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Original Research Article

Deep neck space infections among patients attending a tertiary Ugandan hospital: clinical presentation, bacterial etiology and antimicrobial susceptibility

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ABSTRACT

Background: Deep neck space infection (DNSI) is inflammation often with abscess collection within the potential fascial spaces in the head and neck region. There is limited data on this disease in Uganda. This study sought to determine the clinical presentation and bacterial etiology with antimicrobial susceptibility of bacterial pathogens causing DNSIs among patients at a tertiary hospital.
Methods: A cross-sectional study design was used. The study population comprised 66 patients of all age groups with DNSIs. An interviewer-administered questionnaire was filled. A pus sample was taken off for culture and sensitivity. Data was entered using Epidata, validated and transferred to Stata version 16 for analysis.
Results: The majority of patients with DNSI were males (59.1%) with a mean age of 21.6 years. Neck swelling (100%) and pain (95.5%) were the most common presentation. The study participants were divided into two major groups; 29 patients belonged to the pediatric group, while 37 patients belonged to the adult group. Odontogenic sources were the most common predisposing factor in the adult group and nonodontogenic sources for the pediatric group. In both groups, the submandibular space (48.4%) was the most common site of presentation. *Staphylococcus aureus* (34.5%) was the most common isolated organism in the pediatric group, and MRSA were 46.1% overall *Viridans streptococci* (37.8%) was most common in the adult group with no resistance to clindamycin.
Conclusions: Susceptibility pattern varied, and highlights the necessity of doing antimicrobial sensitivity for all patients.

Keywords: DNSI, Bacterial pattern, Antimicrobial susceptibility, Pediatric age group, Adult age group

INTRODUCTION

Deep neck space infections (DNSI) have declined since the advent of antibiotic therapy; however, they still occur in all age groups. Globally the prevalence of DNSI is unknown, but recent literature from the United States revealed they account for approximately 3,400 hospitalizations annually.[1]

The clinical presentation is widely variable, and often early symptoms do not reflect the disease severity.[2] History may reveal etiology and predisposing factors such as previous dental diseases or procedures, URTIs, and neck trauma. The presence of comorbidities like HIV, and diabetes, predisposes to DNSI with complications.[3] A study by Almutairi et al of 183 patients with DNSI found that the 93 (50.8%) had comorbidities,

with the diabetes and hypertension being the most common.[4]

Aggressive monitoring and management of the airway is the most urgent and critical aspect of care, followed by appropriate antibiotic coverage and surgical drainage.[2] Surgical drainage may be by needle aspiration or incision and drainage depending on the abscess's size and location.[5]

Concerning the bacterial etiology of DNSI, a study by Yang in China where culture records of 130 patients were analyzed, results revealed mixed bacterial flora including, gram-positive organisms like viridans streptococci, *S. aureus*, and gram-negative organisms notably *E. coli* and *H. influenza.* [6]

Antibiotic susceptibility varies from region to region. In East Africa, Motegga et al found clindamycin, amoxicillin, and clavulanate to be effective against both aerobes and anaerobes while in South Africa, Sheetal et al found *Staphylococcus aureus* was 100% sensitive to cloxacillin and resistant to penicillin and ampicillin.[7,8] Initial empiric antimicrobial therapy should include broad coverage for aerobic and anaerobic bacteria. The study therefore set out to determine the current clinical presentation, bacterial etiology and antimicrobial susceptibility of organisms causing DNSIs among all age groups in our setting.

METHODS

A hospital-based descriptive cross-sectional study was conducted in a tertiary hospital in Uganda, Mulago national referral hospital, on the ear, nose and throat, oral maxillofacial, accident and emergency and pediatric wards.

Our study population included all patients with DNSIs of all ages attending the tertiary hospital from September 2022 to March 2023. We excluded patients with cellulitis and infected traumatic neck wounds.

