Review Article

# Halitosis: A silent affliction!


## Abstract

Humans emanate a variety of volatile and non-volatile molecules that are influenced by genetics, diet, stress, and disease. Halitosis is widespread and is believed to affect one quarter of the population around the world. Literature depicts various classifications, causes, contributing factors, associated micro-organisms, and techniques for assessment, diagnosis, and treatment for halitosis. Studies have revealed that oral environment, including periodontal disease, contribute significantly in the production of oral malodor. Based on the current literature and research, this review presents a brief overview of the same; thereby helping the reader bridge information into clinical application by suggesting protocols developed to assist patients in overcoming halitosis.



**Key words:**
*Diagnosis, halitosis, oral malodor, volatile sulfur compounds*


## Introduction

Offensive breath, often referred to as foul-fetid breath or as bad breath, is frequently designated by the medical fraternity as "halitosis" or in the continent of Europe as 'fetor ex ore'. The term is derived from the Latin *'halitus'* (breath) and Greek suffix '*osis*', indicating primarily an increase in volume, either physiologic or pathologic.[1] The term, also referred to as oral malodor, *fetor ex ore*, bromopnea and bad breath, is generally used to describe any disagreeable odor in the breath regardless of its origin.

## Days of Yore

Modern literature on bad breath dates back to a monograph published by Howe in the nineteenth century. Since the 1960's, Dr. Joseph Tonzetich of Columbia, who unfolded the biologic basis for oral malodor, has been a pre-eminent researcher in this field. In fact, Hippocrates[2] is credited with having cited the nose as being 'a true diagnostic guide'. Although the term halitosis was introduced by Listerine Company in 1921, bad breath is not merely a modern affliction. The phrase 'always a bridesmaid,never a bride', was actually created as part of a 1930's ad campaign for Listerine mouthwash. The problem of halitosis has been documented since years having been mentioned in some form or the other in the papyrus manuscripts, by Hippocrates, Romans, Hindus, Christianity and the Buddhist monks.[3]

## Socio-Economic and Physiological Aspects

A transient breath malodor is noticed when waking up in the morning in more than half of the adult population. The real concern of the population is the breath malodor which remains during the day and which can cause social and/or relational problems. In spite of high prevalence of breath malodor, only a few patients visit dental clinics seeking treatment. This fact has been termed the "bad breath paradox", since people suffering from bad breath often remain completely unaware of this fact. In 1971, Pruse-Phillips described an "Olfactory Reference Syndrome", in which, patients claim to actually perceive a malodor that others cannot detect. One type of Olfactory Reference Syndrome with most of the characteristics described by Pruse-Phillips is delusional halitosis.


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## Classification

Various classifications have been given in the past such as the ones by Dominic *et al.* (1982), Dayan *et al.* (1982), Bogdasarin *et al.* (1986), Iwakuru *et al.* (1994), and Murata *et al.* (2002). However, one of the simpler classifications with corresponding treatment needs was reported by Yaegaki K and Coil JM in 1999[4] which is widely used by the practitioners [Table 1].

## Sources/Causes

### Intra-oral

In about 85% of the patients with persistent genuine halitosis, odor originates from the mouth, mainly from microorganisms.[5] It is likely that there is a complex interaction between several oral bacterial species (mainly gram-negative anaerobic flora) because no single specific bacterial infection has invariably been associated with halitosis. The common intra-oral causes are listed in [Table 2].

### Extra-oral

Halitosis is less frequently associated with extra-oral causes (i.e. conditions and diseases that do not affect primarily the oral cavity) [Table 3]. Furthermore, with some metabolic disorders, odiferous agents circulating in the bloodstream can be exhaled, through alveolar gas exchange, into the breath and cause halitosis (also known as blood borne halitosis). The volatile sulfur compound (VSC), *dimethyl sulfide*, is the main contributor to extra-oral or blood-borne halitosis, as the result of a hitherto unknown metabolic disorder.[6] Halitosis can be incurred due to the effect of certain drugs and can act as a biomarker for a number of systemic diseases.

