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Review of Paediatric Deep Neck Space Infection

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Abstract

Pediatric deep neck space infection is an important entity that often requires hospitalisation for antimicrobial therapy. There is a higher pattern of drug resistance in lower income countries such as South Africa. Resource limitations, poor access to healthcare, nutritional deficiencies and immune deficiency necessitate appropriate antimicrobial use as resistance may have a greater socioeconomic impact relative to higher income countries.

Introduction

Deep Neck Space Infection

Deep neck space infection is defined as infection in the potential spaces and fascial planes of the neck [1]. Paediatric deep neck space infections are a distinct entity from adult deep neck space infections as lymph nodes are more predominant in different anatomical sites in children, resulting in different clinical presentations and inciting pathogens from drainage areas affected [2].

Applied Anatomy

A study conducted by Chang et al., in 2010 demonstrated that the location of deep neck space infection differs across age groups in paediatrics, with retropharyngeal and parapharyngeal abscesses affecting a younger age group, whereas peritonsillar abscesses affected adolescents [2].

The attachment of fascia to the hyoid bone anteriorly may limit the spread of infection and therefore has anatomical significance. The anatomical sites may therefore be divided into those above the hyoid bone, those below it and those that involve the entire length of the neck [3,4].

Materials and Methods

We conducted a literature review of paediatric patients with deep neck space infection, specifically looking at microbiology results and medical management. A keyword search strategy was conducted using Pubmed database with the following search terms: “paediatric” or “pediatric” AND “deep neck space” AND “infection”. All studies conducted on paediatric patients such as case reports, case series and systematic review were included. Studies which reported primary surgical management for deep neck space infection were excluded. 19 articles were identified on Pubmed. 8 articles were further excluded based on the presence of a concomitant mass, systemic parasitic infection and studies evaluating primary surgical outcomes. 11 studies were therefore included for evaluation.

Pathogenesis and Distribution of Neck Space Infection

Infections affecting deep neck spaces include lymphadenitis, cellulitis, necrotic nodes and abscesses [5]. Ear, nose or throat infections may spread to these spaces via contiguous or lymphatic spread and may lead to abscess formation and subsequent life-threatening complications if left untreated [5,6].

According to Lawrence, et al. in 2017, peritonsillar space infections are generally due to acute tonsillitis which often occurs in young children [3]. Peritonsillar abscesses are however more common in an older children and adults with an average age of 25years [3].

Submandibular space infections are usually odontogenic in origin and are therefore less prevalent in children than adults [3].

Masticator space infections commonly arise as a result of infection from the third mandibular molar [4]. Buccal infections are also commonly odontogenic but may be non-odontogenic in children [4].

Parotid abscesses may occur as a result of adjacent sepsis, parotitis and sialadenitis [3]. These abscesses are however rare in the paediatric population and affected only 1% of paediatric patients in a study examining site-specific differences of deep neck space infections in children [6].

Post-styloid parapharyngeal space infections are more common in children due to cervical lymphadenitis, whereas pre-styloid infections are more common in adults due to spread from adjacent deep neck spaces such as submandibular, retropharyngeal, parotid and masticator spaces [7].

Retropharyngeal abscesses, however, are more predominant in early childhood as lymph nodes in these areas regress with age, and infections in this space are often due to respiratory infections, with lymph nodes in these areas draining the nose, pharynx and sinuses respectively [3].

Risk factors

Two risk factors were identified in Subsaharan Africa namely HIV infection and anemia, which predisposed children to development of deep neck infections. In a study published in 2019, children with HIV infection had significantly longer hospitalization regardless of age at presentation and there was a considerably high incidence of anemia (44% of patients tested) which reflects the nutritional deficiency associated with lower socioeconomic background and predisposition to infection as a result. Nevertheless, HIV infection was the only factor associated with a significantly longer hospitalization, indicating that in all HIV uninfected patients, adequate antimicrobial therapy alone may lead to faster recovery. Although most patients with anemia were less than 2 years of age, there was no significant difference in the duration of hospitalization related to age.

Children of low weight percentile, higher C-reactive protein levels, and low white cell count levels are also at a higher risk of complications [8.]

Nutritional deficiency and compromised immune status affect a wide spectrum of patients, thus affecting various age groups, as reflected in our recent study. It is imperative to therefore address these public health issues on a national level in order to dampen the burden on our healthcare system. In addition, access to healthcare and education are key issues which may decrease the incidence of deep neck space infections in pediatric patients of lower socioeconomic status.

Complications

Children are an especially vulnerable group as their ability to communicate symptoms is limited and this results in diagnostic challenges from a clinical perspective, which poses a greater risk for serious complications [8]. These complications include airway compromise, jugular vein thrombosis, carotid artery aneurysm or rupture, mediastinitis and sepsis [2]. Internal carotid artery aneurysm may lead to long term stenosis of this vessel [9, 10].

Internal jugular vein thrombophlebitis, otherwise known as Lemierre's syndrome may occur as a result of *Fusobacterium necrophorum* infection, and patients may present with fever, pulmonary and septic emboli, neck stiffness, swelling and pain in the neck along sternocleidomastoid muscle and mandible[4].

