

ORIGINAL RESEARCH

Mucosal emphysematous head and neck infections: Scoping review and a case of emphysematous tonsillitis

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Abstract

Objective: This scoping review seeks to understand the existing research in otolaryngological mucosal emphysematous infections and to elucidate gaps in knowledge in the field. We also present a case of bilateral necrotizing tonsillitis in an immunocompromised patient with the first reported imaging findings of emphysematous abscess of the tonsils.

Data Sources: PubMed, Embase, Web of Science.

Review Methods: We conducted our review according to the Preferred Reporting Items for Systematic Reviews extension for Scoping Reviews. Patient presentation, management, and outcomes were summarized. We also describe the case of a patient with aplastic anemia found to have emphysematous tonsillitis, managed with intubation, broad spectrum intravenous antibiotics and bilateral tonsillectomy.

Results: We identified seven case reports or series, involving nine total patients, who presented with emphysematous epiglottitis, supraglottitis, or tonsillitis. The hallmark imaging characteristic was submucosal “gas bubble” on computed tomography. Presenting symptoms included dysphagia, odynophagia, dysphonia, cough, and fever. Both immunocompetent and immunocompromised patients were affected. All patients were treated with broad spectrum antibiotics, and most with steroids. Patients at risk of airway compromise also underwent intubation and surgical drainage or debridement of the emphysematous infection.

Conclusion: Emphysematous pharyngeal infections are rare but potentially life-threatening infections that can progress rapidly, resulting in airway compromise and sepsis in both immunocompetent and immunocompromised individuals. We highlight the importance of swift intervention, with intubation and surgical intervention often required for severe cases. More research is needed on common pathogens and patient risk factors to guide future medical and surgical management.

This study was presented as an oral presentation at the Triological Society Combined Sections Meeting on January 26, 2024, in West Palm Beach, FL.

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KEYWORDS

emphysematous infection, emphysematous tonsillitis, head and neck infections, necrotizing infection

1 | INTRODUCTION

Emphysematous infections of the upper aerodigestive tract are extremely uncommon, with only a handful of reported cases of emphysematous epiglottitis and supraglottitis¹⁻³ in the literature. An emphysematous infection of the tonsils has not been reported previously. Overall, these infections can have an insidious presentation, and without early medical and sometimes surgical intervention, they can progress rapidly and result in airway compromise and sepsis.

Emphysematous infections occur much more frequently in the abdomen and pelvis and include emphysematous cholecystitis, pancreatitis, cystitis, prostatitis, and pyelonephritis, among others. The characteristic radiological finding of these infections is the presence of gas within the parenchyma of solid organs or within the walls of hollow viscera, without associated perforation, trauma, or recent instrumentation. Computed tomography (CT) is the preferred imaging modality for diagnosis and assessment of the extent of the tissues involved.⁴ These infections are usually caused by gas-forming bacteria, which can produce carbon dioxide and nitrogen by fermenting glucose within necrotic tissues. The most common organisms involved are *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus mirabilis*, *Clostridium perfringens*, and *Staphylococcus aureus*.⁵⁻⁸ Cases of emphysematous infections due to *Candida albicans* and *Pseudomonas aeruginosa* have also been reported.⁸⁻¹² Patients with poorly controlled diabetes and immunocompromised patients are at higher risk but many cases occur in immunocompetent individuals.

Within the field of otolaryngology, the presentation, infectious origin, and management of emphysematous mucosal infections have not been formally described and characterized. We present a novel case of emphysematous tonsillitis which to the best of our knowledge, is the first reported case of successful management in an immunocompromised patient. We also conducted a scoping review to summarize the existing knowledge of these very rare infections with a focus on clinical presentation and management.

2 | CASE REPORT

A 38-year-old male with history of aplastic anemia, glucose-6-phosphate-dehydrogenase deficiency and hypertension presented for transfer of care from an outside hospital after emergent intubation for airway protection, in the setting of worsening tonsillar infection with air pockets in bilateral tonsils, and neutropenic sepsis.