## Clinical Assessment and Diagnosis of Oral Malodor

The first step in assessment is to determine whether halitosis is actually present. This is important as most individuals are poor judges of their own breath odor.[7] The tests can be classified into the following[8]:

### Direct

1. By directly sniffing the bad breath
2. Determination of odoriferous sulfur containing substances by gas chromatography or halimetry and other methods

**Table 1: Classification of halitosis**

| Classification | Treatment need | Description |
|---|---|---|
| Genuine halitosis | | Obvious malodor, with intensity beyond socially acceptable level, is perceived |
| Physiologic halitosis | TN-1 | Malodor arises through putrefactive process within the oral cavity. Neither specific disease nor pathologic condition that could cause halitosis is found.<br>Origin is mainly the dorsoposterior region of the tongue.<br>Temporary halitosis due to dietary factors (e.g., garlic) should be excluded. |
| Pathologic halitosis | | |
| Oral | TN-1 and TN-2 | Halitosis caused by disease, pathologic condition or malfunction of oral tissue.<br>Halitosis is derived from tongue coating, modified by pathologic condition (e.g., periodontal disease, xerostomia) is included in this subdivision. |
| Extra-oral | TN-1 and TN-3 | Malodor originates from nasal, paranasal, and/or laryngeal regions.<br>Malodor originates from pulmonary tract or upper digestive tract.<br>Malodor originates from disorders anywhere in the body, whereby the odor is blood borne and emitted via the lungs (e.g., diabetes, hepatic cirrhosis, uremia, internal bleeding) |
| Pseudohalitosis | TN-1 and TN-4 | Obvious malodor is not perceived by other although the patient having complains of halitosis.<br>Condition is improved by counselling (using literature support, education, and explanation of examination results) and simple oral hygiene measures. |
| Halitophobia | TN-1 and TN-5 | After treatment for genuine halitosis or pseudohalitosis, the patient persists in believing that he or she has halitosis<br>No physical or social evidence exist to suggest that halitosis is present |

TN - Treatment need

**Table 2: Intra-oral sources of halitosis**

| | |
|---|---|
| Plaque-related gingival and periodontal disease | Gingivitis, periodontitis, acute necrotizing ulceration , gingivitis, pericoronitis, abscess |
| Ulceration | Systemic disease (inflammatory/infectious disorders, cutaneous, gastrointestinal hematological disease), malignancy, local causes, apthae, drugs |
| Hyposalivation | E.g., from drugs, Sjogren's syndrome, radiotherapy, chemotherapy |
| Tongue coating | Poor hygiene |
| Wearing dental appliances poor hygiene | Poor hygiene |
| Dental conditions | Food packing |
| Bone diseases | Jaw dry sockets, osteomyelitis, osteonecrosis, malignancy |

**Indirect**

These methods assess the products produced by microorganisms *in vitro* or identify odor producing microorganisms.

**Direct tests**

Organoleptic[9]

Direct sniffing of the expired air ("organoleptic" and "hedonic" assessment) is the simplest, most common method to evaluate oral malodor. An organoleptic examination involves the dentist assessing the odor at a range of distances from the patient [Figure 1]. Organoleptic measurement is highly recommended for initial diagnosis.

One potential risk of the organoleptic measurement is the transmission of diseases via the expelled air (particular concern following the severe acute respiratory syndrome.)

The organoleptic assessment involves the following:

1. Self-assessment,
2. Whole mouth breath test,
3. Spoon test,
4. Dental floss odor test,
5. Saliva odor test.

*Organoleptic scoring scales*[4]: Organoleptic scoring has been suggested by Tonzetich J *et al.* (1976) and Schmidt N.F *et al.* (1978). However, the one by Rosenberg (1991) is frequently used.

***Category description by Rosenberg (1991)***

0: Absence of odor -odor cannot be detected
1: Questionable odor- odor is detectable, although the examiner could not recognize it as malodour
2: Slight malodor- odor is deemed to exceed the threshold of malodor recognition
3: Moderate malodor- malodor is definitely detected
4: Strong malodor: strong malodor is detected, but can be tolerated by the examiner
5: Severe malodor: overwhelming malodor is detected and cannot be tolerated by examiner (examiner instinctively averts the nose).

