

Halitosis: Current concepts on etiology, diagnosis and management

Uditi Kapoor¹, Gaurav Sharma², Manish Juneja³, Archana Nagpal⁴

¹General Dentist, Ontario, Canada,
²Department of Oral Medicine and Radiology, Sudha Rustagi College of Dental Sciences and Research, Faridabad, Haryana, India,
³Advanced Standing DMD Candidate, Henry M. Goldman School of Dental Medicine, Boston University, MA, USA,
⁴Department of Oral Medicine and Radiology, P.D.M. Dental College and Research Institute, Bahadurgarh, Haryana, India

Correspondence: Dr. Gaurav Sharma
 Email: drgaurav7479@rediffmail.com

ABSTRACT

Halitosis or oral malodor is an offensive odor originating from the oral cavity, leading to anxiety and psychosocial embarrassment. A patient with halitosis is most likely to contact primary care practitioner for the diagnosis and management. With proper diagnosis, identification of the etiology and timely referrals certain steps are taken to create a successful individualized therapeutic approach for each patient seeking assistance. It is significant to highlight the necessity of an interdisciplinary method for the treatment of halitosis to prevent misdiagnosis or unnecessary treatment. The literature on halitosis, especially with randomized clinical trials, is scarce and additional studies are required. This article succinctly focuses on the development of a systematic flow of events to come to the best management of the halitosis from the primary care practitioner's point of view.

Key words: Diagnosis, etiology, halitosis, management

INTRODUCTION

Halitosis, also commonly known as "bad breath," is a concern of many patients seeking help from health care professionals.^[1,2] The health care workers have neglected the subject of oral malodor but recently, along with the growing public and media interest in oral malodor; health care professionals are becoming more aware of their patient's concern. A patient with halitosis is most likely to contact primary care practitioner for the diagnosis and management.^[3] Most physicians and dental practitioners are inadequately informed about the causes and treatments of halitosis. The present article succinctly focuses on the

development of a systematic flow of events to come to the best management of the halitosis from the primary care practitioner's point of view. The epidemiological research on halitosis is inadequate since it is still a considerable but underrated taboo.^[2] The reasons for the lack of scientific data are the difference in cultural and racial appreciation of odors for patients and investigators, and there is the absence of uniformity in evaluation methods, as for organoleptical as for mechanical measurements.^[2] Moreover, there are no universally accepted standard criteria, objective or subjective, that define a halitosis patient. There are

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Kapoor U, Sharma G, Juneja M, Nagpal A. Halitosis: Current concepts on etiology, diagnosis and management. Eur J Dent 2016;10:292-300.

DOI: 10.4103/1305-7456.178294

Access this article online	
Quick Response Code: 	Website: www.eurjdent.com

few studies documenting the prevalence of halitosis in population-wide or community-based samples. In the general population, halitosis has a prevalence ranging from 50% in the USA to between 6% and 23% in china, and a recent study had revealed a prevalence of self-reported halitosis among Indian dental students ranging from 21.7% in males to 35.3% in females.^[4-7] Miyazaki concluded that there was increased correlation between older age and malodor with aging resulting in greater intensity the of odor.^[8] In above 60 years age group of the Turkish individuals, the incidence was around 28%.^[9] A thorough literature search reveals a lack of studies on halitosis in India, especially among the general population.

WHAT IS THE TRULY PROBABLE SOURCE OF HALITOSIS?

It is imperative to understand the origin of halitosis as multidisciplinary therapy typically is required in halitosis with emphasis on the causative factor. Halitosis can be broadly classified on the basis of its origin as Genuine Halitosis and Delusional Halitosis [Figure 1].

Physiological halitosis (foul morning breath, morning halitosis) is caused by stagnation of saliva

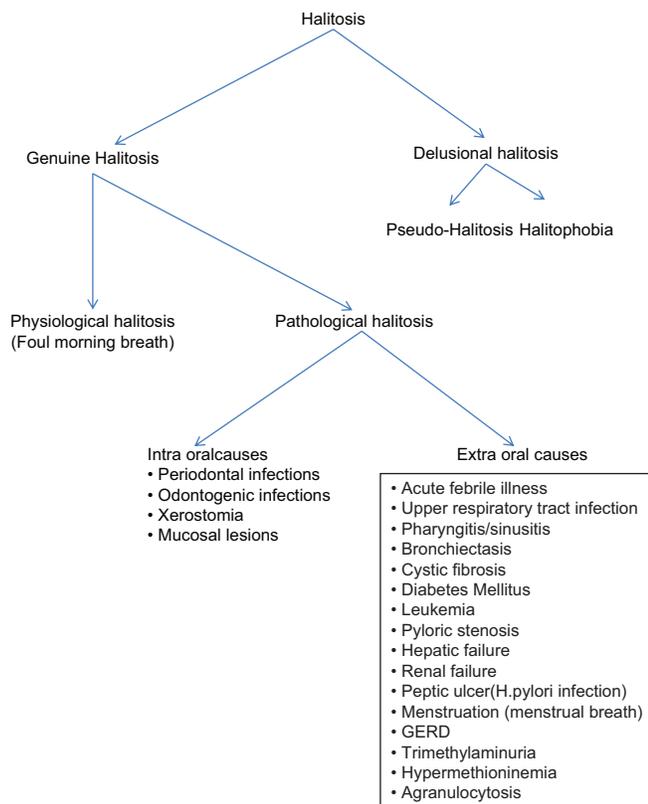


Figure 1: A schematic representation of classification of halitosis

and putrefaction of entrapped food particles and desquamated epithelial cells by the accumulation of bacteria on the dorsum of the tongue, recognized clinically as coated tongue and decrease in frequent liquid intake.^[10]

