

## Artigos originais

# Sinais e sintomas vocais e de fala em indivíduos expostos a agentes químicos: uma análise de prontuários

*Voice and speech signs and symptoms in individuals exposed to chemical agents: an analysis of medical records*

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## ABSTRACT

**Objective:** to identify voice and speech signs and symptoms in patients exposed to chemical agents.

**Methods:** an exploratory and descriptive study analyzing the data from the medical records of patients who sought health services at a toxicology outpatient clinic located in Southeastern Brazil.

**Results:** a total of 139 medical records were obtained, 75 being selected. Twelve of the records selected contained data regarding voice and speech symptoms, including hoarseness (3), loss of voice (2), chronic throat inflammation (1), sore throat (1), secretion and burning in the throat (1), dry throat and mouth (1), lump in the throat associated with difficulty in swallowing (1), difficulty in articulating words (1), and difficulty in verbal expression (1). Diseases capable of causing phono-articulatory problems were detected in 6 cases. These symptoms affected individuals with occupational exposure to different substances, particularly community health agents (7) and pesticide applicators (7).

**Conclusion:** individuals exposed to chemical substances experienced voice and speech problems, either due to a possible irritation caused by chemical agents or due to diseases developed during or after the exposure.

**Keywords:** Signs and Symptoms; Voice; Speech Disorders; Chemical Compound Exposure

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## INTRODUCTION

Exposure to chemical agents may cause severe health problems. According to the World Health Organization, 193,000 deaths occur each year worldwide as a result of unintentional poisoning by chemical agents<sup>1</sup>. In Brazil, the National System of Toxicological and Pharmacological Information reported 4,758, 9,236, 3,555, and 222 cases of human intoxication by agrochemicals (agricultural and domestic use), household cleaning products, industrial chemicals, and metals, respectively, all in 2014 alone, numbers causing extreme concern for public health<sup>2</sup>.

Intoxication may cause many adverse effects in humans, and affect different bodily systems, including those involved in voice and speech production. However, only a few studies worldwide have attempted to identify and evaluate the possible signs and symptoms of such intoxication<sup>3-5</sup>.

A study conducted in the United States reported that airway injury might occur due to inhalation of chemical substances, especially after fires or occupational exposure to hydrocarbons, leading to laryngeal dysfunction<sup>4</sup>. In a study conducted in the United States and Japan, neurological and phono-articulatory changes were identified in three workers at a cushion factory exposed to glue containing 1-bromopropane, ethyl acetate, and aliphatic hydrocarbons<sup>6</sup>.

In Canada, 49% of a total study population of 351 individuals exposed to environmental irritants complained of voice loss or hoarseness<sup>7</sup>. In Brazil, an evaluation of 280 metallurgists indicated that 69.3% were exposed to chemical products, and presented dry throat (72.9%), throat irritation or pain (68.9%), throat clearing (66.1%), episodes of hoarseness (58.2%), cough (50.4%), speech fatigue (20.7%), and voice loss (9.3%)<sup>5</sup>.

A study conducted in China compared 300 workers exposed to benzene, toluene, or both, to 130 workers from a control group without exposure, and found a higher prevalence of sore throat among the exposed workers<sup>8</sup>. A study conducted in Japan compared 25 volunteer students subdivided into four groups, exposed to 100, 250, 500, or 1000 ppm of acetone, and a control group, and reported an irritation of the nasal, throat, and tracheal mucosa in students exposed to 500 and 1000 ppm<sup>9</sup>. In Iran, individuals who inhaled mustard gas presented changes in lung function and maximum phonation time<sup>10</sup>.

A study from Sweden found a relationship between respiratory complaints and exposure to trichloramine

and exhaled nitric oxide in 146 public swimming pool workers, of which 17% complained of airway problems associated with work, including hoarseness, cough, rhinitis, and nasal obstruction<sup>11</sup>. In addition, another Swedish study analyzed a population of hairdressers, and reported that these workers exhibited nasal symptoms, and complained of throat irritation<sup>12</sup>.