Consecutive sampling was used to recruit study participants. The sociodemographic and clinical characteristics of participants were collected using a semi-structured questionnaire.

Samples for microbiological diagnosis were collected aseptically by aspiration of the abscess using a 5 ml syringe and 21-gauge needle, and put into a sterile plain tube by the PI before incision and drainage (I and D). This was done without the aid of imaging and samples were taken to MAKCHS microbiology laboratory for analysis within 3 hours of collection.

Specimen processing

Specimens' information was entered into the laboratory workbook. They were processed by recording their appearance, preparing initial gram stain slides for each, and then inoculated on well dried plates of MacConkey, agar. MacConkey agar was incubated in ambient air, whereas blood agar, and Chocolate in 5% carbon dioxide at 37^0 C for 18-48 hours.

The preliminary identification of bacteria was based on the growth on the plate, colony characteristics of the organism i.e., colonial morphology, changes in the physical appearance of the differential media such as hemolysis on blood agar, pink colonies on MacConkey and biochemical tests such as TSI, citrate and urea.

Routine antibiotic susceptibility testing was performed using the Kirby Bauer method as per the CSLI guidelines of 2021. The cultures and antibiotic discs were read and interpreted by a qualified laboratory technologist.

Data management and statistical analysis

The data was collected and managed in Epi-data version 4.6 and exported to STATA version V16.0 for statistical analysis. Data was analyzed using descriptive analysis, continuous variables that follow a normal distribution were summarized into means and standard deviation, and categorical variables were summarized into medians and interquartile range for non-nominal and frequencies and percentages for continuous variables. Visualization of some variables of interest and Drug sensitivities was done using excel and tableau. The results were summarized and presented in tables. Graphical presentation using bar graphs was used to describe key variables.

Ethical considerations

This study was approved by the Makerere university of school of medicine research and ethics committee. All study participants were voluntarily consented to the study and given unique identification numbers. All data collected was protected by the PI to protect participant confidentiality.

RESULTS

A total of 66 patients with DNSIs of all ages were recruited on wards of MNRH. Of the 66 patients, 28 (42.4%) were from the ENT ward, 21 (31.8%) from the OMF ward, 11 (16.7%) from the accident and emergency ward and 5 (7.6%) from the pediatric surgery ward.

The majority of study participants were males at 59.1% and those of urban residence accounted for 87.9%. The youngest patient was 2 months old and the oldest was 64 years old with a mean age of 21.6 years (SD±19.6). Study participants were divided into two major age groups; 29 (43.9%) patients aged 16 years and below belonged to the pediatric group while 37 (56.1%) patients aged 17 years and above belonged to the adult group. The majority of adult patients were self-employed traders at 34.8% while others were peasants at 16.7%. Children were 31.8% and

students were 16.7%. The participant's demographic characteristics are shown in Table 1.

Table 1: Demographic characteristics of patients with DNSIs according to age.

Variables	Pediatric group, (n=29) (%)	Adult group, (n=37) (%)	Total, (n=66) (%)
Gender			
Female	15 (51.7)	8 (27.6)	27 (40.9)
Male	14 (48.3)	25 (67.6)	39 (59.1)
Address			
Rural	3 (10.3)	5 (13.5)	8 (12.1)
Urban	26 (89.7)	32 (86.5)	58 (87.9)
Occupation			
Self-employed trader	0 (0.0)	23 (62.2)	23 (34.8)
Child	21 (72.4)	0 (0.0)	21 (31.8)
Peasant	0 (0.0)	11 (29.7)	11 (16.7)
Student	8 (27.6)	3 (8.1)	11 (16.7)

Clinical presentation of patients with deep neck space infections

A painful neck swelling was the chief complaint of the majority of the patients across both age groups. The median duration of swelling in days in the pediatric group was 7.0 (IQ 5.0, 14.0) and 14.0 (IQ 7.0, 30.0) for the adult group. One patient had a duration of neck swelling of 1460 days.

