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Recent Advances in the Diagnosis and Treatment of Halitosis

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Abstract: Halitosis is commonly defined as an unpleasant or offensive odour that is emitted from the oral cavity. For many individuals with halitosis, the condition leads to discomfort and affects their social interactions and everday activities. Additionally, bad breath may indicate an underlying health issue. Identifiying the contributing factors and causes of halitosis can help ensure effective treatment and management of the condition. This review aims to improve general awareness of halitosis, with a particular focus on intra oral halitosis and also to provide practitioners with the latest information on the causes of halitosis, hightlighting effective approaches for prevention and treatment. Regular daily oral care including brushing with toothpaste, flossing and using antimicrobial agents, effectively reduces the number of microorganisms responsible for bad breath.

Keywords: Halitosis; Bad Breath; Oral Malodor

Introduction

Halitosis is commonly defined as an unpleasant or offensive odour originating from the oral cavity (Wu et al., 2020). The term 'halitosis' derives from the Latin word 'halitus', meaning 'breath' combined with theGreek suffix -ossis, which denotes a 'pathological condition' (Heboyan,2019). It is considered one of the most frequent complaints reported to dentists, following dental caries and periodontal diseases (Wu et al., 2020)

Halitosis can significantly affect an individual's quality of life. Its psychological impact may lead to social anxiety, reduced social interactions, decreased productivity, and personal discomfort. In more severe cases, the condition can cause embarrassment and affect personal relationship (Khounganian,2023).

The etiology of halitosis is multifactorial; however,the majority of cases originate within the oral cavity. Extra-oral factors may also contribute, including otorhinolaryngological, respiratory and gastrointestinal disorders. The accumulation of halitosis- associated bacteria and food debris on the posterior dorsum of the tounge particularly within its fissures leads to the breakdown of substrates into volatile sulphur compounds (VSC) and other volatile compounds, which are primarily considered to be the major causes of bad breath (Fedorowicz Z,2008).

Despite its high prevalence and notable psychosocial impact, halitosis is often underestimated by both patients and healthcare professionals. Many individuals remain unaware of their condition due to olfactory adaptation, and self- assessment is frequently inaccurate. Furthermore, misconceptions persist regarding its primary causes, the distiction between intra oral and extra oral orignis, and the most effective approaches for diagnosis and treatment. These gaps in public and clincical understandiing highlight the need for updated, evidence-based literature that to guide accurate diagnosis and effective management.

Therefore, this review serves an important role to provide a comprehensive overview of halitosis, with a focus on intra oral causes. By compiling recent findings and clarifying effective prevention and management strategies, this article aims to assist practitioners in improving diagnostic accuracy, guiding appropriate therapeutic interventions and enhancing the quality of life of individiuals affected by halitosis.

Method

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This review article involved an assessment of published studies discussing the diagnosis and treatment of halitosis. Multiple databases, including PubMed, Medline, and Google Scholar were utilized to collect the most relevant articles on this subject. The search used several terms, such as halitosis, halitosis classification, halitosis diagnosis and treatment. By using this method, all the studies discussing halitosis diagnosis, management, and treatment were obtained. We included all studies that addressed halitosis and its diagnosis, treatment and management. Studies with poor methodological quality, outdated data, or insufficient data were excluded. After implementing our inclusion criteria, the most relevant articles were selected and included in this review. The initial screening elicited 158 studies. After implementing our inclusion criteria, the most relevant articles were selected and included in this review. Several articles were related to the subject area but only 25 full text articles were used for this review.

Result and Discussion

Halitosis is a significant clinical condition that should be identified and treated by dentists in their daily practice. First, the aetiology must be pinpointed correctly through detailed clinical examination to tailor the correct treatment for the patient (Wu et al.,2020). This includes a thorough medical history complete with dietary analysis and identification of personal habits to ensure that an extra oral cause is not missed (Armstrong B,2010).