In Italy, dysarthria was detected in a former worker of a rayon viscose factory exposed to carbon disulphide<sup>13</sup>. In Bulgaria, 137 out of 900 workers of a chemical refinery exposed to irritating gases exhibited vocal disorders, including 101 cases of chronic laryngitis, 31 cases of acute vocal fold inflammation, and 5 cases of laryngeal carcinoma<sup>14</sup>. The association between cancer in the head and neck regions, and exposure to toxic agents has been widely reported in the literature<sup>15,16</sup>. Therefore, the evaluation of the occurrence of phono-articulatory changes in populations exposed to chemical substances is essential for the early diagnosis of voice and speech dysfunction, and especially of cancer in voice/speech-related organs and structures.

Therefore, the objective of this study was to identify the presence of voice and speech signs and symptoms in individuals occupationally and/or environmentally exposed to chemical agents, who sought health services in a toxicology outpatient clinic located in Southeastern Brazil, by analyzing their medical records.

## METHODS

This study was approved by two Research Ethics Committees of the Federal University of Rio de Janeiro under Opinion Numbers: 945368 and 954983. This exploratory and descriptive study<sup>17</sup> analyzed 139 medical records of individuals exposed to chemical agents who sought health services in a toxicology outpatient clinic of a university hospital in southeast Brazil in the past two decades. It should be emphasized that the patients treated at the outpatient clinic were not subjected to any procedure in this study, because this study focused exclusively on the medical records.

The selection criterion was: medical records belonging to individuals aged  $\geq 18$  years exposed to chemical agents, alone or in groups. The exclusion criteria were: medical records of individuals with allergic, immunological, respiratory, neurological, otorhinolaryngological, osteomuscular, gastrointestinal, endocrine, and/or psychiatric disorders; and individuals with dysfunction of voice and/or speech and/or swallowing. All these disorders were diagnosed before exposure to chemical substances. Individuals

with a history of alcoholism and/or smoking were also excluded. These criteria were assessed in anamnesis, with the clinical evaluation being performed in the first outpatient consultation, using the data obtained from medical records.

After adopting the inclusion and exclusion criteria, 64 of the 139 initially obtained records were excluded for the following reasons: history of smoking and/or alcoholism (50 cases), respiratory disorders (asthma, bronchitis, pneumonia, tuberculosis) (10 cases), endocrinological disease (hypothyroidism) (1 case), and neurological disorders (ischemic stroke, aneurysm, epilepsy) (3 cases). All these disorders were manifested and diagnosed before chemical exposure. Therefore, 75 records, from patients who attended the toxicology outpatient clinic from 1999 to 2015, were selected.

This study was conducted in four stages. First (1) was the preparation of a data collection form, typed on a computer, and later printed for manual filling of data from medical records, including the following variables: voice and speech signs and symptoms, patient age, occupation, gender, chemical agent(s) to which the patients were exposed, duration of exposure, and other information that might be relevant for analyzing phono-articulatory complaints. Second (2), medical records were selected following application of the inclusion and exclusion criteria; and third (3), manual collection of information present in the selected medical records. Finally (4), descriptive analysis by creating a summary table of data regarding signs and symptoms, gender, age, occupation, chemical agent(s), duration of exposure, and clinical data from the selected records.

## RESULTS

A total of 12 out of the 75 records analyzed contained data regarding voice and speech symptoms and one

sign, including hoarseness (3), loss of voice (2), chronic throat inflammation (1), sore throat (1), secretions and burning sensation in the throat (1), throat and mouth dryness (1), throat lump associated with difficulty in swallowing (1), and difficulty in articulating words (1). The sign was difficulty in verbal expression (1). Data from the medical records are summarized in Figure 1.