Microbiology of Paediatric Deep Neck Space Infection

Microbiological studies of patients with deep neck space infections demonstrated that the main inciting organisms are bacterial in origin, but these bacteria may differ in paediatrics to those seen in the adult population [3]. This may be because adult deep neck space infections are generally due to dental pathology whereas paediatric deep neck space infections may be due to tonsillitis, pharyngitis, haematogenous spread and suppurative cervical lymphadenitis[3].

The most common pathogens isolated in deep neck space infections include aerobes such as group A *Streptococcus* and *Staphylococcus aureus* [11]. Anaerobic bacteria predominance is believed to be underestimated but these species include *Fusobacterium, Peptostreptococcus* and *Porphyromonas* [11]. Cultures may also be polymicrobial, a reflection of the organisms contained within the oral cavity [9]. Songu et al., 2011 state that *Streptococcus* and normal oropharyngeal flora reside within the oropharynx and as a result are cultured in retropharyngeal and parapharyngeal abscesses more commonly. In contrast, *Staphylococcus aureus*, a skin contaminant, may be found in cultures of anterior and posterior neck abscesses including submandibular abscesses as these drainage sites are different to those of the oropharynx [2].

Antimicrobial Management of Paediatric Deep Neck Space Infection

In 2019, Wilkie et al. conducted a study to determine the safety and efficacy of antibiotics versus surgical drainage for paediatric deep neck space abscesses. In their study, they suggested that medical therapy with antimicrobials is a viable treatment option, as opposed to surgical treatment for patients with paediatric deep neck space infections less than 2,5cm in diameter [12].

Lawrence et al., 2017 also promoted the use of initial empiric antibiotic therapy for all patients with deep neck space infections prior to definitive organism identification via microscopy, culture and sensitivity [1]. They advocate that penicillin or that in combination with a β-lactamase inhibitor (such as amoxicillin with clavulanic acid), or a β-lactamase-resistant antibiotic (for example cefoxitin, cefuroxime, imipenem or meropenem) together with a drug (such as clindamycin or metronidazole) effective for anaerobic organisms be used for coverage against aerobic and anaerobic bacteria [1]. Brook et al. Specifically reviewed peritonsillar, retropharyngeal and parapharyngeal infections and also advocated the use of broad spectrum antibiotics due to the high incidence of beta lactamase producing bacteria in paediatric patients [13].

The Problem of Antimicrobial Resistance

Antimicrobial resistance is currently a critical issue worldwide and a higher pattern of resistance is seen in lower socioeconomic countries such as those in Subsaharan Africa [14]. It is defined by Magiorakos et al., 2012 as "the ability of a specific bacterium to survive in the presence of an antibiotic that was originally effective to treat infections caused by the bacterium, or acquisition of a specific antibiotic resistance mechanism" [15]. Bacteria may be either intrinsically resistant or may acquire resistant genes from other bacteria that are already resistant [15].

Resistance is on the rise for example aerobic bacteria such as *Staphylococcus aureus* and this places a greater burden on our healthcare system with prolonged hospital admissions, more rapid disease progression, greater morbidity and eventual costs [14]. Lower-middle income countries have higher resistance patterns and are especially at risk as there are limited resources in terms of the generations of antibiotics readily available, as well as diagnostic challenges which may lead to inappropriate antibiotic use [14].

This problem in lower socioeconomic countries is compounded by the limited amount of studies of a reasonable size reporting antimicrobial sensitivity outside of the intensive care setting. Antibiotic stewardship with de-escalation of antibiotics where necessary is therefore the cornerstone of combatting the problem of antibiotic resistance and the development of 'superbugs' [14].

In our study of 107 paediatric patients with deep neck space infection over a 5,5 year period, *Staphylococcus aureus* was cultured in 65% of positive cultures and all these organisms were resistant to penicillin but with 100% sensitivity to cloxacillin. A systematic review conducted by Lawrence and Bateman in 2017 suggested that penicillin may be used as empiric therapy [6]. It is however clear from our study that there is not only a higher incidence of *Staphylococcus aureus* infection but also a higher pattern of resistance, as patients presenting at our institution are usually referred from primary healthcare facilities which use penicillin as empiric antimicrobial therapy, to which all *Staphylococcus aureus* in our study is resistant. Negative culture results may also reflect empiric antimicrobial therapy of a sensitive organism prior to collection of specimens [20].

Conclusion

Children across all age groups are affected by deep neck space infection in a low socioeconomic environment. Risk factors identified in these settings include anaemia and HIV infection and low weight percentile. The incidence of Tuberculosis and anaerobic infection is lower than expected in paediatric deep neck space infections in lower socioeconomic countries. There is a high level of antimicrobial resistance to penicillin seen especially in Subsaharan Africa, predominantly due to *Staphylococcus aureus* infection. These organisms are however sensitive to Cloxacillin, which is a cost-effective beta-lactam antibiotic. We therefore recommend empiric treatment with cloxacillin in these patients and metronidazole to cover for anaerobic bacterial infection and de-escalation if necessary once culture results are available.

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