VER
Vascular & Endovascular Review

Work-Related Voice Disorders: Causes, Manifestations, and Evidence-Based Interventions

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ABSTRACT

Background: Occupational voice disorders represent a major health problem among professional voice users, including teachers, singers, actors, and other vocally demanding occupations. Prolonged or improper use of the voice, combined with environmental and psychological stressors, can lead to both functional and organic laryngeal pathologies that significantly impair communication and professional performance.

Objective: The purpose of this paper is to review the etiological factors, clinical presentation, and management strategies of occupational voice disorders, with an emphasis on functional dysphonia, muscle tension dysphonia, and benign organic lesions, including nodules, polyps, Reinke's edema, cysts, and granulomas.

Methods: A review of the literature was performed on the basis of recent studies dealing with occupational voice pathologies, their risk factors, and therapeutic approaches. Major occupational categories were reviewed according to voice load, environmental exposure, and ergonomic stressors. Pathophysiology, symptoms, and evidence-based management options were summarized from up-to-date scientific references.

Results: The results highlighted that occupational dysphonia has a multifactorial origin: high vocal load, poor acoustic conditions, psychological stress, and lack of vocal hygiene. Among functional voice disorders, muscle tension dysphonia is quite common among professional speakers and teachers. Organic lesions such as nodules and polyps commonly arise from chronic phonotrauma. Management continues to focus on voice therapy and vocal hygiene education, while surgical intervention is reserved for persistent organic lesions.

Conclusion: The disorders of the occupational voice are preventable and manageable. Preservation of voice and prolongation of the professional career depend on early identification, proper vocal technique, ergonomic modification, and multidisciplinary intervention that includes medical, psychological, and speech-therapy support.

KEYWORDS: Occupational dysphonia; Voice disorders; Muscle tension dysphonia; Vocal nodules; Voice therapy; Professional voice users.

How to Cite: Zienab M. Khalaf, Effat Zaky, Shimaa Khalaf Allah Kamel, Wafaa Helmy Abd el-hakeem, Marowa abd el wahab, (2025) Work-Related Voice Disorders: Causes, Manifestations, and Evidence-Based Interventions, Vascular and Endovascular Review, Vol.8, No.12s, 131-136.

INTRODUCTION

Teachers and other occupational voice users frequently suffer from voice issues. Even though these conditions have detrimental effects on one's personal and professional life, they are rarely acknowledged as occupational diseases in many nations, and their prevention receives little attention **[1]**.

Voice overuse, which is frequently required for a person's line of work, is the root cause of many voice issues. Numerous vocations have high vocal demands and are likely to increase the chance of developing laryngeal pathology, according to reports that link occupational vocal usage patterns to voice disorders [2]. They discovered that the most likely people to seek laryngology and voice evaluation in their clinic were those who worked in the arts and entertainment, education, law, community and social service, and science **[2]**.

between the status of voice disorders among occupations and prevalent kinds and occupational voice users. Compared to non-occupational voice users, occupational voice users were often twice as likely to experience vocal abnormalities **[3]**.

Vocal loading is clearly impacted by occupational demands because some tasks necessitate prolonged, connected speech at a relatively high intensity. Fatigue, poor sleep patterns, and long work hours are also linked to voice changes, mostly in terms of brilliance and roughness. Stress was also discovered to have an impact on voice because an increase in heart rate brought on by stress raised the speaking voice's F0 **[4]**.

Classification

The Union of European Phoneticians recommends that the professions be categorized as follows:

• **Group I**: occupations requiring a high voice quality, such as actors, singers, and other vocal performers.
• **Group II**: occupations like teaching, interpreting, and speaking that require a constant vocal load.
• **Group III**: occupations such as lawyers, doctors, clergy, and military personnel that require more than normal vocal apparatus endurance due to certain voice functions carried out in noisy environments **[5]**.

