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Characteristics and patterns of adult and pediatric deep neck space infection in a tertiary care institute

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Abstract

Background: Deep neck space infections are a serious but treatable group of infections affecting the fascial planes of the neck. The objective of this study is to determine various etiological causes, common sites, bacteriology, and complications in adult and pediatric patients suffering from deep neck space infections.

Results: We studied 80 patients retrospectively who were admitted and treated for deep neck space infections in the otolaryngology department in a tertiary care institute over 2 years between March 2019 and March 2021. The study cohort was divided into two major age groups; 20 patients belonged to the pediatric group, while 60 patients belonged to the adult group. In this study, odontogenic infection was the most common etiological factor, Ludwig's angina and submandibular space abscess were the common sites of presentation. Methicillin-resistant *Staphylococcus aureus* was the most common isolated microorganism. Septicemia was the most common complication developed after drainage of deep neck space infections.

Conclusion: In the wake of an increase in the prevalence of deep neck space infections, close attention must be paid to the management of patients with deep neck space infections to prevent the complications.

Keywords: Deep neck space infections, Odontogenic, MRSA, Morbidity, Mortality

Background

Deep neck space infections (DNSI) are a serious but treatable group of infections affecting the potential spaces and fascial planes of the neck, either with abscess formation or cellulitis [1–3].

Deep neck spaces are divided into primary and secondary fascial spaces by Holmes and Pellecchia. Buccal, canine, sublingual, submandibular, submental, and vestibular spaces are primary spaces. A secondary space infection can occur after direct primary space infection. Pterygomandibular, masseteric, temporal, parapharyngeal, infratemporal, and retropharyngeal spaces are among these spaces [4].

Odontogenic and periodontal infections are among the most common leading risk factors of deep neck space infections. The second most common source is tonsillopharyngitis [5]. DNSIs are almost typically polymicrobial in nature, reflecting the normal resident upper aerodigestive tract flora [6, 7].

Streptococcus viridans, *Peptostreptococcus* species, *Staphylococcus aureus*, *Klebsiella*, and anaerobes are the most encountered microorganisms from DNSI that represent pathological overgrowth of the endogenous flora of the mouth and upper respiratory tract [8].

DNSIs usually present with systemic upset, fever, neck pain with limitation in range of motion, with or without trismus, and neck swelling, but importantly can progress to serious and life-threatening complications in about 10–20% of cases such as airway obstructions, sepsis, descending mediastinitis, endocarditis, acute respiratory distress syndrome and pleura-pulmonary suppuration [4,

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9, 10]. Mortalities after DNSIs are usually attributed to sepsis, pre-existing organ failure, and airway embarrassment [11].

Immediate surgical drainage has been the traditional mainstay of the management, but directed antimicrobial coverage and vigorous supportive care are important adjuvants in achieving successful outcomes [12].

The aim of this research is to study various etiological causes, common sites, bacteriology, and complications in adult and pediatric patients suffering from DNSI.

Methods

The medical records of eighty patients diagnosed with DNSI treated at tertiary care institutes between March 2019 and March 2021 were retrospectively reviewed.

This study was approved by the ethical committee for scientific research at the Otolaryngology Department, Cairo University, and the approval carries the number: 32-2020-11201.

DNSIs were always diagnosed solely from the history along with clinical, laboratory, and radiographic examination. The study cohort was divided into two groups; the pediatric group included patients aged 0–18 years and the adult group included patients older than 18 years old.

Patients of all age groups and both genders with clinically confirmed cases of abscesses were included. Patients with unavailable medical records, patients with cellulitis, infected traumatic wound, infected head, and neck tumors, and patients with associated medical co-morbidities were excluded from this study.

The epidemiological distribution of the study cohort, i.e., the age group and gender, was discussed. All the following parameters (site of neck spaces involved, etiology, culture growth, treatment methods, morbidities, and mortalities) were incorporated into the analysis. According to The Third International Consensus Definitions for Sepsis and Septic Shock, sepsis can be rapidly identified in non-intensive care settings using a quick SOFA (Sequential Organ Failure Assessment), when at least two of the following clinical criteria were met:

- Respiratory rate of 22/min or greater
- Altered mentation
- Systolic blood pressure of 100 mmHg or less

Septic shock is defined as a subset of sepsis in which a vasopressor is required to maintain a mean arterial pressure of 65 mmHg or greater and serum lactate level greater than 18 mg/dL in the absence of hypovolemia.