Of the 12 medical records with data regarding voice and speech signs and symptoms, 8 belonged to women and 4 belonged to men. The following age groups were identified: 34–35 years (2), 36–40 years (1), 41–45 years (2), 46–50 years (3), 51–55 years (1), and 56–59 years (3).

The following occupations were retrieved from the records: health agent (7), production operator (1), smelting assistant (1), metallurgist (1), chemical technician (1), and mechanic (1). The study participants were exposed to the following chemical agents: insecticides (7); toluene (1); toluene, benzene, and trichloroethylene (1); acetone, turpentine, and paints (1); gasoline, fluorine, aluminum sulfate, and chlorine (1), and metallic lead (1). The exposure periods were: 2 years (1), 5 years (1), 8 years (1), 11 years (1), 12 years (1), 14 years (5), 17 years (1), and 24 years (1).

Only one patient was referred to the otorhinolaryngologist for evaluation of the symptom (sore throat).

In addition, 6 of the 12 medical records containing voice and speech signs and symptoms included data on diseases that manifested during or after the exposure to chemical agents had ceased, and could have adverse effects on phono-articulation, namely toxic encephalopathy and ototoxic hearing loss (1), ototoxic hearing loss alone (1), hypothyroidism (1), allergic rhinitis (1), systemic lupus erythematosus (1), and neuropathy due to lead poisoning (1).

Signs and symptoms	Sex	Age	Occupation	Chemical agent(s)	Duration of exposure (years)	Information
Hoarseness (symptom)	M	50 years	Production operator	Acetone, paints, and turpentine	14 years	Patient professionally involved in paper printing and recycling sought health services at the toxicology outpatient clinic with the following symptoms: headache, nervousness, body tremors, insomnia, loss of vision, hoarseness, and auditory complaint. He was referred for neurological and audiological evaluation, and was later diagnosed with toxic encephalopathy and ototoxic hearing loss.
Hoarseness (symptom)	M	42 years	Health agent	Organophosphate insecticide Malathion and an unspecified pyrethroid	14 years	Patient professionally involved in insecticide manipulation and application sought health services at the toxicology outpatient clinic, with the following symptoms: skin lesions, allergic eye reactions, and hoarseness. He was referred for dermatological and immunological evaluation. However, the immunological and dermatological results and diagnosis data were not included in the medical record.
Hoarseness (symptom)	F	58 years	Health agent	Organophosphorus insecticides Malathion and Temephos	12 years	Patient retired 2 years ago from job involving exposure to insecticides (insecticide handling and application), and started working as an administrative assistant. After retirement from job involving pesticide application, she sought health services at the toxicology outpatient clinic for follow-up. During the outpatient appointment, she reported the following symptoms: forgetfulness, hair loss, hoarseness, and anterior cervical enlargement. She was referred for endocrinological evaluation, and was later diagnosed with hypothyroidism.
Loss of voice (symptom)	F	34 years	Health agent	Organophosphorus insecticides Malathion and Temephos	8 years	Patient retired 4 years ago from job involving exposure to insecticides (insecticide manipulation and application), and started working as a homemaker. After retirement, she sought health services at the toxicology outpatient clinic for follow-up, and was diagnosed with allergic rhinitis. During the outpatient appointment, she reported the following symptoms: allergic rhinitis, loss of voice, and laryngeal irritability. No referrals were made during this consultation.
Loss of voice (symptom)	F	41 years	Health agent	Unspecified organophosphate insecticide	14 years	Patient professionally involved in insecticide manipulation and application sought health services at the toxicology outpatient clinic, with a complaint of headache. During the outpatient appointment, she reported the following symptoms: swollen ankle and loss of voice. No referrals were made during this consultation.
Chronic throat inflammation (symptom)	F	40 years	Health agent	Unspecified insecticides	5 years	Patient retired 4 months ago from job involving exposure to insecticides (insecticide handling and application). After retirement, the patient sought health services at the toxicology outpatient clinic, and was diagnosed with changes in visual acuity. During the outpatient appointment, she complained of chronic throat inflammation. No referrals were made during this consultation.
Sore throat (symptom)	F	35 years	Chemistry technician	Toluene	14 years	The patient retired 8 months ago from job involving exposure to toluene. After retirement, she sought health services at the toxicology outpatient clinic for follow-up. During the outpatient appointment, she reported sore throat and burning sensation of the face during occupational exposure to toluene. She was referred for otorhinolaryngological evaluation. However, the laryngological evaluation data were not included in the medical record.
Secretion and burning in the throat (symptom)	M	52 years	Mechanic	Gasoline, fluorine, chlorine, and aluminum sulfate	17 years	Patient working as a mechanic sought health services at the toxicology outpatient clinic with complaints of dizziness. He was diagnosed with ototoxic hearing loss. After retirement from job involving exposure to chemical agents, and after 7 years of follow-up in the outpatient clinic, the patient complained of secretion and burning in the throat. No referrals were made during this consultation.

