

Research Article

A Review of Deep Neck Space Infections: Perspective from a Sub-Saharan African Center

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Abstract: Deep neck space infections (DNSI) are inflammation often with abscess collection within potential fascial spaces in the head and neck region. The incidence of DNSIs is relatively higher in populations of low socioeconomic status. This study aimed at analyzing the pattern of presentation and management of DNSIs seen at our facility over 10 years. Data were extracted from patients' case notes and medical records. A total of 72 patients (47 males and 25 females) were studied with a Male to Female ratio of 1.88:1. The patients' ages ranged from 4 years to 80 years with mean age of 46.2±21.3 years. The commonest presenting complaints were pain (95.8%), dysphagia (81.9%) and odynophagia (70.8%). The mean duration of complaints prior to presentation was 10.9±4.1 days. Majority of the DNSIs were of odontogenic origin (56.9%) and diabetes mellitus (26.4%) was the most commonly encountered co-morbid condition. Submandibular and sublingual infections were the most common (40.3%) followed by peritonsillar space infections (23.6%) and retropharyngeal and prevertebral space infections (16.7%). *S. aureus* (15.3%) was the most commonly isolated organism among the rest with the infection being polymicrobial in 33.3% of the patients. The commonest complications were septicaemia (18.1%), necrotizing fasciitis (12.4%) and mediastinitis (2.8%). In Sub-Saharan Africa, DNSIs can affect all age groups; appear to have more morbidity in people with low socioeconomic class and co-morbidities. They can be managed with a combination of incision and drainage and intravenous antibiotics. Attention to oro-dental hygiene may help reduce the incidence of DNSI as majority are found to be linked with odontogenic and pharyngo-tonsillar conditions.

Keywords: Deep Neck Space, Infection, Sub-Saharan Africa

1. Introduction

Deep neck space infections (DNSI) are inflammation often with abscess collection within potential fascial spaces in the head and neck region. The neck is divided into compartments by condensations of fibrous tissues. [1] These fascial spaces are potential lacunae that can get infected. These infections may be associated with significant morbidity and mortality. [2] The management of these infections often require multidisciplinary team.

Common sources of such infections include dental, tonsillar and salivary gland infections, foreign body impaction and malignancies. [3-5] Odontogenic conditions have been implicated in many DNSIs [6-8] while some others reported tonsillar-related infections as the most common aetiology. [9, 10] Less reported causes include salivary gland infections, foreign body impaction (commonly fishbone impaction into the palatine tonsils or the floor of mouth) and iatrogenic

causes. [10-12] DNSIs have been reported following oral piercings, manipulation in the throat by traditional healers and even following dental extractions. [6, 13, 14]

Many studies have reported significant relationship between low socioeconomic status and incidence of DNSIs. [15-17] The presence of co-morbidities such as diabetes mellitus, HIV/AIDS, Malnutrition, anaemia and chronic alcoholism have also been linked with increased morbidity in DNSIs. [6, 15-17]

The management of DNSI is challenging especially in the presence of complications. In sub-Saharan Africa, the challenges are more evident due to late presentation, poor health system and socio-economic status.

The procedure may be done with local anesthesia, in cases of retropharyngeal abscesses, general anesthesia is required. [18] The burden of care is further heightened by long hospital stay.

Our study set out to review all cases of DNSI seen at our facility over 10 years. The demographics of the patients as well as presentation, assessment, treatment and the clinical outcome of the cases were analyzed. Our management experience is compared with experience of other authors.

2. Methods

This study is a retrospective analysis of patients with DNSIs seen our centre, from January 2010 to December 2019 who met the criteria for DNSI (cellulitis of abscess collection within the deep fascial head and neck spaces confirmed clinically or by radiological investigations). A total of 83 patients were recruited for the study. Eleven patients were excluded due to incomplete records. The 72 patients who met the inclusion criteria had their data extracted from the hospital records. The location of the DNSI was determined by clinical assessment and radiological evaluation. Using the radiological images and aspirate yield, the infections were classified as abscess or cellulitis and where aspirate was obtained, microscopy, culture and sensitivity tests was carried out to determine implicated microbes. Ethical approval for the study was obtained from the hospital ethical clearance committee.

