

# Case Report Series: Clinical Analysis of Severe Deep Neck Space Infection

**Ling Jin**

Tongji University School of Medicine

**kai Fan**

Tongji University School of Medicine

**Shuangxi Liu**

Tongji University School of Medicine

**Shiwang Tan**

Tongji University School of Medicine

**Yang Wang**

Tongji University School of Medicine

**Yumin Zhao**

Tongji University School of Medicine

**YU Shaoqing** (✉ [yu\\_shaoqing@163.com](mailto:yu_shaoqing@163.com))

Tongji University School of Medicine <https://orcid.org/0000-0003-2208-4535>

---

## Case report

**Keywords:** Deep neck space infection, Comorbidities, Diagnosis, Treatment

**Posted Date:** June 23rd, 2021

**DOI:** <https://doi.org/10.21203/rs.3.rs-597200/v1>

**License:**  This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

---

# Abstract

## Background

Severe deep neck space infection is rare and critical. The objective is to deepen the understanding of severe deep neck space infection and improve the level of clinical diagnosis and treatment.

## Case presentation

A retrospective analysis of the diagnosis and treatment of 5 cases of serious deep neck infections admitted to our department. The 5 patients were all diagnosed by cervical CT and surgical exploration. 3 patients with diabetes, 2 patients with diabetic ketoacidosis, 3 patients with mediastinal infection; 3 patients underwent tracheotomy and 2 patients with tracheal intubation; All patients were treated by neck incision, drainage, dressing change and targeted antibiotics.

## Conclusions

Severe deep neck infections are prone to occur in patients with diabetes and other systemic basic diseases. Early diagnosis, timely neck incision exploration, drainage to maintain airway patency and targeted antibiotic treatment are the keys to diagnosis and treatment.

# Background

Deep neck space infections (DNIs) refers to the general term for abscesses or cellulitis in the superficial deep tissues of the deep neck fascia[1–3], with an incidence rate of 9–15/100,000 per year[4–6]. And according to the study of Finland the incidence rate has been on the rise in recent years[7]. The most common symptoms are neck pain, swelling, dysphagia, and fever, but the disease develops rapidly and aggressively, leading to fatal complications such as airway obstruction, mediastinitis, sepsis, pericarditis, and pneumonia, etc[8]. According to other literatures, the mortality rate of this disease is 1.6–50%[9], which is one of the critical illnesses in Otorhinolaryngology Head and Neck Surgery, and can not be solved with antibiotics alone. A summary analysis of 5 cases of severe DNIs admitted from 2011 to 2020 is reported below.

## Case Presentation

### Clinical data

#### Case 1

Male, 43 years old. He was admitted to the hospital on January 14, 2011 because of "pharyngalgia with fever for 2 days, dysphagia and left neck swelling". He had a history of diabetes but was not treated. Physical examination on admission: T: 38.6 C, slightly shortness of breath, epiglottis red and swollen in a hemispherical shape, covered with light yellow pseudomembranes on the surface; The left neck skin is diffusely red and swollen. Initial diagnosis: acute epiglottitis, deep neck infection. On the 5th day of admission, the symptoms worsened, high fever (39.7°C), short breath, orthopnea, diffuse swelling of the neck increased, and the left upper chest was involved. CT of the neck showed that the air cavity between the soft tissues of anterior cervical was multifocal and spread down the anterior trachea to the upper mediastinum and pericardium and there is atelectasis in the left lower lobe (Fig. 1.a). After general anesthesia, tracheal intubation, and neck incision, there was extensive necrosis of the surface of the deep cervical fascia and a large amount of thick light grayish white pus with between it and the strap muscles, and the pus has a foul smell. The upper boundary of the pus cavity reached the level of the hyoid bone., and under the guidance of the endoscopic monitor, the pus was seen to spread downward along the Pretracheal fascial space to the upper mediastinum. Further diagnosis: cervical necrotizing fasciitis (CNF), mediastinitis, pericarditis.

