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# Deep neck infections: review of 263 cases

**Authors' Contribution:**
**A** – Study Design
**B** – Data Collection
**C** – Statistical Analysis
**D** – Data Interpretation
**E** – Manuscript Preparation
**F** – Literature Search
**G** – Funds Collection

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**ABSTRACT:**

**Objectives:** In patients hospitalized due to deep neck infections (DNIs), to investigate the association between demographic parameters, etiology and localization of abscesses and/or phlegmons, complications, comorbidities, treatment, and bacterial cultures.

**Methods:** We analyzed data of 263 patients that were hospitalized from January 1, 2012 to December 31, 2015 due to deep neck space phlegmons and/or abscesses. We performed statistical analysis with the SPSS 22.0 software; statistical significance was set p<0.05.

**Results:** Among the analyzed patients, dental infections were the most frequent, followed by acute phlegmonous pharyngitis. Submandibular space abscesses or phlegmons of the neck were the most frequent complications of these infections. Re-operation was performed in 19.8% of cases, and complications developed in 11% (mostly airway obstruction). DNI complications were less common in smokers than in non-smokers (OR=0.038, p=0.025).

**Discussion:** In our study, dental infections accounted for 70.6% of DNI cases. Thus, our study explains why odontogenic DNIs are the most common DNI type studied in the literature. Poor oral health and odontogenic infections should not be underestimated because they can lead to uncommon but lethal diseases such as descending necrotizing mediastinitis, which requires aggressive surgical treatment and is associated with a mortality rate of 10%-40% despite treatment. Complication developed in 11.4% of cases. In conclusion, oral health and hygiene contribute to DNI development.

**KEYWORDS:** Abscess, Airway obstruction, Head, Neck, Tooth diseases

## ABBREVIATIONS:

BMI – body mass index
DNI – deep neck infection
HIV – human immunodeficiency virus
ICU – intensive care unit

## INTRODUCTION

Currently, the majority of head and neck infections originate from a dental focus [1, 2, 3, 4, 5]. Usually, dental infections are localized, and patients recover without any complications when adequate antibiotics are given [1, 3].

However, dental infections can spread, leading to complications such as bacteremia, bacterial endocarditis, mediastinitis, cavernous sinus thrombosis, suppurative jugular vein thrombophlebitis, carotid artery erosion, maxillary sinusitis, osteomyelitis, and deep neck infections (DNIs) [1, 3]. Typically, DNIs develop in patients with diabetes, immunosuppression, history of radiation and/or chemotherapy, HIV, or alcohol abuse [1, 4, 5, 6].

The deep cervical fascia divides the neck into separate spaces, and DNIs spread within these spaces [5].

At the time when effective antibiotics were not available, the majority of DNI cases were due to pharyngeal infections. Recently, DNIs are most frequently odontogenic, i.e., originate from a dental focus [5].

Acute airway obstruction is one of the most frequent and dangerous complications of DNIs, followed by mediastinitis, Lemierre's syndrome or suppurative internal jugular vein thrombophlebitis, carotid artery aneurysm or rupture, necrotizing cervical fasciitis, and pneumonia [5].

DNI-related mortality depends on the development of complications. If descending necrotizing mediastinitis develops, the mortality rate is 20%-40% [7].

DNIs are treated with broad spectrum antibiotics and/or surgery, i.e., incision and drainage [5]. If DNIs are due to dental infections, the dental infectious focus should be removed [1].

Currently, DNIs are mostly odontogenic infections, and are linked to poor oral hygiene and the socioeconomic status [5].

## MATERIALS AND METHODS

In this retrospective study, we analyzed records of 263 patients with DNIs hospitalized from January 1, 2012 to December 31, 2014. All patients were adult, and had phlegmons and/or abscesses of the deep neck spaces or the floor of the mouth. We analyzed the following data: age, sex, month of hospitalization, risk factors – smoking and body mass index (BMI), etiology, DNI location, complications, used antibiotics, antibacterial therapy length, surgery type, re-operation, hospitalization in an intensive care unit (ICU), treatment before hospitalization, bacterial culture results, and comorbidities.

We performed statistical analysis with the SPSS 22.0 software. Statistical significance was set at $p<0.05$ (two-tailed).

We tested data distribution with the Kolmogorov-Smirnov test. We calculated appropriate central tendency measures, frequencies, and percentages.

We used the Fisher's exact test for comparing pairs of nominal variables.

Binary logistic regression was used to estimate the probability of neck phlegmons, floor of the mouth phlegmons, and complications.