All patients underwent immediate surgical incision and drainage to drain pus according to the affected fascial space either via external cervical approach or

trans-oral approach whenever possible. Needle aspiration from loculated pus in the affected space was done to obtain an appropriate culture specimen using extra-oral approach to exclude sample contamination with normal oropharyngeal flora. After obtaining an appropriate sample for culture and sensitivity, all patients were started on treatment with ampicillin/sulbactam and metronidazole [7] which was later modified based on a culture and sensitivity result. The patients were followed up for 6 months.

Statistical methods

Data were coded and entered using the statistical package SPSS version 25. Data was summarized using mean and standard deviation for quantitative variables and frequencies (number of cases) and relative frequencies (percentages) for categorical variables. Comparisons between groups were done using unpaired *t* test. For comparing categorical data, chi-square (χ^2) test was performed. Exact test was used instead when the expected frequency is less than 5. *P* values less than 0.05 were considered as statistically significant.

Results

This study comprised 80 patients who presented to our institution with DNSI with a mean age of 31.45 years. The study cohort was divided into two major age groups; 20 patients with a mean age of 7.53 years belonged to the pediatric group, while 60 patients with a mean age of 40.22 years belonged to the adult group. Regarding the adult group, 27 patients (45%) were male, and 33 patients (55%) were female. In the pediatric group, 16 patients (80%) were male, and 4 patients (20%) were female.

Etiological factors

In the pediatric age group, the odontogenic source is the most common etiological factor (50%). In 6 patients (30%), the source of infection was unrecognizable. Each of tonsillo-pharyngitis and infected neck cysts was identified as an etiological factor in 2 patients (10%).

Similarly, in the adult age group, odontogenic source is the most common etiological factor (62%) followed by salivary gland infection (13%), tonsillopharyngitis (7%), and infected neck cysts (3%). In 9 patients out of 60 (15%), the source of infection was unrecognizable (Table 1).

Site of infection

In the pediatric age group (*n*=20), 10 patients (50%) had submandibular space involvement followed by 6 cases (30%) of Ludwig's angina, 2 cases (10%) of retropharyngeal abscess, 2 cases of buccal and parapharyngeal spaces involvement, and 1 case for each (5%).

Table 1 Etiological factors in patients with DNSI

| Etiology | Number of patients (%) | |
|------------------------------|------------------------|-----------|
| | Adults | Pediatric |
| 1. Odontogenic source | 37 (62%) | 10 (50%) |
| 2. Tonsillopharyngitis | 4 (7%) | 2 (10%) |
| 3. Salivary gland infections | 8 (13%) | 0 (0%) |
| 4. Infected neck cyst | 2 (3%) | 2 (10%) |
| 5. Unknown | 9 (15%) | 6 (30%) |

Table 2 Location of abscess in patients with DNSI

| Site of presentation | Number of patients (%) | |
|--------------------------------|------------------------|-----------|
| | Adults | Pediatric |
| 1. Ludwig's angina | 20 (33%) | 6 (30%) |
| 2. Submandibular space abscess | 18 (30%) | 10 (50%) |
| 3. Parapharyngeal abscess | 5 (8%) | 1 (5%) |
| 4. Retropharyngeal abscess | 1 (2%) | 2 (10%) |
| 5. Peritonsillar abscess | 3 (5%) | 0 (0%) |
| 6. Buccal space abscess | 3 (5%) | 1 (5%) |
| 7. Multiple spaces affection | 10 (17%) | 0 (0%) |

While in the adult age group, 20 cases (33%) had Ludwig's angina followed by 18 cases (30%) involving the submandibular space, 10 cases (17%) involving multiple deep neck spaces, 5 cases (8%) involving parapharyngeal space, 3 cases (5%) each of buccal space involvement and peritonsillar abscess, and 1 patient (2%) had involvement

of retropharyngeal space (Table 2). The pediatric group developed Ludwig's angina less frequently than the adult group (6/20 and 20/60 patients). The distribution of cases according to deep neck space involved in the pediatric and adult group is statistically significant ($p=0.006$).