Intraoral conditions are the cause of 80–85% of halitosis cases.^[11] Periodontal infections are characterized by a tremendous increase in Gram-negative bacteria that produce volatile sulfur compounds (VSCs). The association between anaerobic bacteria that produces VSCs and halitosis has been well-documented.^[12] Most important VSCs are hydrogen sulfide (H₂S), methyl mercaptan and dimethyl sulfide.^[2] The dorsum of the tongue is the biggest reservoir of bacteria as a source of malodorous gases.^[11] Pericoronitis, oral ulcers, periodontal abscess, and herpetic gingivitis are some of the pathologies that result in increased VSCs. Diamines such as putrescine and cadaverine are also responsible for oral malodor as with the increase in periodontal pocket depth; oxygen tension decreases which results in low pH necessary for the activation of the decarboxylation of amino acids to malodorous diamines.^[2]

Odontogenic infections include retention of food debris in deep carious lesions and large interdental areas, malaligned teeth, faulty restorations, exposed necrotic pulp, over wearing of acrylic dentures at night, wound infection at the extraction site and ill-fitting prosthesis. The absence of saliva or hypofunction results in an increased Gram-negative microbial load, which increases VSCs, a known cause of malodor. Several mucosal lesions such as syphilis, tuberculosis, stomatitis, intraoral neoplasia and peri-implantitis allow colonization of microorganisms that releases a large amount of malodors compounds.^[2,13]

WHAT ARE THE OTHER ORIGINS OF HALITOSIS?

Transient oral malodor can also arise after someone has eaten volatile foods such as garlic, onions, condiments, pickles, radish, spices and consumption of tobacco, betel nut and alcohol.^[13] The resulting breath takes on a different odor that may last several hours.^[10] Various extraoral causes have been postulated as the possible cause of halitosis [Figure 1]. The halitosis of such disorders is unlikely to be an early feature of such disease (including undiagnosed type 1 diabetes mellitus) and is an incidental finding during clinical examination.^[10]

Maximally 10% of the oral malodor cases originate from the ears, nose and throat (ENT) region, from which 3% finds its origin at the tonsils.^[2] The presence of acute/chronic tonsillitis and tonsilloliths represents a 10-fold increased risk of abnormal VSC levels due to deep tonsillar crypts formation.^[14] Foreign bodies in the nose can become a hub for bacterial degradation and hence produce a striking odor to the breath.^[10] The purulent discharge from the paranasal sinuses, seen in regurgitation esophagitis, gets collected at the dorsum of the tongue resulting in halitosis.^[15] Atrophic rhinitis is caused by *Klebsiella ozenae*, which inhibits the self-cleaning property of nasal mucosa. Acute pharyngitis and sinusitis, caused by streptococcal species, are also responsible for producing halitosis.^[16] Carcinoma of the larynx, nasopharyngeal abscess, and lower respiratory tract infections such as bronchiectasis, chronic bronchitis, lung abscess, asthma, cystic fibrosis, bronchiectasis, interstitial lung diseases, and pneumonia have been known to cause halitosis.^[13]

Kinberg *et al.* published a review in 2010, in which they examined 94 patients having halitosis out of which 54 had gastrointestinal pathology suggesting that gastrointestinal is one of the common extra oral causes of halitosis.^[17] Gastrointestinal causes like Zenker’s diverticulum,^[18] Gastro-esophageal reflux disease (GERD),^[19] Gastric and peptic ulcers^[20] have been known to cause halitosis. *Helicobacter pylori* is known to cause a gastric and peptic ulcer and is recently associated with oral malodor. Congenital broncho esophageal fistula, gastric cancer, hiatus hernia, pyloric stenosis, enteric infections, dysgeusia, duodenal obstruction, and steatorrhea are some of the sources of pathological mouth odor.^[2,13]

A list of various well-documented metabolic, systemic and endocrinological diseases in correlation to halitosis resulting in various types of the odor has been summarized in Table 1. Metabolic disorders like Trimethylaminuria (fish odor syndrome) is characterized by the presence of trimethylamine (TMA),

Lithium salts	Penicillamine
Griseofulvin	Thiocarbamide
Dimethylsulfoxide	Ethyl alcohol
Antihistaminics	Diuretics
Phenothiazines derivatives	Tranquilizers
Choral hydrate	Nitrites and nitrates
Amphetamines	Paraldehyde
Suplatozilate	Bisphosphonates
Metronidazole	Arsenic salts

whose odor resembles of rotting fish in the urine, sweat and expired air.^[21] Individuals with TMAuria have diminished the capacity to oxidize the dietary-derived amines TMA to its odorless metabolite TMA N-oxide resulting in an increased excretion of large amounts of TMA in body fluids.^[10,21] In hypermethioninemia the body produces a peculiar odor, which resembles that of, boiled cabbage and is emanated through sweat, breath and urine.^[22] If this condition is present, the extraoral origin should be determined, because the latter requires medical investigation and support in therapy. Various drugs have also been known to cause halitosis [Table 2].^[2,13,23]

WHAT IS IMAGINARY OR DELUSIONAL HALITOSIS?

Delusional halitosis (monosymptomatic hypochondriasis; imaginary halitosis) is a condition in which a subject believes that their breath odor is offensive and is a cause of social nuisance, however, neither any clinician nor any other confidant can approve of its existence.^[10] Since it was poorly documented, it was recently added under miscellaneous disorder classification of “psychosomatic disorders pertaining

