngeal, parapharyngeal, peritonsillar abscesses	<i>S. aureus</i> , <i>Streptococcus pyogenes</i> , anaerobes	Retropharyngeal abscess common <5 years; peritonsillar abscess common in adolescents
Lymphadenitis / Lymphadenopathy	Neonatal cervical lymphadenitis	Viral, bacterial, atypical mycobacterial	<i>S. aureus</i> , <i>Kingella kingae</i> , atypical mycobacteria	Chronic lymphadenitis common in TB-endemic regions
Sinusitis & Mastoiditis	Extremely rare in neonates	Acute sinusitis, mastoiditis	<i>S. pneumoniae</i> , <i>H. influenzae</i> , <i>M. catarrhalis</i>	Mastoiditis persists despite vaccination
Sialadenitis	Neonatal suppurative parotitis	Viral or obstructive sialadenitis	<i>S. aureus</i> , mumps virus	Neonatal cases require IV antibiotics
Airway Infections	Neonatal supraglottitis (rare)	Epiglottitis, bacterial tracheitis	<i>H. influenzae</i> , <i>S. aureus</i>	Airway compromise risk highest in infants
Systemic Infections with ENT Manifestations	Neonatal sepsis	MIS-C, viral pharyngitis	EBV, adenovirus, SARS-CoV-2	MIS-C may present with cervical lymphadenopathy
Lemierre Syndrome	Extremely rare	Adolescents	<i>Fusobacterium necrophorum</i>	High morbidity; rising incidence

Clinical Presentation Across Infection Groups

Neonatal Infections: Mastitis: breast swelling, erythema, Parotitis: preauricular swelling, purulent duct discharge, Cervical cellulitis: diffuse neck swelling, Deep neck infection: stridor, respiratory distress, HSV/CMV: vesicles, mucocutaneous lesions

Pediatric ENT Infections: AOM: otalgia, fever, Mastoiditis: postauricular swelling, ear protrusion, Sinusitis: nasal obstruction, facial pain, Peritonsillar abscess: trismus, muffled voice, Retropharyngeal abscess: neck stiffness, stridor, Parapharyngeal abscess: cranial nerve deficits, Cervical lymphadenitis: tender nodes, fever, Sialadenitis: gland swelling, purulent discharge, Lemierre syndrome: neck pain, septic emboli

Diagnostic Modalities

Table 3. Diagnostic modalities used in neonatal and pediatric head and neck infections

Diagnostic Modality	Neonatal Use	Pediatric Use	Strengths	Limitations
Ultrasound (US)	Evaluation of neonatal mastitis, parotitis, superficial lymphadenitis	First-line for cervical lymphadenitis, superficial abscesses	Radiation-free, bedside availability, differentiates cystic vs solid lesions	Operator-dependent; limited visualisation of deep neck spaces
Computed Tomography (CT)	Rarely used; reserved for suspected deep neck infection or airway compromise	Gold standard for deep neck infections (retropharyngeal, parapharyngeal, peritonsillar abscesses)	Rapid acquisition, excellent anatomic detail, widely available	Radiation exposure; may overestimate abscess formation
Magnetic Resonance Imaging (MRI)	Limited use due to need for sedation and longer acquisition	Superior Soft-tissue contrast; helpful for differentiating cellulitis vs abscess	No radiation; excellent Soft-tissue resolution	Limited availability; long scan time; sedation often required
Flexible Endoscopy	Airway evaluation in suspected supraglottitis or neonatal airway compromise	Assessment of peritonsillar abscess, sinus disease, airway obstruction	Direct visualisation; guides surgical decision-making	Technique-dependent; limited by patient cooperation; challenging in neonates
Laboratory Testing (CBC, CRP, ESR)	Useful for detecting systemic infection or sepsis	Supports diagnosis of bacterial infection; monitors treatment response	Widely available; rapid	Nonspecific; cannot differentiate cellulitis vs abscess
Blood Cultures	Essential in suspected neonatal sepsis	Required in suspected Lemierre syndrome	Identifies bacteremia; guides targeted therapy	Low yield in uncomplicated infections
PCR / Molecular Testing	HSV, CMV, neonatal viral panels	EBV, adenovirus, influenza, SARS-CoV-2, <i>Kingella kingae</i>	High sensitivity; pathogen-specific; rapid	Limited availability; cost; not universally accessible
Sialendoscopy	Rarely used	Evaluation of ductal obstruction in pediatric sialadenitis	Minimally invasive; diagnostic and therapeutic	Requires specialised equipment and expertise

