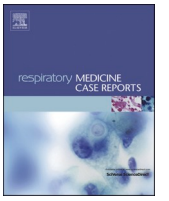
Respiratory Medicine Case Reports 58 (2025) 102306

Contents lists available at ScienceDirect

Respiratory Medicine Case Reports

journal homepage: www.elsevier.com/locate/rmcr



Case Report

Inducible laryngeal obstruction in a healthcare worker exposed to hydrogen peroxide, peracetic acid, and acetic acid

Anne M. Foreman [a], Brie H. Blackley [a], R. Reid Harvey [a], Stella E. Hines [a,b,*]

[a] Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Respiratory Health Division, Morgantown, WV, USA

[b] University of Maryland School of Medicine, Division of Occupational and Environmental Medicine, Baltimore, MD, USA

A B S T R A C T

This report describes a case of severe inducible laryngeal obstruction (ILO) in an emergency department nurse. Onset of the condition occurred after an episode of exposure to a disinfectant product containing hydrogen peroxide, peracetic acid, and acetic acid. Previously exposures had been tolerated by the nurse over a period of nine months. Influenza infection may have been a predisposing factor. Despite various interventions, including botulinum toxin A injections, suture lateralization of the right true vocal cord, and right CO2 laser transverse cordotomy with partial medial arytenoidectomy, the patient continued to experience severe symptoms. Ultimately, a tracheostomy was performed to alleviate the obstruction. This case highlights the need for heightened clinician awareness, early and accurate diagnosis, and the development of effective management strategies for ILO patients.

1. Introduction

Inducible laryngeal obstruction (ILO) is a condition characterized by abnormal vocal cord motion during breathing. It has been referred to by over 40 different terms, including vocal cord dysfunction and paradoxical vocal cord motion. In individuals with ILO, the vocal cords may close or partially close during inhalation, causing a blockage of airflow. Symptoms are often highly variable [1] and typically include stridor, dyspnea, chest tightness, dysphonia, globus sensation, throat tightness, and cough. Several conditions can co-occur with ILO including asthma, chronic cough, and psychiatric disorders (e.g., generalized anxiety disorder, major depressive disorder) [2]. ILO is more commonly diagnosed in female patients and can occur at any age but is most commonly diagnosed in patients between 30 and 40 years of age [2]. Prevalence of ILO is largely unknown. A study of 1025 patients with dyspnea found an ILO prevalence of 2.8 %, and in a meta-analysis of adult patients with asthma, the ILO prevalence was 25 % [3]. Diagnosis is confirmed by direct visualization of the abnormal vocal cord motion via laryngoscopy [4]. However, diagnoses are often delayed due to initial misdiagnosis as asthma, leading to increased direct and indirect healthcare costs for affected patients [5]. Increased awareness and early diagnosis by treating clinicians are crucial to appropriately manage patients with ILO and minimize costs associated with prolonged time to diagnosis.

The causal mechanisms of ILO have not been fully elucidated, but exposure to irritants or allergens often precedes ILO onset. Previous research has documented the development of ILO following exposure to cleaning chemicals including glutaraldehyde [6], chlorine [7], and ammonia [8]. Common antecedents of ILO symptom exacerbation include talking, laughing, singing, acid reflux, cough, physical exertion, exercise, weather changes, emotional stress, perfumes, and deodorants [9].

In this article, we describe a case involving an emergency department nurse who developed ILO after workplace exposure to a

* Corresponding author. University of Maryland School of Medicine, Division of Occupational and Environmental Medicine, Baltimore, MD, USA.
E-mail address: Shines@som.umaryland.edu (S.E. Hines).

https://doi.org/10.1016/j.rmcr.2025.102306
Received 28 April 2025; Received in revised form 15 July 2025; Accepted 16 October 2025
Available online 17 October 2025

disinfectant containing hydrogen peroxide (HP), peracetic acid (PAA), and acetic acid (AA). The severity of symptoms eventually led to a tracheostomy and removal from the workplace.

