

Diagnosis, Prevalence, and Treatment of Halitosis

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Abstract Halitosis affects a large part of the population. Many of those that are affected suffer from this problem for a long time before they visit a professional halitosis clinic. Further, halitosis creates social and psychological disadvantages. Although halitosis has multifactorial origins, in nine out of ten cases the source can be found within the oral cavity. The most frequent intra-oral causes are tongue coating, gingivitis, and periodontitis, or a combination of these. A general dental practitioner is often faced with patients suffering from halitosis in her/his dental practice and therefore should be able to manage it. Using standardized strategies, a high level of treatment success can be achieved. In the literature, several methods to determine halitosis and various possibilities for treatment are described. The present review summarizes diagnostics, prevalence, and current treatments of oral halitosis.

Keywords Halitosis · Bad breath · Psychogenic halitosis · Diagnosis · Prevalence · Treatment

Introduction

Halitosis is a widespread problem in the general population. Due to increasing media exposure in recent years, halitosis has

gotten the attention and awareness of patients and dentists. Nevertheless, it is still a taboo subject. Since the oral cavity is the source of halitosis in most cases, a dental practitioner should be the first person to contact [1]. Before visiting a professional halitosis clinic, the majority of patients try to treat halitosis themselves [2•]. The most commonly used anti-halitosis products are chewing gum, candies, and mouth rinse. However, it is known that these products only have a masking effect, and thus they are not able to influence the cause of bad breath [3]. More than half of the patients have, prior to their appointment at a halitosis clinic, already visited one or more general practitioners or medical specialists. Often, patients have a long history of suffering from halitosis, and the resulting social and psychological stress can be very high [2•].

The present review summarizes the diagnostics, prevalence, and current treatments of oral halitosis.

Terminology

Halitosis (Latin *halitus*: breath, vapor) describes an offensive, unpleasant smell of the breath, independent of the cause. In the literature, the terms halitosis, foetor ex ore [4], bad breath [5], breath odor [4], offensive breath [6], and oral malodor [7] are used synonymously. The recommendation of the international consensus group is to use the term ‘halitosis’ and to distinguish between intra-oral halitosis and extra-oral halitosis. This includes all of the cases of real halitosis [8••]. Real halitosis means that a distinctive bad breath can be recognized, which exceeds the socially accepted level. In the case of intra-oral halitosis, the source lies within the mouth, and in case of extra-oral halitosis outside the mouth. Furthermore, extra-oral halitosis can be subdivided into blood-borne and non-blood-borne halitosis [8••]. In addition to real halitosis, psychogenic halitosis may be diagnosed [9]. Typically, the patient perceives a smell that is neither objectively verifiable nor measurable. After professional assessment and diagnosis, in patients with pseudo-halitosis the situation improves in contrast

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to patients with halitophobia. Even after intensive information and education, halitophobic patients persist in believing that they have bad breath. Halitosis caused by dietary factors such as garlic and onions is called temporary or transient halitosis [8•]. This classification is a slight simplification based on the International Classification of Halitosis published by Yaegaki and Coil [9], Coil et al. [10], and Miyazaki et al. [11] (Table 1).

Causes

Halitosis can have multifactorial causes. Nevertheless, in 80–90 % of halitosis the source can be found in the oral cavity [1]. Anaerobic, mainly Gram-negative, bacteria degrade organic substances (e.g., saliva, food debris, desquamated epithelial cells) into primarily volatile sulphur compounds (VSCs) [13]. These include hydrogen sulfide (H₂S), methyl mercaptan (CH₃SH), dimethyl sulfide ((CH₃)₂S) and other minor component sulfides [12]. The VSCs producing bacteria are commonly found at the bottom of the micro-furrows and crypts on the dorso-posterior surface of the tongue. These bacteria have also been associated with gingivitis and periodontitis [13, 14]. Further possible causes of intra-oral halitosis are gingivitis, periodontitis, open caries lesions, inadequate dental restorations, poor oral and denture hygiene, as well as local infections such as pericoronitis, periimplantitis, or candidiasis [1, 15]. Additionally, there are co-factors that significantly influence halitosis, including reduced salivary flow rate, stress, smoking, mouth breathing, unbalanced diet, low daily amount of water, and coffee or alcohol consumption [16–18].