Odontogenic source was the major predisposing factor to DNSI in the adult age group. Dental caries was the most frequent underlying factor in 32 patients (86.5%) followed by tooth extraction in 20 patients (54.1%). Only 5 (7.6%) were smokers of tobacco. Non-odontogenic sources were more frequent in the pediatric age group, 2 patients had congenital neck swellings,11 patients had lymphadenitis whereas 13 patients (44.8%) in this age group had a history of preceding flu or sore throat. Ten patients (15.1%) had underlying immunosuppressive illnesses like DM and HIV. The distribution of clinical characteristics of patients with DNSI is shown in the Table 2.

Location of deep neck space infection

In both pediatric and adult groups, the submandibular space was the most frequently involved in 32 cases. In the pediatric age group, this was followed by 9 cases of parotid abscess, 6 cases of submental abscess and 2 cases of peritonsillar abscess. While in the adult group, the submandibular space was followed by nine cases each involving the parotid and parapharyngeal spaces, seven cases of masticator space and six cases each of Ludwig's angina and buccal space involvement.

The majority of patients, 52 (78.8%) underwent a neck ultrasound scan, this together with clinical examination and aspiration of the abscess, were used to determine the DNSI location. The location of DNSI among participants is shown in the Figure 1 below.

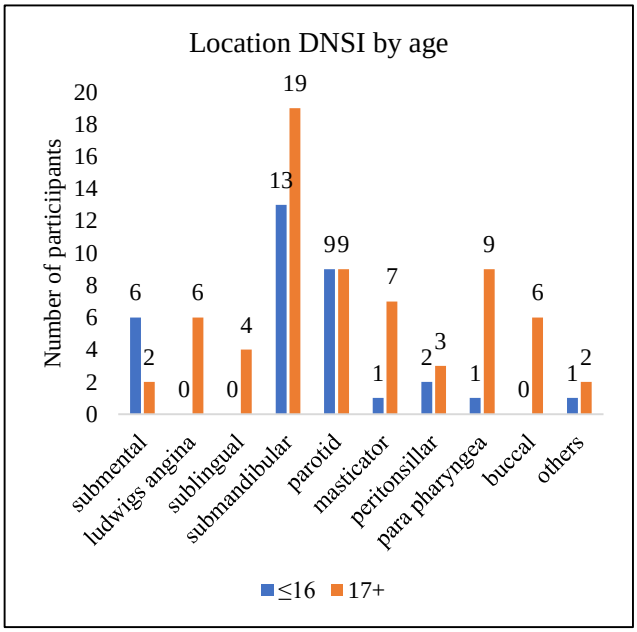

Figure 1: Location of DNSI.

Bacteriology of DNSI

Gram staining found no organism in 20(30.3%) of the samples. It was found that 43 (86.0%) were gram-positive and 7 (14.0%) were gram-negative. On culture, 31 (47.0%) had no growth of microbes and 35 (53.0%) had microbial growth. Overall, the pediatric group had a higher proportion of growth.

Overall, the most frequently encountered organism was viridans streptococci in 21 cases. *S. aureus* was most frequently in the pediatric group in 10 cases. This was followed by viridans streptococci in 7 cases. Coagulase-negative *staphylococcus* was found in 3 cases. *K. pneumoniae* was found in 1 case.

In the adult age group, viridans streptococci were the most frequently isolated group of organisms in 14 cases, followed by *S. aureus* in 4 cases. *E. coli* and *K. pneumoniae* were found in 2 cases each.

Of the patients with immunosuppressive illness, 6 (60%) had growth on culture. Five patients (83.3%) had one bacterial isolate on culture, and 1 patient (16.7%) had 2 isolates.

Isolates included coagulase-negative *staphylococcus*, MRSA, viridans streptococci *and Moraxella spp.* bacteriology of DNSI is shown in Table 3.