2. Case report

A 36-year-old female emergency department nurse, who was a non-smoker with no known chronic medical conditions, experienced a severe reaction following exposure to a disinfectant cleaning product containing a mixture of HP, PAA, and AA. The cleaning product was used on surfaces throughout the hospital including patient rooms and bathrooms, operating rooms, and public restrooms. She had been working as a nurse for six years and had been exposed to the cleaning product at work for nine months prior to the incident. In early 2016, the patient reported smelling the cleaning product's distinctive vinegar-like odor while she was completing patient documentation near a hospital employee performing cleaning activities. Within 15 minutes, she developed chest tightness, dyspnea, wheezing, itchy eyes, throat pain, and audible stridor. She was noted to be hypoxic, requiring 8 L/min of oxygen by nasal cannula. In the emergency department, she was treated with non-invasive positive pressure ventilation (NIPPV), nebulized racemic epinephrine and budesonide, intravenous dexamethasone, diphenhydramine, and lorazepam, with improvement. An otolaryngologist performed a bedside fiberoptic laryngoscopy and diagnosed paradoxical vocal cord motion and bronchospasm. No subglottic stenosis was observed. She was admitted and intubated to control the airway. Chest computed tomography angiography and chest radiograph revealed no infiltrates, pulmonary emboli, or other concerning abnormalities. An environmental allergen serum immunoglobin E (IgE) panel showed one positive result for *Alternaria alternata* (2.90 kUA/L), although the total IgE was not elevated (30 kUA/L). She underwent no additional allergy testing. She tested positive for influenza on a polymerase chain reaction test two days after the initial event. She was prescribed albuterol, lorazepam, and oseltamivir upon discharge. A timeline summarizing her clinical course is provided in Fig. 1.

Three weeks later, the patient's symptoms had resolved. Four weeks after the initial event, the patient smelled a consumer cleaning product at home which triggered stridor and resulted in another hospital admission, during which she was treated with NIPPV and diazepam. After three days, she was discharged with prescriptions for diazepam, omeprazole (laryngopharyngeal reflux was noted during laryngoscopic exam), and a home NIPPV unit. She began seeing a speech therapist, and although she reported frequent attacks of stridor, the stridor improved. The speech therapist noted frequent muscle spasms in her chest and neck, and baclofen was prescribed. On psychological evaluation, she was diagnosed with adjustment disorder with mixed anxiety and depressed mood and post-traumatic stress disorder. She remained out of the workplace.

Six weeks after the initial event, the patient returned to the emergency department because she experienced an attack of dyspnea and stridor after smelling perfume. Despite treatment with NIPPV, intravenous methyl-prednisolone, benzodiazepines, and racemic epinephrine, she required hospital admission and intubation with mechanical ventilation due to unresolved stridor and shortness of breath. During her hospital stay, botulinum toxin A injections were administered to her right and left thyroarytenoid muscles, respectively, and she was discharged on an eight-day steroid taper. She reported a cessation of attacks for approximately a week, but subsequently, attacks recurred triggered by strong odors, which improved with NIPPV and diazepam. She received additional botulinum toxin A injections to both thyroarytenoid muscles two weeks after discharge. Eighteen days after discharge, she was re-admitted to the hospital due to an attack that was triggered by spirometry testing during an allergist appointment. During this admission, she