Extra-oral halitosis is uncommon [2•, 19] and is mostly found in the ear, nose, and throat area or, in rare cases, in the gastrointestinal tract [15, 20, 21].

As the oral cavity is the main source of halitosis, general dental practitioners should be able to manage patients with intra-oral halitosis.

Diagnosis

A complete medical, dental, and halitosis history are indispensable. The medical history focuses on current medications and systemic diseases. The presence of nasal obstruction, mouth breathing, report of snoring and sleep apnea, post-nasal drip, allergy, tonsillitis, tonsilloliths, dysphagia, previous ear, nose and throat encounters, types of food typically eaten, as well as vitamin A, B, C, D, and zinc-containing food intake are recorded. The dental history includes questions assessing the frequency of dental visits, the presence and maintenance of dental prosthesis as well as the frequency and the instruments used for tooth brushing, interdental cleaning, or tongue brushing/scraping and other dental products being used. Furthermore, a specific halitosis history should be taken [8•]. A specifically designed halitosis questionnaire is given to the patient to complete before the first appointment. The questionnaire of the Halitosis Clinic of the University of Basel, Switzerland, can be found online (<http://www.andreas-filippi.ch>). This general and detailed halitosis questionnaire gives information about type, frequency, time of day and extent of halitosis, therapies already carried out through physicians, dentists, oral hygienists or self-treatment, resulting psychological stress, as well as typical halitosis co-factors such as dietary and smoking habits [22]. The question “How do you know that you have halitosis?” (options: self-reported, others have reported by straight or indirect way) gives an indication of possible existing psychogenic halitosis [8•, 9]. The questionnaire also serves as a starting point for the first appointment with the patient [2•].

Clinical Examination

The oral examination focuses on the predilection sites of intra-oral halitosis. Periodontal screening is performed and the need

Table 1 Classification of different types of halitosis

Type of halitosis	Definition
Real halitosis	Obvious malodor with intensity beyond socially acceptable level and/or affecting personal relationships
Temporary halitosis	Malodor caused by food and dietary factors such as garlic or morning bad breath
Intra-oral halitosis	The source lies within the mouth The origin is often a coating on the dorso-posterior region of the tongue and/or a pathologic condition or malfunction of oral tissues (e.g., periodontal disease) The condition is influenced by co-factors (e.g., medication, smoking, stress)
Extra-oral halitosis: blood-borne	The source lies outside the mouth The malodor is emitted via the lungs and originates from disorders anywhere in the body (e.g., hepatic cirrhosis)
Extra-oral halitosis: non-blood-borne	The malodor originates from nasal, paranasal, or laryngeal regions, or the pulmonary or upper digestive tract
Psychogenic halitosis	Obvious malodor is not perceived by others but the patient complains of its existence. No physical or social evidence exists for the presence of halitosis
Pseudo-halitosis	Condition is improved by counselling and simple oral hygiene measures
Halitophobia	The patient persists in believing they suffer from halitosis even after treatment of halitosis or pseudo-halitosis

for periodontal treatment and oral hygiene are assessed. Further examination of the oral and pharyngeal soft tissues (particularly coating of the tongue, Waldeyer's ring, and excretory ducts of the salivary glands) as well as dental fillings and restorations is performed [2•].

Measurements

For the clinical detection of halitosis, the international consensus group recommends two primary methods [8••]: organoleptic measurement and instrumental measurements.

Organoleptic Measurement

Organoleptic measurement implies a subjective sensory test scored on the basis of the examiner's perception of a patient's breath odor [8••, 9]. The organoleptic assessment is easy and cheap and reflects an everyday situation [23]. One of the requirements is that the examiner has a good sense of smell [24•]. This can easily be verified by using the Smell Identification Test™ (Sensoics Inc., Haddon Heights, NJ, USA), which can reveal a person's ability to distinguish different odors [8••, 24•]. Further, the capacity to detect odors at low concentrations can be tested by sniffing series of dilutions of substances [24•]. It is recommended to have a second judge available, especially when dealing with patients suffering from psychogenic halitosis, as a second opinion is helpful [8••]. Several scoring methods have been described. The simplest one is a yes or no decision performed at different distances from the patient's mouth (10, 30, and 100 cm) [25, 26]. For more experienced examiners, the widely used 6-point scale is recommended. It describes the severity of the perceived odor at a defined distance [9, 27, 28].