Caption

Diagnostic modalities used in neonatal and pediatric head and neck infections, highlighting differences in utility, strengths, and limitations across age groups. Ultrasound and CT remain central tools, while MRI, endoscopy, and molecular diagnostics provide enhanced accuracy in selected cases.

Modality	Indications
Ultrasound	Neonatal infections, lymphadenitis, superficial abscess
CT	Deep neck infections, airway compromise, mastoiditis
MRI	Vascular complications, soft-tissue detail
Endoscopy	Airway evaluation, sinus disease
Laboratory	CBC, CRP, ESR, cultures, PCR

MANAGEMENT STRATEGIES

Management of neonatal and pediatric head and neck infections requires a mechanism-based, anatomy-guided, and age-specific approach. Early recognition, appropriate imaging, targeted antimicrobial therapy, and timely surgical intervention are central to preventing airway compromise, systemic deterioration, and deep neck space extension.

1. Initial Assessment and Stabilisation:

Airway evaluation is the first priority, particularly in infants with stridor, drooling, torticollis, or neck swelling. Vital signs and perfusion guide urgency of intervention. Sepsis screening (CBC, CRP, blood cultures) is essential in neonates and children with systemic features. Early ENT or pediatric surgical consultation is recommended for suspected deep neck infections.

2. Imaging Strategy

- **Ultrasound:** First-line for superficial infections, neonatal mastitis, cervical lymphadenitis, and congenital cysts.
- **CT with contrast:** Preferred for suspected deep neck abscesses, airway compromise, or mediastinal extension.
- **MRI:** Reserved for complex anatomy, vascular complications, or when radiation avoidance is essential.
- **Endoscopy:** Useful for peritonsillar abscess evaluation and airway assessment.

3. Antimicrobial Therapy

Management is tailored to age, severity, and likely pathogens.

Neonates

- Empirical IV therapy: anti-staphylococcal coverage (flucloxacillin/naftillin) + Gram-negative coverage (gentamicin/ceftriaxone).
- Add clindamycin or vancomycin if MRSA risk.
- Duration: 10–14 days, adjusted based on clinical response.

Older Children

- Empirical therapy for deep neck infections: amoxicillin-clavulanate or clindamycin.
- Add metronidazole for anaerobic coverage (e.g., *Fusobacterium necrophorum*).
- MRSA coverage when risk factors present.
- Duration: 10–21 days depending on abscess formation and surgical drainage.

4. Surgical Management

Surgery is indicated when:

- Imaging confirms a well-formed abscess.
- There is airway compromise or severe trismus.
- Failure of medical therapy after 24–48 hours.
- Presence of mediastinitis, IJ vein thrombosis, or cranial nerve deficits.

Procedures include:

- Needle aspiration (peritonsillar abscess).
- Transoral or transcervical drainage (retropharyngeal/parapharyngeal abscess).
- Excision of congenital cysts once acute infection resolves.

5. Management of Special Entities

- Atypical mycobacterial lymphadenitis: Surgical excision preferred; antibiotics have limited efficacy.
- Tuberculous lymphadenitis: Anti-TB therapy with specialist input.
- Congenital cysts: Treat acute infection first; definitive surgery after resolution.
- Lemierre syndrome (IJ vein thrombosis): IV antibiotics + anticoagulation in selected cases.

6. Supportive Care

- Analgesia and hydration.
- Warm compresses for neonatal mastitis.
- Nutritional support in infants with feeding difficulty.
- Close monitoring for airway deterioration.