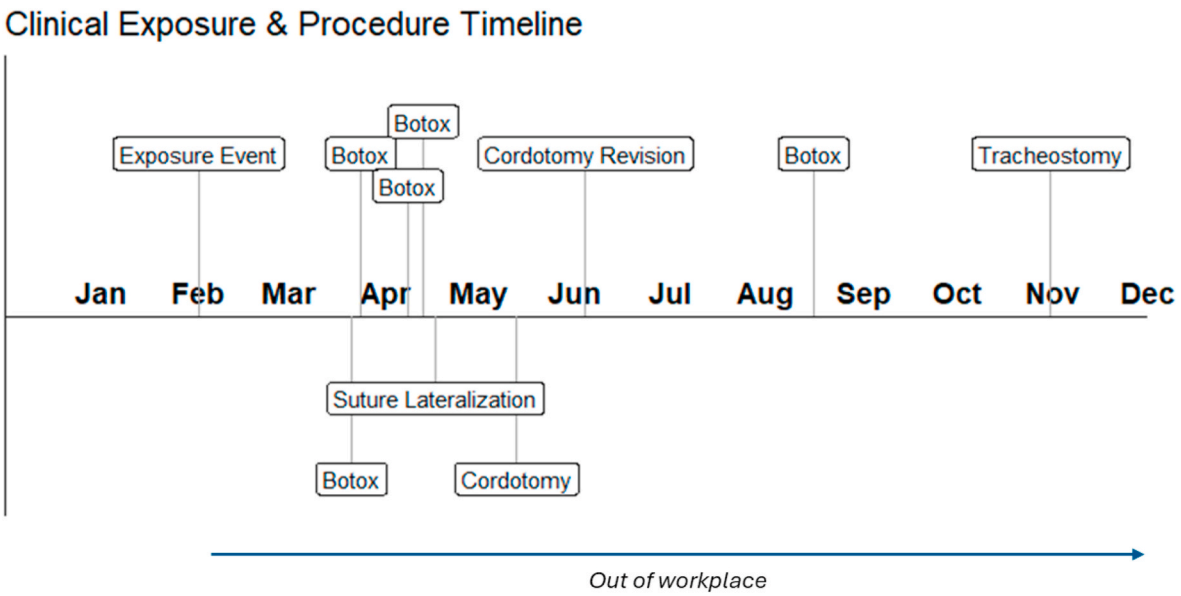


Fig. 1. Timeline of procedures after the exposure event. Each vertical "spoke" marks the date of the exposure event or therapeutic intervention. Procedures include botulinum toxin A injections (Botox), suture lateralization, CO_2 laser transverse cordotomy, cordotomy revision, and tracheostomy.

was not intubated. She received additional botulinum toxin A injections to her thyroarytenoid muscles but remained symptomatic. A suture lateralization of her right true vocal cord was performed to open the glottis and prevent obstruction, and she was discharged six days after admission.

The suture lateralization of the right true vocal cord did not decrease the frequency of attacks. Three weeks later, a microsuspension direct laryngoscopy with right CO_2 laser transverse cordotomy with partial medial arytenoidectomy was performed and repeated after two weeks. During this time, the patient began attending sessions with a psychotherapist. The patient continued in speech therapy, and she was taught breathing techniques to resolve her symptoms. The frequency of exacerbations decreased in the first few weeks after the cordotomy revision, but her symptoms recurred, with no resolution with additional treatment with nebulized lidocaine and oral clonidine. Over the next several months, she had three visits to the emergency department and additional botulinum toxin A injections that did not improve her condition.

During her third visit to the emergency department nine months after the initial event, a tracheostomy was performed. After the tracheostomy, the patient continued speech therapy and psychotherapy appointments. Three months after the tracheostomy, she reported having weekly episodes of stridor when the tracheostomy was capped, forcing her to move air through her larynx. During attacks, she would uncap the Montgomery cannula to bypass the upper airway obstruction and alleviate her symptoms. Four months after the tracheostomy, she reported having daily episodes that would last up to 3 h with muscle spasms across her neck, chest, and into her shoulders, which her physicians attributed to her ILO episodes.

3. Discussion

This report describes a case of severe ILO in an emergency room nurse that developed after an episode of exposure to a disinfectant cleaning product containing a mixture of irritants including HP, PAA, and AA that had been used in her workplace for nine months prior to the episode. During her hospitalization, she was also diagnosed with influenza. Exposure measurements of HP, PAA, and AA in her workplace prior to her development of ILO were not available. However, a subsequent exposure assessment in 2018 at her workplace indicated exposures that were significantly associated with work-related eye and airway symptoms among hospital staff, despite low levels of measured exposure (all levels of HP and AA below established occupational exposure limits) [10]. Botulinum toxin A injections, suture lateralization of the right true vocal cord, and a vocal cord cordotomy with partial medial arytenoidectomy provided only temporary relief from her symptoms of wheezing, stridor, and dyspnea that were triggered by exposures to cleaning solutions, perfumes, deodorants, and other irritants. The patient underwent a tracheostomy for management of frequent laryngeal spasms that persisted five years after her ILO diagnosis. Her recurrence of symptoms with exposure to various odors and chemicals necessitated permanent workplace removal 6 weeks after initial event and subsequent ILO diagnosis.

Cases of work-related asthma among healthcare workers as well as associations between exposure to cleaning and disinfecting products and increases in respiratory symptoms, are well established [11]. Development of ILO after exposure to disinfecting products among nurses has also been reported previously [6,8,12]. One case occurred following frequent exposure to a PAA and HP mixture [12], two of the three chemicals in the mixture to which the case patient was exposed. The present case, however, is the first reported that has resulted in severe ILO requiring a tracheostomy and workplace removal.

Although there is a dearth of studies assessing changes in quality of life and economic consequences associated with ILO, there are several studies that have examined outcomes associated with work-related asthma (WRA). WRA is similar to ILO in that both conditions are frequently diagnosed after substantial delays to diagnosis [13], can involve similar symptoms [13], and often co-occurs with ILO [3]. In WRA, removal from the workplace is often required to improve or resolve symptoms, and this often results in loss of income due to job change or unemployment. Sometimes leaving the workplace is insufficient to improve prognosis, and patients may not see an improvement in symptoms after terminating workplace exposures [14].