The Mann-Whitney U test was used to determine the impact of age in the following age ranges:
1) 18 – 29 years
2) 30 – 39 years
3) 40 – 49 years
4) 50 – 59 years
5) 60 – 89 years

The Mann-Whitney U test was used to determine the impact of BMI in the following ranges:
1) underweight <18.5
2) normal weight 18.5 – 24.9
3) overweight 25 – 29.9
4) obesity >29.9.

We used the nominal by interval directional measures Eta and Spearman's rank correlation coefficients to determine the impact of hospitalization length, the number of prescribed antibiotics, and ICU hospitalization length. Correlation coefficients were used to study the relation of age and BMI to hospitalization length, the number of antibiotics used, and ICU hospitalization length.

The study was approved by the Committee on Research Ethics (30/10/2014), and performed in accordance with ethical standards of the 1964 Declaration of Helsinki.

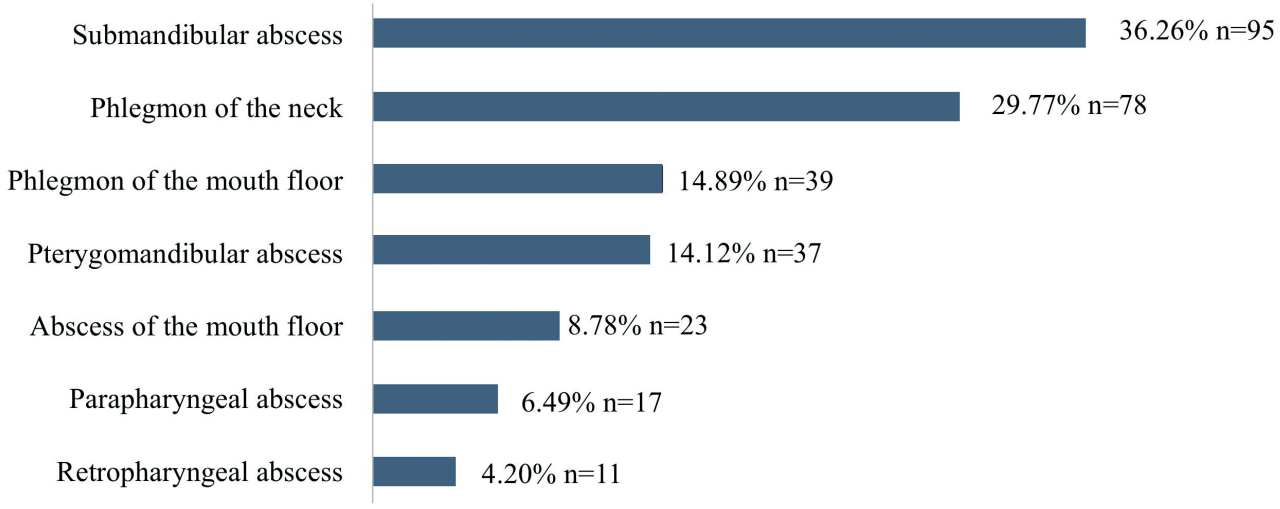


**Fig. 1.** Most frequent anatomical localization of the deep neck infection

## RESULTS

There were 150 males (57%) and 113 females (43%), with the median age of 44 years (IQR 29-60). The male-to-female ratio was 1:1.3. The median hospitalization length was 7 days (IQR 5-11), and 17 patients (6.5%) were transferred from another hospital. There was no seasonality regarding patient hospitalization.

Dental infections were the most frequent etiology of DNIs (n=139, 70.6%), followed by acute phlegmonous pharyngitis (n=29, 14.7%) and chronic decompensated tonsillitis (n=14, 7.1%). Compared to younger patients, the incidence of dental infections was significantly lower in elderly patients (p<0.001), and the incidence of chronic decompensated tonsillitis was significantly higher (p=0.027).

Submandibular space abscesses were the most frequent DNI type and location (see Fig.1).

In 55 (20.90%) patients, DNIs were located in 2 neck spaces. In less than 3% of cases, DNI location was different, e.g. perimandibular abscess, sublingual abscess etc. (Fig. 1).

Eighty-one (30.80%) patients had comorbidities such as primary arterial hypertension (n=38, 46.90%), coronary heart disease (n=21, 25.90%), or diabetes mellitus with its complications (n=20, 24.70%).

Fifty-two (9.80%) patients were overweight (BMI 25-29.9), and 112 (42.60%) were obese (BMI ≥30). Higher BMI values were associated with DNI location and severity ( Table 1).

