

Diagnostic Technique for Assessing Halitosis Origin Using Oral and Nasal Organoleptic Tests, Including Safety Measures Post Covid-19

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Abstract

Organoleptic tests are essential in the diagnosis and treatment of halitosis due to three main functions: (A) measuring halitosis, for which it is considered as the gold standard method; (B) helping patients to recover their self-confidence as they get more confident each time their breath is well evaluated; (C) assessing the origin of halitosis through oral and nasal organoleptic tests and by comparing mouth and nose exhaled air, which is possible for diagnosing oral, nasal or extraoral origins of halitosis with a very small error margin. Nevertheless, literature for organoleptic scales that recommend the use of nasal organoleptic tests and/or techniques to diagnose halitosis origin is scarce. Two significant aspects that must be contemplated seriously are the potential risk of cross infections following organoleptic tests as well as the lack of safety guidelines, especially with regards to the recent contagious potential of SARS-CoV-2 worldwide. An important safety aspect concerns avoiding performing organoleptic tests whenever feeling flu-like symptoms, such as fever, dry cough, or difficulty breathing. Also, individuals at higher risk for severe illness should not be elected examiners. Although a safer oral and nasal organoleptic technique is being proposed based on literature, organoleptic assessment should be temporarily suspended until the COVID-19 pandemic situation has normalized and further studies to evaluate the safety of different organoleptic tests methods are performed. Depending on the results of the tests a different origin of halitosis can be inferred, thus avoiding diagnostic errors and unnecessary treatments. The regular use of the present technique on patients and in research can provide more precise diagnostic results. It also allows patients to check their breath at home and consequently take some actions to solve or identify the causing issue in case an alteration is detected, as well as reinforces patients' self-confidence when receiving pleasant breath results after consecutive tests.

Keywords: Halitosis; COVID-19; Organoleptic; Breath diagnosis; Breath malodor.

Introduction

Halitosis is defined as offensive breath odor, mainly resulting from the

degradation of organic substances by anaerobic bacteria present in the oral cavity and otherwise associated with tongue coating and gingivitis/periodontitis

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Received Date: 08-10-2020

Published Date: 08-25-2020

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[1]. According to Yaegaky & Coil [2], the classification of halitosis patients includes categories of genuine halitosis, pseudo-halitosis and halitophobia, although some authors prefer to classify it into objective or subjective halitosis [3,4]. With regards to halitosis causes, it can be divided into oral halitosis (from 92.7% to 96.2% of cases) and extraoral halitosis (from 3.8% to 7.3% of cases), with varying percentages depending on the study [5-7].

In 2006, Seemann et al. [6], conducted a study with 407 patients who complained of halitosis; only 72.1% had detectable signs, being 92.7% of those from the oral origin and 7.3% from the extraoral origin. In 2009, Quirynen et al. [5], in 2009, conducted a study with two thousand patients with halitosis from Leuven University. Out of those patients, 5% were had exclusively extraoral halitosis causes whereas 94.5% presented with oral causes (90% with exclusively oral causes and 4.5% with combined oral and extraoral causes). Within the oral causes, 57.2% were related to tongue coating, 14.78% to gingivitis and periodontitis and 24.01% to a mixture of those. And in 2012, Zürcher et al. [7], in a retrospective study from 2003 to 2010, examined 465 patients from the Halitosis Clinic at Basel University, Switzerland, and noticed that 96.2% of the patients had oral causes, while only 3.8% had extraoral causes.

Extraoral halitosis can be subdivided into extraoral non-bloodborne halitosis and extraoral bloodborne halitosis [1]. The extraoral non-blood-borne halitosis could originate in the airways, caused by throat infections (tonsillitis and associated tonsilloliths), sinonasal infections (sinusitis, postnasal drip), respiratory tract infections (abscess, bronchopneumonia) and other lung diseases (lung cancer,

tuberculosis) [1,8]. On the other hand, extraoral non-bloodborne halitosis could have gastrointestinal system origin and has been especially correlated with esophageal diverticulosis (Zenker diverticulum), although some rare causes such as gastric trichobezoar, gastrocolic fistula and megaesophagus have been reported as well [9,10]. Finally, extraoral bloodborne halitosis can be caused by systemic diseases such as hepatic failure/liver cirrhosis, uremia/kidney failure, diabetes mellitus and associated ketoacidosis, other metabolic disorders such as isolated persistent hypermethioninemia, as well as fish odor syndrome, odorous food ingestion (garlic, onion) and some medications (disulfiram carbon disulphide, dimethyl sulfoxide dimethyl sulphide, cysteamine dimethyl sulphide) [1].

Halitosis measurement is an essential step for halitosis diagnosis and treatment. Many of body odors carry information that has been particularly helpful to those health practitioners who have used the sense of smell as an aid to diagnosing diseases since the early beginning of medicine [11]. According to Krespi et al. [12], “different methods of breath evaluation can have their vantages, but professionals who are interested to diagnose bad breath must trust in their noses to distinguish the main kind of oral odors. With practice and experience, these odors become different and recognizable, even when they are found in many combinations”.

Organoleptic tests are essential in the diagnosis and treatment of halitosis. They have three main functions [13-16]: (A) measuring halitosis, for which it is considered the gold standard [17]; (B) helping patients to recover their self-confidence as they get more confident each time their breath is well evaluated through

the organoleptic tests along with a reliable confidant [13,18]; (C) assessing the origin of halitosis through oral and nasal organoleptic tests and by comparing mouth and nose exhaled air, which is possible for diagnosing oral, nasal or extraoral origins of halitosis with a very small error margin [15,17,19].

Concerning studies that describe organoleptic tests, five techniques have been published in total, which consist of: (A) the open mouth method, (B) the counting method, (C) the 'HA-HA-HA' method, (D) the glass straw method [20] and (E) the negative pressure technique [21]. All these techniques are performed using the examiner sniffing the oral exhaled breath of the patient.

Seemann et al. [19] summarized the results of a consensus workshop by international authorities that brought general guidelines on the assessment and diagnosis of breath odor concerns and regimens for the treatment of halitosis. These guidelines recommend an organoleptic test to be always performed on oral and nasal air at the first appointment, as comparing mouth and nose exhaled air helps distinguishing between oral, nasal and extraoral halitosis [1,22]. Nevertheless, none of the three organoleptic scales recommended in these guidelines advise testing specifically the air exhaled by the nose and the criteria used do not allow accurate classification of the distance or degree of propagation of halitosis.

A very important guideline of this consensus workshop [19], which is essential to distinguish the possible sources of halitosis when performing an organoleptic assessment, involves asking patients to avoid cleaning their tongues for 24 h before an initial breath assessment. This measure aims to avoid diagnostic errors, as patients

may present genuine halitosis but receive a wrong diagnosis of pseudo-halitosis, as they may maintain an efficient tongue hygiene routine and also a defensive posture when among others [4].

Regarding a diagnostic technique of halitosis origin using oral and nasal organoleptic tests, there are no papers that utilize it or describe it in detail; it is indeed barely mentioned in four publications, limited up to roughly one paragraph each [1,17,23,24]. On the other hand, a method for this technique was presented briefly at an International Conference on Breath Odor (ISBOR meeting) in 2011 and published with more in-depth details, including possible exceptions and the presence of two causes happening simultaneously, in a chapter of a halitosis treatment book (Portuguese and Spanish editions) [15]. The present technique was used in over 8,000 patients in Halitus Clinic (Sao Paulo, Brazil) and proven to be an important procedure for halitosis causes diagnosis, also helping patients to recover their self-confidence in their own treated breath, through its evaluation using oral and nasal organoleptic assessments with someone reliable who is called a confidant [13,15,22]. This is a very important step in halitosis treatment, especially regarding patients' self-assured, spontaneity and self-esteem [13,18,24,25].