The chemical solution that the case patient was exposed to immediately before ILO onset is a mixture of HP, PAA, and AA. Exposure to this mixture has been associated with significant increases in work-related nasal and eye irritation, shortness of breath, and wheeze among hospital staff [10]. HP and PAA are strong oxidants, and symptoms reported in previous studies of exposed hospital staff occurred at exposures below established occupational exposure limits for HP and proposed exposure limits for PAA [10].

The case patient was given a series of increasingly invasive treatments, many of which were effective for only short periods of time. No prospective studies have been conducted to assess the efficacy of therapeutic interventions, and a recent review of ILO treatment found that most of the research on treatment effectiveness is relatively low-quality with a lack of longer-term follow up [15]. The bulk of the studies reported in the review were concerned with glottic airway and respiratory retraining which can be effective in managing ILO symptoms for some patients. The case patient did visit a speech language pathologist several times and found the exercises to be moderately effective, but these interventions were insufficient in reducing the severity of symptom exacerbation when exposed to environmental triggers. Botulinum toxin injections have been found to be effective for some ILO patients [16], but as in the present case, the relief provided is often temporary and frequent injections may be required [17]. The case patient had a suture lateralization of the right true vocal cord, which is a procedure that has been reported to result in tracheostomy decannulation in two ILO patients [18,19]. In the present case, however, the procedure was ineffective at reducing ILO symptoms, and a tracheostomy was performed. Tracheostomy placement occurs inferior to the larynx and vocal cords. When the tracheostomy canula is open, it provides a mechanism for airflow that will bypass any obstruction superior to the tracheostomy canula. If the canula is capped, however, airflow must occur from the mouth or nose and through the larynx and vocal cords. Thus, tracheostomy provides a solution for ILO, but air must be able to pass through the tracheostomy to provide this benefit.

The role of psychopathology in ILO remains a complex issue. Historically, ILO was considered a psychogenic phenomenon and was originally described as “Munchausen’s stridor” [20]. However, subsequent research has suggested that the etiology of ILO is

multifactorial. ILO can be present in the absence of a psychological disorder [21] and has also been associated with other conditions, such as gastroesophageal reflux disease (GERD) [21] and asthma [22]. As in the present case, ILO developed after exposure to irritants [21]. It is also possible that psychological disorders may develop subsequent to the development of respiratory symptoms. Symptoms of ILO have been known to induce feelings of panic in affected individuals [2], and anxiety disorders are often co-morbid with other respiratory conditions like asthma [23]. In the present case, the patient had been treated for postpartum depression on an outpatient basis following the birth of her child, 11 years prior to her ILO diagnosis. The patient reported no other psychiatric diagnoses before the ILO diagnosis.

The case patient tested positive for influenza while in the intensive care unit, two days after experiencing wheezing, dyspnea, and stridor. Notably, she did not report any influenza symptoms on the day of the initial event, and the consulting infectious disease physician documented that her influenza infection was likely acquired after the hospital admission. There have been two documented cases of ILO onset after viral upper respiratory tract infection, additionally, three cases reported ILO with onset after COVID-19 infection [24–26], and one case of exacerbation of existing ILO with viral upper respiratory tract infection [27]. In all cases, the patients had symptomatic infections when they developed ILO. It is possible that the influenza infection played a role in the sudden development of ILO and subsequent intolerance to the cleaning and disinfecting agent. Additionally, her most severe episodes were accompanied by symptoms of spasms across the neck, chest, and shoulders and left shoulder tightness. Chest tightness represents a cardinal feature of laryngeal dysfunction, although “spasms” may be less typical. Laryngeal dysfunction presents with symptoms localizing to the neck and upper chest [28]. When severe, abnormal chest movement may be observed, such as sternal recession [29]. While the reporting of “spasms” in muscles adjacent to the larynx and neck could be a manifestation of a different condition, spasms were not reported or observed elsewhere in the body, and no alternate diagnoses were concluded by her clinicians.

4. Conclusion

This case report describes the development and treatment of ILO in an emergency room nurse after exposure to a mixture of HP, PAA, and AA. The severity of her ILO led to tracheostomy which has not eliminated her symptoms when the tracheostomy remains capped and not drawing air through it. This case is indicative of the potentially serious risks of exposure to common disinfecting agents used in healthcare settings and demonstrates the need for increased clinician awareness and early diagnosis of ILO to implement appropriate management. Further, additional studies could help improve the currently limited understanding of work-related exposures and occupational ILO such that appropriate exposure mitigation strategies can be adopted, thereby reducing the burden from ILO.