Gas Chromatography: It is the preferred method if precise measurements of specific gases are required. It is performed with an apparatus equipped with a flame photometric detector; specific to detecting sulfur in mouth air; It is considered the "gold standard" for measuring oral malodor because it is specific for VSC's. However, traditional laboratory gas chromatography is cumbersome, needs inert column carrier gas, and requires technicians with adequate training. However, a newly developed portable gas chromatograph (OralChroma™, Abimedical, Abilit Corp., Osaka, Japan) has now been described, which does not use a special carrier gas

**Table 3: Extra-oral sources of halitosis**

| |
|---|
| Respiratory system: (Microbial etiology) |
| Sinusitis |
| Cleft palate |
| Antral and nasal malignancy |
| Foreign body in the nose |
| Tonsilloliths and tonsillitis |
| Pharyngeal malignancy |
| Lung infections |
| Lung malignancy |
| Bronchitis |
| Bronchiectasis |
| Gastrointestinal tract |
| Esophageal diverticulum |
| Gastro-esophageal reflux disease |
| Malignancy |
| Metabolic disorders |
| Acetone like smell in uncontrolled diabetes |
| Uremic breath in renal failure |
| Foetor hepaticus in liver disease |
| Trimethyaminuria |
| Hypermethiominemia |
| Psychogenic causes |

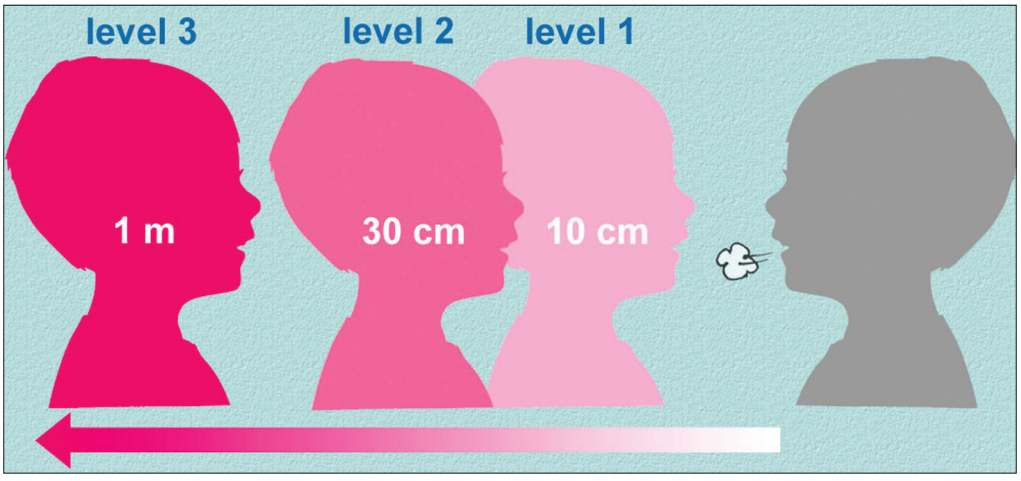


**Figure 1:** A three-stage scale at variable distance

(using air instead) and is highly sensitive yet of relatively low cost compared with a standard gas chromatograph. The device analyses individual concentrations of VSC's and displays the concentrations on a display panel.

Sulfide Monitoring: This is an electronic device that aspirates the air of the mouth or expired air through a straw and analyses the concentration of hydrogen sulfide and methyl mercaptan, without discriminating between the two. It can also be used to measure the headspace above incubated saliva (Rosenberg *et al*. 1991). Three measurements are taken and the mean of these values are determined in parts per billion sulfide equivalents.

Tanita BreathAlert™[10] is an innovative palm-size monitor that detects and measures the presence of VSC's and hydrocarbon gases in mouth air.

Halitox™: Halitosis Linked Toxins is a quick, simple, colorimetric test that detects both VSC's and polyamines. The kit consists of two testing vials that contain specific reagent chemicals. The only thing that comes in contact with the patient is a sterile cotton tipped swab used to obtain a tongue scraping sample or packet sample.

Tongue Sulfide Probe (Diamond General Development Corp., Ann Arbor, MI, USA)[11]: The Probe is placed directly into the periodontal pocket or tongue. The sulfide-sensing element generates an electrochemical voltage proportional to the concentration of sulfide ions present. The control unit reports the sulfide level at each site in a digital score from:

- 0.0 (undetectable pS, less than $10^7$ M of sulfide) to
- 5.0 (more than or equal to $10^2$ M of sulfide) in increments of 0.5.