Etiology and Risk Factors
The etiology of occupational voice problems is complex. While individual-specific characteristics may influence an employee's susceptibility to dysphonia, workplace conditions may have an impact on voice. The following are some of the variables that may result in occupational voice issues **(see Table 1)**.

One of the main causes of professional voice issues is voice loading.
Long-term speaking at high volume (over 70 dB) at a pitch outside of the usual range, with incorrect intonation and aberrant resonance, results in load-related alterations in the vocal tract **[6]**.

• **Environmental factors:** Dust, pollutants, humidity, and temperature changes can influence the status of the upper respiratory tract mucosa. Another relevant ergonomic factor, which lowers the Speech Transmission Index (STI), is background noise and poor acoustic conditions with short reverberation times. STI expresses speech transmission in space. Poor room acoustics can lead to more vocal effort. Estimates on subglottal pressure (ESP) and sound pressure level (SPL) indicate that speakers tend to maintain a voice intensity of approximately 10-15 dB above ambient noise when trying to be heard in poorer acoustic conditions (Lombard effect) **[5]**.

• **Psycho-emotional elements** are crucial in managing the demands of a professional voice: voice problems are more common when people voice with a negative psycho-emotional attitude. Many voice professionals who suffer from dysphonia are caught in a vicious cycle where psychological variables worsen vocal pathology and voice disability affect psychological well-being by interfering with job satisfaction, performance, and attendance **[7]**.

• **Inadequate vocal hygiene and improper voice production methods** can result in pathological compensation for a high vocal load, which can then produce muscle tension in the neck, larynx, and pharynx, which can impact breathing and posture. Furthermore, muscle tension is increased when coping mechanisms for work stress are lacking **[8]**.

Table 1: Risk factors of occupational voice disorders

Factors related to ergonomics	Health-related factors	Personal characteristics
loading the voice Background noise Bad acoustics Air quality indoors: Humidity Temperature-Related Irritants Stress at work	Diseases of the respiratory system Laryngopharyngeal reflux (LPR) allergy Mucosal issues Hormonal imbalances anomalies of the musculoskeletal system Decline in overall physical and mental health	Gender: female Voice abnormalities in the family Inaccurate phonation method Smoking and Posture Characteristics of the personality Both mental and physical activity Capacity to manage stress

Clinical Aspects of Occupational Voice Disorders
Occupational dysphonia can cause a variety of voice symptoms, such as persistent or recurring hoarseness, a dry throat or lump in the throat, even pain, dry cough, loss of singing range, voice fatigue, or voicelessness (aphonia), according to **Zehnhoff-Dinnesen et al. 2020 [5].**

Types of occupationally determined voice disorder may take the form of:
• ***Functional (Non-organic) Dysphonia***
The most common type of hyperfunctional origin phonation with high muscle forces that leads to chronic abuse syndrome creates vocal fatigue with decreased voice capacity. A phoniatric examination may reveal incorrect respiratory activities, increased neck muscle tension, incorrect resonator activation, and "hard" phonation with rough voice, as well as atypical vibration parameters found by videostroboscopy (e.g., decreased amplitude of vocal fold vibration, reduced mucosal wave, or glottal sphincter closure with vestibular phonation). Unremitting functional dysphonia can also precede irreversible laryngeal lesions, sometimes of organic etiology **[5]**.

• ***Organic Dysphonia***
The most common organic effects of vocal hyperfunction include vocal nodules (an extension of the vocal folds' edge), glottic vascular lesions, contact ulcers, and weakness of the internal larynx muscles resulting in glottal insufficiency. Vocal nodules are recognized as the most frequent occupational pathology. Vocal nodules signal the consequences of chronic phono-trauma, and are noted in females, also an explanation for the sex differences noted earlier. Before these organic changes occur, patients will often display what are called vocal nodule pre lesions-reversible symmetric mild edema of the vocal fold margins, with functional dysphonia accompanied by an hourglass shaped vibration pattern with imbalance of muscle tension. These edemas can turn into permanent hyalinized fibrous nodules, or epithelial callouses along the free edge of the vocal folds near the anteroposterior midpoint of the membranous folds as a result of chronic vocal injury. In the usual case of persistent vocal fold nodules, the nodules will be white, symmetrical, small, and bilateral **[5]**.