CRediT authorship contribution statement

Anne M. Foreman: Writing – review & editing, Writing – original draft, Investigation, Formal analysis, Data curation, Conceptualization. **Brie H. Blackley:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Conceptualization. **R. Reid Harvey:** Writing – review & editing, Supervision, Investigation. **Stella E. Hines:** Writing – review & editing, Supervision, Project administration.

Consent

Written informed consent was obtained from the patient for publication of this case report.

Disclaimer

The findings and conclusions in this report are those of the author(s) and do not necessarily represent the official position of the Centers for Disease Control and Prevention. Mention of any company or product does not constitute endorsement by the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention.

Funding

This work was supported by intraumural funds of the National Institute for Occupational Safety and Health (NIOSH).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

We thank Nadia Saif and Girija Syamlal for their thoughtful and detailed reviews of a draft of the manuscript.
We appreciate the assistance of Emily Whyte, B.S., in the journal submission process.

References

[1] T. Halvorsen, E.S. Walsted, C. Bucca, A. Bush, G. Cantarella, G. Friedrich, F.J.F. Herth, J.H. Hull, H. Jung, R. Maat, L. Nordang, M. Remacle, N. Rasmussen, J. A. Wilson, J.-H. Heimdal, Inducible laryngeal obstruction: an official joint European respiratory society and european laryngological society statement, Eur. Respir. J. 50 (3) (2017) 1602221, https://doi.org/10.1183/13993003.02221-2016.

[2] M. Hicks, S.M. Brugman, R. Katial, Vocal cord dysfunction/paradoxical vocal fold motion, Prim. Care Clin. Off. Pract. 35 (1) (2008) 81–103.

[3] J.-H. Lee, J. An, H.-K. Won, Y. Kang, H.-S. Kwon, T.-B. Kim, Y.S. Cho, H.-B. Moon, W.-J. Song, J.H. Hull, Prevalence and impact of comorbid laryngeal dysfunction in asthma: a systematic review and meta-analysis, J. Allergy Clin. Immunol. 145 (4) (2020) 1165–1173, https://doi.org/10.1016/j.jaci.2019.12.906.

[4] K.L. Christopher, R.P. Wood, R.C. Eckert, F.B. Blager, R.A. Raney, J.F. Souhrada, Vocal-cord dysfunction presenting as asthma, N. Engl. J. Med. 308 (26) (1983) 1566–1570.

[5] R.S. Traister, M.L. Fajt, A.A. Petrov, The morbidity and cost of vocal cord dysfunction misdiagnosed as asthma, Allergy Asthma Proc. (2016).

[6] E. Galdi, L. Perfetti, F. Pagella, G. Bertino, M. Ferrari, G. Moscato, Irritant vocal cord dysfunction at first misdiagnosed as reactive airway dysfunction syndrome, Scand. J. Work. Environ. Health (2005) 224–226.

[7] S. Bhargava, H.B. Panitch, J.L. Allen, Chlorine induced paradoxical vocal cord dysfunction, Chest 118 (4) (2000) 295S–296S.

[8] J.J. Perkner, K.P. Fennelly, R. Balkissoon, B.B. Bartelson, A.J. Ruttenber, R.P.I.I. Wood, L.S. Newman, Irritant-associated vocal cord dysfunction, J. Occup. Environ. Med. 40 (2) (1998). https://journals.lww.com/joem/Fulltext/1998/02000/Irritant_Associated_Vocal_Cord_Dysfunction.9.aspx.

[9] M. Morrison, L. Rammage, A.J. Emami, The irritable larynx syndrome, J. Voice 13 (3) (1999) 447–455.

[10] B.H. Blackley, R.J. Nett, J.M. Cox-Ganser, R.R. Harvey, M.A. Virji, Eye and airway symptoms in hospital staff exposed to a product containing hydrogen peroxide, peracetic acid, and acetic acid, Am. J. Ind. Med. (2023).

[11] H.H. Mwanga, M.F. Jeebhay, Work-related asthma and exposure to cleaning agents in healthcare settings–a review of the literature, Curr. Allergy Clin. Immunol. 33 (2) (2020) 101–112.

[12] S. Tonini, A. Dellabianca, C. Costa, A. Lanfranco, F. Scafa, S. Candura, Irritant vocal cord dysfunction and occupational bronchial asthma: differential diagnosis in a health care worker, Int. J. Occup. Med. Environ. Health 22 (4) (2009) 401–406, https://doi.org/10.2478/v10001-009-0038-z [Article].