This digital score, *pS*, is defined by $pS=(7+\log S)$, where *S* is the molar concentration of sulfide in an"equivalent model sulcus fluid"

Electronic Nose[12] Electronic noses are chemical sensors that have been used in recent times for a quantitative assessment of malodor associated with food and beverages.

The FF-1 odor discrimination analyzer (Electronic nose, Shimadzu Corporation) was used by Tanaka M *et al*. The setup comprises a pre-concentrator, an array of six metal oxide semiconductor sensors selected for their different sensitivities and selectivities to fragrant substances, and a pattern recognition software. The instrument can be set to various modes such as the "all note measurement mode" which is the standard setting used for measuring all volatile substances and the "top note measurement mode" which primarily measures volatile substances with a low boiling point. The results of their preliminary study showed that main compounds related to oral malodor were volatile substances with a low boiling point.

**Indirect tests**

BANA Test: It is a chair side, enzyme-based assay, which is used to determine the proteolytic activity of certain oral anaerobes that contribute to oral malodor and which are considered as active $H_2SO_4$ producers. If any of the these species are present, they hydrolyze the BANA enzyme-producing B-naphthylamide which in turn reacts with imbedded diazo dye to produce a permanent blue color indicating a positive test.[13]

Commercially available chair side kit for the same is Perioscan (Oral B).

Bacteriologic Analysis: Polymerase chain reaction (PCR) has become the favored detection modality. PCR is rapid, inexpensive, and simple and can produce relatively large numbers of DNA copies, even if the source DNA is of relatively poor quality (e.g., from saliva or the tongue coating).

Other tests include the following:

- Quantifying B-galactosidase activity
- Ammonia monitoring
- The ninhydrin method,
- Zinc oxide thin film conductor (Ora test)
- Cry-osmoscopy,
- Ion trap transportable monitors.

## VSC's: Origin and Relation to Periodontitis

VSCs are mainly produced through putrefactive activities of bacteria present in saliva, the gingival crevice, the tongue surface, and other areas.[14] The substrates are sulfur-containing amino acids which are found free in saliva, gingival crevicular fluid, or produced as a result of proteolysis of protein substrates. Apart from the presence of gram-negative anaerobic bacteria, certain physical-chemical conditions are needed for the production of odoriferous gases. These conditions such as pH, $pO_2$, and Eh are usually determined by the bacterial metabolism [Figure 2].

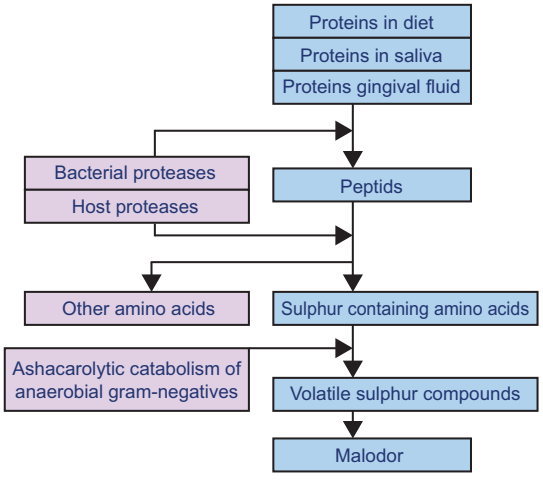


**Figure 2:** Production of volatile sulfur compounds

VSC's are highly toxic to tissues even at extremely low concentrations and, therefore, may play a role in the pathogenesis of inflammatory conditions affecting the periodontium. Different *in vitro* studies have demonstrated that VSC's alter the permeability of oral and junctional epithelium.[15] They are toxic to fibroblasts, altering their morphology and function,[16-18] alter the metabolism of fibronectin43, and interfere in the enzymatic and immunological reactions leading to tissue destruction while showing an increase in the release of interleukin-1 and prostaglandin $E_2$. Takeuchi *et al*.[19] indicated that $H_2S$ inhibits cell proliferation and induces cell cycle arrest via the expression of p21Cip1 in Ca9-22 cells.