Antimicrobial susceptibility

The drug susceptibility test of different isolates to antibiotic agents revealed that most organisms were resistant to cotrimoxazole (*E. coli* 2 (100%), *K. pneumoniae* 3 (100%), *S. aureus* 6 (53.8%)), followed by ampicillin, erythromycin and meropenem.

All organisms tested for sensitivity against ampicillin were all resistant to the drug (*E. coli* 2 (100%),

K. pneumoniae 2 (100%), *S. aureus* 1 (100%). *S. aureus* was resistant to most drugs followed by *K. pneumoniae*.

S. aureus showed resistance to oxacillin 6 (46.1%), cotrimoxazole 6 (54.5%), clindamycin 7 (53.8%), and no resistance to ciprofloxacin.

Viridans streptococci showed some resistance to ceftriaxone 2 (25%) and tetracycline 3 (33.3%) but demonstrated no resistance to clindamycin and erythromycin.

The proportion of gram-negative rods resistant to 3rd generation cephalosporin was 100%. Results of antimicrobial susceptibility profiles shows in Table 4.

Table 2: Distribution of clinical characteristics of patients with deep neck space infection.

Variables	Pediatric group, (n=29) (%)	Adult group, (n=37) (%)	Total, (n=66) (%)
Duration of swelling in days			
Mean (SD)	74.7 (274.7)	25.8 (35.4)	47.3 (183.9)
Median (Q1, Q3)	7.0 (5, 14)	7.0 (5, 14)	10.0 (5, 21)
Symptoms			
Swollen neck	29 (100)	37 (100)	66 (100)
Difficulty in breathing	1 (3.4)	8 (21.6)	9 (13.6)
Painful swelling	28 (96.6)	35 (94.6)	63 (95.5)
Difficulty in swallowing	2 (6.9)	9 (24.3)	11 (16.7)
Pain on swallowing	6 (20.7)	15 (40.5)	21 (31.8)
Predisposing factors			
Tooth extraction	1 (3.4)	20 (54.1)	21 (31.8)
Sore throat/ flu and cough	13 (44.8)	2 (5.4)	15 (22.7)
Dental caries	3 (10.3)	32 (86.5)	35 (53.0)
Smoking	1 (3.4)	4 (10.8)	5 (7.6)
Diabetes	0 (0.0)	4 (10.8)	5 (7.6)
HIV	2 (6.9)	6 (16.2)	8 (12.1)
Signs			
Fever	27 (93.1)	30 (81.1)	57 (86.4)
Trismus	7 (24.1)	27 (73.0)	34 (51.5)
Tenderness	27 (93.1)	35 (94.6)	62 (93.9)
Pus discharge	25 (86.2)	34 (91.9)	59 (89.4)

Table 3: Bacteriology of DNSI.

Variables	Pediatric group, N (%)	Adult group, N (%)	Total, N (%)
Gram stain finding			
No organism	9 (31.0)	11 (29.7)	20 (30.3)
Organism	20 (69.0)	26 (70.3)	46 (69.7)
Negative	2 (6.9)	5 (13.5)	7 (14.0)
Positive	18 (62.1)	25 (67.5)	43 (86.0)
Culture growth			
No	12 (41.4)	19 (51.4)	31 (47.0)
Yes	17 (58.6)	18 (48.6)	35 (53.0)
Organism			
Viridans streptococci	7 (36.8)	14 (66.7)	21 (52.5)
S. aureus	10 (52.6)	4 (19.1)	14 (35.0)
Coagulase-negative staphylococcus	3 (15.7)	1 (4.8)	4 (10.0)
K. pneumoniae	1 (5.3)	2 (9.5)	3 (7.5)
S. pneumoniae	1 (5.3)	1 (4.8)	2 (5.0)
Enterobacter spp	1 (5.3)	0 (0.0)	1 (2.5)

Continued.