Halitosis can have multifactorial causes. Nevertheless, in 80– 90 % of halitosis the source can be found in the oral cavity. Anaerobic, mainly Gram-negative, bacteria degrade organic substances (e.g., saliva, food debris, desquamated epithelial cells) into primarily volatile sulphur compounds (VSCs) (Zürcher et al., 2014). About 80–90 % of halitosis is intra-oral halitosis, as a result of the interaction between halitosis-related bacteria and sulfur-containing compounds in saliva, which could generate the volatile sulfur compounds (VSCs) such as hydrogen sulfide and methyl mercaptan. These compounds are byproducts of bacterial metabolism (Yuan,2025). Halitosis-forming gases are largely Volatile Sulfur Compounds (VSCs). These gases are hydrogen sulfide, methyl mercaptan, and dimethyl sulfide. Not only VSCs play a role in halitosis formation, at the same time, volatile aromatic compounds such as indole, skatole, organic acids such as acetic acid, propionic acid, and amines such as cadaverine and putrescin are also effective in the formation of halitosis. VSCs production in the oral cavity and its emergence depend on many local factors. These factors are saliva, decreased Oxygen (O2) concentration in the oral cavity, bacterial reproduction and metabolism (Bicak, 2018).

Halitosis can be classified into genuine halitosis, pseudo-halitosis, or halitophobia. Genuine halitosis is a real problem that can be easily diagnosed through organoleptic and/or physicochemical methods. It can be further subclassified into physiological halitosis or pathological halitosis, while the latter is further subclassified as oral or nonoral. Physiological halitosis is sometimes misinterpreted as a change in breath; however, it is considered normal (Silva CR & Silva CC, 2022). Halitophobia is the condition where patients persist in believing that they have halitosis even after the treatment of either genuine halitosis or pseudo-halitosis, without any physical or social evidence suggesting the presence of halitosis. (J Wu, 2020).

Mechanical removal of biofilm and microorganisms is the first step in the control of halitosis (Kapoor et al, 2016). 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.(Van der Sleen, 2010). 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.

Diagnostic methods of halitosis help to differentiate between genuine halitosis, pseudo-halitosis and halitophobia. Therefore, assessment of diagnosis and severity of halitosis is important to prevent incorrect or unnecessary treatment (Çoban & Sönmez, 2017). The assorted tests disbursed to work out the presence of halitosis are direct and indirect methods (Renvertet al., 2020). Direct breath odour includes the organoleptic method, gas chromatography, and portable sulfide monitoring.

Organoleptic assessment is the most popular diagnostic procedure (Khounganian al.,2023). Organoleptic measurement is a simple and widely used method. In this technique, a plastic tube is placed in the mouth of the patient and the patient is told to slowly breathe into the tube. During this time, the examiner evaluates the smell from the other side of the tube. This method increases reliability when used in conjunction with other measurement methods. In the most commonly used scoring system, the odor is classified between 0 and 5. (0: Odor cannot be detected. 1: Questionable malodor, barely detectable, 2: Slight malodor exceeds the threshold of malodor recognition. 3: Malodor is definitely detected, 4: Strong malodor, 5: Very strong malodor) (Bicak,2018). The result largely depends on the experience of the examiner; therefore, it is a very subjective method. However, there are also objective methods for assessing halitosis, including gas

chromatography, portable VSC analyzers, and Artificially Intelligent Olfactory (AIO). (Poniewierka E al.,2022).

Gas chromatograph (GC), which is an objective, reproducible and reliable method, analyses air, incubated saliva, tongue debris or crevicular fluid for volatile sulfur compounds (VSC). GC has a high specificity that can detect VSC even at low concentrations. In this method the measurements are carried out with instruments equipped with a flame photometric detector or mass spectrum. The concentration of VSC (10 ng/mL) is assessed on the basis of hydrogen sulfide and methyl mercaptan preparations prepared as standard. In practice, the patient is told to close his mouth and hold his breath for 30 seconds. After the aspiration with the help of a gas-tight syringe of breath is injected into the GC column at 70 °C various disadvantages are expensive, requires trained staff, takes up a lot of space, is not suitable for daily practice and application takes much time (Çoban & Sönmez, 2017).

Portable sulfur compounds,This method involves letting the patient keep his mouth closed for five minutes. Then, the patient is asked to breathe into a transparent tube that carries the breath to a suction pump that is connected to the sulfide monitor (Iba B,2021). The sulfide monitor is a portable device that allows easy measurement of the VSCs found in the expiration air outside the laboratory environment (Bicak,2018). The device was developed over time and presented to the market under the name of 'Halimeter' (Interscan Corp., Chatsworth, CA, USA). This method is reproducible and simple to use though, the flexibility to detect only sulfur-containing compounds can result in an incorrect assessment of the source and intensity of oral malodour (Çoban & Sönmez, 2017).