## Microbiology and Breath Malodor

Some of the evidence in support of periodontal disease is indirect, as it is based on the *in vitro* ability of species indigenous to the sub-gingival plaque to produce VSC's. For example, *Fusobacterium nucleatum*, *Treponema denticola*, *Prevotella intermedia*, *Porphyromonas gingivalis*, *Bacteroides forsythus*, *Eubacterium*, and other sub-gingival species which can produce large amounts of $CH_3SH$ and $H_2S$ from methionine, cysteine, or serum proteins.[20]

## Management and Treatment

The management of halitosis entails four steps:

1. Confirm the diagnosis,
2. Identify and eliminate the predisposing and modifying factors,
3. Identify any contributing medical conditions and refer for management,
4. Review and reassure.

After a positive diagnosis for oral halitosis has been made, the treatment plan is implemented, which comprises the elimination of causative agent and improvement of oral health status. This may be accomplished by mechanical or chemical methods.

(I) Mechanical reduction of microorganisms: The best way to treat bad breath is to instill in patients good oral hygiene practices.[20,21] Common methods include tongue brushing, tongue scraping, and chewing gum. Because bad breath is worse when the mouth dries out (e.g. at night, while fasting), subjects should also be encouraged to maintain a good hydration.

(II) Chemical reduction of oral microbial load: Even with the implementation of good oral hygiene, many patients continue to have halitosis of oral origin. In such instances, rinsing and gargling with an efficacious mouthwash may be advised. These compounds decrease the bacterial load and thus decrease the VSC and VOC production.

A. Chlorhexidine (CHX): Mouth rinses containing antibacterial agents such as CHX and cetylpyridinium chloride (CPC) may play an important role in reducing the levels of halitosis producing bacteria on the tongue. Chlorine dioxide and zinc containing mouth rinses can be effective in neutralization of odoriferous sulfur compounds. Roldan. S *et al*.[22] evaluated five different commercial mouth rinses with respect to their anti-halitosis effect and anti-microbial activity on salivary bacterial counts. Formulations that combine CHX and CPC achieved the best results, and a formulation combining CHX with NaF resulted in the poorest.

B. Essential oils: Listerine was found to be only relatively effective against oral malodor (±25% reduction vs. 10% of placebo) and caused a sustained reduction in level of odorigenic bacteria.

C. Chlorine dioxide: It is a powerful oxidizing agent that oxidizes the sulfides of the VSC's to nonodorous sulfates and raises the oxidation/reduction ratio of the saliva toward the more oxidizing state.

D. Two-phase oilwater rinse: The efficacy of oilwater CPC formulation is thought to result from the adhesion of a high proportion of microorganisms to the oil droplet which is further enhanced by the CPC.

E. Triclosan: A broad-spectrum antibacterial agent, has been found to be effective against most oral bacteria and has a good compatibility with other compounds used for oral home care.

F. Aminefluoride/Stannous fluoride (AmF/$SnF_2$): The association of AmF/$SnF_2$ resulted in encouraging reduction of morning breath odor, even when oral hygiene is insufficient (Quirynen et al., 2004).

G. Hydrogen peroxide: Suarez *et al*. reported that rinsing with 3% $H_2O_2$ produced impressive reductions (±90%) in sulfur gas that persisted for 8 h.

H. Oxidizing lozenges: The anti-malodor effect of lozenges may be caused by the activity of dehydroascorbic acid which is generated by peroxide-mediated oxidation of ascorbate present in the lozenges.

(III) Conversion of VSCs

A. Metal salt solutions: Metal ions with affinity for sulfur are rather efficient in capturing the sulfur-containing gases. Zinc is nontoxic, noncumulative, and gives no visible discoloration.

B. Tooth paste: Baking soda dentifrices have been shown to be effective, with a 44% reduction of VSCs level 3 h after tooth brushing versus a 31% reduction for fluoride dentifrices (Brunnet *et al*. 1998).

C. Chewing gums: Tsunoda *et al*. (1996) investigated the beneficial effects of chewing gums containing tea extract for its deodorizing mechanism.

Epigallocatchin (EGCg) is the main deodorizing agent among the tea catechins. The study stated the hypothesis that EGCg reduces VSCs by suppressing *mgl*, the gene encoding L-methionine-α-deamino-γ-mercaptomethane-lyase, responsible for methyl mercaptan ($CH_3SH$) production by oral anaerobes. Thus, it was concluded that EGCg may represent a natural and alternative agent to the antimicrobial chemicals currently available for halitosis control.[23]

(IV) Masking the malodor: Treatment with rinses, mouth sprays, and lozenges containing volatile substances with a pleasant odor have only short-term effects. A typical example is mint-containing lozenges.