3. Results

We studied a total of 72 patients with a male to female ratio

Table 3. Duration of presenting complaints.

Duration of presenting symptoms (days)	Sex of patients		Total (%)
	Males	Females	
<7	25	17	42 (58.3)
8-14	7	3	10 (13.9)
15-21	12	4	16 (22.2)
>21	3	1	4 (5.6)
Total (%)	47 (65.3)	25 (34.7)	72 (100.0)

P=0.672.

The aetiological factors as well as co-morbidities that contributed to DNSIs are shown in table 4. Odontogenic conditions accounted for 56.9 of cases while pharyngo-tonsillitis was found to be responsible for 37.5% of cases.

of 1.88:1. The patients had a mean age of 46.2±12.3 years. The majority of the patients (20.8%) were aged 70 years and above. There was a statistically significant increase in the odds of developing of DNSI with age (P=0.038). The patients were categorized into 3 socioeconomic classes (as shown in table 1). Criteria used in this classification include level of education, employment status and income level. Majority of the patients (55.5%) were of low socioeconomic class. There was a statistically significant relationship between low socioeconomic status and development of DNSI.

Table 1. Socioeconomic status of patients.

Socioeconomic class	Sex of patients		Total (%)
	Males	Females	
Low	26	14	40 (55.5)
Middle	21	10	31 (43.1)
High	0	1	1 (1.4)
Total (%)	47 (65.3)	25 (34.7)	72 (100.0)

P=0.014.

The presenting complaints of the patients are represented in table 2 below. Pain was the commonest presenting complaint (95.8%), 81.9% of the patients presented with dysphagia.

Table 2. Presenting complaints among patients.

Presenting symptoms	Number of patients		Total (%)
	Males	Females	
Pain	46	23	69 (95.8)
Dysphagia	33	26	59 (81.9)
Odynophagia	29	22	51 (70.8)
Sore throat	28	21	49 (68.1)
Neck swelling	31	17	48 (66.7)
Fever	24	20	44 (61.1)
Dyspnea	19	18	37 (51.4)
Change of voice	20	17	37 (51.4)
Otalgia	14	12	26 (36.1)
Headache	11	8	19 (26.4)
Cough	11	7	18 (25.0)
Purulent discharge	10	4	14 (19.4)

The duration of the complaints prior to presentation is represented in table 3 below. Majority of the patients (58.3%) presented to our facility within 7 days of onset of their symptoms while only 4 patients (5.6%) presented after 21 days.

Table 4. Aetiological and contributory factors among patients.

Aetiological factors	Sex of patients		Total (%)
	Males	Females	
Odontogenic infection	26	15	41 (56.9)
Pharyngo-tonsillitis	16	11	27 (37.5)
Foreign body impaction	5	4	9 (12.5)
Penetrating injury	4	1	5 (6.9)
Salivary gland infection	2	3	5 (6.9)
Iatrogenic	3	1	4 (5.6)

Contributory co-morbidities	Sex of patients		Total (%)
	Males	Females	
Diabetes Mellitus	8	11	19 (26.4)
HIV infection	5	2	7 (9.7)
Tuberculosis	0	2	2 (2.8)
Malnutrition	3	3	6 (8.3)
Others	3	5	8 (11.1)

P=0.762.

The anatomical location of the infections (abscesses and cellulitis) were identified and classified below in table 5. Sublingual and submandibular abscesses were classified together as they are often implicated together in Ludwig's angina and they were the anatomical site of DNSI in the majority of patients (40.3%).

Table 5. Site of infection.

Sites of infection	Sex of patients		Total (%)
	Males	Females	
Submandibular/sublingual spaces	19	10	29 (40.3)
Peritonsillar space	10	7	17 (23.6)
Retropharyngeal/Prevertebral spaces	8	4	12 (16.7)
Parotid/Buccal/Masseteric spaces	8	3	11 (15.3)
Parapharyngeal space	2	1	3 (4.1)
Total (%)	47 (65.3%)	25 (34.7)	72 (100.0)

P=0.023.