Signs and symptoms	Sex	Age	Occupation	Chemical agent(s)	Duration of exposure (years)	Information
Dry throat and mouth (symptom)	F	59 years	Health agent	Organophosphorus insecticides Temephos	14 years	Patient working with insecticide handling and application sought health services at the toxicology outpatient clinic. She complained of forgetfulness, and dryness in the mouth and throat. She was referred for psychological examination.
Lump in the throat and difficulty swallowing (symptom)	F	56 years	Health agent	Organophosphorus insecticides Malathion and Temephos	11 years	Patient working with insecticide handling and application sought health services at the toxicology outpatient clinic, with the following symptoms: headache, insomnia, lump in the throat, and difficulty swallowing. It is of note that the words "lump in the thyroid?" were written next to the words "lump in the throat." However, no lumps were detected in the thyroid gland during physical examination, and the patient was referred for biochemical examination.
Difficulty in articulating words (symptom)	F	50 years	Metallurgist	Benzene, toluene, and trichloroethylene	24 years	Patient working with cleaning of warfare components sought health services at the toxicology outpatient clinic with complaints of cramps. During the outpatient appointment, she reported the following symptoms: difficulty in articulating words, joint pain, and altered sensitivity of the hands. No referrals were made during this consultation. The patient was diagnosed with systemic lupus erythematosus.
Difficulty in verbal expression (sign)	M	47 years	Smelting assistant	Metallic lead	2 years	Patient professionally involved in the manufacture of jewelry sought health services at the toxicology outpatient clinic. The results of physical examination indicated difficulty in verbal expression and a decrease in muscle strength in the limbs. The patient was referred for clinical tests, and was diagnosed with neuropathy due to lead exposure.

Figure 1. Data from medical records

## DISCUSSION

The symptoms and the sign were found in the medical records of individuals of both sexes and different age groups with chronic occupational exposure to chemical substances. The impairment of vocal mechanisms and speech production in workers exposed to toxic agents was also found in previous studies conducted in China (1987)<sup>8</sup>, Japan and the United States<sup>6</sup>, Sweden<sup>11,12</sup>, Italy<sup>13</sup>, Bulgaria<sup>14</sup>, and Brazil<sup>5</sup>. It is noteworthy that labor activities may affect the dynamics of the health-disease binomial pair because, particularly for chemical exposure, workers are in contact with chemical components in high doses and for a long period, and do not necessarily have access to or use personal protective equipment<sup>18</sup>.

Hoarseness is one of the vocal symptoms detected, which may indicate deviations or irregularities in the vocal fold vibration, and may have organic and functional etiologies. Hoarseness may be due to malignant laryngeal neoplasia, whose primary symptom is a rough vocal quality, an indication that is often underestimated<sup>19</sup>.