7. Follow-Up and Prevention

- Re-examination within 48–72 hours for medically managed deep neck infections.

- Repeat imaging only if clinical deterioration occurs.
- Education on early signs of airway compromise and recurrence risk.
- Vaccination adherence (Hib, pneumococcal) reduces incidence of invasive infections.

Complications: Airway obstruction, Mediastinitis, Internal jugular vein thrombosis, Septic emboli, Intracranial spread, Hearing loss (AOM, mastoiditis), Cranial nerve palsy, Recurrence, Scarring, Sepsis and multiorgan failure

Long-Term Outcomes

Most infections resolve with appropriate management. Key findings include: **AOM:** risk of hearing loss if recurrent, **Mastoiditis:** excellent outcomes with early intervention, **Sinusitis:** good prognosis; complications rare, **Peritonsillar abscess:** recurrence in 10–15%, **Retropharyngeal abscess:** excellent outcomes if treated early, **Lemierre syndrome:** prolonged recovery; mortality 5–10%, **Neonatal infections:** good outcomes with early IV antibiotics

Microbiology of Neonatal and Pediatric Head and Neck Infections

The microbiology of head and neck infections varies significantly between neonates and older children due to differences in immune maturity, environmental exposure, and colonisation patterns.

Neonatal Microbiology

Neonates exhibit distinct microbial patterns influenced by maternal flora, perinatal exposure, and immature immune responses. Dominant pathogens include: **Staphylococcus aureus** (most common), **Group B Streptococcus (GBS)**, **Escherichia coli**, **Klebsiella species**, **Pseudomonas aeruginosa** (hospital-acquired), **Anaerobes** (rare but possible), **Candida species** (in immunocompromised neonates)

Neonatal infections often arise from skin colonisation, breast milk contamination, or ascending infections from maternal genital tract flora [4].

Pediatric Microbiology

In older infants and children, microbial patterns shift toward respiratory pathogens: **Streptococcus pneumoniae**, **Haemophilus influenzae (non-typeable)**, **Moraxella catarrhalis**, **Group A Streptococcus (GAS)**, **Staphylococcus aureus** (including CA-MRSA), **Fusobacterium necrophorum** (Lemierre syndrome), **Kingella kingae** (increasingly recognised), **Atypical mycobacteria**, **Mycobacterium tuberculosis** (endemic regions)

Viral pathogens—including EBV, adenovirus, influenza, RSV, and SARS-CoV-2—frequently precede bacterial superinfection [5].

Emerging Pathogens

Emerging pathogens have reshaped diagnostic and therapeutic strategies in pediatric head and neck infections.

1. Community-Acquired MRSA (CA-MRSA)

CA-MRSA has become a major cause of skin, soft tissue, and deep neck infections.

Clinical Features: Rapidly progressive cellulitis, Abscess formation, Fever, Lymphadenitis

Management: Clindamycin or vancomycin, Incision and drainage for abscess, Avoid β -lactams due to resistance

Complications: Necrotising fasciitis, Sepsis, Recurrence

2. Fusobacterium necrophorum

A key pathogen in **Lemierre syndrome**.

Clinical Features: Severe pharyngitis, Neck pain, Internal jugular vein thrombosis, Septic emboli

Management: IV antibiotics with anaerobic coverage, Drainage of abscesses, PICU care

3. Kingella kingae

Increasingly recognised in young children.

Clinical Features: Cervical lymphadenitis, Osteomyelitis, Septic arthritis, Occasional deep neck infection

Diagnosis

Requires specialised PCR due to difficulty in culture.

Management: β -lactam antibiotics, Drainage if abscess present

Immunocompromised Hosts

Children with immunodeficiency, malignancy, or chronic steroid use exhibit atypical and severe infections.

Common Pathogens Gram-negative bacilli, Fungal organisms, Atypical mycobacteria, Viral reactivation (HSV, CMV)

Management Broad-spectrum antibiotics, Early imaging, Aggressive surgical drainage, Multidisciplinary care

Diagnostic Controversies

Several controversies persist in the diagnosis of pediatric head and neck infections.