#### Case 2

Male, 75 years old. On June 17, 2016, he was admitted to the hospital due to "4 days of swelling and pain in the face and neck, and aggravation with dyspnea for 1 day." He has a history of hypertension, cerebral infarction, and no history of diabetes. Physical examination on admission: T: 37.4°C, shortness of breath, orthopnea, diffuse redness on face, bilateral necks (submandibular to clavicle below about 3 transverse fingers), obvious on the left side; high skin temperature, tenderness, local subcutaneous crepitus, neck activity is restricted; left-sided tonsillar congestion and swelling Ⅱ degree, left soft palate and palatoglossal arch hyperemia and swelling. Preliminary diagnosis: left peritonsillar abscess, deep neck space infection. Incising the left swollen palatoglossal arch, no obvious pus overflow was observed, but the cavity was grayish brown with odor. On the day of admission, "tracheotomy" was performed under general anesthesia to keep the airway open. On the fourth day after admission, enhanced CT of the neck showed diffuse swelling in the neck, anterior mediastinum, left pharyngeal recess, parotid gland, masseter muscle area with local low-density area and pneumatosis sign, and abscess formation in the left neck was considered (Fig. 1.b). Neck incision was performed to drain pus, and there was a large amount of stench and gray-brown pus overflowed from the deep side of the platysma. The deep normal tissue structure of neck was destroyed, fascia diffuse necrosis and part of soft tissue necrosis were observed. The pus cavity reaches the level of the clavicle from the lower edge of the mandible, and reaches the prevertebral space backwards, scattered small blood vessel occlusion, muscle swelling but no obvious necrosis. Further diagnosis: left CNF, anterior superior mediastinitis.

#### Case 3

Male, 81 years old. He was admitted to the hospital on March 17, 2019 due to "three days pharyngalgia and dysphagia". He has hypertension and diabetes. Physical examination: T: 37.5°C, breathing is stable, the lingual surface of epiglottis congestion and swelling. Initial diagnosis of "acute epiglottitis". On the

fourth day of admission to the hospital, there was hyperemia and swelling in the suprathyroid cartilage in the middle of the neck, accompanied by laborious breathing. Neck CT showed soft tissue swelling with pneumatosis from left epiglottis to thyroid cartilage (Fig. 1.c). Perform tracheotomy and neck incision exploration, see the formation of abscesses in the anterior epiglottic space between thyroid cartilage and hyoid bone, which were thick yellow pus with smelly. Further diagnosis: Abscess of deep neck space.

#### Case 4

Male, 62 years old. On June 24, 2019, He was admitted to the hospital because of "pharyngalgia, fever with dysphagia for 5 days, neck swelling and pain for 2 days", without history of diabetes and other basic diseases. Physical examination: T: 38.2 C, left laryngopharyngeal side wall swelling is obvious, epiglottis without hyperemia, swelling; bilateral upper neck swelling is obvious with tenderness. On the second day of admission, the neck swelling became worse, spreading to the upper sternum fossa, and there was a feeling of crepitus. Neck CT: The swelling of the left parapharyngeal space and the soft tissue of the lower neck is accompanied by a large liquid low-density shadow, considering abscess formation (Fig. 1.d). General anesthesia, oral trachea cannula, neck incision and drainage of pus, see a large number of thick yellow pus with odor; pus cavity involving submandibular space, supraclavicular fossa space and pre-tracheal space. Diagnosis: infection of the left parapharyngeal space; infection of multiple spaces in the deep neck.

#### Case 5

Male, 48 years old. He was admitted to the hospital on March 17, 2020 due to "left-sided sore throat, limitation of mouth opening with neck swelling and fever" for 3 days. He has a history of diabetes, poor normal control, and a history of drug abuse. He has been detoxified for 10 years. Physical examination on admission: T: 38.5 C, heart rate 108 beats/min, short breath, limited mouth opening (one finger), most of the lower left teeth are missing or only have residual roots; Left tonsil II degree swelling, left soft palate and Palatoglossal arch swelling obviously, epiglottis and Laryngopharynx can not be examined; The skin on the left parotid gland, submandibular area, and left upper neck was hyperemic, with mild swelling and tenderness. Initial diagnosis peritonsillar abscess with infection of the deep neck space. The next day, the symptoms worsened, The patient was mentally depressed, drowsiness, heart rate continued to be 110 beats per minute and dyspnea. The left parotid gland area, submandibular and upper neck swelling aggravated, the skin temperature was high, and there was a feeling of crepitus. There were also ketoacidosis and sepsis. Head and neck CT: left oropharynx lateral wall, left facial parotid region, bilateral submandibular, left neck and upper mediastinum pneumatosis (Fig. 1.e).