The patient's presenting symptoms at the outside hospital included sore throat, difficulty swallowing and hemoptysis. CT neck at that time showed right tonsillitis without evidence of abscess or gas formation, associated with oropharyngeal airway narrowing. The patient was started on antibiotics and steroids, but began to complain

of shortness of breath, so was started on high flow nasal cannula. He received platelet transfusions and Filgrastim for his pancytopenia. CT neck with intravenous (IV) contrast at day six and eight of admission showed worsening tonsillitis, with new presence of gas in the bilateral palatine tonsils. The patient was started on meropenem, micafungin and vancomycin. His respiratory status continued to worsen and 2 weeks after admission he developed stridor, drooling, severe dysphonia, and respiratory distress, at which point he was intubated for airway protection and transferred to our tertiary care center for higher level of care.

Upon transfer to our institution, repeat CT neck demonstrated an extensive emphysematous oropharyngeal and tonsillar infection (Figure 1). He remained intubated and was continued on multiple antimicrobials including ceftolozane/tazobactam, tobramycin, vancomycin, trimethoprim/sulfamethoxazole, acyclovir, metronidazole, and isavuconazole. His white blood cell count remained low ($0.04-0.8 \times 10^3/\mu\text{L}$) despite continued treatment with Filgrastim, and his thrombocytopenia was minimally responsive to platelet transfusions (18,000–32,000/ μL). Blood and respiratory cultures were positive for *P. aeruginosa*. Testing for infectious mononucleosis caused by Epstein–Barr virus (EBV) or cytomegalovirus was negative.

The patient continued to have fevers and interval imaging showed progression of emphysematous infection to the soft palate and base of tongue. Given lack of improvement, on day nine after hospital transfer, he was brought to the operating room for surgical tracheotomy and bilateral palatine tonsillectomy. In the operating room, the tonsillar tissue appeared necrotic and avascular bilaterally (Figure 2, Video 1). The tissue approaching the pharyngeal constrictors was inflamed and intensely hemorrhagic, which combined with his thrombocytopenia, posed a challenge in achieving surgical hemostasis; thus, surgical dissection was carried forward via Coblator wand. Both tonsillar fossae were packed with tonsil sponges and a surgical tracheotomy was performed. On post-operative day one, the packing was removed and there was no further bleeding. Pathology report of the resected tonsils was significant for necrosis and acute inflammation with no acid fast or fungal organisms seen on tissue stains. Tissue cultures were positive for *P. aeruginosa* and *C. albicans*. His antibiotic course for 2 weeks postoperatively included ceftolozane/tazobactam, tobramycin, caspofungin, metronidazole, and vancomycin. His infectious symptoms resolved after the surgical procedure and subsequent antibiotic regimen. The patient remained on acyclovir, trimethoprim/sulfamethoxazole, isavuconazole, and levofloxacin for prophylaxis. His repeat CT scan of the neck on post-operative day 19 showed complete resolution of the infection without any abnormal gas in the oropharynx (Figure 3). On post-operative day 24, the tracheostomy was successfully decannulated. The patient did experience postoperative dysphagia which was treated with gastrostomy tube supplementation and swallow therapy. He was eventually discharged without further