Long-term voice abuse or overuse, which is commonly seen in jobs with a high vocal load, is the primary cause of vocal fold injury. As a result, benign vocal fold lesions are frequent. The most prevalent include cysts, granulomas, Reinke's edema, voice nodules, and polyps **[9]**.

Muscle tension dysphonia

The recommended diagnostic term for functional voice issues is currently "muscle tension dysphonia," which is thought to be caused by dysregulated or imbalanced larygeal and paralaryngeal muscle activity **[5]**.

Primary muscle tension dysphonia (MTD-1) is classified in the Classification Manual of Voice Disorders as a "dysphonia in the absence of current organic vocal fold pathology, without obvious psychogenic or neurologic etiology, associated with excessive, atypical or abnormal laryngeal movements during phonation." Other standard descriptions suggest "excessive tension" in the intrinsic or extrinsic laryngeal muscles, which is generally accepted to be the primary mechanism of the disorder. Patients with MTD-1 may experience voice fatigue, pain with phonation, or changes in quality of voice, which can severely limit communicative activities and decrease voice-related quality of life **[10]**.

MTD-1 is believed to happen without an organic basis, while secondary MTD is thought to arise from an aberrant laryngeal function as it relates to an organic basis, such as the compensation for vocal fold lesions **[11]**.
Heightened vocal demands can worsen primary muscular tension dysphonia, a functional voice disorder. In contrast to those with secondary muscular tension who are thought to have laryngeal compensation due to structural or neurological voice changes, individuals with primary MTD do not have neurological or anatomical laryngeal abnormalities that can explain their voice disorder **[12]**.

What is the cause of Muscle Tension Dysphonia?

The formation of an MTD often involves several aspects. The most typical ones consist of :
A "guarding" response to acid reflux or other type of irritant; sudden changes to the voice secondary to a period of vocal overuse, infection, or emotional stress; compensations for an underlying vocal fold pathology; such as a cyst, paresis, or vocal muscle fatigue, or a combination of some or all of these factors **[13]**.

Symptoms

- MTD has a wide range of symptoms that can differ from person to person. Additionally, they can come and go, causing the voice to occasionally sound normal before the discomfort and hoarseness return for no apparent cause.
- Changes in voice quality are among the signs to be aware of, especially at the end of the day or after extended durations of voice use. The voice might begin to say:
    - Rough, harsh, or start to sound raspy
    - Breathy, weak, and quiet, weakening at the end of phrases.
    - Tight, tense, strained, with a confined or "squeezed" quality
    - Extremely high or low in pitch, or the pitch may be unstable; intermittent with voice "breaks," when the sound abruptly stops or the voice takes a long time to begin vibrating **[13]**.

Treatment

Voice Therapy
MTD is frequently treated with voice therapy. Encouraging appropriate vocal use and reducing laryngeal muscle tension are the two main objectives of voice therapy. Among other methods, voice exercises to improve glottic closure, vocal hygiene, manual laryngeal treatment, respiratory exercises, nasal exercises, and frequency modulation are examples of voice therapy **[14]**.

The most common Benign Organic Voice Disorders

1-Vocal Fold Nodules ;

These are defined as benign, isolated, superficial "growths" on the medial surface of the true voice. They are usually bilateral, tiny, gray-white, and have an underlying chronic inflammatory infiltration and hyperplastic epithelium. They are restricted to the superficial squamous epithelium and are traditionally found at the intersection of the anterior and middle thirds of the vocal fold, or the halfway of the membranous vocal fold **[15]**.