Tracheotomy and a total of 3 neck incisions for drainage, the pus cavity spread to the left anterior parotid space, left parapharyngeal space, left sublingual, bilateral submandibular, submental space, left suprasternal space and the anterior superior mediastinum, there are a lot of gray-brown pus with odor. Fascial necrosis is like a pseudomembrane. Further diagnosis: CNF, upper mediastinitis.

## Treatment

### Antibiotic treatment:

The five patients were treated with cephalosporin antibiotics and metronidazole intravenous drip in the early stage of the disease, while vancomycin, linezolid, meropenem, ornidazole and other antibiotics were empirically upgraded in the progression of infection, and then antibiotics were adjusted according to bacterial culture and drug sensitivity.

### Surgical treatment

All 5 patients underwent neck incision, debridement and drainage in time. Daily rinsing and dressing changes after surgery: Trilocular tube irrigation in 2 cases (cases 2 and 4); 2 cases of negative pressure drainage (case 1, 3); 1 case (case 5) negative pressure drainage combined with partial wound opening and dressing change. And 3 cases (cases 2, 4, 5) tracheotomy, Three cases (cases 2, 4, and 5) had tracheotomy, and two cases (cases 1, 3) were intubated through the mouth to keep the airway open.

### Comorbidities and complications treatment:

Three cases (cases 1, 3, and 5) with diabetes were treated with hypoglycemic therapy by insulin, of which cases 1 and 5 were also expanded with blood volume to correct ketoacidosis. Except for case 2, the remaining 4 cases were complicated by pneumonia and pleural effusion, and were actively treated for anti-inflammatory, atomizing inhalation, and sputum excretion.

### Systemic supportive treatment:

Nasal feeding, intravenous fluid supplement and timely correction of hypoproteinemia.

## Results

The five patients were all in the SICU intensive care unit after surgical drainage, and were transferred back to the general ward after stable disease. After the above systemic treatment, all patients were cured and discharged, hospitalized for 14–53 days, with an average hospitalization of 35.8 days. 3 cases (Case 1, Case 2, case 5) were finally diagnosed as "neck Necrotizing Fasciitis", which underwent more than 2 times of debridement and drainage, and had a long time of washing and dressing change. Two cases had ketoacidosis, three had mediastinum infection, and four had pneumonia. We summarize the relevant information of the diagnosis and treatment of these 5 patients as follows, see Table 1.

Table 1  
Statistical comparison of patient diagnosis and treatment process data

	Gender	Age	Comorbidities	Route of infection	Complications	Bacterial culture	Drainage method after incision	Ways to keep the airway open	ICU days	Hospital days
Case 1	Male	43	Diabetes	Epiglottitis	Ketoacidosis Uppermediastinitis Left mediastinitis Pericarditis	Drug-resistant acinetobacter baumannii Peptostreptococcus Streptococcus viridans	Negative pressure drainage	Tracheal intubation	8	24
Case 2	Male	75	Hypertension	Peritonsillar abscess	Anterior superior mediastinitis Double lower pneumonia	Negative	Trilobar tube drainage	Tracheotomy	12	49
Case 3	Male	81	Diabetes Hypertension	Epiglottitis	Double lower pneumonia Pleural effusion Pericardial effusion	Acinetobacter baumannii streptococcus viridans Neisseria sicca	Negative pressure drainage	Tracheotomy	9	53
Case 4	Male	62	None	Parapharyngeal space infection	None	Candida parapsilosis streptococcus viridans Neisseria sicca candida albicans	Trilobar tube drainage	Tracheal intubation	3	14
Case 5	Male	48	Diabetes	Peritonsillar abscess Sublingual gland	Ketoacidosis Uppermediastinitis Double lower pneumonia Pleural effusion	Klebsiella oxytoca Streptococcus constellatus candida albicans	Negative pressure drainage	Tracheotomy	12	39