Compared to younger patients, complication rate, ICU hospitalization, hospitalization length (p<0.001), and re-operations (p=0.044) were more frequent in elderly patients. The incidence of dental infections was lower in the elderly patients compared to younger patients (p<0.001).

One-hundred twenty-two (46.40%) patients were smokers, and 141 (53.60%) were non-smokers. DNI complications were more common in non-smokers than in smokers (OR=0.038 p=0.025).

Thirty (11.40%) patients had complications, including airway obstruction (n=27, 90%), mediastinitis (n=8, 26.67%), pneumonia (n=4, 13.33%), sepsis (n=3, 10%), pleuritis (n=3, 10%), facial nerve paresis (n=2, 6.67%), and jugular vein thrombosis (n=1, 3.33%). Only one patient, who developed jugular vein thrombosis, died.

Positive intraoperative swab bacterial cultures were found in 33 patients (12.50%), most commonly due to *Acinetobacter baumanii* (n=13, 38.20%) (Table 2). However, complications were more common in patients with a positive culture for methicillin-sensitive coagulase-negative Staphylococcus (OR=7.567, p=0.002) and methicillin-sensitive Staphylococcus aureus (OR=5.067, p=0.032).

All patients received antibiotics, usually a combination of 2 agents. The most frequently used antibiotics were: metronidazole (n=209, 79.50%), cefazolin (n=107, 40.7%), ceftriaxone

**Tab. I.** The impact of body mass index in the development of deep neck infection

| IF BODY MASS INDEX INCREASES | | | |
|---|---|---|---|
| | Parameter | Frequency of parameter | P value |
| Etiology | Dental infection | ↓ | <0.001 |
| | Acute phlegmonous laryngitis | ↑ | 0.002 |
| DNI localization | Pterygomandibular abscess | ↓ | 0.003 |
| | Submandibular abscess | ↓ | <0.001 |
| | Phlegmon of the neck | ↑ | <0.001 |
| Severity | Complications | ↑ | 0.03 |

↓ Frequency of parameter decreases ↑ Frequency of parameter increases
Method of calculation: Mann-Whitney U test

**Tab. II.** Most frequently found pathogens in bacterial culture

| PATHOGEN | NUMBER OF CASES |
|---|---|
| Acinetobacter baumanii | 13 |
| Methicilin-sensitive coagulase-negative Staphylococcus | 11 |
| Methicillin-sensitive Staphylococcus aureus | 8 |
| Candida albicans | 6 |
| Enterococcus spp. | 5 |
| Enterobacter cloacae | 4 |
| Pseudomona aeruginosa | 4 |
| Klabsiella pneumonia | 4 |

**Tab. III.** Most common antibacterial resistance results

| ANTIBACTERIAL MEDICINE | NUMBER OF CASES |
|---|---|
| Ceftazidime | 12 |
| Gentamicine | 12 |
| Trimepeoprime/sulfametaxazole | 12 |
| Piperaciline/tazobactame | 10 |
| Imipeneme | 8 |
| Ciprofloxacine | 8 |

(n=69, 26.20%), ampicillin (n=64, 24.3%), and amoxicillin/clavulanic acid (n=52, 19.80%). Information on antibiotic resistance in presented in Table 3.

Two-hundred forty-six patients (93.50%) underwent surgery, including 237 (96.3%) patients who underwent incision and drainage. Reoperation was performed in 52 (19.8%) patients.

In addition to primary incision and drainage, to eliminate infection source, tooth extraction and tonsillectomy were performed in 56 (22.80%) and 22 (8.90%) patients, respectively.

Sixteen patients (6.10%) were transferred to an ICU, with a median stay of 18 days (IQR 7.5 – 22.75). Among the ICU-hospitalized patients, eleven (68.80%) were female (p=0.038). Twelve (75.00%) patients hospitalized in an ICU had cultures positive for *Acinetobacter baumanii* (p<0.001), 84.60% required re-operation (p<0.001).

## DISCUSSON

Because our hospital provides emergency ENT care for nearly all patients in our state, we estimated that the DNI incidence was approximately 4.3/100,000 inhabitants per year (approximately 87 cases per year) [8]. There is limited information regarding DNI incidence in other countries. Gorjon et al. reported an incidence of approximately 15/100,000 inhabitants per year in Spain (Avila and Salamanca) [9]; thus, DNIs seem to be less common in Latvia.