Aspirates obtained after tapping or draining the abscesses were subjected to microscopy, culture and sensitivity and the isolated organisms are as seen in table 6 below. Staphylococcus aureus was isolated in 15.3% of patients. No organisms were isolated in 37.5% of cases and the infection was polymicrobial in 33.3% of patients.

Table 6. Bacteriology of patients.

Organisms isolated	Sex of patients		Total
	Males	Females	
Staphylococcus aureus	5	6	11 (15.3)
Streptococcus pyogenes	4	3	7 (9.7)
Streptococcus viridans	4	1	5 (6.9)
Streptococcus pneumoniae	2	3	5 (6.9)
Escherichia coli	2	2	4 (5.6)
Klebsiella pneumoniae	2	1	3 (4.2)
Pseudomonas aeruginosa	3	0	3 (4.2)
Bacteroides fragilis	1	2	3 (4.2)
Peptostreptococcus	0	2	2 (2.8)
Mycobacterium tuberculosis	0	2	2 (2.8)
No growth	19	8	27 (37.5)

Number of isolates	Sex of patients		Total
	Males	Females	
Negative culture	19	8	27 (37.5)
Polymicrobial	15	9	24 (33.3)
Monomicrobial	13	8	21 (29.2)
Total	47 (65.3)	25 (34.7)	72 (100.0)

P=0.056.

The modality of treatment among the patients are represented in table 7 below. Majority of the patients (87.5%) were treated with intravenous antibiotics as well as abscess drainage. The remainder were treated with intravenous antibiotics alone. In addition, 33.3% of patients had tooth extraction while 26.4% had tracheostomy to secure their airways.

Table 7. Treatment modalities among patients.

Treatment modality	Sex of patients		Total (%)
	Males	Females	
Main treatment			
IV Antibiotics alone	5	4	9 (12.5)
IV Antibiotics with Incision and drainage	42	21	63 (87.5)
Total	47 (65.3)	25 (34.7)	72 (100.0)
Adjunctive treatment			
Tooth extraction	11	13	24 (33.3)
Debridement	14	8	22 (30.6)
Tracheostomy	10	9	19 (26.4)
Anti-tubercular treatment	0	2	2 (2.8)

P=0.065.

Table 8 shows data on identified major complications of deep neck space infections in the study. The commonest complication among the patients was septicaemia (18.1%).

Table 8. Major complications of DNSI encountered.

Complications	Sex of patients		Total (%)
	Males	Females	
Septicaemia	6	7	13 (18.1)
Necrotizing fasciitis	5	4	9 (12.4)
Mediastinitis	2	0	2 (2.8)
Facial nerve palsy	1	1	2 (2.8)
IJV Thrombophlebitis	1	0	1 (1.4)
None	32	13	45 (62.5)
Total	47 (65.3)	25 (34.7)	72 (100.0)

P=0.450.

The range of hospital stay was 1 to 126 days. The mean duration of hospital stay was 13.9±7.6 days.

The charts below illustrate data on follow up of patients up to 4 weeks after management and discharge of the patients. Majority of the patients (77.8%) were followed up to at least 4 weeks after discharge from hospital whereas the remaining 22.2% were lost to follow up (see figure 1 below).

The outcome of patients after 4 weeks of discharge from the hospital is summarized in table 9 below. The general outcome of the patient was assessed as satisfactory recovery (63.9%), residual morbidity (8.3%) or death (5.6%).