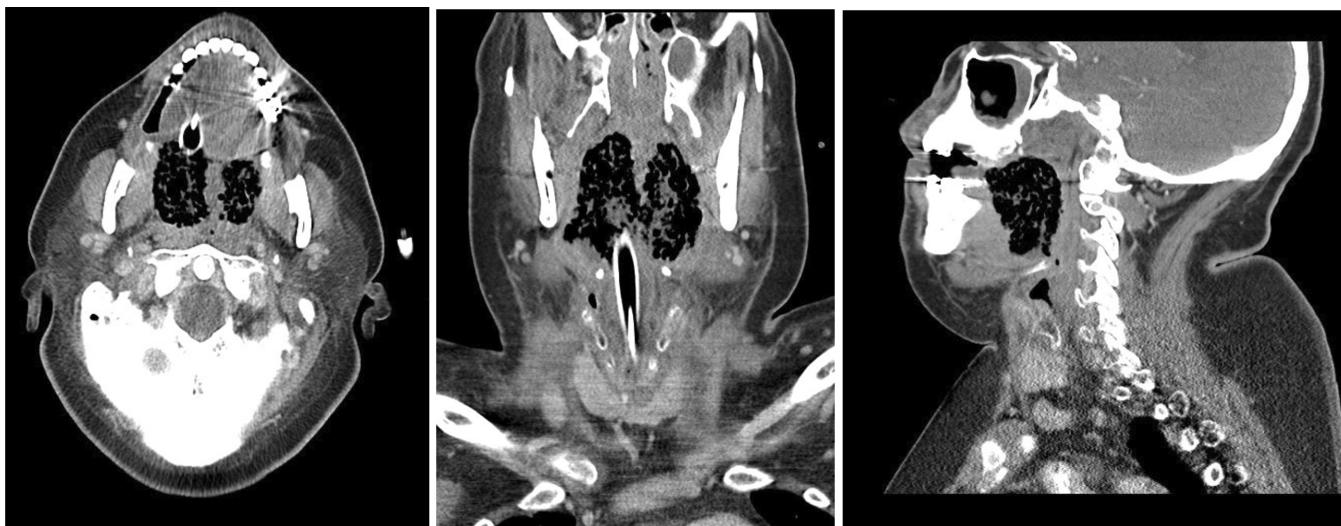


FIGURE 1 Computed tomography neck with intravenous contrast in the axial, coronal and sagittal planes demonstrating submucosal gas within the bilateral tonsils and extending to the soft palate and base of tongue.

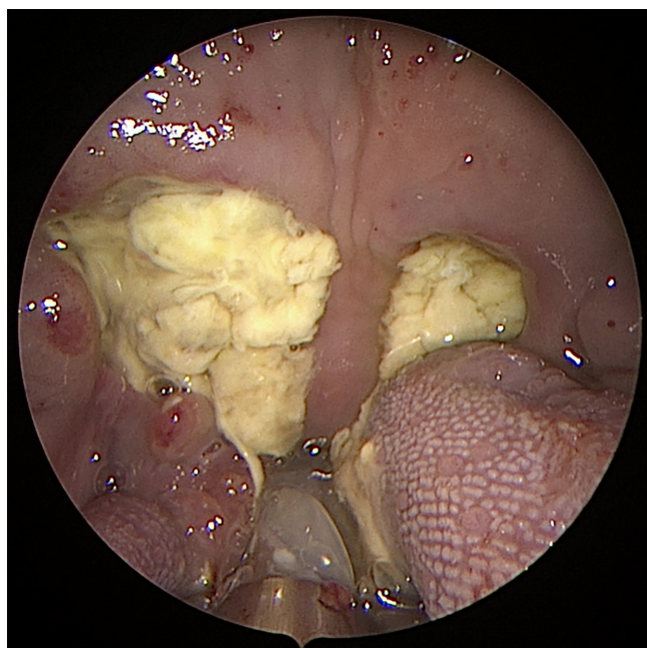


FIGURE 2 Intraoperative photo demonstrating necrotic tissue in the bilateral tonsillar fossa extending to the soft palate.

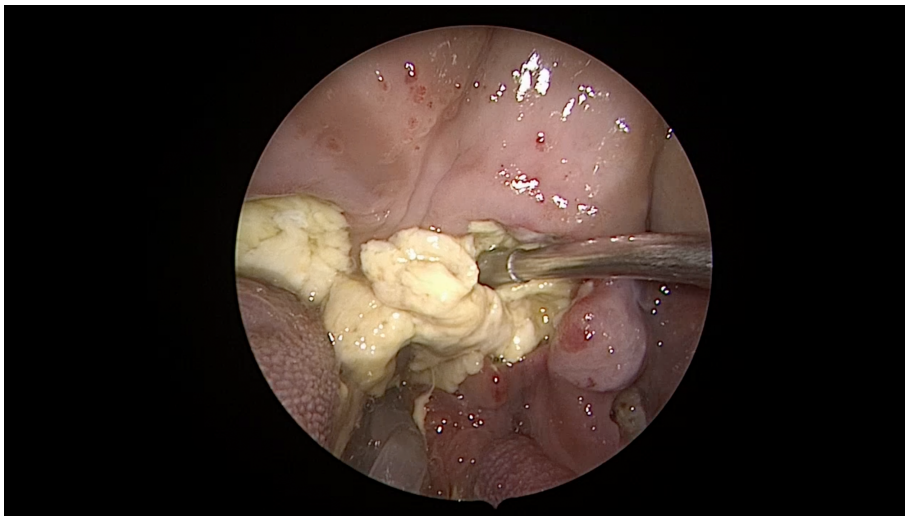
complications. There has been no relapse of emphysematous infections after follow-up of 6 months.