Hawxhurst [26], in 1873, mentioned by Sterer et al. [18], was conscious of the necessity to check his breath with a confidant and had advised his dentist colleagues to benefit from "a trustworthy friend" to let them know if they suffered from bad breath, demonstrating that this method of using a reliable person (confidant) to check other's breath has been used for almost 150 years. Concerning the choice of a confidant, research realized

during the First International Conference in Breath Odors, in 1993, with 37 dentists, 33 researchers in the halitosis area and 31 people (control group), showed that there wasn't a significant difference among the three groups ability to evaluate organoleptically four odoriferous samples [27]. Therefore, at first, the reliable person chosen by the patient should be able to perform organoleptic tests correctly, although some inclusion and exclusion criteria will be described ahead.

One significant aspect that must be considered is the potential risk of acquiring infections while undergoing organoleptic tests [28]. Despite the importance of organoleptic tests in the treatment of halitosis, until today there are no safety guidelines that would prevent cross-contamination when undergoing and/or performing the tests [29], as most air-transmitted diseases occur through droplets, that might be generated amid the expiratory flow during patient's breath evaluation [29-31]. And, given the recent contagious potential of COVID-19 worldwide, the need for having safety guidelines when applying organoleptic tests has become imperative [31,32].

Considering all these facts, the present study aims to describe a clinical diagnostic technique, named Halitus, to allow the diagnosis of the origin of breath malodor, using an organoleptic test, that has been accomplished with patients in the daily clinical practice and also research. The possibilities are to diagnose an oral, nasal or extraoral halitosis origin or even the presence of two of the halitosis causes above mentioned, happening concomitantly. As a second objective, this study will present an oral and nasal organoleptic scale for the classification of

the degree of propagation of halitosis, being simple enough to be taught to patients and their confidants to render them self-assured each time their breath is well evaluated [13]. Finally, the third objective is to propose a much safer way to perform the organoleptic tests, concerning the potential risks of spreading disease, given the recent contagious potential of COVID-19 worldwide.

Method

Restriction Criteria for when Organoleptic Tests Should not be Done

Some important guidelines concerning the potential risk of spreading diseases through organoleptic tests are to avoid performing these tests whenever patients have flu-like symptoms such as fever, dry cough, difficulty in breathing or shortness of breath. It is also important to avoid electing individuals at higher risk for severe illness such as the elderly, diabetic, immunocompromised, hypertensive, with moderate to severe asthma and/or bearing chronic lung disease or known cardiac diseases, as confidants.

Scale to Determine the Degree of Halitosis

To standardize the classification of the degree of spread of halitosis and how to perform the oral and nasal organoleptic tests, as both are used by the dental professional to check the patient's breath before and during treatment, as well as for the patient to check oral and nasal breath during treatment with their confidant [33]. Table 1 shows Halitus oral and nasal organoleptic scale [14] with the classification of the degree of propagation of halitosis.

Table 1: Halitus oral and nasal organoleptic scale.

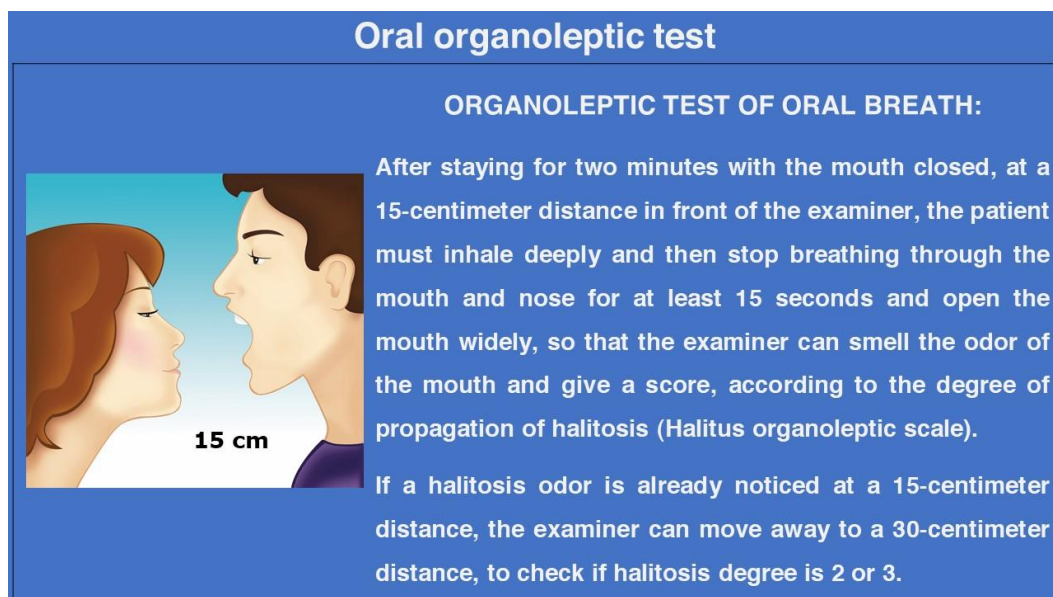
Degree	Description
0 - Absence of odor (No Halitosis)	No odor is perceived by the examiner at a distance of up to 15 centimeters.
1 - Natural Breath (No Halitosis)	It is clear that there is an odor in the breath, but it is not considered to be halitosis, perceived at a distance of up to 15 centimeters.
2 - Slight Halitosis (or intimate halitosis)	A slight halitosis odor is detected if the examiner approaches the mouth of the patient slowly exhales the air through the nose, perceived at a distance of up to 15 centimeters.
3 - Moderate halitosis (or interlocutor's halitosis)	A halitosis odor is detected if the examiner approaches the mouth of the patient or when the patient exhales the air through the nose, perceived at a distance of 30 centimeters.
4 - Strong halitosis (or social halitosis)	There is a halitosis odor if the examiner approaches the patient, perceived at a distance of 1 meter.
5 - Severe halitosis	Aside from halitosis being easily perceived throughout the environment, it is also difficult for the examiner or people close by to tolerate the odor.
Note: degrees 0.5, 1.5, 2.5, 3.5, or 4.5 are accepted and considered intermediate to the levels above.	

The technique to Determine the Origin of Halitosis

The oral organoleptic test is presented in Figure 1. The patient must stay for two minutes with the mouth closed and then stop breathing through the mouth or nose for at least 15 seconds and open it widely.

At a 15-centimeter distance, the examiner should sniff the odor and provide its corresponding degree, according to Halitus oral and nasal organoleptic scale. If no bad odor is noticed, the examiner can move closer, to a 10 to the 5-centimeter distance to check if there is breath alteration.