Diagnosis and treatment

The laboratory data was available in 80 patients. The reference range of leucocyte count was $(4.0-11.0) \times 10^9$ cells/L. The leucocyte count was higher than 11.0×10^9 cells/L in 71 (88.8%) patients with a mean value of $(15.3 \pm 4.3) \times 10^9$ cells/L. There were no cases of leukopenia. C-reactive protein (CRP) was recorded and positive (>6 mg/L) in 52 (65%) patients mean (62.0 ± 38.2) mg/L.

Contrast-enhanced CT scan of the neck (CECT) was performed in 32 patients (40%) upon admission. CECT was performed at admission to confirm the diagnosis. The mean size of the abscess in the CT scan, considering the greater axis, was (58.47 ± 18.45) mm (Fig. 1).

All patients underwent immediate surgical incision, drainage, and debridement to drain the pus according to the affected fascial space either via external cervical approach (73 patients) or via trans-oral approach (7 patients).

Microbiology

Among 80 patients included in this study, pathogens were isolated in all cases.

In the pediatric age group, methicillin-resistant *Staphylococcus aureus* (MRSA) was the most predominant encountered organism with a prevalence of 35%

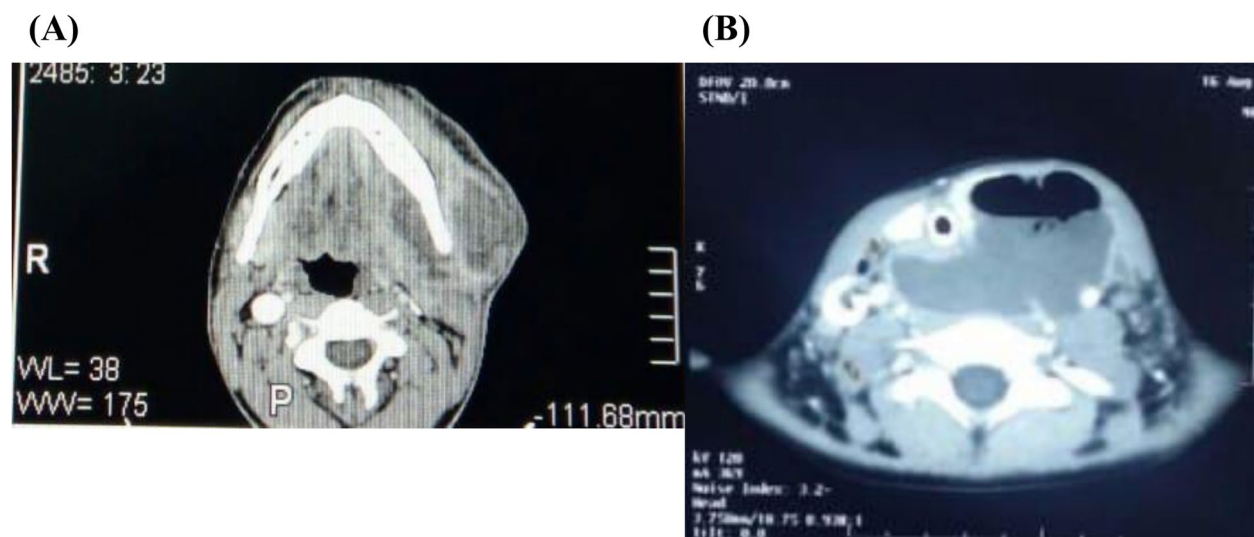


Fig. 1 Contrast-enhanced CT of the neck demonstrated. **A** An abscess in the left submandibular space. **B** Large sized retropharyngeal space abscess