3 | METHODS

We conducted a scoping review of the literature according to Preferred Reporting Items for Systematic Reviews extension for Scoping Reviews (PRISMA-ScR) and reporting guidelines.¹³ The need for

institutional review board (IRB) approval for the scoping review and single case report was waived by the IRB. A literature search of PubMed, Embase and Web of Science databases was performed using the following key words: “emphysematous infection” AND “head and neck” OR “otolaryngology” (Supplemental Table 1). Additional searches were also performed using the key words: “emphysematous epiglottitis,” “emphysematous supraglottitis,” and “emphysematous tonsillitis.” There were no date or publication type limitations on the search. The search was originally performed in November 2023 using PubMed and Embase databases, and then an updated and expanded search was performed in April 2024 with the addition of the Web of Science database. Duplicate results or articles published in non-English languages were excluded. Articles were reviewed by title, and then by abstract, and non-relevant articles were excluded. This process was performed by two reviewers (CM and LE) and disagreements were resolved by consensus.

This systematic review is formulated using the PCC model: population, concept, and context. For study population, studies involving emphysematous mucosal infections for patients of all ages and sexes were included. All types of evidence sources were acceptable, including primary research studies, case studies, radiologic case studies, and review articles. The core concept of this scoping review is to develop a framework around presenting features and effective interventions for rare emphysematous mucosal head and neck infections, and to identify gaps in knowledge for further research. Inclusion criteria for articles were: (1) pertaining to emphysematous mucosal infections (2) involving the upper aerodigestive tract. Exclusion criteria were: (1) emphysema due to surgery or trauma; (2) emphysematous infections of the skin or subcutaneous soft tissue; (3) not otolaryngologic in origin. With regards to context, there were no restrictions on countries or healthcare settings.



VIDEO 1 Intraoperative findings demonstrating necrotic tissue in the bilateral tonsillar fossa extending to the soft palate.

Video content can be viewed at <https://onlinelibrary.wiley.com/doi/10.1002/lio2.1274>



FIGURE 3 Computed tomography neck with intravenous contrast demonstrating resolution of emphysematous tonsillitis bilaterally, in the axial, coronal and sagittal planes.

4 | RESULTS

The initial search on Medline, Embase, and Web of Science databases yielded 389 total results, accounting for duplicates, which was ultimately narrowed down to seven studies that met our eligibility criteria by review of the full text (Figure 4). Table 1 presents the characteristics of the included studies.

4.1 | Patient demographics

The average age of patients was 41.2 years old, with a range of 19 to 74 years. Six patients were male, two were female and one was of undisclosed sex. Seven cases involved the epiglottis, one was described more broadly as involving the supraglottis (including the epiglottis), and one involved the bilateral tonsils. In terms of

preexisting medical conditions, in a radiologic case series, it was noted that patients with emphysematous infections tended to have immunocompromising conditions, although the specifics of said conditions were not disclosed.¹⁴ One 19-year-old patient with hemorrhagic tonsillitis had known infectious mononucleosis.¹⁵ Otherwise, patients were either previously healthy or had no disclosed medical comorbidities.

4.2 | Presenting symptoms

Common presenting symptoms of these emphysematous infections included dysphagia, odynophagia, dysphonia, inability to swallow secretions, nonproductive or productive cough and fever. The severity of presentations and onset of symptoms varied across cases. Airway compromise was a concern in four cases,^{2,3,16,17} and notably these