Variables	Pediatric group, N (%)	Adult group, N (%)	Total, N (%)
Acinetobacter spp	0 (0.0)	1 (4.8)	1 (2.5)
Moraxella spp	1 (5.3)	0 (0.0)	1 (2.5)
Streptococcus group B	1 (5.3)	0 (0.0)	1 (2.5)

Table 4: Antimicrobial susceptibility of common isolates.

Organisms	Pen G	Clotrim-azole	Chloram-phenicol	Cipro-floxacin	Ceftri-axone	Mero-penem	Clinda-mycin	Erythro-mycin	Oxacillin
***S. aureus*, n=14 (%)**	13 (92.9)	(54.5)	0 (0.0)	0 (0.0)	0 (0.0)	-	7 (53.8)	9 (69.2)	6 (46.1)
Coagulase-negative *staphylococcus*, n=4 (%)	0 (0)	0 (0)	0 (0.0)	0 (0.0)	-	-	-	0 (0.0)	0.0 ()
V. strep, n=21 (%)	-	-	0 (0.0)	-	2 (25)	-	0 (0.0)	0 (0.0)	-
Gram-negative rods, n=7 (%)	-	5 (100)	2 (50)	1 (50)	2 (100)	3 (100)	-	-	-

DISCUSSION

Deep neck space infection is an infection in the potential spaces and fascial planes of the neck either with abscess formation or cellulitis. Their prevalence has been declining since the advent of antibiotic therapy; however, they still occur and remain a challenge in the developing world. Our study included 66 patients with DNSI, intending to determine their clinical presentation, bacteriology, and antimicrobial susceptibility profiles of bacterial pathogens causing DNSI. Out of 66 patients, males were 39 (59.1%) and outnumbered females who were, 27 (40%). This is in agreement with the findings of other studies.[4,9,10] In contrast, female preponderance was found by Nassar et al.[11] The reason for these variations is unknown, however, in our setting, it can be attributed to poor oral hygiene habits and poor health-seeking behaviour among men compared to women.

DNSI occurs in a wide range of age groups as shown in this study where the youngest patient was 2 months old and the oldest, 64 years old. In this study, the majority of the adult patients belonged to the third and fourth decades. This correlates with studies where DNSI commonly occurred in the third decade of life.[12,13]

The majority were residents of urban areas, 58 (87.9%), similar to a study by Brittany et al.[14] Though differs from other studies in literature where the majority of patients were from a rural setting.[3,15] This finding could be explained by the proximity of the areas of residence to the health facility, which is located in an urban area.

The study found that almost all patients presented with pain (95.5%) and neck swelling (100%). All the patients who presented with neck swelling did not have a prior incision and drainage done. Other common presenting symptoms in the study included dysphagia (16.7%), odynophagia (31.8%), difficulty in breathing (13.6%) and fever (86.4%). The presence of pain and swelling were also the most frequent clinical findings in similar studies.[3,8]

The mean duration of swelling in days at presentation was 74.7 (SD±274.7) in the pediatric group and 25.8 (SD±35.4) in the adult group. The longer duration in the pediatric group can be attributed to congenital neck swellings in this age group. The relatively longer duration of swelling in the adult group could be due to delays in seeking care and delayed referral from primary healthcare facilities. However, the median duration of symptoms at presentation was between 7 to 14 days similar to studies done where on average patients presented within 7 to 11 days of the onset of presenting complaints.[3,16]

Dental caries (86.5%) and tooth extractions (54.1%) were the most common predisposing factor to DNSIs in the adult group whereas DNSIs in the pediatric group were majorly preceded by URTIs (44.8%). Odontogenic source of DNSI is more prevalent in adults even in the reviewed literature.[3,12,17]

Immunocompromised states are a previously established predisposing factor for DNSIs.[17] The proportion of patients with co-morbid immunosuppressive illnesses like DM and HIV in this study was 15.1%. HIV was the most commonly associated co-morbid illness (n=8) and 2 patients had diabetes mellitus. Though in most studies, diabetes mellitus is the most significant comorbid pathology for developing deep neck space infection, this was not demonstrated in this study.[6,17,18]

The commonest anatomical site of DNSI in our study was the submandibular space in 32 cases followed by the parotid space. In our study, there was no age-related difference in the spectrum of the deep neck space affected as the submandibular space was the most commonly affected across both age groups. Our study findings

correlate with other studies.[19,20] This can be attributed to the submandibular space being the site of the spread of infection from mandibular molars and lymphadenitis.