Table 3 Pathogens of the DNSI

| Microorganism | Number of patients (%) | |
|-----------------------------------------------------------|------------------------|-----------|
| | Adults | Pediatric |
| Methicillin-resistant <i>Staphylococcus aureus</i> (MRSA) | 14 (23%) | 7 (35%) |
| <i>Klebsiella pneumoniae</i> | 11 (18%) | 4 (20%) |
| <i>Pseudomonas aeruginosa</i> | 7 (12%) | 2 (10%) |
| Alpha hemolytic streptococci | 4 (7%) | 3 (15%) |
| <i>Proteus mirabilis</i> | 6 (10%) | 2 (10%) |
| Enterococci | 4 (7%) | 0 (0%) |
| Mixed | 14 (23%) | 2 (10%) |

Table 4 Morbidities after the DNSI

| Morbidities | Number of patients (%) | |
|--------------------|------------------------|------------|
| | Adults | Pediatric |
| Cervical skin loss | 4 (6.6%) | 0 (0%) |
| Airway obstruction | 6 (10%) | 2 (10%) |
| Pneumonia | 4 (6.6%) | 2 (10%) |
| Empyema | 4 (6.6%) | 0 (0%) |
| Septicemia | 9 (15%) | 5 (25%) |
| Total | 27/60 (45%) | 9/20 (45%) |

of positive pus cultures. This was followed by *Klebsiella pneumoniae*, with a prevalence of 20%, and Alpha hemolytic *Staphylococcus* with a prevalence of 15%. *Proteus mirabilis* and mixed organisms had an equal prevalence of 10% of positive cultures.

Similarly, in the adult age group, methicillin-resistant *Staphylococcus aureus* and mixed organisms were the most cultured organism among 14 cases (23%) each, followed by *Klebsiella pneumoniae* in 11 cases (18%), *Pseudomonas aeruginosa* in 7 cases (12%), *Proteus mirabilis* in 6 cases (10%), and alpha-hemolytic streptococci and *Enterococcus* in 4 cases (7%) each (Table 3).

The distribution of patients according to microbiology in the adult and pediatric group is significant ($p=0.04$).

Morbidity and mortality

Out of 80 patients with DNSI, 36 patients (45%) experienced postoperative complication; 27 cases were adults and 9 cases belonged to the pediatric group.

In the pediatric group, septicemia was the most common complication in 5 cases (25%) followed by airway obstruction and pneumonia in 2 cases (10%) each.

Similarly, in the adult group, septicemia was developed in 9 cases (15%) followed by airway obstruction in 6 cases (10%), empyema, pneumonia, and cervical skin loss in 4 cases (6.6%) each (Table 4) (Fig. 2).

**Fig. 2** Cervical skin loss after adequate incision, drainage, and debridement of Ludwig's angina**Table 5** Mortality after of the DNSI

| Mortalities | Number of patients (%) | |
|--------------------|------------------------|-----------|
| | Adults | Pediatric |
| Septic shock | 3 (5%) | 1 (5%) |
| Airway obstruction | 2 (3%) | 0 (0%) |
| Total | 5/60 (8%) | 1/20 (5%) |

All patients survived without sequelae except 5 cases (8%) in the adult groups and 1 case (5%) in the pediatric group. The most common cause of death in this study was septic shock (4 cases) and airway obstruction (2 cases) (Table 5).

It was worth noting that all fatality cases were diagnosed as Ludwig's angina.

The distribution of patients according to Morbidity and mortality in the adult and pediatric age group is statistically insignificant ($p = 0.7$).

Discussion

In this study, most of the adult patients belonged to the age group of third and fourth decades. This is in agreement with the studies done by Singhal et al. and Meher et al. [13, 14].

Unlike the results of this study that showed female predominance in the adult group, Rega et al. and Jevon et al. showed male predominance in patients presented with DNSI [15, 16]. This may be attributed to the lack of access to qualified health care among the female population in low resource environment.

Odontogenic source was the most common etiological factor in the pediatric and adult groups, 50% and

62%, respectively. Holmes et al., Parhiscar et al., Huang et al., and Frydman et al. also showed similar findings [4, 17–19].

In this study, Ludwig's angina was the most common site for abscess formation in the adult group followed by a submandibular abscess. Our study results go in accordance with studies by Kataria et al., Maharaj et al., and Khode et al. [20–22].

Both our results and Singhal results agreed that the most commonly affected site in the pediatric population was the submandibular space [13]. Our research team believes that the relative ease of breakdown of submandibular lymphadenopathy, the relatively wide loose areolar tissue spaces, and the relatively weak response of the developing immune system make the submandibular space more prone to suppuration and abscess formation among the pediatric population.