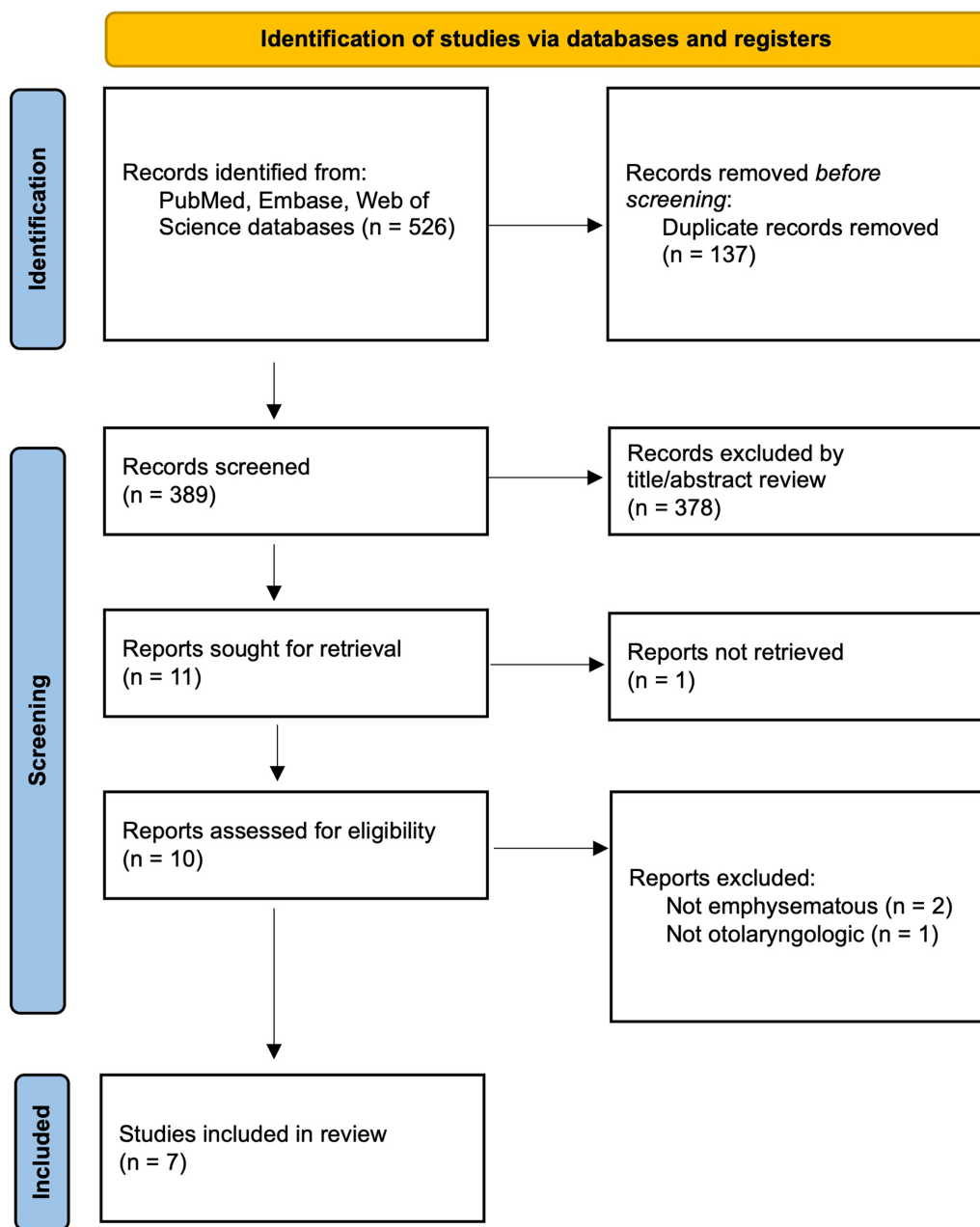


FIGURE 4 PRISMA flow diagram of scoping review.

patients did not necessarily initially present with respiratory distress. One case was rapidly progressive, where the patient's odynophagia and dysphagia progressed to dysphonia and inability to swallow secretions within one day.²

4.3 | Imaging findings

In all cases, workup included CT imaging, upon which “gas bubbles” or “air bubbles” were seen, revealing the emphysematous infection. These gas bubbles were described as “central”¹⁶ or submucosal.³ Several cases also noted swelling of both the affected and surrounding structures. In cases of emphysematous epiglottitis, there was

“significant swelling between the tongue base and the epiglottis”¹ and “edema of the bilateral aryepiglottic folds.”³ Neck radiographs can be useful in identifying infections like epiglottitis, and raising suspicion for emphysematous infection if air densities are seen.¹⁷ However, a follow-up CT is needed to more definitively identify the emphysematous evolution of these infections.¹⁴

4.4 | Pathology and cultures

Only one patient had cultures of their emphysematous abscess, of which the anaerobic culture speciated to *Prevotella melaninogenica* and *Fusobacterium necrophorum*.³ In the case of infectious

TABLE 1 Characteristics of included studies.