No growth of organisms occurred in 47.0% (n=31) of patients. This could be due to the inability to isolate anaerobes and other atypical microbes such as mycobacterium tuberculosis coupled with antibiotic use before presentation by the majority of correspondents (59.1%) in the study. These findings are similar to those by Meher et al who found no isolate in 66% of the samples.[12]

In our study overall, the majority of the isolates were gram-positive at 86.0%. The commonest isolates were *S. aureus* in the pediatric group and viridans streptococcus in the adult group. These organisms have been frequently implicated in DNSIs in these age groups and are reported in similar studies.[7,10,21]

Overall, the bacteria commonly isolated in the pediatric group included *S. aureus* (n=10), viridans streptococcus (n=7), and coagulase negative *staphylococcus* (n=3). This is in tandem with findings by Mungul et al in South Africa regarding the microbiology of pediatric deep neck space infections.[7] *S. aureus* is commonly implicated in the cause of acute lymphadenitis and cellulitis in children which may progress to abscess formation.

In the adult group, commonly encountered bacterial Isolates included viridans streptococcus (n=14), *S. aureus* (n=4), and *K. pneumoniae* (n=2). Viridans streptococcus group are most abundant in the mouth and the main cause of dental caries. This correlates to findings by Sultana et al and Motegga et al.[8,17]

Overall gram-positive and gram-negative isolates had poor susceptibility to cotrimoxazole and ampicillin but had high susceptibility to clindamycin and chloramphenicol.

In our study, it was found that *S. aureus* was resistant to most drugs, including penicillin G (92.9%), ampicillin (100%), erythromycin (96.2%) and oxacillin (46.2%) referred to as methicillin-resistant. The high pattern of resistance against penicillin is an expected finding as most *S. aureus* is currently resistant, probably due to the indiscriminate use of penicillin antibiotics. The prevalence of MRSA in our study is higher than that reported by Amir et al in a meta-analysis indicating prevalence rates of 5.36-14.08% in South Africa.[22]

S. aureus was however susceptible to linezolid (100%), vancomycin (100%), chloramphenicol (91.7%) and ciprofloxacin (77.8%). Similar results were reported by other authors though to the contrary, a study done in Taiwan showed *S. aureus* demonstrated only 5.3% resistance to penicillin.[7,18,23]

Viridans streptococcus showed some resistance to tetracycline (33.3%) and ceftriaxone (25%) and demonstrated no resistance to clindamycin and erythromycin. Kityamuwesi et al found a similar susceptibility pattern for viridans streptococcus.[21]

Our study highlights the challenge of DSNIs in our setting. It however had some limitations which should be put into consideration when interpreting the results; First, the aspiration of DNSI was done blindly without the aid of an ultrasound scan which might have resulted in missing the abscess and exclusion from the study. Second, we examined a limited number of micro-organisms because of the limited laboratory capacity. Future studies can study a wider scope of micro-organisms.

CONCLUSION

DNSIs are highly frequent with a male predominance in our setting. Neck swelling and pain are the most common presentation of patients with DNSI.

Odontogenic source is the most common predisposing factor for DNSIs in the adult group while non-odontogenic sources are the most common predisposing factor for DNSIs in the pediatric group. *S. aureus* and viridans streptococcus are the most commonly implicated organisms in the causation of DNSI were *S. aureus* in the pediatric and adult populations respectively. There's variation in susceptibility patterns. Culture and sensitivity should be done on all patients with DNSIs.

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