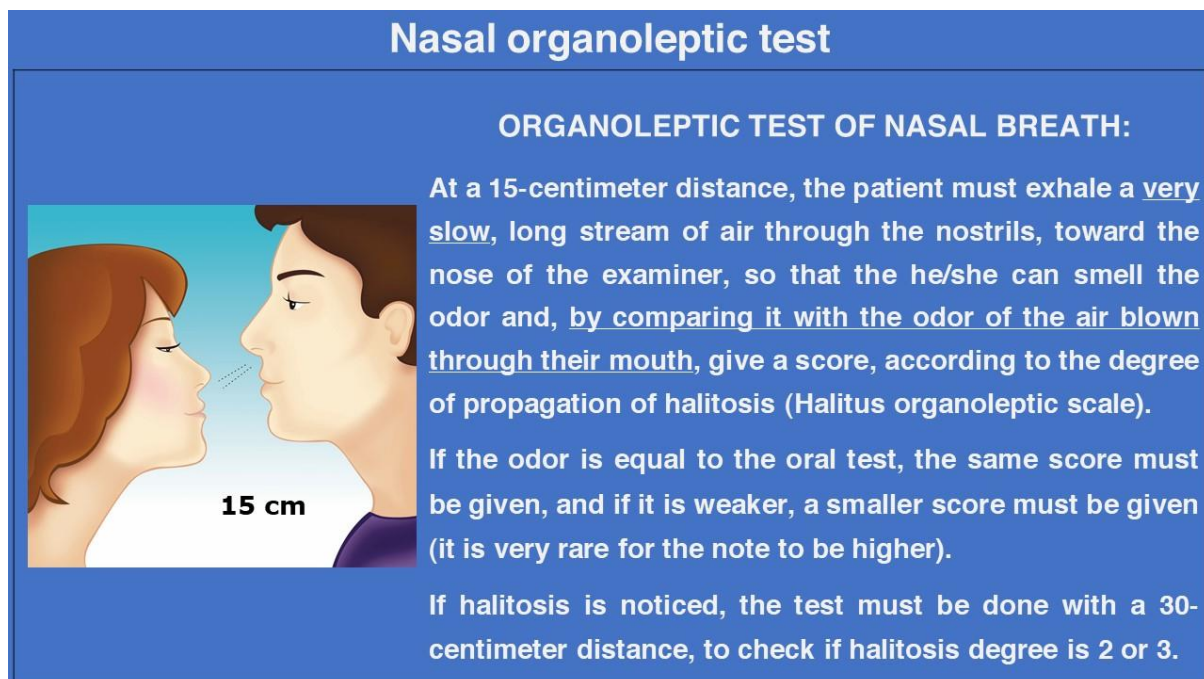
Figure 1: How to perform an oral organoleptic test.



According to Asadi et al. [30,34], when following a decreasing order of droplet emission risks and therefore, the potential risk for contamination, speaking in a high tone, speaking in a normal tone, speaking in a whisper, and finally nose breathing (nearly zero droplet emission) can be cited. The nasal organoleptic test presented in Figure 2 is performed with nasal breathing, but exhaling very slowly to diminish even more the possible emission of droplets. The act of exhaling air through the nose must

be preceded by a long inhalation, followed by an exhalation at a very low speed for 10 seconds so that the examiner can smell the odor. If no bad odor is noticed, the examiner can move closer, to a 10 to the 5-centimeter distance to check if there is breath alteration. And, in rare cases, the alteration in nasal air can be perceived at a 30-centimeter distance. In this case, this test should be performed at this distance only if there is an alteration in the air exhaled through the nose at a 15-centimeter distance.

Figure 2: How to perform nasal organoleptic test.

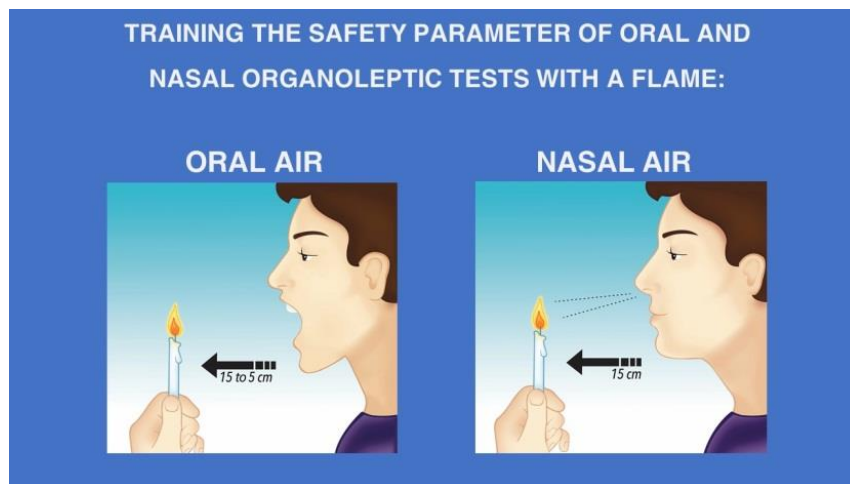


Although these tests intend to be safer than the existing ones, as their droplet emissions have not yet been tested there is still a potential cross-infection risk that must be evaluated. Hence, all organoleptic tests should be suspended until the COVID-19 pandemic situation has normalized and the risk of the different organoleptic methods is assessed.

Safety Guidelines to Perform the Organoleptic Oral and Nasal Tests

For a safer test, patients must be taught how to perform the tests. In this sense, patients must be trained by the dental professional before the tests, to hold their breath for 15 seconds, and also to exhale the air through their nose at a very slow speed. A flame of a candle or lighter can be used as a parameter for it, as shown in Figure 3, that should not be disturbed while performing the tests, to offer the minimum risk of spreading virus or bacteria.

Figure 3: How to open the mouth widely while holding the breath and slowly exhale the air through the nose, without disturbing the flame of a candle or lighter, to offer the minimum risk of spreading virus or bacteria.

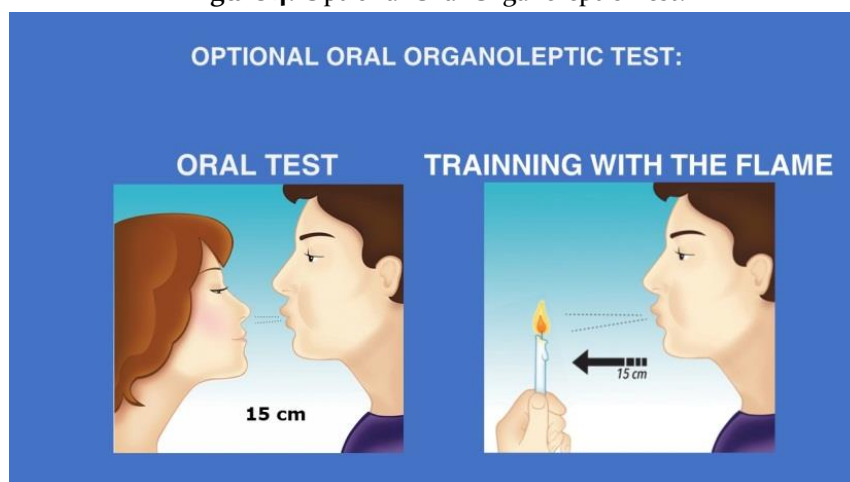


If correctly performed, the oral organoleptic test will yield no exhalation of air, theoretically offering no risk of spreading droplets and the nasal organoleptic test exhaling air through the nose, with very slow speed, will also have a virtually zero droplet emission, according to Asadi et al. [30,34].

Another option for doing the oral organoleptic test, that can be performed by patients with their family confidants, is to ask the patient to stay for two minutes with the mouth closed, at a distance of 15 centimeters, and then blow a jet of air through the mouth, very slowly, towards

the examiner's nose, so that he/she can smell the odor of the breath and give the score, according to Halitus oral and nasal organoleptic scale. If no bad odor is noticed, the examiner can move closer, to a 10 to the 5-centimeter distance to check if there is breath alteration. And, if a halitosis odor is already noticed, the examiner can move away up to a distance of 30 centimeters while the patient is blowing, to check if halitosis degree is 2 or 3. According to Figure 4, it is also important to train the expiration speed of the oral organoleptic test, using a flame as a parameter, without disturbing the flame.