Table 1. Diagnostic methods of Halitosis

Direct Method	Indirect Method
Organoleptic assessment	BANA test
It is based on the examiner's subjective perception and is the gold standard for the assessment of halitosis. This method is cheap, does not need equipment, and detects a wide range of odour. It is however subjective, lacks quantification and repeatability.	Detects short-chain fatty acids & proteolytic obligate gram negative anaerobes
Gas chromatography	Ammonia monitoring
Gas chromatography encompasses a high specificity to volatile sulfur compounds and can detect odorous molecules even in low concentrations.	Detects ammonia quantity which is produced by oral bacteria.
Portable sulfur compounds	Ninhydrin method
The sulfide monitor is a portable device that allows easy measurement of the VSCs found in the expiration air outside the laboratory environment.	Used for examination of amino acids and polyamines that cannot be detected using the sulfur monitor. It is simple, fast and less expensive.
	Polymerase chain reaction (PCR)
	PCR is used for quantitative analysis of microorganisms causing VSCs from oral specimens like saliva, tongue coating, and subgingival plaque. It is a rapid, sensitive, and specific diagnostic technique.

Various indirect diagnostics methods including the Benzoyl-DL-Arginine-Alpha-Naphthylamide (BANA) test, ammonia monitoring, the ninhydrin method, and polymerase chain reaction (PCR). BANA (Benzoyl-DL-arginine-α-Naphthylamide) Test, It detects short-chain fatty acids and proteolytic obligate gram-negative anaerobes, playing a crucial role in identifying key bacteria such as *Treponema denticola, Porphyromonas gingivalis,* and *Tannerella forsythia,* which are highly related to adult periodontitis. When these proteolytic bacteria are treated with an artificial trypsin substrate BANA, the arginine hydrolase enzyme successfully reacts with the diazo dye embedded in the substrate to produce a permanent blue colour indicating a positive test confirming the presence of the bacteria (Iba et al.,2021). Ammonia Monitoring, It detects ammonia quantity which is produced by oral bacteria. The ammonia monitor consists of a pump that pulls the expiratory air into the ammonia gas detector and a disposable tube that is inserted into the patient's mouth. The patient is allowed to rinse with urea and then blow into the tube and therefore, the amount of ammonia is read by the gas detectors. The ammonia concentration produced by the bacteria is read directly from the scale (Bicak, 2018). Ninhydrin Method, it is utilized to detect amines and polyamines that cannot be detected using the sulphur monitor. This process involves mixing isopropanol with the patient's sample, followed by centrifugation. The mixture is then analysed based on its light permeability using a spectrometer. This method is

a quick, fast, simple and cost- effective technique (Iba B,2021). Polymerase Chain Reaction (PCR), it is a rapid, sensitive, and specific diagnostic technique that has gained popularity in recent years. By using PCR, the measure of the microorganisms causing mouth odour from oral specimens like saliva, tongue coating, and subgingival plaque are often performed (Bicak, 2018). There are different approaches to the management of halitosis however, for this study, it shall be discussed based on this classification (Iba al ,2021): Physiological halitosis is the first stage of treatment consists of mechanical removal of biofilm and microorganisms. The mechanical methods are used to clean the dorsum of the tongue, such as tongue scraping and tongue brushing. This procedure is important in reducing the level of volatile sulphur compounds, tongue coating, and malodour, especially morning breath-related malodour in subjects with healthy periodontium and patients with gingivitis. Cleaning the interdental space with dental floss is also essential for the control of oral microorganisms and plaque (Chen et al, 2018; Wang & He, 2017). Mouthwashes with antimicrobial properties are beneficial in reducing bad breath by reducing the number of microorganisms. They include chlorhexidine (CHX), essential oils (EOs), triclosan, and cetylpyridinium chloride (CPC). Those that have a neutralizing or therapeutic effect include metal ions and oxidizing agents (Tungareet al, 2021)., and they play an important role in reducing the levels of halitosis-producing bacteria on the tongue. Chlorine dioxide and Zinc containing mouthrinses can be effective in neutralisation of odoriferous sulphur compounds (Fedorowicz Z,2008). The application of dentifrices, rinsing liquids that contain fluoride, chewing gums and mint tablets have short-term effects on halitosis. Diet plays an important role and should be balanced to effectively fight against oral malodour. The patients suffering from halitosis should consider quitting smoking, minimising alcohol intake, and avoiding dentifrices containing baking soda (Heboyan et al.,2019). Peppermint oil can also increase salivation, which is useful because dry mouth may result in halitosis *(*Thosar N,2013).