Reasons The most common cause of vocal fold nodules is persistent vocal abuse, misuse, or overload. Since they can manifest as both localized edema and epithelial thickenings, this somewhat simplistic concept should be expanded. Vocal tension is undoubtedly the primary cause, but there are additional unknown contributing variables. Deviations in the epithelial tissue around the nodules have drawn attention in recent years as an additional element of the pathogenesis. Nodule growth appears to be more correlated with functional load during speaking and singing than with age **[16]**.

Signs and Symptoms At the mid-membranous vocal fold, nodules are typically bilateral lesions. The genesis and prognosis of the two types of nodules may differ. The first kind is characterized by widespread swellings that are initially rather malleable and mushy. The superficial lamina propria appears to have a higher concentration of the histological anomaly. Chronic vocal load may cause them to grow over time to the extent of Reinke's edema. Focal hard and fibrotic epithelial thickenings are the hallmark of the other type of nodule. An hourglass-closure pattern and normal or slightly decreased mucosal wave vibratory activity are shown by laryngostroboscopic examination **[5]**.

Treatment

Many studies have reported positive treatment effects, and voice therapy is often advised as the initial course of treatment. Therefore, a key component of the treatment method is paying attention to underlying causal problems through voice therapy and education **[17]**.

VOCAL FOLD POLYPS

Definition Vocal fold polyps (VFPs) are common benign lesions of the vocal fold that specifically impair voice quality. Due to the complexity of phonation, a patient with VFP typically complains of hoarseness, which can be challenging to evaluate. By modifying the laminar structure, vocal fold rigidity, and glottal vibratory patterns, VFPs may have an impact on voice production. Additionally, the laryngeal mass impact of VFPs causes partial glottal closure **[18]**.

Causes Phono traumatic traumas are the main source of polyps. Vocal fold morphological abnormalities are more common in those who abuse their voice, whether by shouting loudly or excessively. These abnormalities encourage the development of lesions. The etiological relationship between smoking and vocal fold polyps has been the subject of numerous investigations. According to some writers, smoking is the primary cause of vocal fold polyps, particularly when paired with vocal abuse **[19]**.

Signs and Symptoms

Vocal tiredness and hoarseness or breathiness are the primary symptoms of vocal fold polyps. However, there have also been isolated reports of huge or enormous polyps obstructing the airways **[20]**.

A hemorrhagic polyp is red in color, while a hyaline or glassy polyp is seen as distinctly whitish. There is a clear demarcation between the polyps and surrounding epithelium. The stroboscopic assessment typically demonstrates a well-defined closure pattern related to the polyp size and location. During phonation, the mass of a pedunculated polyp either compresses beneath the level of the vocal fold into the inframarginal area or collapses over and rests on the superior plane of the vocal fold. If the polyp occurs at the margin of the medial vocal fold, there is often a resultant hourglass-closure pattern. The location of the polyp inhibits the delivery of the mucosal wave action even in the portions of the vocal fold that appear to be moving appropriately **[5]**.

Treatment,

Alternative treatments for vocal fold polyps, including conservative medical therapy; endoscopic laser; steroid injection; flexible laryngestroboscopic surgery; massage; and vocal health education with antireflux medications; have shown positive results, although laryngeal microsurgery is still regarded as the standard of care and traditional surgical procedures have made great strides in efficacy **[21]**.

POLYPOID CORDITES (REINKE'S EDEMA)

Definition: Reinke's edema is a benign condition of the vocal folds that represents an increase in the volume of the superficial lamina propria, or Reinke space. Reinke's edema is also called polypoid laryngitis or polypoid corditis because this is directly related to the polypoid degeneration of the superficial layer of the lamina propria. Histologically, this could perhaps be demonstrated in more extreme circumstances **[23]**.