Table 2: A list of systemic diseases with characteristic halitosis

Disease	Characteristic odor
Diabetes mellitus	Acetone breath, fruity
Unbalanced insulin dependent diabetes	Rotten apples
Liver insufficiency	Sweet odour that can be described as dead mice; fetor hepaticus (breath of death)
Trisomy	Cabbage odor
Kidney insufficiency, trimethylaminuria	Fish odor
Uremia, kidney failure	Ammonia or urine like
Maple syrup urine disease	Burned sugar odor
Homocystinuria	Sweet musty odor
Isovaleric aciduria	Sweating feet odor
Lung abscess or bronchiectasis	Odorous rotten meat smell, foul putrefactive
Putrefaction of pancreatic juices	Hunger breath smell
Portocaval venous anastomosis	Feculent “amine” odor resembling a fresh cadaver known as “fetor hepaticus” but characteristically intermittent in nature for long period of time
Blood dyscrasias	Resembling decomposed blood of a healing surgical wound
Liver cirrhosis	Resembling decayed wound
Weger’s granulomatosis	Necrotic putrefactive
Syphilis, exanthematous disease, granuloma venereum	Fetid
Azotemia	Ammonia-like

to dental practice.^[24] Interestingly, advertisements of oral hygiene products are responsible for the increase in a number of patients with delusional halitosis.^[25]

Pseudo-halitosis patients complain of having oral malodor without actually suffering from the problem and eventually gets convinced of a disease free state during diagnosis and therapy.^[25] Twenty-eight percentage of patients complaining of bad breath did not show signs of bad breath.^[2] Halitophobia is fear of having bad breath seen in at least 0.5–1% of adult population.^[2] Such patients need psychological counseling and should be given enough time during the consultation. The physician must keep in mind the other major cause of halitosis mentioned above to confirm the final diagnosis of halitophobia. Clinicians might be perplexed by the patient's complaint of their imaginary oral malodor.^[26]

Olfactory Reference Syndrome is another psychological disorder in which there is a preconceived notion about one having foul mouth breath or emits offensive body odor. Drugs like selective serotonin reuptake inhibitors have shown significant improvement.^[27]

HOW IS HALITOSIS DIAGNOSED AND EVALUATED?

The patient history should contain main complaint, medical, dental and halitosis history, information about diet and habits, and third part confirmation confirming an objective basis to the complaint.^[28] Halitosis history should be discretely and intermittently recorded. Questions such as frequency, duration, time of appearance within a day, whether others have identified the problem (excludes pseudo-halitosis from genuine halitosis), list of medications taken, habits (smoking, alcohol consumption) and other symptoms (nasal discharge, anosmia, cough, pyrexia, and weight loss) should be carefully recorded.^[25] The authors have designed an investigative protocol for the diagnosis of oral malodor that can be used in clinical practice and is of significance to family health care practitioners [Figure 2].

The clinical assessment of oral malodor is usually subjective examination and is based on smelling the exhaled air of the mouth and nose and comparing the two (organoleptic assessment).^[10] Organoleptic assessment is considered as the "gold standard" to diagnose halitosis in a clinical setting.^[29] Odor detectable from the mouth but not from the nose is likely to be of oral or pharyngeal origin. Odor from

the nose alone is likely to be coming from the nose or sinuses.^[10] In rare instances, when the odor from the nose and mouth is of similar intensity, a systemic cause of the malodor may be likely. The advantages of organoleptical scoring are: Inexpensive, no equipment needed and a wide range of odors is detectable.^[2]

The trained judge or clinician smells a series of different air samples of the patient as follows: Oral cavity odor is examined on the subject as he is made to refrain from breathing while the examiner places his nose 10 cm from the oral cavity.^[30] The judge smells the expired air as the patient counts from 1 to 10 as this is done to promote drying up of the palate and tongue mucosa, expressing VSCs. In saliva odor test (same as the wrist lick test), the patient licks the wrist, and it is allowed to dry up for 10 s after which the judge allots a score to it.^[31] Nasal breath odor is checked as the patient is asked to breathe normally with mouth close and the judge gives a score to the exhaled air.^[31] Scrapping from the tongue dorsum is taken using a nonodorous spoon as the periodontal problem is presented to the judge. The judge and the patient both may find the method of directly assessing the exhaled air a bit uncomfortable, alternatively, the patient is asked to exhale into a paper bag, and then the judge examines the odor from the bag.^[13] Various disadvantages are the extreme subjectivity of the test, the lack of quantification, the saturation of the nose and the reproducibility of the test.^[2]

Gas chromatography (GC) analyses air, incubated saliva, tongue debris or crevicular fluid for any volatile component and is objective, reproducible and reliable.^[32] GC is highly specific to VSCs and can detect odorous molecules even in low concentrations. However, it is expensive, bulky and a well-trained operator is required. The progression of the method takes much more time, and the machine cannot be used in daily practice and has been confined to research.^[33] Portable volatile sulfide monitor is easily operable and reproducible, but they are only sensitive to sulfur-containing compounds. As oral malodor may comprise agents other than volatile sulfur compounds, this may provide an inaccurate assessment of the source and intensity of oral malodor.^[34]

The other objective measurement of the breath components is rarely used in routine clinical practice, as they are expensive and time-consuming.^[10] Various tests are Dark-field or Phase-Contrast Microscopy, Quantifying