The most important disadvantage of organoleptic assessment is the poor inter- and intra-examiner correlation of reliability and reproducibility [29•]. Furthermore, because of the subjectivity of this method [30, 31], it is not always accepted by the patients, especially by those suffering from psychogenic halitosis [29•]. There are also some criteria for the examiner. A person who smokes, is pregnant, has chronic allergies, or asthma is not suitable as an odor judge [24•].

Instrumental Measurements

This is an objective way to measure VSCs, which are the principal components of oral malodor. An instrumental detection is not mandatory but it can help to build a second opinion, to calibrate odor judges, or to build trust with the patient, especially with patients suffering from psychogenic halitosis [8••, 32]. There are two devices that can be recommended for use at a dental practice: the Halimeter® and the OralChroma™ [29•].

The Halimeter® (Interscan, Chatsworth, CA, USA) is a portable sulfide monitor [31] that measures the total sulfide

concentration. It is easy to use, the results are shown immediately, and the data are more reproducible than that of the organoleptic assessments. The disadvantages include the higher costs and that ethanol and other compounds can disturb the measurements [30, 33–35]. Furthermore, the sensitivity for CH₃SH is five times lower than for H₂S and it is almost insensitive to [CH₃]₂S [9, 36]. Therefore, it is not suitable for measuring extra-oral blood-borne halitosis with [CH₃]₂ origin [37].

The OralChroma™ (CHM-1, Abimedical, Kawasaki, Japan) is a chairside instrument based on a gas chromatograph, which detects and discriminates the three most important VSCs [29•]. This information can be included in the diagnosis. For example, a high concentration of CH₃SH compared to H₂S may indicate periodontitis [38], and an increased H₂S level may indicate a problem with oral hygiene. Further, increased levels of [CH₃]₂ may indicate extra-oral halitosis [37]. The measurements are more reproducible and reliable than organoleptic measurements, and even extremely low gas concentrations can be detected. But the device is expensive and the results are not shown in real time; it takes 8 min before the results are shown. Recently, a new model has been introduced (CHM-2) with a reduced analysis time (4 min). To date, no literature is yet available about it [29•].

A disadvantage of both the Halimeter® and the OralChroma™ is that they can only detect sulphur gases and not any other volatile components. Because other odorants (indoles, amines, acids), as well as VSCs, can contribute to halitosis, it is possible that an organoleptic rating is not always accompanied by a corresponding measurement on the Halimeter® or OralChroma™ [29•]. In Table 2, the advantages and disadvantages of the above-mentioned measurements are summarized.

Discussion

For the organoleptic and instrumental detection of halitosis, there are many sampling methods described. Sniffing of the patient's breath air using the nose of the examiner (organoleptic measurement) is the usual technique for halitosis examination in daily practice. However, a sampling method, using a negative pressure syringe or a sample bag, was recommended by the international consensus group [8••]. In comparison to directly sniffing the exhaled air of the patient during organoleptic assessment, sampling methods have the advantage of creating a higher degree of privacy for the patient and of receiving a more concentrated sample [8••].

To receive the most reliable measurement results, the patient should receive instructions prior the first appointment [8••, 9, 11]. At least 24 h before the appointment, the patient must not have eaten, for example, any onion or garlic or have cleaned her/his tongue. Furthermore, on the day of the investigation, the patient should refrain from using or doing

Table 2 Advantages and disadvantages of organoleptic and instrumental measurements of halitosis