Figure 4: Optional Oral Organoleptic Test.



Results

Possible Causes of Halitosis using Halitus Technique

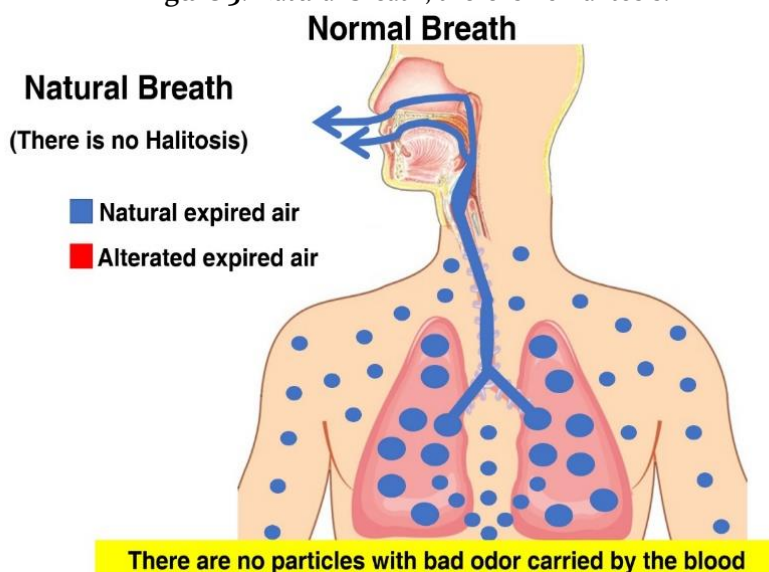
According to the results of the Halitus

diagnostic technique using oral and nasal organoleptic tests, it is possible to assess the origin of halitosis by using the diagnostic classification of halitosis origin with the oral and nasal organoleptic tests [22]; different possible results are shown in Table 2.

Table 2: Possible origins of halitosis detected by Halitus diagnostic technique using oral and nasal organoleptic tests.

Origin of the breath Alteration Detected by organoleptic test		
Oral Breath Test	Nasal Breath Test	Origin of the breath alteration
Normal	Normal	Natural breath - there is no alteration in breath
Altered	Normal	Oral halitosis: originated from within the oral cavity (very common: from 92.7 to 96.2% of the cases*)
Altered	Altered	Extra-oral halitosis: originated from within the body, with the same odor and eliminated through the air expired by the lungs (less comon = 3.8 to 7.3% of the cases*)
Normal	Altered	Nasal halitosis: originated from within the nasal cavity and surrounding areas (very rare - less than 0.075% of the cases**)
Two Causes occurring simultaneously		
Altered	Altered with a lighter odor	Oral and Extraoral halitosis occurring simultaneously (rare - 3% of the cases**)
Altered	Altered	Oral and Nasal halitosis occurring simultaneously (very rare - 0.025% of the cases**)
Altered	Altered	Nasal and Extraoral halitosis occurring simultaneously (Irrelevant possibility)
*Seemann et al., 2006; Quirynen et al., 2009; Zurcher et al.,2012 - **Conceicao MD, 2013		

Figure 5: Natural breath; there is no halitosis.



Natural or Normal Breath

The first possibility of results in oral and nasal organoleptic tests is the natural breath, which means no halitosis (Figure 5).

Oral Halitosis

The second possibility of results in oral and

Figure 6: Oral halitosis; halitosis originated into the oral cavity, which corresponds from 92.7% to 96.2% of cases.

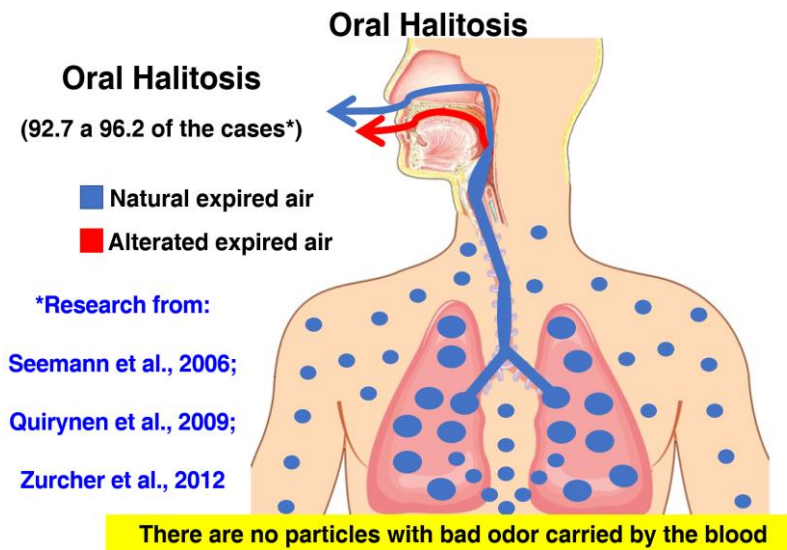
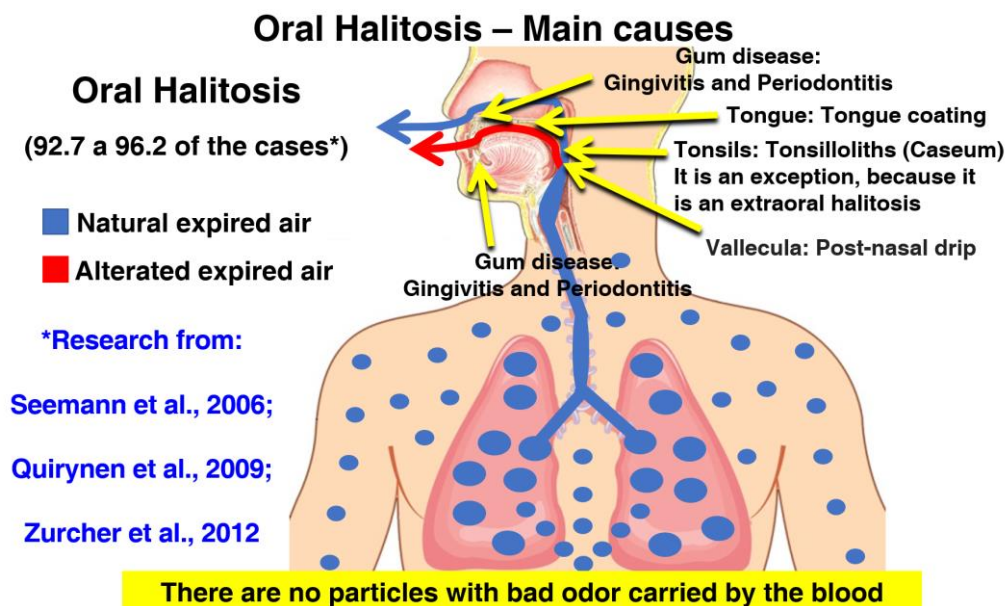


Figure 7: Oral halitosis most common causes in their respective niches, where bacterial plaques sources of VSC are formed, and also an important indirect halitosis cause, postnasal drip, that can accumulate on vallecula.



nasal organoleptic tests is the oral halitosis (Figure 6), which means halitosis is being originated in the oral cavity. This corresponds to 92.7% to 96.2% of the cases [5-7]. Figure 7 shows the most common causes of halitosis exhaled through the oral cavity.