Regarding microbiology, MRSA was the most common isolated organism in both pediatric and adult groups. Naidu et al. and Tan et al. studied reinforced our results [23, 24]. The abuse of empirical antibiotic therapy at the ambulatory setting might be contributing to the predominance of this virulent organism.

Complications like septicemia, airway obstruction, cervical skin loss, and empyema were reported in this study. Septicemia was the most common complication in both groups in this study. Jundt and Gutta showed similar results [25].

All patients survived without fatality except 5 cases of the adult group and 1 case of the pediatric group. All mortalities are diagnosed as Ludwig's angina. The most common cause of death was septic shock. These results are in agreement with studies made by Bali et al. and Gorjon et al. [11, 26]. Ludwig's angina is known to be associated with the highest rate of incidence of fatal complications [27, 28]. For this, aggressive wound debridement with adequate drainage and postoperative aggressive anti-microbial therapy should be instituted early upon diagnosis.

The main limitation of the present analysis is that this study was conducted retrospectively so, we were unable to obtain data regarding antibiotic susceptibility and resistance of fascial space microbiological spectrum. Another important factor is the small sample size due to the strict exclusion criteria.

The main strength of this study is that it reports an appropriate number of patients in a limited resource environment. The relatively small sample size in our study is attributed to the strict exclusion criteria.

Conclusion

DNSIs are potentially fatal processes and susceptible to morbidities and mortalities. Odontogenic source is still the commonest cause leading to DNSI and hence proper dental hygiene is essential for prevention. Close attention must be paid to the management of patients with deep neck space infections to prevent complications.

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Authors' contributions

A. A. N. made substantial contributions to the conception or design of the manuscript, data collection, and manuscript writing. H. O. I. gave final approval of the manuscript version to be published. A. M. E. made substantial contributions to the conception or design of the manuscript, data collection. The authors read and approved the final manuscript.

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Availability of data and materials

All data generated or analyzed during this study had already been included in this manuscript. Patient's case file was retrieved from the medical record section of the institution. The clinical data had been collected from the prospectively maintained computerized database and the case file. The follow-up status was updated from the above-mentioned manner.

Declarations

Ethics approval and consent to participate

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This study was approved by the ethical committee for scientific research at the Otolaryngology Department, Cairo University, and the approval carries the number: 32-2020-11201. Written informed consent to participate in this study was obtained from the participants or their parents or legal guardian in the case of children under 16.

Consent for publication

Written informed consent to publish the patient's clinical details information was obtained from the study participants or their parent or legal guardian in the case of children under 16.

Competing interests

The authors declare that they have no competing interests.

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References

1. Velhonoja J, Lääveri M, Soukka T, Irjala H, Kinnunen I (2020) Deep neck space infections: an upward trend and changing characteristics. *Eur Arch Otorhinolaryngol* 277(3):863–872
2. McDonnough JA, Ladzekpo DA, Yi I, Bond WR Jr, Ortega G, Kalejaiye AO (2019) Epidemiology and resource utilization of Ludwig's angina ED visits in the United States 2006–2014. *Laryngoscope* 129(9):2041–2044
3. Vieira F, Allen SM, Stocks RM, Thompson JW (2008) Deep neck infection. *Otolaryngol Clin N Am* 41(3):459–483
4. Holmes CJ, Pellicchia R (2016) Antimicrobial therapy in management of odontogenic infections in general dentistry. *Dental Clin* 60(2):497–507
5. Buckley J, Harris AS, Addams-Williams J (2019) Ten years of deep neck space abscesses. *J Laryngol Otol* 133(4):324–328