Table 2. Management of halitosis

Physiological Halitosis	Pathological Halitosis	Pseudo- Halitosis	Halitophobia
TN-1 (Treatment Needs) and it involves: Explanation of halitosis and instructions for oral hygiene. Improve oral health by professional and patient administered tooth cleaning. Regular tongue cleaning. Regular clinical review Nutritionist intervention. Quitting habits that do not promote oral health.	vi. Oral vii. TN-1 + Oral prophylaxis, professional cleaning, and treatment for oral diseases, especially periodontal disease. Extraoral TN-1 + Referral to a physician or a medical specialist.	TN-1 + Explanation of examination data, further professional instruction, education and reassurance.	TN-1 + Referral to a clinical psychologist, a psychriatrist, or other psychology specialists.

Pathologic halitosis of oral origin: halitosis arising from the oral cavity is chiefly because of pathologic conditions within the mouth like periodontal disease (Liu et al., 2017). Therefore, reduction of the bacterial load is an essential means of controlling halitosis of intra-oral origin. This can be achieved through periodontal treatment {scaling and root planning} which reduces the severity of gingival inflammation, alleviate the depth of the periodontal pocket and eliminate halitosis caused by bacteria. Other conditions such as xerostomia, dental caries, pericoronitis, oral ulceration, or malignancy also cause halitosis and should be diagnosed and treated as appropriate (West & Tawhid, 2019). Unsuitable prosthetics and conservative restorations, can create avenues for food impactions and hinder proper oral hygiene practices thereby creating a reservoir area for bacteria. Replacement or renewing of such restorations with adequate and proper restorations will eliminate those reservoirs and facilitate effective oral hygiene (Heboyan et al.,2019).

Pathologic halitosis of extra-oral origin: Patients with halitosis that originate from non-oral causes and underlying systemic disorders (such as respiratory, gastrointestinal, hepatic, renal, endocrine, or haematological disease) should be referred to an appropriate specialist for further management (West & Tawhid, 2019).

Pseudo-halitosis: In the management of patients with pseudo-halitosis, counselling, explanation of examination results to the patient, oral hygiene instructions, education and reassurance are sufficient and well accepted by the patient (Iba B et al., 2021).

When treating patients with oral malodour, clinicians should relate not only to physiological odour 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 clincian 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 (Porter SR, Scully C, 2006).

Dealing with patients suffering from halitophobia is difficult and requires a lot of experience. 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 (Zürcher A,2014). Probiotics are a relatively new treatment for halitosis. They are living microorganisms that, when administered in sufficient amounts, improve host health (Tay, J.R.H.2022).

From Tay article the available evidence suggests no convincing benefit for the use of probiotics in the management of halitosis. Standardized protocols on recruitment of halitosis subjects and organoleptic measurements are required for future studies on probiotics as an intervention. Based on the review literature, both conventional and modern approaches have been presented for managing halitosis. However, conventional methods appear to be more effective and more commonly used in the diagnosis and treatment of halitosis.

Conclusion

Halitosis is an often-overlooked issue that affects a large portion of the global population. Without proper diagnosis and management, it can severely impact quality of life, leading to psychological effects such as social, professional, and emotional limitations, as well as unnecessary medical interventions. Regular daily oral care including brushing with toothpaste, flossing and using antimicrobial agents, effectively reduces the number of microorganisms responsible for bad breath.

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Leedwin Kalyana Alison and Susanna Halim conceptualized the research idea, while Leedwin Kalyana Alison and How Kim Cuan conducted the analysis, research process, and literature review. All authors read and approved of the final manuscript.

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Conflicts of Interest
The authors declare no conflicts of interestt.

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