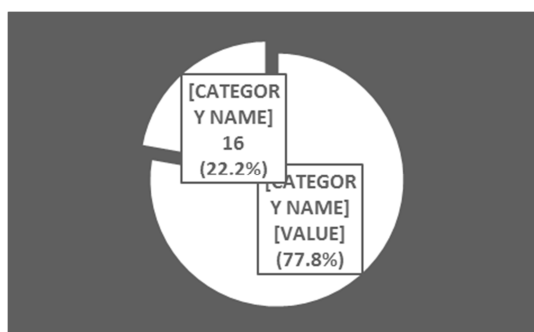


Figure 1. Follow up of patients up to 6 weeks after discharge.

Table 9. Outcome of patients 4 weeks after discharge.

Assessment	Sex of patients		Total (%)
	Males	Females	
Satisfactory recovery	28	18	46 (63.9)

Assessment	Sex of patients		Total (%)
	Males	Females	
Residual morbidity	4	2	6 (8.3)
Death	4	0	4 (5.6)
Lost to follow up.	11	5	16 (22.2)
Total	47 (65.3)	25 (34.7)	72 (100.0)

P=0.574.

4. Discussion

Our study analyzed 72 patients with a male to female ratio (M:F) of 1.88:1. This male predominant pattern was seen in similar works by Kataria et al (1.23:1), [8] Osunde et al (1.73:1) [15] and Almutairi et al (4.2:1). [10] In contrast, female predominance was found in studies by Nasir et al (1:1.6) [19] and Adegbiyi et al (1:1.6). [20] The reasons for these variations are not clear. The ages of the patient ranged from 4 years to 80 years (with mean age of 46.2±21.3 years) in this study underscoring the fact that DNSIs can affect all age groups. Some other studies have reported such infections in infants and neonates. [15, 19, 21] The patients in this study were categorized into 3 socioeconomic classes (see table 2) with most patients (55.5%) belonging to the low socioeconomic class. There was a statistically significant relationship (p=0.014) between low socioeconomic status and development of DNSIs. One study found that people in the lower socioeconomic classes were by far more likely to suffer a longer and more severe course of the disease than those of higher classes. [15]

In this study, pain was the most common presenting complaints (95.8%). Other common presenting symptoms in this study including dysphagia (81.9%), odynophagia (70.8%), neck swelling (66.7%) and fever (61.1%) largely mirror the complaints in similar studies such as those by Afolabi et al, [9] Almutairi et al [10] and Adegbiyi et al. [20] Majority of the patients (58.3%) presented within 7 days of onset of the presenting complaints. Patients who had peritonsillar abscesses (Quincy) were found to have presented earlier than those with submandibular and retropharyngeal abscesses. This is possibly because pain (a predominant feature in Quincy) is a more profound symptom than swelling or dysphagia (which are more characteristic of the submandibular and retropharyngeal abscesses). Pain was the foremost presenting complaint in other studies, however in studies that analyzed predominantly

Ludwig's angina or retropharyngeal abscesses, dysphagia and dyspnea appeared to be more predominant. [6, 7, 16, 19]

Odontogenic and pharyngo-tonsillar infections were found to be the origin of majority of the DNSIs in our study accounting for 56.9% and 37.5% respectively. Other less common causative factors include fishbone impaction, salivary gland infections, penetrating injuries and iatrogenic interventions. Odontogenic infections appear to be the commonest cause of DNSIs in many other studies with the proportion of patients ranging from 50%-90%. [7, 8, 10, 16] A few studies however, identified tonsillar related infections as the leading cause of DNSIs, notable among them being the study by Nasir and colleagues. [19] Undoubtedly, there is overwhelming evidence that odontogenic and tonsillar related infections account for a vast majority of DNSIs compared to other causes. Our study found one case of parapharyngeal abscess following attempted tonsillectomy by a traditional healer. The patient presented with features of septicaemia and required drainage of abscess and prolonged hospital stay with intravenous antibiotics. Agbara et al reported a similar case of poorly managed dental carie by a traditional healer which subsequently led to DNSI complicated by empyema thoracis and consequently, death. [14] DNSIs have been reported to develop following dental extractions, tonsillectomies and even treatment of cervical disc herniation. [13, 6, 22, 23] In our study, Diabetes mellitus was the most commonly encountered co-morbidity with 26.4% of the patients being diabetic. This pattern is similar to findings in other studies on patients with DNSI. [6-8, 16] Statistical analysis of our study found a significant relationship between presence of diabetes and prolonged hospital stay ($p=0.003$) as well as between presence of a co-morbidity and development of complications ($p=0.039$).