6. Jayagandhi S, Cheruvu SC, Manimaran V, Mohanty S (2019) Deep neck space infection: study of 52 cases. *Indian J Otolaryngol Head Neck Surg* 71(1):923–926
7. Caruso SR, Yamaguchi E, Portnof JE (2021) Update on Antimicrobial Therapy in Management of Acute Odontogenic Infection in Oral and Maxillofacial Surgery. *Oral Maxillofac Surg Clin* 34(1):169–77
8. Lawrence R, Bateman N (2017) Controversies in the management of deep neck space infection in children: an evidence-based review. *Clin Otolaryngol* 42(1):156–163
9. Li RM, Kiemeny M (2019) Infections of the Neck. *Emerg Med Clin* 37(1):95–107
10. Rajab B, Laskin DM, Abubaker AO (2013) Odontogenic infection leading to adult respiratory distress syndrome. *J Oral Maxillofac Surg* 71(2):302–304
11. Bali RK, Sharma P, Gaba S, Kaur A, Ghanghas P (2015) A review of complications of odontogenic infections. *Natl J Maxillofac Surg* 6(2):136
12. Al-Belasy FA, Haiman AR (2003) The efficacy of azithromycin in the treatment of acute infraorbital space infection. *J Oral Maxillofac Surg* 61(3):310–316
13. Singhal G, Jain S, Sen K (2020) Clinical presentation and microbiological profile of deep neck space infections in different age groups. *Indian J Otolaryngol and Head Neck Surg* 12:1–7
14. Meher R, Jain A, Sabharwal A, Gupta B, Singh I, Agarwal AK (2005) Deep neck abscess: a prospective study of 54 cases. *J Laryngol Otol* 119:299–302
15. Rega AJ, Aziz SR, Ziccardi VB (2006) Microbiology and antibiotic sensitivities of head and neck space infections of odontogenic origin. *J Oral Maxillofac Surg* 64(9):1377–1380
16. Jevon P, Abdelrahman A, Pigadas N (2020) Management of odontogenic infections and sepsis: an update. *Br Dent J* 229(6):363–370
17. Parhiscar A, Har-El G (2001) Deep neck abscess: a retrospective review of 210 cases. *Ann Otol Rhinol Laryngol* 110(11):1051–1054
18. Huang TT, Liu TC, Chen PR, Tseng FY, Yeh TH, Chen YS (2004) Deep neck infection: analysis of 185 cases. *Head Neck* 26(10):854–860
19. Frydman WL, Abbaszadeh K (2014) Diagnosis and management of odontogenic oral and facial infections. *Oral Health* 1:1
20. Khode SR, Bhat P, Rane S, Dasgupta KS (2013) Retrospective analysis of 298 cases of deep neck infections: its diagnosis and management. *Sci J Med Clin Trial* 2013
21. Kataria G, Saxena A, Bhagat S, Singh B, Kaur M, Kaur G (2015) Deep neck space infections: a study of 76 cases. *Iranian J Otorhinolaryngol* 27(81):293
22. Maharaj S, Ahmed S, Pillay P (2019) Deep neck space infections: a case series and review of the literature. *Clin Med Insights: Ear Nose Throat* 12:1179550619871274
23. Naidu SI, Donepudi SK, Stocks RM, Buckingham SC, Thompson JW (2005) Methicillin-resistant *Staphylococcus aureus* as a pathogen in deep neck abscesses: a pediatric case series. *Int J Pediatr Otorhinolaryngol* 69(10):1367–1371
24. Tan PT, Chang LY, Huang YC, Chiu CH, Wang CR, Lin TY (2001) Deep neck infections in children. *J Microbiol Immunol Infect* 34(4):287–292
25. Jundt JS, Gutta R (2012) Characteristics and cost impact of severe odontogenic infections. *Oral Surg Oral Med Oral Pathol Oral Radiol* 114(5):558–566
26. Gorjón PS, Pérez PB, Martín AC, de Dios JC, Alonso SE, de la Cabanillas MI (2012) Deep neck infection: review of 286 cases. *Acta Otorrinolaringologica (English Edition)* 63(1):31–41
27. Moreland LW, Corey J, McKenzie R (1988) Ludwig's angina: report of a case and review of the literature. *Arch Intern Med* 148(2):461–466
28. Yamaguchi R, Sakurada K, Saitoh H, Yoshida M, Makino Y, Torimitsu S, Mizuno S, Iwase H (2021) Fatal airway obstruction due to Ludwig's angina from severe odontogenic infection during antipsychotic medication: a case report and a literature review. *J Forensic Sci* 66(5):1980–5

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