Study authors	Year	Design	N	Type of emphysematous infection	Management	Outcome
Nemzek et al. ¹³	1995	Radiologic case series	3	Emphysematous epiglottitis	Not disclosed	Not disclosed
Chang et al. ¹	2013	Case report	1	Emphysematous epiglottitis	Antibiotics and steroids	Direct laryngoscopy showed “a significant reduction in the swelling of the epiglottis and visible vocal cords after treatment with antibiotics and dexamethasone for 3 days.” No further follow-up or outcomes reported.
Rohrbach et al. ²	2016	Case report	1	Emphysematous epiglottitis	Awake trans-nasal fiber optic intubation and direct laryngoscopy, biopsy and abscess drainage, broad spectrum IV antibiotics and steroids	By three-week outpatient visit, patient fully recovered with resolution of infection on laryngoscopy
Durán et al. ¹⁴	2017	Radiologic case report	1	Emphysematous supraglottitis/epiglottitis	Not disclosed	Not disclosed
Hsu et al. ¹⁵	2021	Radiologic case report	1	Emphysematous epiglottitis	Antibiotics	Patient recovered after administration of antibiotics without requiring intubation or surgical drainage
Sunycz et al. ³	2023	Case report	1	Emphysematous epiglottitis	Awake nasal fiber-optic intubation and suspension laryngoscopy, incision and drainage of the epiglottic abscess, IV antibiotics and steroids	By two-week outpatient visit, complete resolution of symptoms with normal-appearing epiglottis on flexible laryngoscopy
Rewis et al. ¹⁶	2023	Case report	1	Infectious mononucleosis hemorrhagic tonsillitis	IV antibiotics and steroids	Patient discharged on oral antibiotics; no further follow-up or outcomes reported

Abbreviation: IV, intravenous.

mononucleosis hemorrhagic tonsillitis, blood cultures confirmed EBV infection.¹⁵ However, it was not disclosed whether any further cultures were directly taken from the tonsils to rule out a superimposed infection.

4.5 | Treatment

Treatment varied depending on the patient's presentation and severity. In the cases that were rapidly progressive or where there was immediate concern for airway compromise, patients underwent awake fiber-optic intubation to secure the airway.^{2,3} There was a case with noticeable airway narrowing where there was concern for impending airway compromise based on CT findings, but the patient recovered on antibiotics before intubation was required.¹⁷ In all cases where treatment was disclosed, medical management included broad spectrum antibiotics. Steroids, namely dexamethasone, were also typically utilized. Patients who began on IV antibiotics were eventually transitioned to oral antibiotics. In the two more severe and progressive cases where intubation was required to protect the airway,^{2,3} patients also underwent surgical management, which consisted of incision and drainage of the emphysematous abscess. In case reports where the

focus was on initial presentation or radiologic findings, there was limited information provided on management.

4.6 | Outcome

In all cases where outcomes were reported, the combination of medical and surgical management led to complete resolution of symptoms and resolution of infection on laryngoscopy at their interval-follow up visit, with no reported mortalities from this disease process.

5 | DISCUSSION

Emphysematous infections of the upper aerodigestive tract are rare but potentially life-threatening and can affect both immunocompromised and immunocompetent patients. Review of the literature revealed limited information on causative pathogens, with reports of *Prevotella* and *Fusobacterium* in one patient and known EBV infection in another, in both cases in immunocompetent patients.^{3,16} *Prevotella* and *Fusobacterium* have both previously been implicated in tonsillar and parapharyngeal abscess, and *Fusobacterium* can be gas-

forming.^{18,19} In our reported case of emphysematous tonsillitis in an immunocompromised patient, cultures showed *P. aeruginosa* and *C. albicans*. Although oropharyngeal candidiasis is a very common opportunistic fungal infection, especially in immunocompromised individuals like our patient, tissue stains did not identify any fungal organisms. Additionally, blood cultures in our patient were also positive for *P. aeruginosa* which is consistent with an opportunistic infection secondary to neutropenic sepsis. Therefore, *P. aeruginosa* is the most likely causative pathogen in this case. Outside of the head and neck, *C. albicans* and *P. aeruginosa* have both been implicated in emphysematous infections of the abdomen and pelvis.^{8-10,18,19} The mechanism of gas formation in head and neck infections has not been definitively elucidated. In abdomen and pelvis infections, possible mechanisms include gas-forming organisms, mixed acid fermentation of glucose particularly by anaerobes, and impaired transport of catabolic end products resulting in gas accumulation.^{7,20,21} Immunocompromised patients may be especially susceptible to opportunistic pathogens.