Measurement	Advantages	Disadvantages
Organoleptic	No material costs Chairside Easy to handle	Subjective Low reliability and reproducibility
Halimeter®	Chairside Easy to handle Results immediately displayed Objective Relatively good reliability and reproducibility	Additional costs Other compounds can disturb the measurement Low detection of methyl mercaptan Detects only total sulphide concentration
OralChroma™ (CHM-1/CHM-2)	Chairside Differentiation between three different gases Objective Relatively good reliability and reproducibility	Relatively high costs Single measurement takes 8 min/4 min Technically sensitive Software not always reliable

anything that could cover the halitosis (e.g., perfumed cosmetic products, candies, chewing gums, mouth rinse) and should not smoke. In addition, ideally 4 h prior, the patient should not practice any oral hygiene, eat, or drink coffee [2•, 8•, 9, 24•]. The examiner should also follow the same restrictions for consumption of beverages and the use of cosmetics [2•, 22, 24•]. For the organoleptic evaluation of halitosis, it is advisable that the examiner calibrates her/his nose [24•, 39].

Prevalence

The prevalence of halitosis has been studied in different populations all over the world with a variety of techniques and cut-offs, but the prevalence of halitosis is still not well-established. Most of the prevalence studies are based on self-perceived breath odor and do not correlate well with other halitosis measurements [40]. Therefore, the results of self-perceived halitosis should be interpreted with caution. A total of 31 % of American seniors have been reported to suffer from chronic or recurrent halitosis ($N=270$) [41], 32 % of Swiss adults reported experiencing halitosis sometimes or often ($N=419$) [25], and 45 % of Indian dental students ($N=277$) reported halitosis, with >80 % of them experiencing morning bad breath [42].

One study has investigated the prevalence of halitosis in the general Dutch population ($N=1,002$, >16 years old), and reported that almost 90 % of the population was regularly faced with a person having halitosis, 40 % at least once a week [43].

Using organoleptic measurements, trained examiners recorded halitosis (score ≥ 2 on a scale from 0 to 5 [9, 27, 28]) in 27.5 % of a Chinese population ($N=2,000$, aged 15–64 years) [44] and in 31.5 % of a Swiss population ($N=$

419, aged 18–94 years) [25], whereas 85 % of Swiss army recruits ($N=626$) [45] were diagnosed with halitosis as classified by Seemann [46].

Instrumental measurements of halitosis may give an objective and exact value for halitosis, but it is important to notice that different studies have used various threshold levels for halitosis. On the basis of Halimeter®, halitosis was established in 2,672 Japanese Government employees (aged 18–64 years), and 6–23 % of the subjects showed VSC values above the suggested socially acceptable level of 75 ppb at some time during the day [40]. With the same VSC cut-off level, a total of 23 % of a Chinese population [44], 43 % of Swiss army recruits [45], and 28 % of a Swiss general population were diagnosed with halitosis [25]. However, with the thresholds of ≥ 110 and ≥ 150 ppb, respectively, 4.3 and 1.2 % of the Swiss and 35 and 20 % of the Chinese population had halitosis [25, 44].

On the basis of OralChroma®, measuring three different VSCs, >60 % of a Thai elderly population ($N=428$, mean age 68 years) have been diagnosed with halitosis [47].

In general, halitosis has been reported to be similarly prevalent in females and males [25, 40, 44]. However, some studies have found a higher prevalence of halitosis in women [44, 48]. Liu et al. found a higher prevalence in women only in the age group of 35–44 years old [44]. There are contradictory reports on the influence of age on halitosis; some studies have associated halitosis with increasing age [40, 48], whereas others have not [25, 44]. It is difficult to determine the actual influence of factors such as age and gender on halitosis, since breath odor may be influenced by many factors such as periodontal and dental status, dental hygiene, tongue coating, smoking, nutrition, level of education, and medication.

Prevalence of pseudohalitosis in the general population is not known but it has been reported to be about 16 % in the patients visiting professional halitosis clinics [1, 2•].

Treatment

The choice of treatment is made on the basis of the diagnosis and includes cause-related therapy [21]. The recommendations for the treatment of halitosis are based on publications by Yaegaki and Coil [9], Coil et al. [10], and Miyazaki et al. [11].