## Discussion

*The definition of deep neck space infection and the characteristics of serious deep neck infection, and the relationship between neck necrotizing fasciitis.*

The fascia of the neck divides the neck into many potential cell ulitis spaces, with the hyoid bone as the boundary, which can be divided into the submandibular space, the submental space, and the parapharyngeal space above the hyoid bone. The pretracheal space, and the suprasternal space and the superficial cervical space, the retropharyngeal space, the Visceral vascular space, and the prevertebral space below the hyoid bone that communicates with each other. Due to the interconnection between the deep gaps of the neck [10], after the gap infection, the infection where the pus accumulates can spread along the anatomical pathway or between adjacent gaps. These spaces communicate downward with the pericardium, parietal pleura and mediastinum, thus becoming the entrance and passage for neck and throat infections to enter the thoracic cavity. DNIs are mostly caused by infection sources around them, such as pharynx, tonsils, teeth and other infections, not limited to a single space, but can spread to adjacent spaces and tissues to cause airway obstruction, pneumonia, neck necrotizing fasciitis, descending mediastinum inflammation, septicemia, sepsis and other high-risk complications [11, 12], so it can be considered that the development of the above complications is a serious DNIs. All cases have airway obstruction; 4 cases complicated with pneumonia; 3 cases caused upper mediastinitis and pericarditis; 3 cases developed cervical necrotizing fasciitis (CNS). We believe that CNF is a serious DNIs, and its diagnosis is not established at one time, but is gradually confirmed according to the development and changes of the disease. Some authors believe that gas formation indicates a more serious infection process [13]. In this group of all cases, there is gas formation on CT images. It can be considered that one of the characteristics of severe DNIs is the formation of "gas".

*The inducement of serious deep neck infection, pathogenic bacteria, and the experience of diagnosis and treatment of this disease.*

In this study, 3 of 5 patients had a history of diabetes, and all the 3 patients who with descending mediastinitis had a history of diabetes. Umeda et al. [14] reported 48 cases of CNF patients with descending mediastinitis. Among them, the mortality rate of patients with diabetes was 39.5%, which was significantly higher than the mortality rate of patients without underlying diseases (16.7%). Diabetes has been identified as the most common systemic disease of deep neck infections [1, 2, 4, 16, 17]. In particular, patients with diabetes over 10 years of age are more prone to multi-space infections in the deep neck [18]. DNIs with diabetes are more severe and difficult to control, prone to ketoacidosis, and in severe cases may have complications such as septicemia and sepsis, and have a higher mortality rate [11].

The possible mechanisms for analysis are as follows: Disorders of substance metabolism, dysfunction of carbohydrates, increased lipolysis, and negative balance of protein metabolism in diabetic patients make the body's immune function decline, and it is in a susceptible state; In diabetic patients, fat metabolism products increase and accumulate in the body, which increases the growth and reproduction of Gram-negative in the body; Hyperglycemia is also conducive to the growth of pathogenic microorganisms such as bacteria, and concurrent infections can form a vicious circle, that is, infections cause

uncontrollable hyperglycemia to further aggravate the infection; Monocyte IL-1 $\beta$  expression is abnormally low in diabetes, which can increase the body's susceptibility to certain toxic bacteria[19]; The risk of periodontal infection, caries, and apical abscess in diabetic patients is significantly higher than that in non-diabetic patients, and it is more prone to odontogenic DNIs. Therefore, diabetes is an important cause of severe DNIs.