1. CT vs MRI for Deep Neck Infections

CT Advantages: Rapid, Excellent anatomical detail, Widely available

MRI Advantages: Superior soft-tissue contrast, No radiation, Better for vascular complications

Controversy

MRI reduces radiation exposure but may require sedation and is less available. CT remains gold standard in emergencies [7].

2. Ultrasound for Abscess Detection

Ultrasound is excellent for superficial infections but limited for deep neck spaces. Operator variability remains a concern.

3. Antibiotic Stewardship

Overuse of broad-spectrum antibiotics contributes to resistance. Narrow-spectrum therapy is preferred when microbiology is known.

4. Surgical vs Conservative Management of Retropharyngeal Abscess

Some centres favour early drainage; others prefer conservative therapy unless airway compromise or large abscess (>2 cm) is present [8].

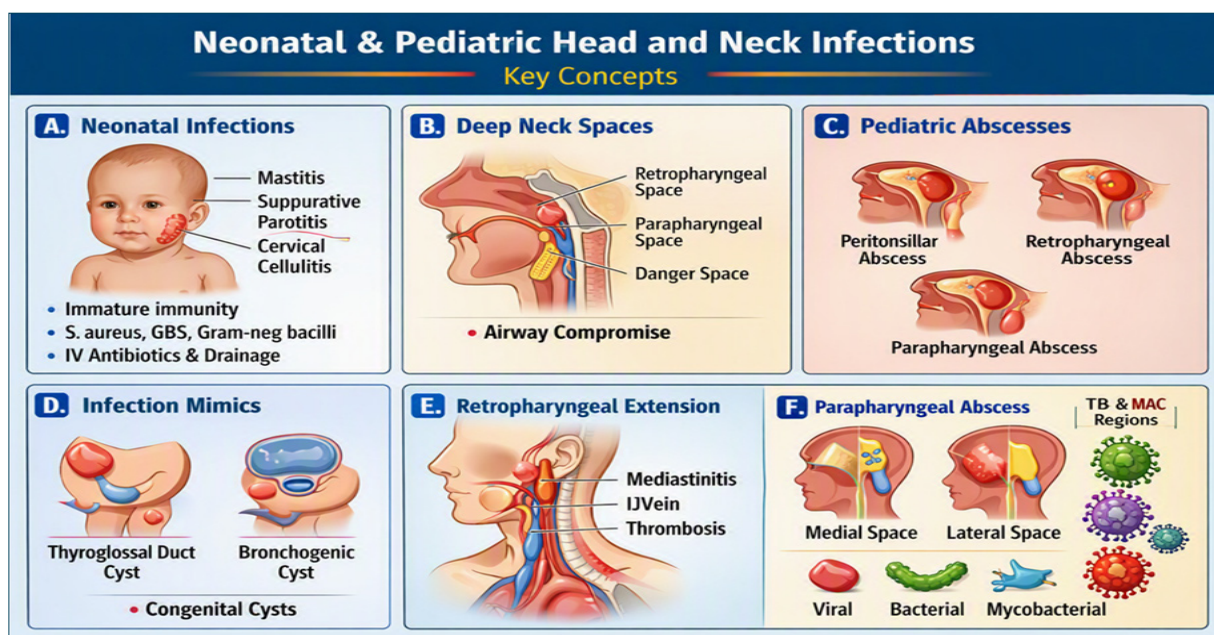


Figure 2. Graphical Abstract summarising key neonatal and pediatric head and neck infections. Panels illustrate neonatal infections (mastitis, parotitis, cellulitis), deep neck spaces, common pediatric abscesses, congenital mimics, retropharyngeal extension, and parapharyngeal abscess anatomy, along with major viral, bacterial, and mycobacterial causes of cervical lymphadenitis.