In our study, the female-to-male ratio was 1:1.3, which is similar to previous studies that reported the female-to-male ration in the range of 1:1.2 - 1.77 [10, 11, 12]. The median hospital stay duration was 7 days (IQR 5 – 11), similar to that in other countries (6.6 and 8 days) [10, 13].

Currently, dental infections account for 20.5%-88.7% of DNI cases [10, 12, 13, 14]; similarly, we found in our study that dental infections accounted for 70.6% of all DNIs. This is reflected by the fact that most research regarding DNIs has focused only on odontogenic DNIs [4, 11]; however, oropharyngeal infections are the most common cause of DNIs in the pediatric population [15].

Poor oral health and odontogenic infections should not be underestimated [5] because they can lead to uncommon but lethal diseases such as descending necrotizing mediastinitis [7], which requires aggressive surgical treatment and is associated with a mortality rate of 10%-40% despite treatment [5]. Thus, oral health and hygiene play an important role in DNI development. As mentioned previously, DNI affects preferentially males, possibly, because men pay less attention to oral hygiene than women do [16]. Also, dental infections become less common with age due to a decreasing number of teeth in the oral cavity [16].

We believe than a low socio-economic status and/or poor health literacy are risk factors of DNI. In 2014, 30.9% of Latvia's population was at risk of poverty or social exclusion [17]. Zamiri B. et al. showed that patients with a middle socioeconomic status were more likely to be admitted to hospital in the area of Shiraz, Iran. However, Barber et al. showed that affordability of dental care was not a significant factor for DNI development in Alberta, Canada [6, 16]. We suggest carrying out public education campaigns to improve oral health.

The submandibular space was the single most frequent location of DNIs in our study (36.26%), which is in line with previous research (26.1%-78.6%) [1, 12, 13, 14, 16].

Anatomically, the mandibular dental roots lie next to the submandibular space, which allows dental infections to spread to the submandibular space; indeed, this route of transition causes the majority of submandibular space infections [5, 16]. We suppose that dental infections were the most frequent cause of DNIs in our study because submandibular space infections, which are typically odontogenic, accounted for the majority of DNIs.

In previous reports, many DNI cases spread into more than one fascial space, which can lead to life-threatening complications [13]; in our study, infections that involved at least 2 interfascial spaces were found in 20.9% of patients. Complications developed in 11.4% of our patients, similar to the study by Bakir et al. (13.8%) [13], and airway obstruction was the most common complication (n=27, 90%). Other DNI-related complications include mediastinitis – the second most frequent complication, pneumonia, sepsis, pleuritis, facial nerve paresis, jugular vein thrombosis etc. [15, 18, 19].

Before hospitalization, 10.3% of our patients received antibiotics. According to Gorjon et al., inappropriate antibiotic use might predispose to complications [9].

In our study, the elderly patients had a significantly higher complication rate, longer hospital stay (p<0.001), and need for re-operation (p=0.044) compared to younger patients. This is in line with Chi TH et al. and Zheng L. et al. who showed that the elderly had longer hospital stays (p=0.029; p=0.02), developed complications more frequently (p=0.024; p=0.04), and/or needed surgical interventions more often (p<0.001) [2, 20].

*Staphylococci* were the most frequent pathogens in our study (n=19). Cultures of DNI aspirates are mostly polymicrobial and reflect the oropharyngeal flora, which indicates an odontogenic etiology [5]. In other studies, *Streptococci* have been widely reported as the main pathogen responsible for DNIs [1, 13, 14, 21, 22]. In our study, cultures were positive for *Acinetobacter baumanii* in 13 cases, which reflects hospital-acquired infections in patients hospitalized in an ICU.

Systemic antibacterial therapy is indispensable in such infections. In our study, similar to previous research, metronidazole in combination with cefazolin or ceftriaxone was the treatment of choice; however, there is a tendency to use ampicillin/sulbactam instead but this treatment was only the 4$^{th}$ most common choice in our study [5, 11, 13, 14, 15, 19, 22]. The combination of ceftriaxone and metronidazole is appropriate because ceftriaxone covers gram-positive bacteria and displays an excellent activity against gram-negative bacteria, especially against the species that produce β-lactamases [23], and metronidazole is approved by the FDA for the treatment of adults with serious infections caused by susceptible anaerobic bacteria [24].

Data regarding the impact of smoking on DNI are limited but smoking might be a risk factor of DNI that leads to longer hospitalization of patients with DNIs [6]. However, we observed that complications were less common in smokers. We speculate that the data regarding smoking habits in our patients could have been biased by reluctance to admit to smoking.

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