The commonest anatomical sites of DNSI in our study were the submandibular and sublingual spaces, which collectively accounted for 40.3%. These spaces were considered together in our study as they were commonly involved together in Ludwig's angina. Furthermore, it may be impossible to differentiate these spaces. Other studies have identified the submandibular space as the most commonly involved site. [8, 15, 16] This may be explained by the finding that odontogenic conditions are the most commonly implicated causative factors in DNSIs. Infections of the lower roots of premolar and molar teeth are known to be precursors for submandibular and sublingual space infections. [5]

In our study, the commonest organism isolated was by staphylococcus aureus (15.3%), followed by Streptococcus pyogenes (9.7%) and streptococcus viridans (6.9%). These organisms have frequently been implicated in DNSIs and widely reported in similar studies. [6, 8, 17, 19, 20] There was a wide variety of isolates in our study and this could have been due to the widely varying ranges of age found in our study. Again, because the different anatomical sites of DNSIs have various precipitating conditions with the implicated organisms varying from one site to another, this finding may not be entirely unexpected. Negative culture results were identified in 37.5% of patients. This could be due to inability to isolate

anaerobes and fastidious organisms as well as antibiotic abuse prior to presentation. The culture results yielded polymicrobial growths in 33.3% of patients, isolates often being a combination of aerobes and anaerobes. These findings are largely in tandem with patterns reported in many literatures. [5-8, 10] In our study, mycobacterium tuberculosis was isolated from the purulent material drained from 2 patients with prevertebral abscess. They were subsequently treated for extrapulmonary tuberculosis in addition to their management for DNSI.

Majority of our patients (87.5%) were treated by a combination of surgical drainage of the abscesses where present, and the indicated antibiotics based on sensitivity results. The other 12.5% of patients were treated with intravenous antibiotics alone as many of them had cellulitis which did not require drainage. All patients studied received intravenous antibiotics. The choice of drainage technique for the abscesses were made based on the peculiarities of each patient. Generally, per-oral drainage was carried out for patients with peritonsillar, retropharyngeal and prevertebral abscesses while the extra-oral access was employed for parapharyngeal abscesses and submandibular abscesses. Similar treatment options have been adopted and described by authors of similar works. [7-9, 15] In addition, some patients were offered adjunctive treatment such as dental extraction (33.3%) and tracheostomy (26.4%). The extraction of offending teeth was imperative for the eradication of the source of infection and this is common practice especially among maxillofacial surgeons. [6, 7, 17] A large study by Velhonoja and co-workers on the current trends in the management of DNSI found that early dental extraction significantly shortened the hospital stay of patients. [18] Our experience is similar. Because airway compromise can often be a knotty challenge in the management of DNSIs, it is sometimes necessary that tracheostomy is carried out before surgical drainage of abscess is done. This perhaps underscores the necessity of multi-disciplinary co-operation between teams. It is not unusual that a maxillofacial surgeon in the course of managing a Ludwig's angina, invites an Otorhinolaryngologist to secure surgical airway by means of a tracheostomy. Tracheostomy was done in 35.4% of patients in the study on Ludwig's angina by Ojoje et al [7] but in only 5.3% and 5.4% of patients in the studies on DNSI by Kataria et al [8] and Cho et al [24] respectively. This discrepancy suggests that there may be more need for surgical airway in patients on management for submandibular and sublingual abscesses than in patients with other forms of DNSI.