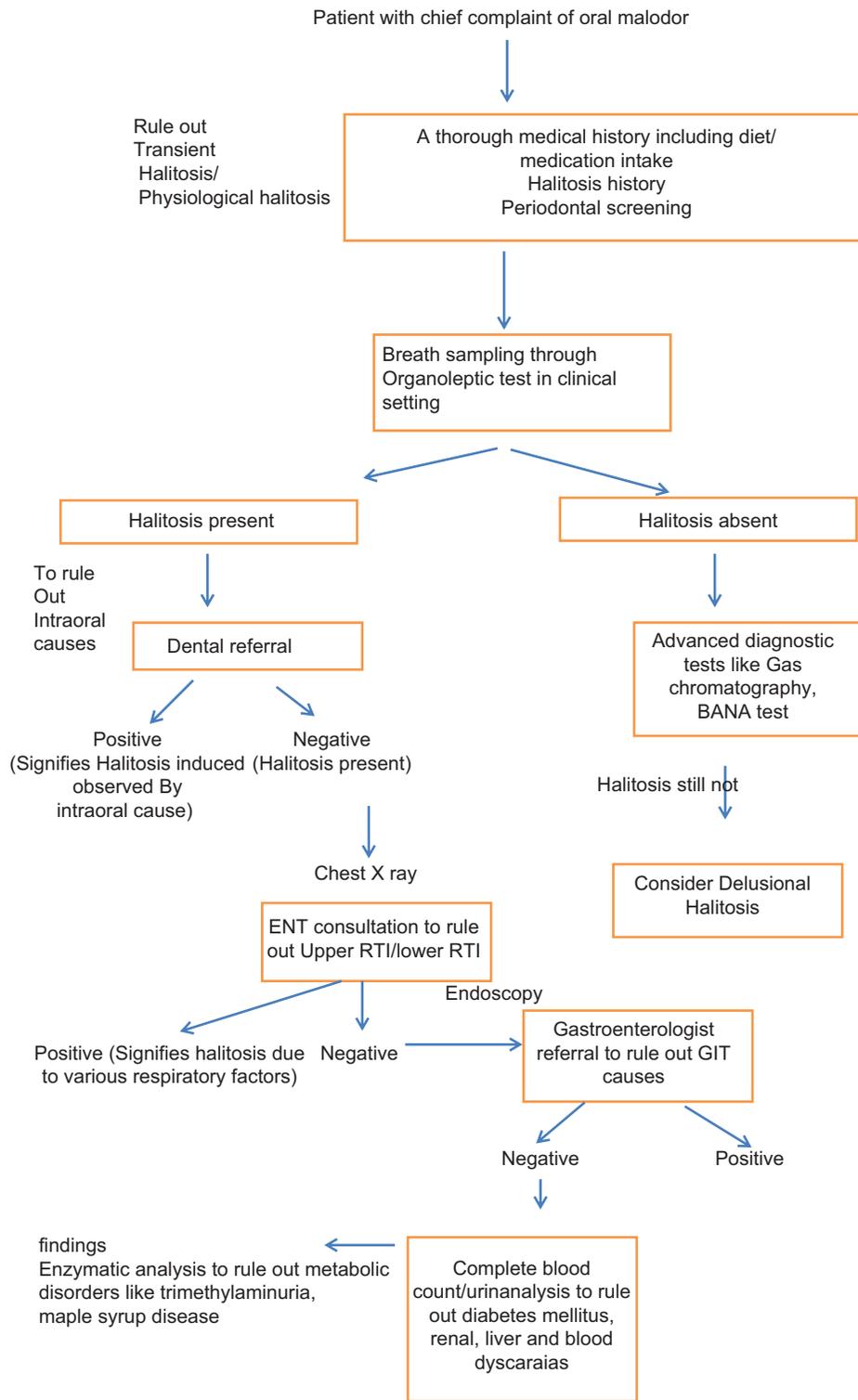


Figure 2: An investigative protocol workup in a clinical setting for a patient who presents to primary care practitioner

β -galactosidase activity,^[35] Salivary encubation test,^[36] Benzoyl-DL-arginine-a-naphthylamide (BANA) test,^[32] Ammonia monitoring,^[37] Ninhydrin method,^[38] polymerized chain reaction,^[32] Taqman DNA,^[39] Tongue Sulfide Probe^[40] and Zinc Oxide Thin Film Conductor Sensor.^[41] BANA Test is an enzyme-linked user-friendly

test that detects the presence of proteolytic obligate Gram-negative anaerobes, primarily those who form the red complex viz *Treponema pallidum*, *Porphyromonas gingivalis* and *Tannerella forsythia* and can be used as an adjunct to volatile sulfur measurement in the detection of halitosis.^[41]

HOW IS HALITOSIS MANAGED?

One must keep in mind that the patient suffering of halitosis is a person looking for help, often anxious and suspicious of any treatment, due to bad experiences using traditional approaches.^[42] An accurate diagnosis of halitosis must be achieved to manage it effectively. The available methods can be divided into a mechanical reduction of microorganisms, chemical reduction of microorganisms, usage of masking products, and chemical neutralization of VSC.^[43] If periodontal disease or multiple decayed teeth are evident, they should be treated as a contributor of halitosis. Professional oral health care examination

must be provided to all the patients irrespective of the type of halitosis. The authors have developed a management strategy based on the types of halitosis in Figure 3.

Mechanical removal of biofilm and microorganisms is the first step in the control of halitosis.^[43] A systemic review by van der Sleen *et al.* demonstrated that tongue brushing or tongue scraping have the potential to successfully reduce breath odor and tongue coating.^[44] Tongue scrapers are shaped according to the anatomy of the tongue and reduces 75% VSCs compared to only 45% using a toothbrush.^[45] However, a Cochrane review in 2006 compared randomized controlled