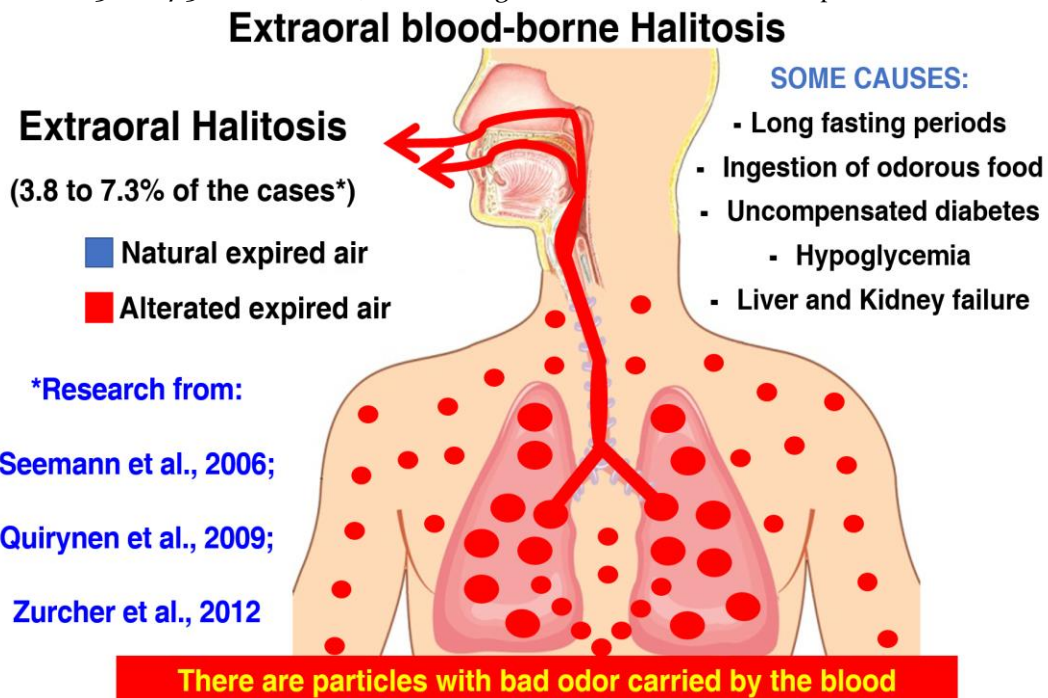
It is possible to see these causes in their respective niches, that are VSC sources - tongue: tongue coating; teeth and gum: gingivitis and periodontitis; tonsils: tonsilloliths. One exception to oral halitosis is that the VSC originated from tonsils. Although tonsils are a cause of halitosis located in the oropharynx, and therefore considered extraoral halitosis, as there is proximity with the oral cavity, the manifestation of altered odor that VSC cause is through the oral cavity and not nostrils. And the mucus coming from postnasal drip deposited at the vallecula, an area situated between the posterior dorsal tongue and the epiglottis, is also an important indirect cause of oral halitosis because it is a protein source to tongue

coating and tonsilloliths formation by anaerobic proteolytic bacteria.

Extraoral Halitosis

The third possibility of results in oral and nasal organoleptic tests is the extraoral halitosis (Figure 8), which corresponds to extraoral bloodborne halitosis, when there is odor alteration in the exhaled air through the mouth as well as through nose, both with the same odor. In this case, the altered breath comes through the exhaled air by lungs, derived from odoriferous particles that are in the blood circulation and are eliminated by the respiratory tract in the gas exchange process. It is less common than oral halitosis but is relatively frequent.

Figure 8: Systemic halitosis corresponds to extra-oral bloodborne halitosis; there is odor alteration in the exhaled air through the mouth as well as through nose, both with the same odor, corresponding to 3.8 to 7.3% of the cases, considering the inclusion of some exceptions.



The first exception to extraoral halitosis (Figure 9), which consists of very rare cases, correspond to extraoral non-bloodborne halitosis (except nasal causes) derived from problems originating in the

digestive tract (located at oropharynx, hypopharynx, esophagus, and stomach). In this case, although the altered breath is eliminated by exhaled air through the mouth as well as through nose, with the

same odor, there are no odoriferous particles derived from blood circulation and eliminated by the respiratory tract.

Figure 9: Extraoral halitosis – first exception; corresponds to extraoral non-bloodborne halitosis (except nasal causes); derives from problems originating in the digestive system (oropharynx, hypopharynx, esophagus and stomach). Although the altered breath is eliminated by exhaled air through the mouth as well as through nose, with the same odor, there are no odoriferous particles from blood circulation eliminated by pulmonary via [15].

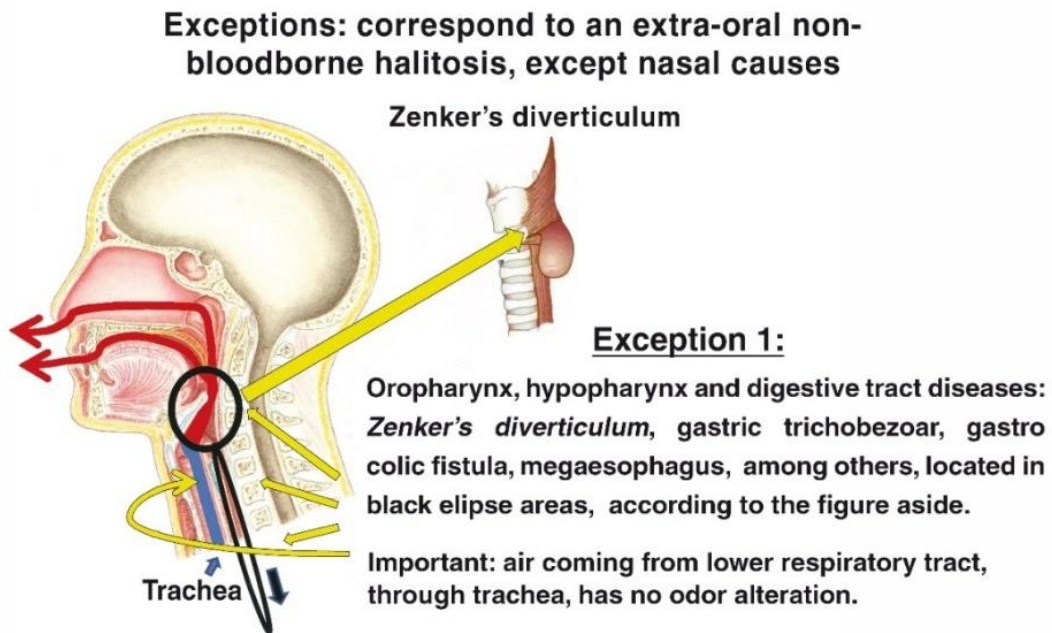
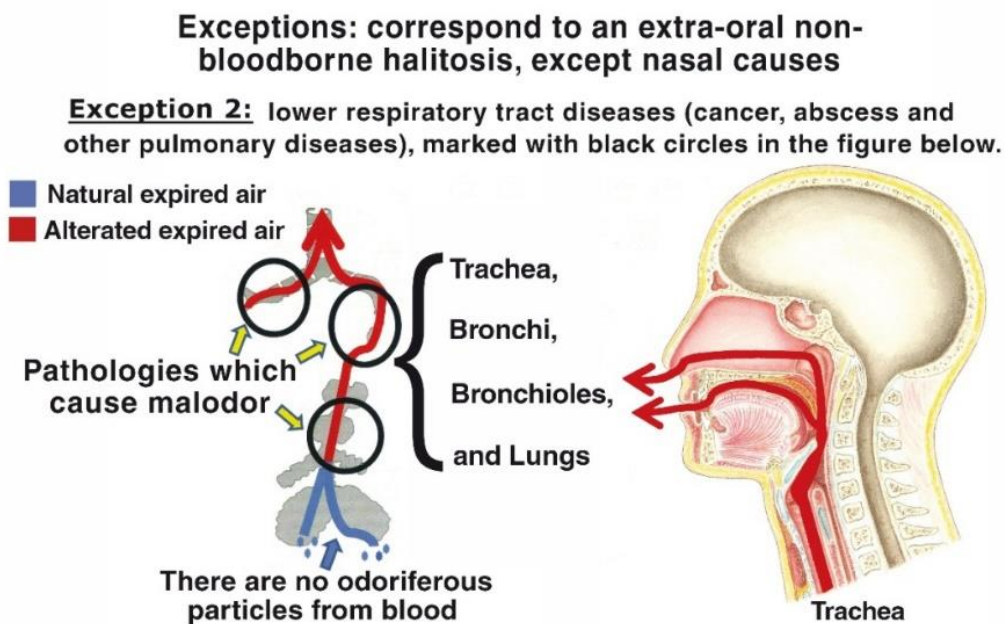