Analysis of DNIs in 173 cases by Srivanitchapoom et al. [20] showed that DNIs infection route was odontogenic > pharyngeal > with unknown cause > glandular origin (48.6%, 19.7%, 16.8%, 6.9%). Although different sources of infection have been reported, pharyngeal and odontogenic DNIs is still the main infection route for most DNIs, but there are still some unknown causes. In this study, 2 of the 5 patients were acute epiglottitis and 3 were DNIs secondary to peritonsil abscess, all of which were pharyngeal.

Another study believes that advanced age is one of the high-risk factors for DNIs[21]. Cases in this group are 43–81 years old, with an average age of 61.8. It can be considered that elderly DNIs tend to develop into severe cases. The severe DNIs in this group are all males. Whether males are more likely to develop into severe DNIs remains to be further investigated in the future, but previous literature have reported that DNIs show a trend of more men than women[3, 22].

Streptococcus and anaerobic bacteria are the main pathogenic bacteria in the deep neck space infection, and mixed infection is the main[23, 24]. In this group of cases, except for one case, the culture of the bacteria was negative, and the culture of the other cases was negative bacilli, streptococcus, and anaerobic bacteria, which is consistent with the characteristics of mixed infection. There are 2 cases of drug-resistant *Acinetobacter baumannii*, 1 case of anaerobic bacteria (digestive streptococcus), and 1 case of facultative anaerobe (*Klebsiella oxytoca*), all of which are difficult to control. It is easy to cause serious disease of DNIs. 2 cases cultured fungal, considering the diabetes itself and the secondary infection caused by antibiotics.

CT has the advantages of fast and intuitive, and has obvious advantages in the diagnosis of DNIs, so imaging examination is particularly important. The characteristic manifestations of CT diagnosis of DNIs are as follows: 1. When cellulitis occurs, the infected muscle is swollen, the edge is blurred, the fat in the fascial space disappears, and the flocculent density increases; After the formation of the abscess, the pus cavity showed a low density, the pus wall strengthened annularly, and some pus cavity had gas[3]. CT can promptly diagnose potential serious complications such as upper airway obstruction, jugular vein thrombosis, and descending mediastinitis[25]. The CT of this group of patients showed a large amount of gas accumulation in multiple spaces of the fascia, and some of the soft tissues were torn in the center and the edges were uneven, which was consistent with the imaging characteristics of severe DNIs.

## Treatment and experience:

Active antimicrobial therapy, open drainage and supportive care are the basic treatment of DNIs. Some scholars[11] believe that if CT examination reveals that abscesses are widespread, early surgical incision and drainage is the key method of treatment. It has been reported in the literature [26, 27] that patients with dyspnea and a maximum abscess diameter > 2.0 cm should be surgically intervened as soon as possible. Incision and drainage can reduce local pressure, prevent infection from spreading further to the deep neck and mediastinum, inhibit anaerobic bacteria, and reduce upper airway obstruction.

Therefore, incision and drainage is the key to the treatment of severe DNIs. We believe that individualized drainage schemes should be selected according to the infection gap, location and scope: 1) Direct incision and drainage: the debridement can be repeated multiple times, the disadvantages are the need for multiple dressing changes, excessive trauma, and large scars left on the skin after recovery; 2) Negative pressure drainage: sucking out the pus after debridement, which can continuously discharge the pus out of the body, and it is also convenient for continuous washing and uninterrupted negative pressure suction can close the gap caused by the formation of abscess, Cases 1 and 3 adopted this method. 3) trilocular tube drainage: It has negative pressure suction and is also conducive to washing when dressing change. Cases 2 and 4 use this method. Case 5 due to multiple gap infections and abscess formation on both sides of the deep neck, a combination of direct incision and negative pressure drainage was used. Therefore, according to the condition of the patient and choosing the appropriate incision and drainage method for the patient, it is conducive to treatment. Some studies have found that using a drainage tube does not prolong the patient's hospital stay[28].