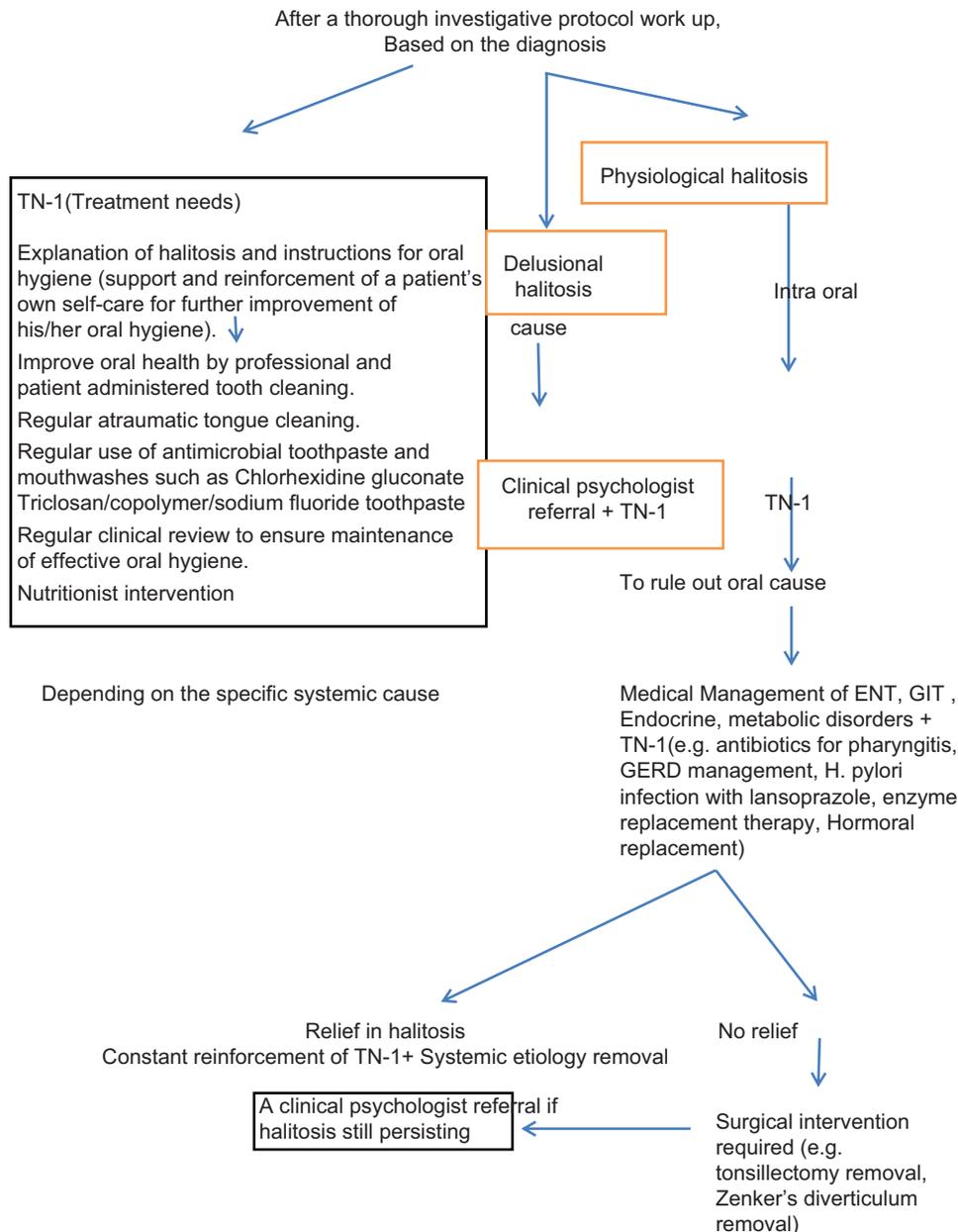


Figure 3: Management strategy for a patient with halitosis depending on the type and etiology (Modified from porter and scully, 2006)^[10]

trials for different methods of tongue cleaning to reduce mouth odor in adults with halitosis.^[46] It was concluded that there was a faint indication that there is a minor but statistically significant difference in reduction of VSC levels when scrapers or cleaners rather than toothbrushes are used to reduce halitosis in adults. Interdental cleaning is also necessary to control plaque, and oral microorganisms as failure to floss lead to a significantly high incidence of malodor.^[47]

In a recent systematic review, no evidence of diet modification, use of a sugar-free chewing gum, tongue cleaning by brushing, scraping the tongue or the use of zinc-containing toothpaste resulted in clinically significant results for the management for intraoral halitosis.^[48]

Antibacterial mouth rinsing agents include chlorhexidine (CHX), cetylpyridinium chloride (CPC) and triclosan, which act on halitosis-producing bacteria.^[13] A systematic review, published by Cochrane, compared the effectiveness of mouth rinses in controlling halitosis.^[49] The researchers concluded that mouth rinses containing CHX and CPC could inhibit production of VSCs while mouth rinses containing chlorine dioxide and zinc may neutralize the sulfur compounds producing halitosis.^[49]

CHX is considered as the gold standard mouth rinse for halitosis treatment.^[50] CHX in combination with CPC produce greater fall in VSCs level, and both aerobic and anaerobic bacterial counts showed the lowest percentage of survival in a randomized, double-blind, cross-over study design.^[50] Combined effects of zinc and CHX were studied in a study conducted in 10 participants, Zinc (0.3%) and CHX (0.025%) in low concentration led to 0.16% drop in H₂S levels after 1 h, 0.4% drop after 2 h and 0.75% drop after 3 h showing a synergistic effect of the two.^[51] However, patients may be reluctant to use CHX long-term as it has an unpleasant taste and can cause (reversible) staining of the teeth.^[10]

Usage of Listerine containing essential oils resulted in significant reduction in halitosis-producing bacteria in healthy subjects.^[52] Triclosan, a broadly used antimicrobial agent, is known to reduce dental plaque, gingivitis and halitosis.^[53] By using triclosan dentifrice and toothbrush/tongue cleaner a significant reduction in organoleptic scores and mouth air sulfur levels were obtained.^[53] A formulation of triclosan/copolymer/sodium fluoride in 3 weeks randomized double blind

trial by Hu *et al.* seemed to be particularly effective in reducing VSC, oral bacteria, and halitosis.^[54]

Oxidation of VSCs and sulfur containing amino acids by an oxidizing agent such as chlorine dioxide (Chlorodioxide) reduced the incidence of malodor in 29% of test subjects after 4 h.^[55] Positively charged metal ions binds with sulfur radicals inhibiting VSCs expression.^[56] A recent study indicated that daily consumption of tablets with probiotic *Lactobacillus salivarius* WB 21 could help to control oral malodor and malodor-related factors.^[57] The combination of tea tree oil (0.05%) and alpha-bisabolol (0.1%) exerted a synergistic inhibitory effect on halitosis associated Gram-positive *Solobacterium moorei* strain.^[58] Photodynamic therapy involves the transfer of energy from the activated photosensitizer (activated by exposure to light of a specific wavelength) resulting in a reduction of the concentration of VSCs reducing by 31.8%.^[59]

Extra-orally specific investigations should be carried out to isolate the source that should be either pharmaceutically (broad spectrum antibiotic coverage for pharyngitis, drugs such as proton pump inhibitors for GERD) or surgically (tonsillectomy/adenotonsillectomy, liver/kidney transplantation) managed.^[60] When *H. pylori* infections are observed, the therapy consists of the intake of omeprazole, amoxicillin and clarithromycin.^[2] In the endocrinological and metabolic disorders, the underlying diseases should be treated.