After detailed information and explanation of halitosis, each patient is given instructions for oral hygiene. Because the tongue coating is the most common cause of halitosis, the instructions also include mechanical tongue cleaning as a part of daily oral hygiene [9, 22, 49]. Various studies have shown that tongue cleaning leads to reduced levels of VSCs and thus to reduction of halitosis [50–53]. Many different tongue cleaners are available on the market. A tongue scraper can only remove the upper surface layer of the biofilm, which is why the effect of a tongue scraper is shorter in duration than the effect of a tongue brush [54]. Moreover, cleaning too hard with a tongue scraper, is a risk for tongue injury. Additionally, the effect of tongue cleaning may be extended using a tongue paste with active substances [22, 55]. Any kind of electrical device for professional tongue cleaning is not recommended [8••]. Animal experiments have shown that mechanical injuries of the tongue may be carcinogenic [56–58]. Therefore, detailed and comprehensive tongue cleaning instructions are necessary. Tongue cleaning should be carried out gently with low force at the posterior part of the tongue dorsum. Further, the lateral borders should not be cleaned because of the risk of traumatic injury [9].

If tongue cleaning alone is not sufficient, additional mouth rinse can be used [2•, 8••]. As well as flavoring agents (e.g., mint) for masking odor, mouth rinses often contain antibacterial (e.g., chlorhexidine [59]) or neutralizing components (e.g., zinc [60]), which are able to absorb the VSCs or their precursors [22, 61], and are responsible for the therapeutic effect [62]. In commercial products, antibacterial and odor-neutralizing agents are often combined. This leads to a strengthening or even synergistic effect [22, 61]. Some patients may experience side effects such as discoloring and altered taste when chlorhexidine-containing mouth rinses are used for a long period [9, 60, 63].

In the literature, there is some evidence that probiotics (Greek *Pro bios*: ‘for life’) not only have a positive effect in the gastrointestinal tract, but also in the oral cavity [64, 65]. With the help of chewing gums, bacteria such as *Streptococcus salivarius* and *Lactobacillus salivarius* are introduced into the oral cavity and are aimed at displacing halitosis-associated bacteria [66–69]. Despite promising results, further research is needed before probiotics can be used to treat oral halitosis [70, 71].

If halitosis originates from another oral cause such as gingivitis, periodontitis, caries, or insufficient dental restorations, corresponding therapy is initiated [2•, 9]. In addition,

possible co-factors are addressed and, if necessary, adjusted. Sometimes, consultation with a physician is indicated [22]. If extra-oral halitosis is diagnosed, the patient is referred to appropriate specialists such as an otorhinolaryngologist or internist [8••, 22].

If no halitosis is diagnosed upon the first examination, it is recommended that a second appointment at a different time of day should be arranged to avoid any effects of circadian rhythms. In the case of psychogenic halitosis, the diagnosis is communicated at the second appointment [72]. Dealing with patients suffering from halitophobia is difficult and requires a lot of experience [10]. Not every patient takes the advice given in psychological counseling immediately. Any dentist who offers a halitosis consultation should work together with a psychologist or psychiatrist and, if the patient agrees, refer her/him [22, 72].

Conclusion

Halitosis is a common problem affecting approximately 30 % of the general population. In many cases, halitosis originates from a combination of oral causes and existing co-factors. Therefore, a comprehensive diagnosis is required. In addition to a halitosis history, an extensive evaluation of the patients’ general health is also taken. A full investigation of the predilection sites of intra-oral halitosis as well as the pharyngeal soft tissue is performed. This is necessary to exclude an extra-oral cause. Furthermore, an organoleptic and instrumental measurement of the patient’s breath air is carried out.

If intra-oral halitosis is diagnosed, a cause-related treatment is conducted. In most cases, tongue cleaning is the treatment of choice. Additional mouth rinses with proven efficacy (e.g., with a chlorhexidine and zinc formulation) can be used.

The treatment of patients with halitosis should be performed according to a standardized scheme. Patients with extra-oral halitosis and halitophobia must be referred to appropriate specialists such as an otorhinolaryngologist, internist, psychologist, or psychiatrist.

With the consistent implementation of the above-mentioned diagnostic and therapeutic concepts, a high level of treatment success can be achieved [2•].

Compliance with Ethics Guidelines

Conflict of Interest Andrea Zürcher and Andreas Filippi declare that they have no conflict of interest.

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This article does not contain any studies with human or animal subjects performed by any of the authors.

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- Of major importance

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