Figure 10: Extraoral halitosis – second exception; corresponds to extraoral non-bloodborne halitosis (except nasal causes); derives from problems originating from low respiratory tract diseases. Although the altered breath is eliminated by exhaled air through mouth as well as through nose, with the same odor, there are no odoriferous particles from blood circulation eliminated by the respiratory tract [15].

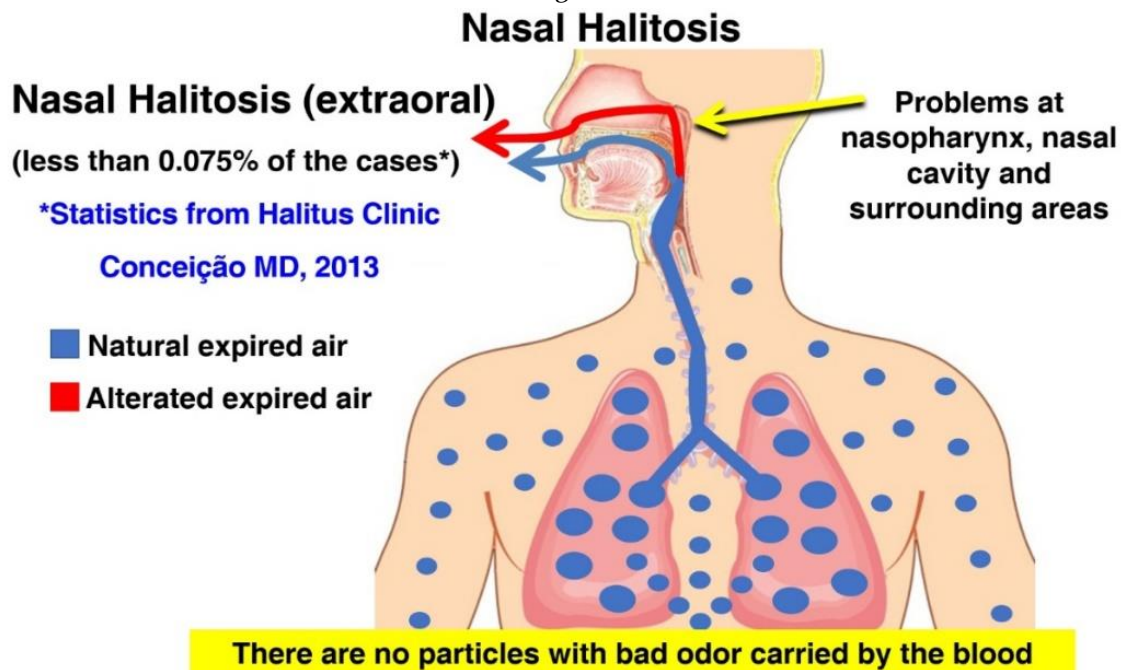


The second exception to extraoral halitosis (Figure 10) are also rare cases and correspond to extraoral non-bloodborne halitosis (except the nasal causes) derived from diseases of the lower respiratory tract. In this case, although the altered breath is eliminated by exhaled air through mouth as well as through nose, with the same odor, there are no odoriferous particles derived from blood circulation and eliminated by the respiratory tract.

Nasal Halitosis

The fourth possibility of results in oral and nasal organoleptic tests is the nasal halitosis (Figure 11), which is extra-oral non-bloodborne halitosis with causes in the nasopharynx, nasal cavity, sinuses and bordering areas. Nasal halitosis manifests only by exhaled air through the nose and is very rare according to Halitus Clinic statistics, corresponding to 0.075% of the cases (three out of more than 4,000 patients) [15].

Figure 11: Nasal halitosis – corresponds to extraoral non-bloodborne halitosis with causes in the nasopharynx, nasal cavity, sinuses and surrounding areas. Nasal halitosis manifests only by exhaled air through the nose.



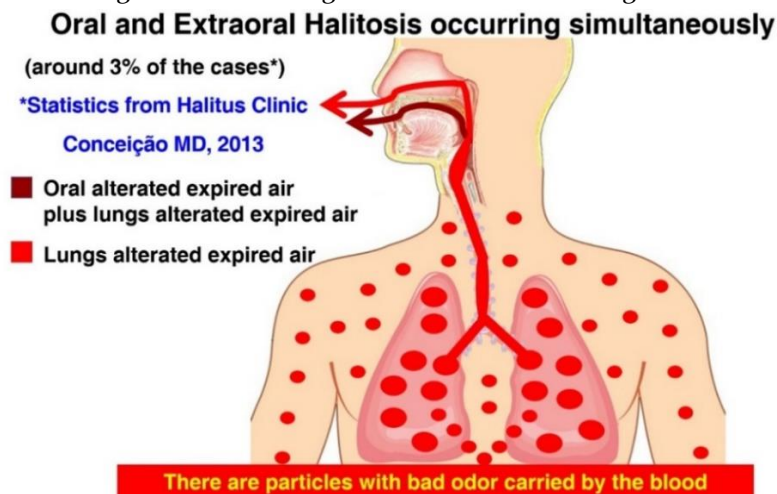
Finally, if the test is positive to the exhaled air through mouth and nose, with two different odors, two concomitant causes might be happening.

Oral and Extraoral Halitosis Occurring Simultaneously

The fifth possibility of results in oral and nasal organoleptic tests is the oral and

extraoral halitosis occurring simultaneously, which is rare when compared to oral and extraoral halitosis alone; it has been verified to account for only approximately 3% of Halitus Clinic patients [15] (Figure 12). With this kind of halitosis, the odor of the exhaled air through the mouth is stronger than that exhaled through the nose.

Figure 12: Oral and extraoral bloodborne halitosis occurring simultaneously, the odor of exhaled air through mouth is stronger than exhaled air through the nose.