The usage of masking agents like rinsing products, sprays, toothpaste containing fluorides, mint tablets or chewing gum only have a short-term masking effect.^[61] Peppermint oil can also increase salivation, which is useful because dry mouth may result in halitosis.^[62] A patient's diet is another factor that should be discussed when recommending a plan to combat oral malodor.^[47] Propolis has also been used in the management of halitosis.^[63,64] The patient should be instructed to quit smoking, avoidance of tobacco products and usage of baking soda dentifrices.

Eli *et al.* reported that patients suffering from halitosis have significantly elevated scores for obsessive-compulsive symptoms, depression, anxiety, phobic anxiety, and paranoid ideation compared with similar patients without halitosis.^[65] Primary healthcare clinicians must not argue with patients about whether or not oral malodor exists and must determine if a patient is conscious of other

individuals' behaviors, real or perceived, toward them.^[26] In general, patients with psychosomatic halitosis evaluate their oral malodor by other people's attitudes, and they must be counseled that avoidance behaviors can occur naturally by other reasons.^[26] Patients with halitophobia require referral for clinical psychology investigation and treatment.^[10] Patients, who relate their emotional state to be a possible cause of their oral malodor, would benefit more from early referral to clinical psychologist for mental assessment and appropriate treatment.^[66] To treat delusional halitosis a multidisciplinary approach of health care practitioner, psychologists and psychiatrist are required.

When treating patients with oral malodor, clinicians should relate not only to physiological odor and associated parameters but also to the nature of the subjective complaint. In halitosis management, a well-established understanding between a patient and a primary healthcare clinician can bring a successful result. A primary healthcare clinician must exhibit attitudes of acceptance, sympathy, support, and reassurance to reduce the patient's anxiety. Professionals can improve patient quality of life as a whole, improving their social interactions and relationships. A sustained encouragement and reassurance need to be given by the patient's primary healthcare clinician, family, and friends.^[10]

Due to the multifactorial complexity of halitosis, patients should be treated individually, rather than be categorized.^[67] Diagnosis and treatment need to be a multidisciplinary approach involving the primary healthcare clinician, dentist, an ENT specialist, nutritionist, gastroenterologist and clinical psychologist.^[66] Future research is needed to test accessible methods of drawing a person's attention to his/her halitosis, being the first step of seeking treatment.^[68]

CONCLUSION

Halitosis is an extremely unappealing characteristic of sociocultural interactions and may have long-term detrimental aftereffects on psychosocial relationships. With proper diagnosis, identification of the etiology, and timely referrals when needed, steps can be taken to create a successful individualized therapeutic approach for each patient seeking assistance. It is significant to highlight the necessity of an interdisciplinary method for the treatment of halitosis to prevent misdiagnosis or unnecessary treatment. The literature on halitosis,

especially with randomized clinical trials, is scarce and additional studies are required. Since halitosis is a recognizable common complaint among the general population, the primary healthcare clinician should be prepared to diagnose, classify, and manage patients that suffer from this socially debilitating condition.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Scully C. Halitosis. *BMJ Clin Evid* 2014;2014. pii: 1305.
2. Bollen CM, Beikler T. Halitosis: The multidisciplinary approach. *Int J Oral Sci* 2012;4:55-63.
3. Struch F, Schwahn C, Wallaschofski H, Grabe HJ, Völzke H, Lerch MM, *et al.* Self-reported halitosis and gastro-esophageal reflux disease in the general population. *J Gen Intern Med* 2008;23:260-6.
4. Bornstein MM, Kisligh K, Hoti BB, Seemann R, Lussi A. Prevalence of halitosis in the population of the city of Bern, Switzerland: A study comparing self-reported and clinical data. *Eur J Oral Sci* 2009;117:261-7.
5. Liu XN, Shinada K, Chen XC, Zhang BX, Yaegaki K, Kawaguchi Y. Oral malodor-related parameters in the Chinese general population. *J Clin Periodontol* 2006;33:31-6.
6. Lee SS, Zhang W, Li Y. Halitosis update: A review of causes, diagnoses, and treatments. *J Calif Dent Assoc* 2007;35:258-60.
7. Ashwath B, Vijayalakshmi R, Malini S. Self-perceived halitosis and oral hygiene habits among undergraduate dental students. *J Indian Soc Periodontol* 2014;18:357-60.
8. Miyazaki H, Sakao S, Katoh Y, Takehara T. Correlation between volatile sulphur compounds and certain oral health measurements in the general population. *J Periodontol* 1995;66:679-84.
9. Avcu N, Ozbek M, Kurtoglu D, Kurtoglu E, Kansu O, Kansu H. Oral findings and health status among hospitalized patients with physical disabilities, aged 60 or above. *Arch Gerontol Geriatr* 2005;41:69-79.
10. Porter SR, Scully C. Oral malodour (halitosis). *BMJ* 2006;333:632-5.
11. Wilhelm D, Himmelmann A, Axmann EM, Wilhelm KP. Clinical efficacy of a new tooth and tongue gel applied with a tongue cleaner in reducing oral halitosis. *Quintessence Int* 2012;43:709-18.
12. Delanghe G, Ghyselen J, van Steenberghe D, Feenstra L. Multidisciplinary breath-odour clinic. *Lancet* 1997;350:187.
13. Aylikci BU, Colak H. Halitosis: From diagnosis to management. *J Nat Sci Biol Med* 2013;4:14-23.
14. Fletcher SM, Blair PA. Chronic halitosis from tonsilloliths: A common etiology. *J La State Med Soc* 1988;140:7-9.
15. Newman MG, Takei H, Klokkevold PR, Carranza FA. *Carranza's Clinical Periodontology*. 10th ed. Missouri: Saunders and Elsevier Inc.; 2006. p. 330-42.
16. Rösing CK, Loesche W. Halitosis: An overview of epidemiology, etiology and clinical management. *Braz Oral Res* 2011;25:466-71.
17. Kinberg S, Stein M, Zion N, Shaoul R. The gastrointestinal aspects of halitosis. *Can J Gastroenterol* 2010;24:552-6.
18. Stoeckli SJ, Schmid S. Endoscopic stapler-assisted diverticuloesophagostomy for Zenker's diverticulum: Patient satisfaction and subjective relief of symptoms. *Surgery* 2002;131:158-62.
19. Kim JG, Kim YJ, Yoo SH, Lee SJ, Chung JW, Kim MH, *et al.* Halimeter ppb levels as the predictor of erosive gastroesophageal reflux disease. *Gut Liver* 2010;4:320-5.
20. Lee H, Kho HS, Chung JW, Chung SC, Kim YK. Volatile sulfur compounds produced by *Helicobacter pylori*. *J Clin Gastroenterol* 2006;40:421-6.
21. Messenger J, Clark S, Massick S, Bechtel M. A review of trimethylaminuria: (fish odor syndrome). *J Clin Aesthet Dermatol* 2013;6:45-8.