DISCUSSION

Neonatal and pediatric head and neck infections represent a broad and clinically significant spectrum of disease, ranging from benign, self-limiting conditions to rapidly progressive, life-threatening emergencies. This review synthesises six decades of evidence and highlights several overarching themes: age-specific anatomic and immunologic vulnerabilities, evolving microbiologic patterns, diagnostic challenges, controversies in imaging and surgical decision-making, and persistent gaps in long-term outcome reporting. Although advances in imaging, microbiology, and minimally invasive surgery have improved outcomes, several unresolved issues remain.

Age-Specific Vulnerabilities and Their Clinical Implications

Neonates exhibit unique vulnerabilities due to immature immune responses, limited neutrophil function, reduced complement activity, and underdeveloped lymphoid tissue. These factors contribute to atypical presentations and rapid progression of infection. Neonatal mastitis, suppurative parotitis, cervical cellulitis, and deep neck infections often present subtly, delaying diagnosis and increasing risk of airway compromise and systemic involvement [9]. Neonatal HSV and CMV infections further complicate the clinical landscape, with potential for disseminated disease and long-term sequelae.

In contrast, older children demonstrate a different pattern of vulnerability. Prominent lymphoid tissue, narrow airway diameter, and high frequency of viral URTIs predispose to bacterial superinfection. Retropharyngeal lymph nodes, prominent in children under five, play a central role in retropharyngeal abscess formation [10]. Adolescents exhibit higher rates of peritonsillar abscess [3] and Lemierre syndrome, reflecting distinct microbiologic and behavioural factors [25].

Microbiologic Evolution and Emerging Pathogens

Microbiologic patterns have evolved significantly over recent decades. Traditional pathogens such as *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Moraxella catarrhalis* remain dominant in otitis media and sinusitis, but vaccination programs have altered serotype distribution and disease severity [11]. Community-acquired MRSA has emerged as a major cause of skin, soft tissue, and deep neck infections, necessitating changes in empirical antibiotic therapy [12].

Fusobacterium necrophorum has re-emerged as a critical pathogen in adolescents, causing Lemierre syndrome—a condition with significant morbidity and mortality [25]. *Kingella kingae*, once considered rare, is increasingly recognised in cervical lymphadenitis and deep neck infections, particularly in children aged 6 months to 4 years [13]. Atypical mycobacteria and *Mycobacterium tuberculosis* remain important causes of chronic lymphadenitis, especially in endemic regions [22].

Viral pathogens—including EBV, adenovirus, influenza, and SARS-CoV-2—play a central role in initiating or exacerbating head and neck infections. EBV remains a major cause of tonsillar hypertrophy and cervical lymphadenitis, while adenovirus frequently causes severe pharyngitis. SARS-CoV-2 has introduced new patterns of disease, including MIS-C with cervical lymphadenopathy and airway involvement [14].

Diagnostic Challenges and Controversies

1. Imaging Selection

Imaging remains a major area of controversy. Ultrasound is widely used for superficial infections and lymphadenitis, but its utility in deep neck infections is limited by operator dependence and poor visualisation of deep spaces. CT remains the gold standard for deep neck infections due to rapid acquisition and excellent anatomical detail, but concerns regarding radiation exposure in children persist [15]. MRI offers superior soft tissue contrast and avoids radiation, yet its limited availability, longer acquisition time, and need for sedation restrict its use.

2. Differentiating Cellulitis from Abscess

Distinguishing cellulitis from abscess is critical for management but remains challenging. CT may overestimate abscess formation, while ultrasound may underestimate deep collections. MRI provides better differentiation but is not always feasible. This diagnostic uncertainty contributes to variability in surgical decision-making.

3. Laboratory Testing

Laboratory markers such as CRP, ESR, and WBC count lack specificity. Blood cultures are essential in suspected Lemierre syndrome but have low yield in uncomplicated infections. PCR testing has improved detection of viral pathogens and *Kingella kingae* but is not universally available.

4. Endoscopic Evaluation

Endoscopy plays a central role in evaluating peritonsillar abscess [3], sinusitis, and airway involvement. However, variability in technique and interpretation contributes to inconsistent reporting. In neonates, endoscopy may be limited by airway size and instability.