[13] A. Lau, S.M. Tarlo, Update on the management of occupational asthma and work-exacerbated asthma, Allergy Asthma Immunol. Res. 11 (2) (2019) 188–200.

[14] X. Munoz, M. Viladrich, L. Manso, V. Del Pozo, S. Quirce, M. Cruz, F. Carmona, A. Sánchez-Pla, J. Sastre, Evolution of occupational asthma: does cessation of exposure really improve prognosis? Respir. Med. 108 (9) (2014) 1363–1370.

[15] J. Mahoney, M. Hew, A. Vertigan, J. Oates, Treatment effectiveness for vocal cord dysfunction in adults and adolescents: a systematic review, Clin. Exp. Allergy 52 (3) (2022) 387–404, https://doi.org/10.1111/cea.14036.

[16] B. deSilva, D. Crenshaw, L. Matrka, L.A. Forrest, Vocal fold botulinum toxin injection for refractory paradoxical vocal fold motion disorder, Laryngoscope 129 (4) (2019) 808–811.

[17] G.A. Grillone, D.J. Annino Jr, A. Blitzer, M.F. Brin, M.H. Saint-Hilaire, Treatment of adductor laryngeal breathing dystonia with botulinum toxin type A, Laryngoscope 104 (1) (1994) 30–32.

[18] J. van Griethuysen, C. Al Yaghchi, G. Sandhu, Use of bilateral suture lateralisation technique in severe paradoxical vocal fold movement, allowing removal of long-term tracheostomy: case report, J. Laryngol. Otol. 126 (3) (2012) 328–330, https://doi.org/10.1017/S0022215111003318.

[19] O. Young, J.R. Russell, Suture lateralization of vocal cord treating paradoxical vocal cord movement: a case report, Eur. Arch. Otorhinolaryngol. 265 (4) (2008) 485–487, https://doi.org/10.1007/s00405-007-0472-0.

[20] R. Patterson, M. Schatz, M. Horton, Munchausen's stridor: non-organic laryngeal obstruction, Clin. Exp. Allergy 4 (3) (1974) 307–310.

[21] K.W. Altman, N. Mirza, C. Ruiz, R.T. Sataloff, Paradoxical vocal fold motion: presentation and treatment options, J. Voice 14 (1) (2000) 99–103.

[22] W.A. Heffern, T.M. Davis, C.J. Ross, A case study of comorbidities: vocal cord dysfunction, asthma, and panic disorder, Clin. Nurs. Res. 11 (3) (2002) 324–340.

[23] B.M. Yellowlees, R.S. Kalucy, Psychobiological aspects of asthma and the consequent research implications, Chest 97 (3) (1990) 628–634, https://doi.org/10.1378/chest.97.3.628.

[24] A. El Kik, H. Eid, Z. Aoun Bacha, Post-COVID-19 paradoxical vocal cord movement and dysfunctional dysphonia: a clinical case, Respir. Med. Case Rep. 39 (2022) 101710, https://doi.org/10.1016/j.rmcr.2022.101710.

[25] A. Garg, B.E. Peterson, A.P. Comellas, Post–COVID-19 vocal cord dysfunction, Am. J. Respir. Crit. Care Med. 206 (2) (2022) e4–e6, https://doi.org/10.1164/rccm.202106-1384IM.

[26] J.R. Lechien, M.P. Circiu, L. Crevier-Buchman, S. Hans, Post-COVID-19 paradoxical vocal fold movement disorder, Eur. Arch. Otorhinolaryngol. 278 (3) (2021) 845–846, https://doi.org/10.1007/s00405-020-06391-z.

[27] P. Taramarcaz, J.D. Seebach, L. Motteli, C. Benaïm, A.J. Schwitzguebel, Spirometry and provocation tests for vocal fold dysfunction diagnosis: a retrospective case series, Swiss Med. Wkly. 148 (2018) w14692.

[28] J.H. Hull, V. Backer, P.G. Gibson, S.J. Fowler, Laryngeal dysfunction: assessment and management for the clinician, Am. J. Respir. Crit. Care Med. 194 (9) (2016) 1062–1072.

[29] D.P. Park, J.G. Ayres, D.T. McLeod, A.H. Mansur, Vocal cord dysfunction treated with long-term tracheostomy: 2 case studies, Ann. Allergy Asthma Immunol. 98 (6) (2007) 591–594, https://doi.org/10.1016/S1081-1206(10)60742-9.