22. Mudd SH, Levy HL, Tangerman A, Boujet C, Buist N, Davidson-Mundt A, et al. Isolated persistent hypermethioninemia. *Am J Hum Genet* 1995;57:882-92.
23. Saleh J, Figueiredo MA, Cherubini K, Salum FG. Salivary hypofunction: An update on aetiology, diagnosis and therapeutics. *Arch Oral Biol* 2015;60:242-55.
24. Shamim T. The psychosomatic disorders pertaining to dental practice with revised working type classification. *Korean J Pain* 2014;27:16-22.
25. Yaegaki K, Coil JM. Examination, classification, and treatment of halitosis; clinical perspectives. *J Can Dent Assoc* 2000;66:257-61.
26. Yaegaki K, Coil JM. Clinical dilemmas posed by patients with psychosomatic halitosis. *Quintessence Int* 1999;30:328-33.
27. Lochner C, Stein DJ. Olfactory reference syndrome: Diagnostic criteria and differential diagnosis. *J Postgrad Med* 2003;49:328-31.
28. Donaldson AC, Riggio MP, Rolph HJ, Bagg J, Hodge PJ. Clinical examination of subjects with halitosis. *Oral Dis* 2007;13:63-70.
29. Erovic Ademovski S, Lingström P, Winkel E, Tangerman A, Persson GR, Renvert S. Comparison of different treatment modalities for oral halitosis. *Acta Odontol Scand* 2012;70:224-33.
30. Greenman J, Duffield J, Spencer P, Rosenberg M, Corry D, Saad S, et al. Study on the organoleptic intensity scale for measuring oral malodor. *J Dent Res* 2004;83:81-5.
31. Rosenberg M, McCulloch CA. Measurement of oral malodor: Current methods and future prospects. *J Periodontol* 1992;63:776-82.
32. van den Broek AM, Feenstra L, de Baat C. A review of the current literature on aetiology and measurement methods of halitosis. *J Dent* 2007;35:627-35.
33. Kini VV, Pereira R, Padhye A, Kanagotagi S, Pathak T, Gupta H. Diagnosis and treatment of halitosis: An overview. *J Contemp Dent* 2012;2:89-95.
34. Salako NO, Philip L. Comparison of the use of the Halimeter and the Oral Chroma2 in the assessment of the ability of common cultivable oral anaerobic bacteria to produce malodorous volatile sulfur compounds from cysteine and methionine. *Med Princ Pract* 2011;20:75-9.
35. Yoneda M, Masuo Y, Suzuki N, Iwamoto T, Hirofuji T. Relationship between the β -galactosidase activity in saliva and parameters associated with oral malodour. *J Breath Res* 2010;4:017108.
36. Quirynen M, Zhao H, van Steenberghe D. Review of the treatment strategies for oral malodour. *Clin Oral Investig* 2002;6:1-10.
37. Toda K, Li J, Dasgupta PK. Measurement of ammonia in human breath with a liquid-film conductivity sensor. *Anal Chem* 2006;78:7284-91.
38. Iwanicka-Grzegorek K, Lipkowska E, Kepa J, Michalik J, Wierzbicka M. Comparison of ninhydrin method of detecting amine compounds with other methods of halitosis detection. *Oral Dis* 2005;11 Suppl 1:37-9.
39. Suzuki N, Yoshida A, Nakano Y. Quantitative analysis of multi-species oral biofilms by TaqMan Real-Time PCR. *Clin Med Res* 2005;3:176-85.
40. Morita M, Musinski DL, Wang HL. Assessment of newly developed tongue sulfide probe for detecting oral malodor. *J Clin Periodontol* 2001;28:494-6.
41. Shimura M, Yasuno Y, Iwakura M, Shimada Y, Sakai S, Suzuki K, et al. A new monitor with a zinc-oxide thin film semiconductor sensor for the measurement of volatile sulfur compounds in mouth air. *J Periodontol* 1996;67:396-402.
42. Dal Rio AC, Nicola EM, Teixeira AR. Halitosis – An assessment protocol proposal. *Braz J Otorhinolaryngol* 2007;73:835-42.
43. Armstrong BL, Sensat ML, Stoltenberg JL. Halitosis: A review of current literature. *J Dent Hyg* 2010;84:65-74.
44. Van der Sleen MI, Slot DE, Van Trijffel E, Winkel EG, Van der Weijden GA. Effectiveness of mechanical tongue cleaning on breath odour and tongue coating: A systematic review. *Int J Dent Hyg* 2010;8:258-68.
45. Pedrazzi V, Sato S, de Mattos Mda G, Lara EH, Panzeri H. Tongue-cleaning methods: A comparative clinical trial employing a toothbrush and a tongue scraper. *J Periodontol* 2004;75:1009-12.
46. Outhouse TL, Al-Alawi R, Fedorowicz Z, Keenan JV. Tongue scraping for treating halitosis. *Cochrane Database Syst Rev* 2006;CD005519.