To standardize the reporting and grading of Reinke edema severity, a number of classification schemes have been described. A categorization scheme that unifies earlier approaches into a single arrangement was most recently presented by de Vincentiis et al. Four forms of Reinke edema are described by this system:

Type 1, which affects a single vocal fold; **Type 2**, which affects both vocal folds; **Type 3**, one vocal fold with Reinke edema and a polypoid lesion on each fold; **Type 4**, Polypoid lesion on one or both vocal folds with Reinke edema of both vocal folds **[22]**.

Reasons Reinke's Edema: Three Primary Causes One or more of the risk factors listed below are responsible for the majority of Reinke's Edema cases.

- Just as smoking is a big risk factor for lung, throat, and voice box cancer, it is also a substantial risk factor for Reinke's edema. But not every smoker develops Reinke's Edema.
- Overuse and "abuse" of the voice: Persistent overuse, misuse, or "abuse" of the voice can irritate the vocal folds, leading to a number of voice disorders, including Reinke's edema.
- Laryngopharyngeal reflux, or the backflow of stomach fluids to the voice box, is caused by the extremely acidic nature of stomach fluid. The unique characteristics of stomach lining cells allow them to withstand irritation from the stomach's acidic secretions. Reinke's edema is one of the many abnormalities and voice problems that develop from exposure to stomach fluid backflow (reflux) because the lining cells of the neck and voice box are not resistant **[23]**.

Signs and Symptoms Dysphonia varies in severity among patients with Reinke's edema. Some people may also have dyspnea, however this depends on the extent of edema and the ensuing blockage of the airways. It may be regular or sporadic. Vocal tiredness, diminished vocal range, loss of high notes, and thickening of the voice are all signs of dysphonia. Female patients usually seek treatment because of this deepening of the fundamental frequency and poor endurance of voice **[24]**.

Treatment Once Reinke's oedemas have grown significantly, phono-microsurgery is recommended. After quitting smoking or receiving treatment for laryngopharyngeal reflux, patients are unlikely to relapse. When done correctly, the procedure can be performed simultaneously on both vocal folds. When a space develops between the vocal folds following the elimination of the oedema, vocal effort may increase. Because of this, it is never advisable to fully remove the delicate and thin epithelium that

covers the gelatinous masses. A so-called stripping is unquestionably malpractice, and almost invariably results in permanent vocal damage and scarring. These surgical side effects are more uncomfortable than the actual oedema. Before surgery, voice therapy can assist stop vocal abuse and improve the outcome **[25]**.

VOCAL FOLD CYSTS

Definition

Cystic lesions within the membranous vocal fold are referred to as vocal fold cysts, a benign subepithelial pathology that is more prominent among women and constitutes between 6% to 13% of cases of benign lesions of the larynx. There are two main types of vocal fold cysts: mucoid retention cysts and epidermoid cysts. Epidermoid cysts are lined with squamous epithelium and are thought to result from subepithelial fragments of epithelium that originate either congenitally or through microtrauma. Mucoid retention cysts are lined with columnar epithelium, ciliated or non-ciliated, and occur due to obstruction of glandular ducts. Mucoid retention cysts contain clear mucoid or gelatinous substance. Mucoid retention cysts tend to affect the medial aspect of the vocal fold and are generally more superficial within the lamina propria compared to epidermoid cysts, which tend to occur on the superior surface of the vocal fold, contain a caseous substance, are located closer to the pathology ligament, and are opaque. Both result in varying degrees of dysphonia, due to aberrations in the mass effect and/or pliability of mucosa that change phonatory mechanics or that impede glottic closure and mucosal vibration **[25]**.

Causes: Epidermoid cysts can be attributed to vocal misuse or residual epithelium trapped within the lamina propria. They contain a duct that ends blindly at the inferior margin of the vocal fold and are lined with stratified squamous and keratinized epithelium. Mucous-retention cysts develop when, due to a variety of ailments, upper-airway infections, laryngitis caused by gastro-oesophageal reflux, or excessive use of voice obstructs the glandular ducts. These are covered with ciliated cylindrical epithelium lining the cavity **[26]**.