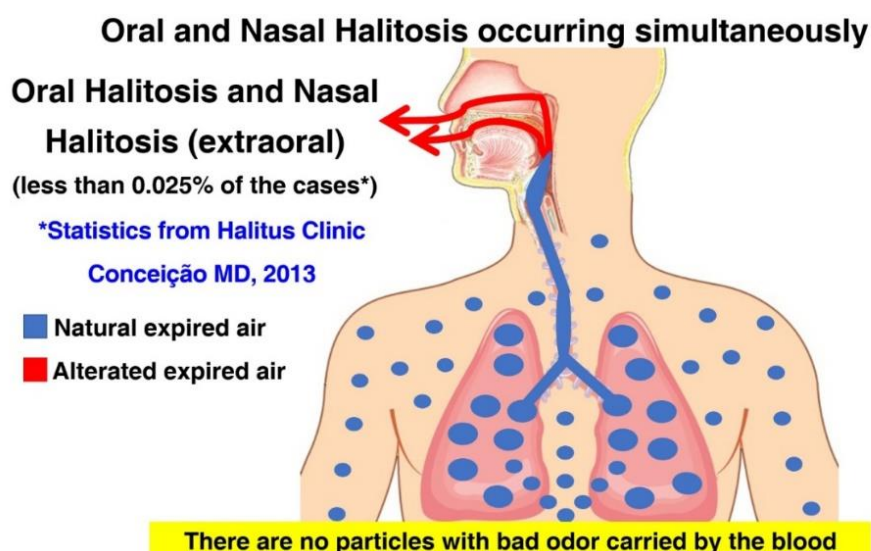


Oral and Nasal Halitosis Occurring Simultaneously

The sixth possibility of results in oral and nasal organoleptic tests is oral and nasal halitosis occurring simultaneously (Figure 13). It is very rare and it was verified with only one case among more than 4,000 Halitus Clinic patients (less than 0.025%) [15]. With this kind of halitosis, either the air exhaled through the mouth or the nose may be responsible for the strongest odor.

In case the oral exhaled air is stronger, this could suggest oral and systemic halitosis occurring simultaneously; the differential diagnosis is only possible after controlling the oral component of halitosis. If a light oral odor remains and is very similar to the nasal expired air, this rather indicates that oral and systemic halitosis are happening simultaneously. However, if only a nasal odor remains, that means an oral and nasal malodor is occurring concomitantly.

Figure 13: Oral and nasal halitosis occurring simultaneously. In this case, either the exhaled air through the mouth or nose may be stronger. The differential diagnosis is only possible after controlling oral halitosis. If a light oral odor remains, equal to nasal odor, it indicates oral and systemic halitosis happening simultaneously. However, if only a nasal odor remains, it points to oral and nasal halitosis occurring concomitantly.



Observation

Theoretically, nasal and extraoral halitosis could happen concomitantly. However, it is a rather extremely remote possibility. Nevertheless, if it does happen, the exhaled air through nose as well as through mouth would be altered, with different odors, and the odor of the exhaled air through the nose would be stronger than that exhaled through mouth [15].

Discussion

Concerning the three organoleptic scales recommended by Seemann et al. through guidelines for the general dental practitioner, besides they do not advocate for the nasal organoleptic test, a given difficulty in evaluating intermediate distances or lack of establishment of the distance halitosis is perceived catches our attention [19]. Also, one of the major advantages of the present technique is that it might be taught to patients to evaluate their treated breath with a confidant, as they get more confident each time their breath is well evaluated in the tests; they would then follow an established protocol if the result becomes unsatisfactory at a given point [13]. As an example, patients may realize that they have a breath alteration due to an oral cause, thus implying that redoing their oral hygiene routine very carefully would possibly solve the problem; another possibility is that they may present with extraoral bloodborne halitosis, which cause could be found out to be provoked by the ingestion of odorous food. This procedure is regularly used with Halitus Clinic patients [13].

Importantly, the characteristic of an ideal confidant is to have a normal olfactory perception, within the average, which

means they must neither have a deficient olfactory perception nor be extremely keen. The reliable person should be someone that the patient trusts and with whom they have a stable relationship. For example, partners undergoing matrimonial difficulties and adolescents who usually present many mood variations should be discarded. Children younger than 9 years old should be avoided due to possible difficulties in objectively interpreting the different degrees of halitosis propagation scale [13].

It is also essential to check treated breath at the return appointments through oral and nasal organoleptic tests to identify if any alteration is present. If there is any alteration, depending on its origin – oral, extraoral or nasal – the reason must be identified and corrected, or the patient must be oriented. However, if there is no alteration, the organoleptic test will reinforce the patient's security [13].

One important aspect of the oral and nasal organoleptic tests is to complement and make the diagnosis of halitosis more accurate, given the fact that the portable sulphide monitors, e.g. Halimeter or Oralchroma, are not able to analyze the nasal breath and also other breath components, such as ammonia, dimethylamine, trimethylamine or acetone [1,15]. Thus, the regular use of oral and nasal organoleptic tests in daily clinical practice and also research will improve the identification of halitosis origin, providing more precise results.

According to Grapp [23], in 1933: "In tests made as to source (halitosis), whether from nasal or oral exhalations, the results were conclusive that this fetor was postoral, not postnasal. The act of speech gives such an impetus to exhalations as they pass over the surface of the tongue that the gaseous

odor is often carried to the extent of three or four feet.”

Rosenberg [24], in 1996 affirmed: “The simplest way to distinguish oral from non-oral etiologies is to compare the smell coming from the patient's mouth with that exiting the nose. If the odor is primarily from the mouth, an oral origin may be inferred.”

Tangerman et al. [1], in 2010, also reported this fact: “Differentiation between intraoral and extraoral halitosis can be easily done by examining mouth as well as nose breath. Patients with intraoral halitosis only have bad breath from the mouth but not from the nose. One might argue that the unobstructed nasopharynx allows air exchange between the mouth and nasal cavity, thereby allowing small volatile molecules formed on the back of the tongue to be carried up and out during a nasal exhalation. However, this was not observed. The VSC hydrogen sulphide and methyl mercaptan, typical for intraoral halitosis, were not found in nasal exhalations of patients with intraoral halitosis [35]. All patients with extraoral bloodborne halitosis have bad breath from both the mouth and the nose [35,36] because of the presence of the odorous volatiles in alveolar air. Nearly all patients with extra-oral non-bloodborne halitosis also have bad breath from both the mouth and the nose, except those patients by whom the origin of bad breath is situated in the upper respiratory tract above the throat, e.g. in the nose. The latter patients have only bad breath from the nose and not from the mouth.”

Finally, Greenman et al. [17] stated in 2014 that “from the oral and nasal test it is possible to deduce, with a very small mistake margin, the origin of the breath ‘ailment’ or alteration from normal: oral,

nasal or systemic halitosis (extra-oral blood-borne halitosis or extra-oral non-blood-borne halitosis, with sources originating from the lower airway system). An individual may have mixed causes for bad breath including a portion from chronic oral (microbial) malodor and a portion from blood-borne halitosis as simultaneous conditions.”

In a study performed by Seeman et al. with 407 patients [6], some received an overtreatment due to incorrect diagnoses; 36% underwent at least one endoscopy, 14% were submitted to ENT surgeries and only 2.5% had their breath checked by professionals. If these professionals had used oral and nasal organoleptic tests as diagnostic tools for halitosis origin according to the diagnostic technique described in this study, the percentage of over-treated patients could have been significantly smaller [16].

Campisi et al. [37] emphasize that several systemic diseases have been found to provoke malodor or to act as a cofactor to it; halitosis was also mentioned to be a possible early sign of a serious local or systemic condition, highlighting that it is important to determine quickly whether the odor comes from an oral cause or not: if an oral cause is identified it would require further referral to a dentist; if not (extraoral origin alone or combined), management would require treatment of the underlying causes. Thus, it is important to assess the origin of halitosis through this diagnostic technique, using oral and nasal organoleptic tests.