This is the first reported case of emphysematous pharyngotonsillitis, which can have a similar clinical presentation as the non-emphysematous infections but can progress rapidly and result in airway compromise, at which point prompt intubation is needed. After initial evaluation with flexible laryngoscopy, CT imaging may be warranted in a patient whose tonsillar infection demonstrates a more rapid or severe progression despite medical treatment. In our reported case, the initial differential diagnosis included acute tonsillitis or tonsillar abscess in the setting of neutropenic sepsis. However, a CT scan of the neck 1 week after initial presentation revealed the new presence of gas in the palatine tonsils. Additionally, there was no drainable abscess. This led to the diagnosis of emphysematous tonsillitis. Including our patient, three total patients were at imminent risk of airway compromise and required intubation and surgical intervention. While our patient was immunocompromised, the other two patients were not, and had no documented comorbidities. Therefore, otolaryngologists should consider this rare but serious diagnosis in their differential regardless of immunocompromise status.

Broad spectrum antibiotics, steroids, close airway monitoring and prompt surgical debridement if there is failure of medical management is an effective approach in emphysematous head and neck infections. In two reported cases of emphysematous epiglottitis, the patients' abscesses were drained and decompressed, and their symptoms completely resolved following treatment with broad spectrum antibiotics and steroids.^{2,3} This case of emphysematous tonsillitis had the additional complexity of the patient's aplastic anemia which placed him at higher risk for postoperative bleeding and resulted in a longer hospital stay and longer course of IV antibiotics than other reported cases in immunocompetent patients. There are also cases in which medical management of these emphysematous infections may be sufficient, particularly in patients who did not develop airway compromise. In three cases, two of emphysematous epiglottitis^{1,17} and the other of infectious mononucleosis hemorrhagic tonsillitis,¹⁵ patients showed interval improvement and even complete resolution of symptoms with antibiotics and steroids alone. It is important to note that in

these patients, signs of respiratory distress were not reported, their infections were not rapidly progressive on presentation, and they showed improvement when antibiotics were started. However, the importance of intubation must be emphasized in cases where there is impending airway compromise. Ideally, this would be achieved via awake nasal fiber-optic intubation, but if this approach is not possible, the next option would be awake tracheostomy. As soon as the airway is stable, surgical intervention should also be strongly considered if the infection is severe and progressive, with consideration of the patient's surgical candidacy and risk for bleeding or complications. Surgical approaches include draining and decompression if applicable for an emphysematous abscess, or in our patient's case, debridement of necrotic tissue. In all cases in this scoping review where outcomes were disclosed, patients did achieve favorable outcomes from a combination of timely medical and surgical management. Outside of the head and neck, emphysematous infections of the abdomen and pelvis carry a high risk of mortality, between 10% and 50%.⁶⁻⁸

There are limitations to this review. The included studies are in the form of case reports or series. As such, there is heterogeneity in the patients studied and their treatment settings. Additionally, some studies lacked definitive diagnostic information, such as identifying causative pathogens from tissue culture, or focused primarily on radiographic findings instead of treatment and outcomes. Especially in light of these limitations, this review highlights the need for further research on otolaryngologic emphysematous mucosal infections to understand the most common pathogens, as well as factors that may predispose patients to a more rapidly progressive infection and that increase their risk for airway compromise. This could help guide the initial approach in selection of antibiotics as well as decision factors that favor medical or surgical management. It would be valuable to further investigate histologic and pathologic differences between emphysematous versus non-emphysematous infections. This would provide insight into the pathophysiology of gas formation and the evolution of non-emphysematous supraglottitis, epiglottitis and tonsillitis into emphysematous infections. In other head and neck infections, such as deep space neck infections, gas formation tends to be predictive of more severe infection, mortality, and morbidity,²² and thus better understanding emphysematous mucosal infections is highly valuable for patient care in otolaryngology.

6 | CONCLUSION

Emphysematous mucosal infections of the head and neck are rare but potentially life-threatening infections. In this case report, we describe a novel CT imaging finding of emphysematous tonsillitis and detail the first report of successful management of this infection in an immunocompromised patient. The scoping review of the literature highlights the paucity of reported cases, with the epiglottitis and supraglottitis being the most reported site. The diagnosis of emphysematous infections using CT imaging is a key first step and broad-spectrum IV antibiotics and steroids play an important role in initial management. These infections carry a risk of rapid progression and airway

compromise. In those cases, intubation and surgical intervention for drainage and debridement may be warranted to achieve clinical resolution.

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CONFLICT OF INTEREST STATEMENT

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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