Signs and Symptoms Individuals present with a gradual onset of voice hoarseness. The individual's voice has a limited range in terms of pitch and loudness. Intra-cordal cysts are noted to appear as small globules at the margins of the vocal cords and occasionally on the superior aspect of the cords. The majority of these cysts are unilateral. Mucus retention cysts often appear yellow, while epidermoid cysts appear white. A flexible laryngoscopy may show normal stroboscopic examination findings or interrupted mucosal wave vibratory activity with an hourglass-closure pattern, depending on the size of the cyst **[15]**.

Treatment

In general, cysts are any lesion that is surgical by nature. There are conflicting outcomes of voice therapy; some patients report it is beneficial, while other patients report it is not effective in those who have surgery. Surgery for a vocal fold cyst is predicated on the principle of excising the entire lesion, which is ideally done by removing the cyst intact, which minimizes damage to the lamina propria in which the cyst is contained, and maintaining the vocal fold epithelium that overlies the cyst. In comparisons to other benign lesions, such as a polyp or pseudocyst, a cyst excision can have a higher risk of scarring, since it may require more dissection in the lamina propria **[25]**.

Vocal Fold Contact Granuloma

Definition and causes

Primitive granulomatous tissue at the vocal process of the arytenoid cartilage that results from a mucosal lining defect is called a contact granuloma.

Round, benign tumors in the posterior glottis are called contact granulomas. Both sexes are affected by vocal granulomas, which have a variety of causes. Acid laryngitis resulting from laryngopharyngeal reflux disease, excessive use of the voice, and traumatic **[27]**.

Signs and Symptoms When bulky lesions are present, patients with laryngeal granulomas may exhibit dysphonia of varied degrees, discomfort at the level of the larynx, and dyspnea. The vocal process of the arytenoid cartilage is typically the source of contact ulcers and contact granulomas. When the arytenoid apices come into contact during phonation, they could also be higher than the glottal level. They have complementary shapes, like a hammer and anvil, and can be on one side or both. The size might vary from a huge exophytic ball resting on the vocal fold and obstructing vocal fold vibrations to a shallow bowl-shaped area **[27]**.

Treatment: The tissue should be removed if a histological examination has not verified the diagnosis. The most effective method for doing this is micro-laryngoscopy with jet ventilation and a CO2 laser. When someone has a habitually pressured voice, voice treatment can help them return to a normal voice **[15]**.

CONCLUSION

For those whose jobs strongly rely on their ability to utilize their voices effectively, occupational voice disorders are a severe worry. The main contributing factors identified in this review include inadequate working conditions, high vocal loading, and poor vocal hygiene. When the underlying stress continues, functional dysphonia typically precedes organic lesions like nodules or polyps. Prevention, early diagnosis, and customized rehabilitation programs should be the focus of comprehensive management. The mainstays of interventions are voice therapy, instruction on vocal hygiene, and ergonomic workplace changes. When conservative approaches are ineffective, surgical intervention is saved for more advanced cases. For those in high-risk occupations, increasing awareness among occupational voice users and integrating preventative voice care programs into

professional training can greatly lower the prevalence of dysphonia and enhance quality of life and career sustainability.

Funding: No funding
Conflict of interest: The Authors declared no conflict of interest

Authors' Contribution

Zienab M. Khalaf: Conceptualization of the study, literature review, and supervision of manuscript preparation.
Effat Zaky: Study design, data organization, and critical revision of the manuscript.
Shimaa Khalaf Allah Kamel: Corresponding author; drafting, writing, and coordination of manuscript submission.
Wafaa Helmy Abd El-Hakeem: Data collection, analysis of voice disorder classifications, and manuscript editing.
Marowa Abd El-Wahab: Compilation of references, formatting, and contribution to the discussion and conclusion sections.

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