The complications of DNSI we encountered include septicaemia (18.1%), necrotizing fasciitis (12.4%) and Mediastinitis (2.8). Our study found a higher prevalence of complications among the elderly and patients with co-morbidities than younger patients (less than 40 years old) and patients without co-morbidities. The risk of developing complications was 8 times more in patients above 40 years of age than those below 40 years old in a study by Osunde et al. [15] We found statistically significant association between presence of diabetes and development of complications ($p=0.005$). Less common complications in our study include

facial nerve palsy in 2 patients (2.8%) and internal jugular vein thrombophlebitis in 1 patient (1.4%). There were no complications identified in 62.5% of all the patients we studied.

The duration of hospital stay for patients managed for DNSI can vary widely due to various factors notable among which are extent of infection, presence of co-morbidities and development of complications. Only 27.8% of our patients stayed in the hospital for less than 7 days as good number of them had prolonged wound dressing especially in cases such as Ludwig's angina often with extensive area of skin loss. The mean hospital stay however, in our study was 13.9 days (S. D \pm 7.6 days) and this compares considerably with the experiences of contemporary workers. The mean duration of hospital stays in the studies by Okoje et al, [7] Osunde et al [15] and Nasir et al [19] were 10 days, 11 days and 8 days respectively. In contrast, the mean duration of stay in a study of peritonsillar abscess alone by Afolabi et al was 4 days. [9] Osunde et al in their study found a strong relationship between late presentation to the hospital and prolonged hospital stay. Patients who were treated for peritonsillar and retropharyngeal abscesses by intraoral drainage tend to have shorter hospital stays than those who had external drainage done. This is probably due to the large skin defect that result from drainage.

About 77.8% of patients were followed up till at least 4 weeks after discharge from the hospital while the remainder were lost to follow up. We found that there was 3-fold likelihood for defaulting follow up among patients in the low socioeconomic class than those in the middle class (O. R 3.1, C. I 1.27-6.91, p=0.021). Being that the levels of exposure and employment/income status of the patients were considered in classifying patients into socioeconomic classes, it is rational to assume that these factors may have played a role in the patients' attitude to follow up. Satisfactory recovery after 4 weeks of discharge from the hospital was recorded in 63.9% of our patients while we recorded 4 deaths (5.6%). Of the 4 deaths recorded, 2 had Ludwig's angina, while the other 2 cases were parapharyngeal abscess and prevertebral abscess. The patients were all diabetic males with 3 of them being above 70 years of age. Significant relationship was also found between presence of underlying medical conditions and poor clinical outcome in studies by Wang et al, [12] Osunde et al, [15] Kokong et al [16] and Motahari et al. Osunde et al studied 41 patients and recorded similar mortality rate (4.9%) as in our study of 72 patients. The mortality rate was considerably more in the studies by Braimah et al [17] (10.7%), Kokong et al [16] (15.2%), Okoje et al [7] (15.4%) and Ugboko et al [6] (25.0%). These relatively higher figures may be attributable partly to the lower number of patients reviewed in these studies ranging from 13 cases by Okoje et al to 33 cases by Kokong et al. Factors which may influence mortality rates among patients on management for DNSI include late presentation, old age, presence of co-morbidities and complications as well as limited availability of facility and skills for management. [12, 15-17, 25]

We recommend that coordinated efforts to educate the

public on features of possible precursors of DNSI so that early treatment may be instituted. The elderly and patients with co-morbidities who are at risk of severe disease should receive aggressive management. Adjunctive treatment modalities such as tracheostomy and dental extraction should always be considered when indicated as they are found to improve treatment outcome and duration of hospital stay.

5. Conclusion

Deep neck space infections can affect all age groups and are found to mostly follow odontogenic and pharyngo-tonsillar infections. Co-morbidities such as Diabetes mellitus, HIV/AIDS, Tuberculosis and Malnutrition were found to play a role in disease progression. Submandibular and sublingual spaces appear to be favourite sites of DNSI and although most infections appear to be polymicrobial, staphylococcus aureus are by far the most common organisms isolated in our study. Satisfactory recovery is likely following concerted multi-disciplinary co-operation in the management of these patients and mortality can be reduced to the barest minimum if the principles of management are meticulously followed.

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Conflicts of Interests

The authors declare that they have no competing interests.

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