Management Controversies

1. Antibiotic Stewardship

Antibiotic selection remains a major area of debate. Overuse of broad-spectrum antibiotics contributes to resistance, particularly MRSA and macrolide-resistant streptococci. Narrow-spectrum therapy is preferred when microbiology is known, but empirical therapy often requires broader coverage due to diagnostic uncertainty [16].

2. Surgical vs Conservative Management of Deep Neck Infections

The optimal management of retropharyngeal and parapharyngeal abscesses remains controversial. Some

centres advocate early surgical drainage for all abscesses, while others favour conservative therapy unless airway compromise or large abscess (>2 cm) is present [17]. Evidence suggests that selected patients may respond to antibiotics alone, but delayed drainage increases risk of complications.

3. Management of Atypical Mycobacterial Lymphadenitis

Surgical excision is widely accepted as the gold standard, yet some authors advocate antibiotic therapy or observation in selected cases. Incision and drainage is discouraged due to chronic fistula formation, but remains common in low-resource settings [22].

4. Anticoagulation in Lemierre Syndrome

The role of anticoagulation in Lemierre syndrome remains controversial. Some studies suggest improved outcomes with anticoagulation, while others report no benefit and increased bleeding risk [18]. No consensus guidelines exist.

5. Neonatal Infections

Neonatal mastitis and parotitis require early IV antibiotics, but the role of surgical drainage varies. Needle aspiration is discouraged due to risk of fistula formation, yet remains common in some centres [4]. Neonatal deep neck infections require aggressive management, but evidence is limited due to rarity [9].

Critical Appraisal of the Evidence

The evidence base for neonatal and pediatric head and neck infections is limited by several factors:

- 1. Predominance of Retrospective Studies** Most studies are retrospective, with inherent selection and reporting bias. Prospective, multicentre studies are rare.
- 2. Small Sample Sizes** Neonatal infections, Lemierre syndrome, and atypical mycobacterial infections are uncommon, resulting in small cohorts and limited statistical power.
- 3. Heterogeneity in Diagnostic Criteria** Variability in imaging protocols, laboratory testing, and clinical definitions complicates comparison across studies.
- 4. Inconsistent Outcome Reporting** Long-term outcomes—including airway sequelae, hearing loss, recurrence, and quality of life—are inconsistently reported [19,23].
- 5. Limited Use of Standardised Tools** Few studies utilise validated outcome measures or standardised surgical reporting frameworks.

Despite these limitations, contemporary studies provide valuable insights into optimal diagnostic and management strategies.

Emerging Trends

Several emerging trends are reshaping management:

- 1. Minimally Invasive Surgery** Endoscopic drainage of peritonsillar abscess [3], sinus surgery for complications, and sialendoscopy for sialadenitis represent major advances.
- 2. Improved Imaging** High-resolution ultrasound, low-dose CT protocols, and MRI with diffusion sequences have improved diagnostic accuracy [15].
- 3. Molecular Diagnostics** PCR testing for viral pathogens, *Kingella kingae*, and atypical mycobacteria has improved diagnostic precision [13,22].
- 4. Multidisciplinary Care** Integrated care involving ENT, pediatrics, infectious diseases, radiology, and critical care improves outcomes.
- 5. AI-Assisted Imaging** Emerging AI tools may enhance detection of abscesses and differentiate cellulitis from abscess, though clinical validation is ongoing.

Future Directions

Future research should prioritise: Prospective multicentre studies, Standardised diagnostic and surgical protocols, Long-term functional outcome reporting, Development of pediatric-specific imaging algorithms, Integration of AI-assisted imaging, Genetic and molecular analysis of emerging pathogens, Quality-of-life assessments, Structured follow-up pathways

CONCLUSION

Neonatal and pediatric head and neck infections require early recognition, accurate diagnosis, and coordinated multidisciplinary care. Advances in imaging, molecular diagnostics, and targeted therapy have improved outcomes. Persistent challenges include early identification of deep neck infections, antibiotic stewardship, and surgical decision-making. Future progress will rely on personalised approaches and improved reporting of long-term outcomes.

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