In DNI, tracheotomy has been stated as the gold standard in the management of compromised airway[29]. Maintaining airway unobstructed is also a top priority for treatment. Severe DNIs are often associated with airway obstruction. When surgical incision and drainage are performed, intraoperative traction and damage to the tissue of the posterior pharyngeal space and upper mediastinal tracheoesophageal sulcus can cause tissue edema. Postoperative airway obstruction may be aggravated. Therefore, the airway should be closely observed, and emergency tracheal intubation or tracheotomy should be prepared at any time to maintain the airway patency. For example, patients with moderate to severe laryngeal obstruction and difficulty in opening mouth should consider tracheotomy. However, tracheotomy is an operation after all, and it will aggravate neck trauma, so it still needs to be cautious. In this group of cases, there are 2 cases of tracheal intubation, extubation within one week, close observation to avoid tracheotomy, and from these 5 patients, tracheotomy patients treated in ICU longer than tracheal intubation. But some studies think[30], in DNI, tracheotomy may decrease the need for ICU care and decrease complications related to longer intubation periods. Some studies believe that the exact location of the infection may also affect the choice of airway management[31]. Therefore, for severe DNI, the choice of tracheal intubation or tracheotomy needs to be individually evaluated according to the disease and systemic condition.

Although there is no uniform standard for the use of antibiotics, antibiotics are used empirically in the early stages of treatment, and then sensitive antibiotics are selected based on bacterial culture. Monitoring of vital signs, attention should be paid to the treatment of patients with underlying diseases. Patients with severe DNIs often have diabetes, should control blood sugar, and correct ketoacidosis. To strengthen systemic nutrition support, those who have difficulty opening their mouth or cannot eat due to intubation, need to nasally feed a high-protein, high-vitamin and low-fat diet, regularly review electrolytes, liver and kidney function, etc., pay attention to liver and kidney function damage and other complications caused by drugs and diseases themselves, pay attention to water and electrolyte balance and correct it in time.

## Conclusion

In a word, severe DNIs often occur in patients with low immunity such as diabetes. They are often infected by a combination of streptococcus and anaerobic bacteria. Pharyngeal and odontogenic are the most common. The "pneumatosis" of CT is the imaging feature of severe DNIs. Timely personalized incision and drainage, correct evaluation of the disease, choose tracheal intubation or tracheotomy to maintain airway opening, combine with the results of bacteriological culture to select sensitive antibiotics, and pay attention to the treatment of complications.

## Declarations

### Ethics approval and consent to participate

According to Medical Research Council Tool, the presented case series does not require ethical clearance.

### Consent for publication

Written informed consent for publication was obtained from all Five patients.

### Availability of data and materials

Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.

### Competing interests

The authors declare that they have no competing interests.

### Funding

None.

### Authors' contributions

Ling Jin and KaiFan have written the following article. Ling Jin and Kai Fan contribute equally to this work.; Shuangxi Liu,Shiwang Tan, Yang Wang,and Yumin Zhao completed the collection of case information and data;Shaoqing Yu has reviewed the article and operated on all of the cases discussed. The author(s) read and approved the final manuscript.

### Acknowledgements

Not applicable.