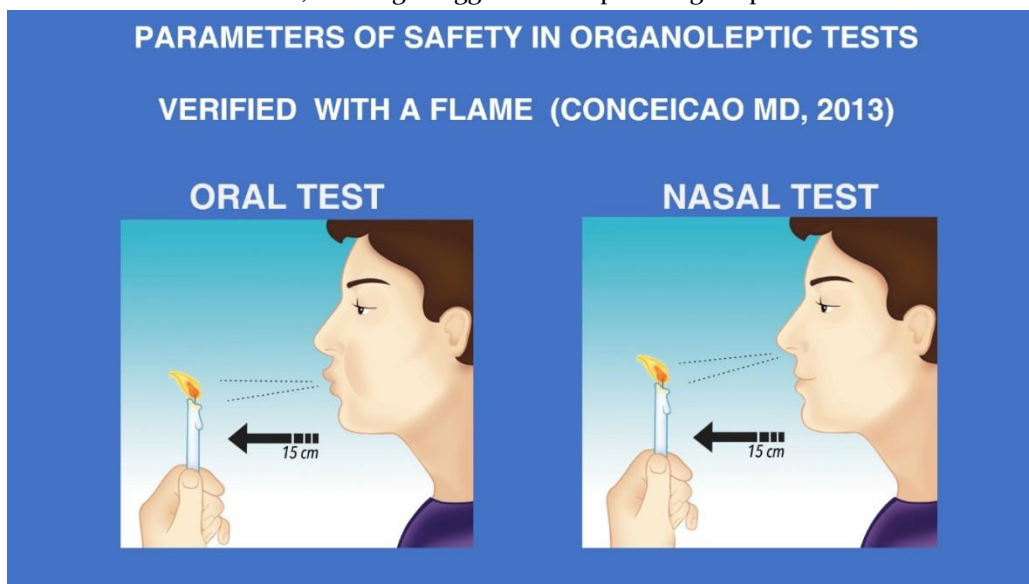
Safety guidelines in organoleptic tests were not considered to be very important until the COVID-19 pandemic. Most of the tests preconized did not offer a step by step teaching/training method for the patient [17,19,21]. As an exception, Conceição MD

[14] recommends that patients should slowly blow dry air through the mouth and the nose, always asking to practice beforehand by blowing a long and dry air jet using examiner's (dental professional or confidant) finger to train at a 15-centimeter distance, to make it safer. But, when these tests are verified using the flame of a candle or lighter as a safety parameter, it is possible to notice that they offer a bigger risk of spreading saliva droplets than the method presented in this study. This is demonstrated in Figure 14, with the flames getting disturbed while the tests are performed.

When comparing to an example of extreme risk, the organoleptic test would be much safer than being less than two meters away from someone coughing or sneezing [16]. To highlight this fact, according to Bourouiba et al. [38] violent respiratory

events such as coughs and sneezes play a key role in transferring respiratory diseases between infectious and susceptible individuals. The turbulent multiphase cloud plays a critical role in extending the range of the majority of pathogen-bearing drops that accompany human coughs and sneezes. Smaller droplets (less than 50 mm diameter) can remain suspended in the cloud long enough for the cough to reach heights where ventilation systems can be contaminated (4–6 m). A droplet of very small diameter could remain suspended in a cough or sneeze cloud, meters away from the cougher [38,39]. And given various combinations of an individual patient's physiology and environmental conditions, such as humidity and temperature, the gas cloud and its payload of pathogen bearing droplets of various sizes can travel 23 to 27 feet (7-8 m) [32].

Figure 14: Safety of other organoleptic tests prescribed by Conceição MD (2013) when verified with a flame, offering a bigger risk of spreading droplets.



Xu et al. [40] highlight that the positive rate of COVID-19 in patients' saliva can reach 91.7%, and that saliva samples can also cultivate the virus, suggesting that COVID-19 transmitted by an asymptomatic infection may originate from infected

saliva. According to van Doremalen et al. [41] SARS-CoV-2 transmission by aerosols is plausible as it can remain suspended in the air throughout at least 3 hours. In that way, challenges for Dentistry now emerge with COVID-19 and future

recommendations and safety protocols need to consider the reduction of droplets and aerosols production, such as by using high-volume saliva ejectors, as well as by avoiding aerosol-generating procedures (use of a 3-way syringe, for instance) or even by averting procedures that might trigger coughing, such as intraoral x-ray examination [42].

Asadi et al. [30] indicated that speech is potential of much greater concern than breathing for two reasons: released particles are larger on average and thus could potentially carry a larger number of pathogens; and much greater quantities of particles are emitted when compared to breathing. They also showed that the rate of particle emission during normal human speech is positively correlated with loudness (amplitude) of vocalization, as it happens with classic oral organoleptic measurement, which recommends counting out loud from zero to ten [21]. Morawska et al. [31] reported that counting aloud for 10 seconds followed by 10 seconds of breathing, repeated over two minutes, releases half as many particles as 30 seconds of continual coughing. But, concerning the importance of counting from 1 to 10 whispering in oral organoleptic test Morawska et al. reported that more particles are released when speech is voiced, which involves vocal folds vibration, rather than whispered, which does not [30]. Morawska et al. also reported that the average particle number concentration for continuous vocalization is higher than breathing (1.1 cm^{-3} for speaking and 0.1 cm^{-3} for breathing), a finding they interpreted to be an additional contribution of laryngeal particle generation that does not occur during normal breathing [31]. In this sense, considering this information all together,

exhaling air through the nose at a very slow speed, as recommended in the nasal organoleptic test, could theoretically offer a lower risk of airborne disease transmission.

Even though a safer way of doing organoleptic tests is proposed in the present technique, organoleptic tests should be temporarily suspended until the COVID-19 pandemic situation has normalized and for as long as the current risks of contamination are not well understood and health authorities maintain the ongoing restrictions. Moreover, it is very important to avoid doing the organoleptic tests with people that belong to risk groups, especially during flu seasons or epidemics, and also when patients have flu-like symptoms. These guidelines aim to diminish the risk of spreading diseases, but also to offer a safe method for patients to recover self-confidence in their treated breath, through successively positive results when performing oral and nasal organoleptic tests with a confidant. This method uses a technique derived from behaviorist psychology, adapted to halitosis treatment, called exposure in vivo [13]. The results of research with a clinical protocol to help patients to recover their self-confidence, spontaneity and self-esteem will be the aim of a future publication.

Future halitosis studies using organoleptic tests should use the present technique to deduce the possible causes with higher precision, in addition to the recommendation for the patients to stop cleaning their tongues for 24 h before an initial breath assessment [19], so that many of these patients will receive a true genuine halitosis diagnosis, instead of pseudo-halitosis. These procedures could guide future halitosis research to lead to more

accurate results regarding these two aspects.

Conclusion

The present technique fills a gap in the literature and offers a possibility to make a precise diagnosis of the origin of halitosis – oral, extraoral or nasal – making it possible to avoid diagnostic errors and unnecessary treatments. It also can help patients to check their breath at home and to take some actions to solve or identify the problem in case an alteration is detected, as well as reinforces patients' self-confidence when receiving pleasant breath results after consecutive tests. Further studies should evaluate the safety of different organoleptic test methods and refine the safety guidelines to prevent the spreading of diseases through saliva

droplets and airborne transmission while performing the tests.

Conflict of interest

The authors declare that there is no conflict of interest.

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