47. Froum SJ, Rodriguez Salaverri K. The dentist's role in diagnosis and treatment of halitosis. *Compend Contin Educ Dent* 2013;34:670-5.
48. Scully C, Porter S. Halitosis. *Clin Evid (Online)* 2008;17:1305.
49. Fedorowicz Z, Aljufairi H, Nasser M, Outhouse TL, Pedrazzi V. Mouthrinses for the treatment of halitosis. *Cochrane Database Syst Rev* 2008;CD006701.
50. Roldán S, Herrera D, Santa-Cruz I, O'Connor A, González I, Sanz M. Comparative effects of different chlorhexidine mouth-rinse formulations on volatile sulphur compounds and salivary bacterial counts. *J Clin Periodontol* 2004;31:1128-34.
51. Thrane PS, Young A, Jonski G, Rölla G. A new mouthrinse combining zinc and chlorhexidine in low concentrations provides superior efficacy against halitosis compared to existing formulations: A double-blind clinical study. *J Clin Dent* 2007;18:82-6.
52. Thaweboon S, Thaweboon B. Effect of an essential oil-containing mouth rinse on VSC-producing bacteria on the tongue. *Southeast Asian J Trop Med Public Health* 2011;42:456-62.
53. Davies RM, Ellwood RP, Davies GM. The effectiveness of a toothpaste containing triclosan and polyvinyl-methyl ether maleic acid copolymer in improving plaque control and gingival health: A systematic review. *J Clin Periodontol* 2004;31:1029-33.
54. Hu D, Zhang YP, Petrone M, Volpe AR, Devizio W, Giniger M. Clinical effectiveness of a triclosan/copolymer/sodium fluoride dentifrice in controlling oral malodor: A 3-week clinical trial. *Oral Dis* 2005;11 Suppl 1:51-3.
55. Frascella J, Gilbert R, Fernandez P. Odor reduction potential of a chlorine dioxide mouthrinse. *J Clin Dent* 1998;9:39-42.
56. Young A, Jonski G, Rölla G. Inhibition of orally produced volatile sulfur compounds by zinc, chlorhexidine or cetylpyridinium chloride – Effect of concentration. *Eur J Oral Sci* 2003;111:400-4.
57. Suzuki N, Yoneda M, Tanabe K, Fujimoto A, Iha K, Seno K, et al. *Lactobacillus salivarius* WB21 – Containing tablets for the treatment of oral malodor: A double-blind, randomized, placebo-controlled crossover trial. *Oral Surg Oral Med Oral Pathol Oral Radiol* 2014;117:462-70.
58. Forrer M, Kulik EM, Filippi A, Waltimo T. The antimicrobial activity of alpha-bisabolol and tea tree oil against *Solobacterium moorei*, a Gram-positive bacterium associated with halitosis. *Arch Oral Biol* 2013;58:10-6.
59. Lopes RG, de Godoy CH, Deana AM, de Santi ME, Prates RA, França CM, et al. Photodynamic therapy as a novel treatment for halitosis in adolescents: Study protocol for a randomized controlled trial. *Trials* 2014;15:443.
60. Bunzen DL, Campos A, Leão FS, Morais A, Sperandio F, Caldas Neto S. Efficacy of functional endoscopic sinus surgery for symptoms in chronic rhinosinusitis with or without polyposis. *Braz J Otorhinolaryngol* 2006;72:242-6.
61. Haghgoo R, Abbasi F. Evaluation of the use of a peppermint mouth rinse for halitosis by girls studying in Tehran high schools. *J Int Soc Prev Community Dent* 2013;3:29-31.
62. Thosar N, Basak S, Bahadure RN, Rajurkar M. Antimicrobial efficacy of five essential oils against oral pathogens: An *in vitro* study. *Eur J Dent* 2013;7 Suppl 1:S71-7.
63. Almas K, Dahlan A, Mahmoud A. Propolis as a natural remedy: An update. *Saudi Dent J* 2001;13:45-9.
64. Torwane NA, Hongal S, Goel P, Chandrashekar BR, Jain M, Saxena E. A clinical efficacy of 30% ethenolic extract of Indian propolis and recaldent™ in management of dentinal hypersensitivity: A comparative randomized clinical trial. *Eur J Dent* 2013;7:461-8.
65. Eli I, Baht R, Koriati H, Rosenberg M. Self-perception of breath odor. *J Am Dent Assoc* 2001;132:621-6.
66. Akpata O, Omoregie OF, Akhigbe K, Ehikhamenor EE. Evaluation of oral and extra-oral factors predisposing to delusional halitosis. *Ghana Med J* 2009;43:61-4.
67. Rayman S, Almas K. Halitosis among racially diverse populations: An update. *Int J Dent Hyg* 2008;6:2-7.
68. de Jongh A, van Wijk AJ, Horstman M, de Baat C. Attitudes towards individuals with halitosis: An online cross sectional survey of the Dutch general population. *Br Dent J* 2014;216:E8.