## References

1. Priyamvada S, Motwani G. A Study on Deep Neck Space Infections. *Indian J Otolaryngol Head Neck Surg.* 2019;71(Suppl 1):912–7.
2. Nwashindi A. Analysis of facial and deep neck space infections in patients with comorbidities. *Int J of Health Allied Sci.* 2019;8:48–52.
3. Bakir S, Tanriverdi MH, Gun R, et al. Deep neck space infections: a retrospective review of 173 cases. *Am J Otolaryngol.* 2012;33:56–63.
4. Boscolo-Rizzo P, Stellin M, Muzzi E, et al. Deep neck infections: a study of 365 cases highlighting recommendations for management and treatment. *Eur Arch Otorhinolaryngol.* 2012;269:1241–9.
5. Staffieri C, Fasanaro E, Favaretto N, et al. Multivariate approach to investigating prognostic factors in deep neck infections. *Eur Arch Otorhinolaryngol.* 2014;271:2061–7.
6. Adovica A, Veidere L, Ronisl M, et al. Deep neck infections: review of 263 cases. *Otolaryngol Pol.* 2017;71(5):39–45.
7. Seppänen L, Rautemaa R, Lindqvist C, Lauhio A. Changing clinical features of odontogenic maxillofacial infections. *Clin Oral Investig.* 2010;14:459–65.
8. Kauffmann P, Cordesmeier R, Tröltzsch M, et al. Deep neck infections: A single-center analysis of 63 cases. *Med Oral Patol Oral Cir Bucal.* 2017;22(5):e536–41. doi:10.4317/medoral.21799. .Published 2017 Sep1.
9. Huang TT, Liu TC, Chen PR, et al. Deep neck infection: Analysis of 185 Cases[J]. *Head Neck.* 2004;26(10):854–60.
10. Hyun SY, Oh HK, Ryu JY, et al. Closed suction drainage for deep neck infections [J]. *J Craniomaxillofac Surg.* 2014;42(6):751–66.
11. Dalla TD, Burtscher D, Höfer D, et al. Odontogenic deep neck space infection as life-threatening condition in pregnancy [J]. *Aust Dent J.* 2014;59(3):375–8.
12. Raffaldi I, Le SD, Garazzino S, et al. Diagnosis and management of deep neck infections in children: the experience of an Italian paediatric centre [J]. *J Infect Chemother.* 2015;21(2):110–3.
13. Jarno V, Meira L, Tero S, et al. Deep neck space infections: an upward trend and changing characteristics. *European Archives of Oto-Rhino-Laryngology.* 2020; 277:863–872.
14. Umeda M, Minamikawa T, Komatsubara H, et al. Necrotizing fasciitis caused by dental infection: a retrospective analysis of 9 cases and a review of the literature [J]. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2003;95(3):283–90.
15. Hidaka H, Yamaguchi T, Hasegawa J, et al. Clinical and bacteriological influence of diabetes mellitus on deep neck infection: Systematic review and meta-analysis [J]. *Head Neck.* 2015;37(10):1536–46.

16. Sharma K, Das D, Joshi M, Barman D, Sarma AJ. Deep neck space infections—a study in diabetic population in a tertiary care centre. *Indian J Otolaryngol Head Neck Surg.* 2018;70:22–7.
17. O'Brien KJ, Snapp KR, Dugan AJ, et al. Risk Factors Affecting Length of Stay in Patients with Deep Neck Space Infection. *Laryngoscope.* 2020;130(9):2133–7.
18. Juncar M, Popa AR, Baciut MF, et al. Evolution assessment of head and neck infections in diabetic patients—a case control study [J]. *J Craniomaxillofac Surg.* 2014;42(5):498–502.
19. Pongcharoen S, Chansantor W, Supalap K, et al. Impaired interleukin-1beta expression by monocytes stimulated with *Staphylococcus aureus* in diabetes. *Southeast Asian J Trop Med Public Health.* 2011;42(5):1197–203. PMID: 22299446.
20. Srivarnitchapoom C, Sittitrai P, Pattarasakulchai T, et al. Deep neck infection in Northern Thailand[J]. *Eur Arch Otorhinolaryngol.* 2012;269(1):241–6.
21. Wang LF, Kuo WR, Tsai SM, Huang KJ. Characterizations of life-threatening deep cervical space infections: a review of one hundred ninety-six cases. *Am J Otolaryngol.* 2003;24:111–7.
22. Favaretto N, Fasanam E, Staffiefi A, et al. Deep neck infections originating from the major salivary glands[J]. *Am J Otolaryngol.* 2015;36(4):559–64.
23. Al-Qamachi LH, Aga H, McMahon J, et al. Microbiology of odontogenic infections in deep neck spaces: a retrospective study [J]. *Br J Oral Maxillofac Surg.* 2010;48(1):37–9.
24. Farmahan S, Tuopar D, Ameerally PJ, et al. Microbiological examination and antibiotic sensitivity of infections in the head and neck. Has anything changed? [J]. *Br J Oral Maxillofac Surg.* 2014;52(7):632–5.
25. Gonzalez-Beicos A, Nunez D. Imaging of acute head and neck infections[J]. *Radiol Clin North Am.* 2012;50(1):73–83.
26. Adil E, Tarshish Y, Roberson D, et al. The Public Health Impact of Pediatric Deep Neck Space Infections. *Otolaryngol Head Neck Surg.* 2015;153:1036–41.
27. Hoffmann C, Pierrot S, Contencin P, et al. Retropharyngeal infections In children: Treatment strategies and outcomes. *Int. J Pediatr Otorhinolaryngol.* 2011;75:1099–103.
28. O'Brien KJ, Snapp KR, Dugan AJ, et al. Risk Factors Affecting Length of Stay in Patients with Deep Neck Space Infection. *Laryngoscope.* 2019;130(9):2133–7.
29. Karkos PD, Leong SC, Beer H, Apostolidou MT, Panarese A. Challenging airways in deep neck space infections. *Am J Otolaryngol.* 2007;28:415–8.
30. Tapiovaara L, Bäck L, Aro K. Comparison of intubation and tracheotomy in patients with deep neck infection. *Eur Arch Otorhinolaryngol.* 2017;274(10):3767–72.
31. Cho SY, Woo JH, Kim YJ, et al. Airway management in patients with deep neck infections: A retrospective analysis [published correction appears in *Medicine (Baltimore)*. 2016 Oct 21;95(42):e36c2]. *Medicine (Baltimore)*. 2016;95(27):e4125. doi:10.1097/MD.0000000000004125.