One of the three patients who presented this symptom was a production operator with occupational

exposure to acetone, paints, and turpentine, and during the clinical consultation, was diagnosed with toxic encephalopathy and ototoxic hearing loss. These dysfunctions may impair voice and speech mechanisms<sup>20,21</sup>. In addition, acetone is a volatile organic compound, and the inhalation of its vapors, depending on the dose, may irritate the airways, with the exposed individuals complaining of throat irritation<sup>9</sup> and central nervous system depression<sup>22</sup>.

Paints are usually composed of different solvents, including naphtha, toluene, xylene, and n-hexane, which may have neurotoxic effects<sup>23</sup>. A study conducted in 1988 reported a high risk of laryngeal cancer among workers exposed to this product<sup>24</sup>. The United States Centers for Disease Control and Prevention have reported that turpentine damages the respiratory tract, leading to throat and nose irritation and discomfort. In addition, chronic exposure to turpentine may affect the neurological system<sup>25</sup>.

Hoarseness was also reported by two other patients who served as public health agents. One worker manipulated and applied organophosphorus insecticides (Malathion) and an unspecified pyrethroid for 14 years. The second worker had been retired for 2 years

when she sought outpatient care, after being exposed to the organophosphate insecticides Malathion and Temephos for 12 years, and was diagnosed with hypothyroidism, which may have adverse effects on the phonatory mechanism, including edema in vocal folds<sup>26</sup>.

Organophosphate insecticides may inhibit the enzyme acetylcholinesterase, which leads to cholinergic hyperstimulation by the accumulation of acetylcholine in the synapses, with neurological involvement<sup>27</sup>. Paralysis of vocal folds is rare, and the etiology is linked to the neurological effects produced by organophosphate insecticides<sup>28</sup>. Pyrethroids cause respiratory problems in exposed workers, including nasal and throat irritation, sneezing, and coughing<sup>29</sup>.

Voice loss was diagnosed in two patients who worked as health agents. One of them had been exposed to an unspecified organophosphate insecticide for 14 years. The second patient had a history of exposure to Malathion and Temephos for 8 years. After retirement, she sought care in the toxicology clinic with vocal complaints, and was diagnosed with allergic rhinitis. Therefore, organophosphates are neurotoxic<sup>27</sup>. Further, insecticides cause rhinitis, which may lead to airway irritation<sup>30</sup>.

Chronic throat inflammation were reported by a health agent who was exposed to insecticides for 5 years, and sought our service 4 months after retirement. This symptom may be caused by different etiologic factors, including bacteria, parasites, viruses, and traumas, as well as environmental and chemical factors. The latter two categories involve continued exposure to irritant agents, which may cause chronic inflammation<sup>31</sup>.

It should be emphasized that acute or chronic sore throat may be a consequence of inflammatory processes caused by irritation<sup>31</sup>. Sore throat was reported by a chemical technician after occupational exposure to toluene. The detrimental effects of toluene include mild or moderate irritation of the respiratory tract, resulting in sore throat. In this respect, a study conducted in 1987 reported that workers exposed to toluene complained of sore throat<sup>8</sup>.

Secretion and burning in the throat were reported by a mechanic, who was diagnosed with ototoxic hearing loss, and was occupationally exposed to gasoline, fluorine, chlorine, and aluminum sulfate for 17 years. The patient reported these symptoms during an outpatient consultation, 7 years after retirement. Exposure to chemical irritants may produce secretions and burning

in the laryngeal mucosa, and these symptoms may be due to chronic inflammation triggered by chemical agents in contact with the airways<sup>31</sup>.

Chlorine is an inorganic compound that causes irritation to the respiratory system<sup>32</sup>. Gasoline is a volatile organic compound that contains a mixture of chemical substances, including toluene, xylene, and benzene, a toxic combination. Gasoline may damage the respiratory and neurological systems, and gasoline vapors increase the risk of laryngeal and pharyngeal cancer<sup>33</sup>.