A simple classification with corresponding treatment needs was reported by Miyazaki[4] and others [Table 4]. While many patients genuinely suffer from halitosis, halitophobia, an exaggerated fear of having bad breath, should be considered if no clinical findings support the patient's complaints. Such patients can be helped by using a simple air bag method.[24]

(V) Role of probiotics in the treatment of oral malodor: Quick look into dental and oral health literature confirms that probiotics are being thoroughly investigated for their effect on halitosis and oral bacteria. By using certain microbe colony-modifying products, like Blis Probiotics, individuals with bad breath may be able to stem the tide of odor-causing oral bacteria. In oral cavity, probiotics can create a biofilm, acting as a protective lining for oral tissues against oral diseases. Such a biofilm keeps bacterial pathogens off oral tissues by filling a space pathogens would invade in the absence of the biofilm[25] and competing with periodontal pathogens growth.[26] After taking *Weissellacibaria*, reduced levels of VSC's produced by *Fusobacterium nucleatum* were observed by Kang *et al*.[27] The effect could be due to hydrogen peroxide production by *Weissella cibaria*, causing *F.nucleatum* inhibition. *Streptococcus salivarius* also suppress volatile sulfide effects, by competing for colonization areas with volatile sulfide-producing species.[28]

(VI) Oil pulling: The concept of oil pulling was familiarized by Dr. F. Karach in the 1990s in Russia. Oil pulling therapy can be done using edible oil's like sunflower or sesame oil. For oil pulling therapy, a tablespoon of sesame oil is taken in the mouth, sipped, and pulled between the teeth for 10 to 15 min. Oil pulling therapy should be followed by tooth brushing and is preferably done on empty stomach in the morning.

There is no scientific proof to accept oil pulling therapy as a treatment adjunct to cure halitosis. The results showed that oil pulling therapy has been equally effective like chlorhexidine on halitosis and organisms, associated with halitosis.[29]

(VII) Natural herbs for halitosis relief: Many herbs frequently used in the preparation of various beverages like herbal tea and alcoholic drinks contain volatile oils that are anti-bacterial and therefore can be useful for the natural treatment of halitosis. It is consequently quite natural to think about using these herbs themselves as natural remedy for the relief of halitosis.

Some of the common herbs for the treatment of halitosis are as follows:

1. Thyme (*Thymus vulgaris*)
2. Eucalyptus (*Eucalyptus globulus*)
3. Peppermint (*Menthapiperita*)
4. Sage (*Salvia officinalis*)
5. Ginger (*Zingiberofficinale*)
6. Cardamom (*Eletteria cardamomum*)
7. Anise (*Pimpinella anisum*)
8. Cinnamon (*Cinnamomum verum*)
9. Fennel (*Foeniculum vulgare*)
10. Fenugreek (*Trigonellafoenum graecum*)

**Table 4: Treatment need for halitosis**

| Category | Description |
|---|---|
| TN-1 | Explanation of halitosis and instructions for oral hygiene (support and reinforcement) |
| TN-2 | Oral prophylaxis, professional cleaning, and treatment for oral disease, especially periodontal disease |
| TN-3 | Referral to a physician or medical specialist |
| TN-4 | Explanation of examination data, further professional instructions, education and reassurance |
| TN-5 | Referral to a clinical psychologist, psychiatrist or other psychological specialist |

TN - Treatment need

## Conclusion

Halitosis is a crippling social problem. Surprisingly, a problem of this magnitude has been neglected by dental professionals, even though the most common cause is related to microbiota of oral cavity. The study of oral malodor and its components is a growing science that may, at the surface, appear to be a simplistic exercise in curing a merely social problem. Deeper investigation into the chemical compounds found in halitosis and their effect on tissues and cells may expand our understanding of cell function in normal and diseased tissue.

The field of halitosis research would benefit from:

- More reliable, portable instruments for measuring VSC's,
- A standard scale for assessing oral malodor,
- Further studies with larger sections of the population, and
- Development of site-specific measurements.

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