## Figures

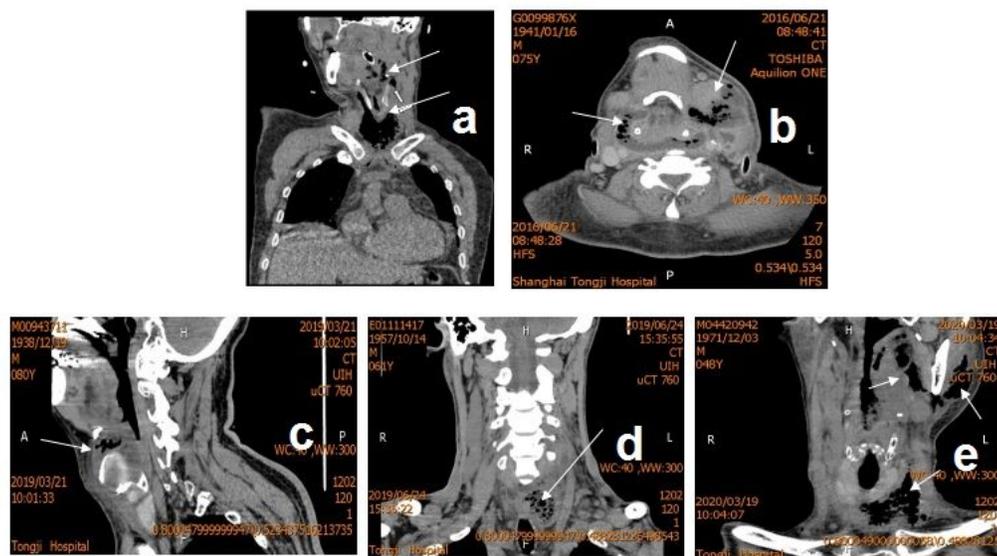


Figure 1

(a) Case 1 Coronal reconstruction CT: larynx, anterior tracheal space of neck and patchy pneumatosis of anterior superior mediastinum (white arrow), anterior middle superior mediastinum fat structure is blurred. (b) Case 2 CT in transverse position: bilateral neck swelling with pneumatosis (white arrow), obvious on the left side. (c) case 3 sagittal CT: epiglottis to thyroid cartilage layer soft tissue swelling with pneumatosis (white arrow). (d) Case 4 Coronal CT: Abscess formation in the lower neck and paratracheal space with pneumatosis (white arrow). (e) Case 5 coronal CT: left side oropharyngeal side wall, left parotid gland area, submandibular, inferior neck and upper mediastinum pneumatosis (white arrow)