Fluorine is an inorganic substance used to manufacture other chemical compounds, and causes severe irritation to exposed tissues, especially to the respiratory mucosa<sup>34</sup>. Aluminum is used in the manufacture of many products, including pots, pans, and cosmetics. Exposure to aluminum dust compromises the respiratory system. In Germany, workers exposed to aluminum dust were diagnosed with respiratory tract dysfunction during a health evaluation<sup>35</sup>.

Symptoms of dryness in the throat and mouth were reported by a health agent exposed to the organophosphate insecticide Temephos for 14 years, an insecticide class known to cause adverse events<sup>27,28</sup>. Exposure to chemical agents may cause dryness in the laryngeal mucosa, and affect the viscosity of the vocal folds, and their vibration during phonation<sup>31</sup>.

Lump in the throat accompanied by difficulty in swallowing were reported by a health agent who was exposed to the organophosphate insecticide Malathion and Temephos for 11 years. Lumps in the neck are known to possibly indicate different clinical conditions, including thyroid dysfunction<sup>36</sup>. Further, lumps in the throat, combined with difficulty in swallowing, is a symptom usually observed in cases of pharyngeal cancer<sup>37</sup>.

Difficulty in articulating words may indicate an articulatory disorder, and is also observed in patients with speech disorders<sup>20</sup>. This symptom was reported by a metallurgist exposed to toluene, benzene, and trichloroethylene for 24 years, and later diagnosed with systemic lupus erythematosus, which may trigger neurological disorders, and impair phonation and speech<sup>38</sup>. Toluene and benzene may affect the respiratory system, and lead to airway irritation<sup>9</sup>. Trichloroethylene is a volatile organic compound that may depress the nervous system. Intoxication symptoms include tremors, difficulty swallowing, and weakness in the oral musculature<sup>39</sup>.

Difficulty in verbal expression was reported by a smelting assistant who worked in a jewelry factory, and was exposed to metallic lead for 2 years. This patient was diagnosed with neuropathy due to lead poisoning. Lead is highly toxic to the nervous system, and may affect the motor bases of speech<sup>40</sup>.

In most cases, phono-articulatory problems were diagnosed in individuals without associated comorbidities, and those with diseases capable of impacting voice and speech. This result may suggest that the unfavorable effects on phonation and vocal production in workers exposed to chemical agents may be due to local and chronic irritation of the vocal tract,<sup>31</sup> and diseases that directly or indirectly affect the speech apparatus<sup>20,21,26,30,36</sup>. However, additional clinical studies are necessary to better establish a causal inference.

It should be emphasized that the present study relied solely on medical records. Therefore, complaints and/or signs should be acknowledged and recorded by health professionals as indications of possible voice and speech disorders, which may not have happened in all of the cases. The results indicate that only the patient with sore throat was referred for assessment of the symptom. This low number of referrals may be due to the lack of professionals in the areas of speech therapy and otorhinolaryngology among the outpatient toxicology clinic staff. However, an even higher number of observations related to voice and speech disorders could be observed in the presence of professionals trained to provide care for patients exposed to chemical substances.

A greater emphasis should be given to studies correlating exposure to chemical agents and changes in voice and speech production<sup>3-5</sup>. However, implementing this strategy in toxicological health services is also essential. To assist in this process, we believe the application of speech therapy and otorhinolaryngology in the toxicological clinic is fundamental to promote the investigation of phono-articulatory symptoms and signs in individuals with current exposure or with a history of exposure to chemical substances, especially occupational exposure, in addition to encouraging research and preventive and rehabilitative actions for vulnerable populations.

## CONCLUSION

Individuals exposed to chemical substances experienced voice and speech problems, either due to a possible irritation caused by chemical agents or due to diseases developed during or after the exposure.

Therefore, diagnosing voice and speech disorders in the clinical routine of toxicological health services, and hiring specialized health professionals, including speech therapists, is essential for the early identification and rehabilitation of such dysfunctions.

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