Oral Malodor - A Cause or Disease in Humans

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ABSTRACT

Oral malodor, also called halitosis or bad breath, is the general term used to describe any disagreeable odor in expired air, regardless of whether the odorous substances originate from oral or non-oral sources. Specific groups of bacteria have been identified with the production of oral malodor, in particular, gram- negative anaerobic bacteria. Volatile sulfur compounds (VSCs) resulting from bacterial breakdown of proteins are considered to be the main agents for malodor. This paper reviews the current knowledge, etiology, diagnosis, and possible treatment strategies for oral malodor.

Keywords: Fetor ex ore, Halimeter, stomatodysodia, Tongue coating, Breath tests, diagnosis

Introduction

Malodor is the scientific term for bad breath and has its origin from Latin ("malus," bad, evil + "odorem, odor," smell, scent) and defined as a distinctive smell that is offensively unpleasant. Halitosis is a medical term, first coined by the Listerine Company in 1921, to describe oral malodour or bad breath. Listerine was first formulated by Lister in 1879 as a surgical antiseptic and then by Dr. Joseph Lawrence and Jordan Wheat Lambert in 1879. It was given to dentists for oral care in 1895 and became the first over-the-counter mouthwash sold in the United States in 1914.[1] Halitosis frequently causes embarrassment, and may affect interpersonal social communication.[2]

Factors Involved in the Etiology of Halitosis

Halitosis is caused due to the presence of odorous gases in the air expelled from the oral cavity. The odorous compounds are mainly divided into;

1) Sulphur containing gases (VSCs).
   a. Hydrogen sulphide
   b. Methyl mercaptan
   c. Methyl sulphide
   d. Dimethyl disulphide
2) Non-Sulphur containing gases.
   a. Volatile aromatic compounds
   b. Organic acids (acetic and propionic acids)
   c. Amines (putrescine, cadeverine)[3]

Microbiota associated with Oral Malodor

Putrefaction is thought to occur under anaerobic conditions, involving a range of gram-negative bacteria such as Fusobacterium, Veillonella, T. denticola, P. gingivalis, Bacteroides and Peptostreptococcus. Fusobacterium nucleatum is one of the predominant organisms associated with gingivitis and periodontitis and this organism produces high levels of VSCs. The nutrients for the bacteria are provided by oral fluids, tissue and food debris.[4]

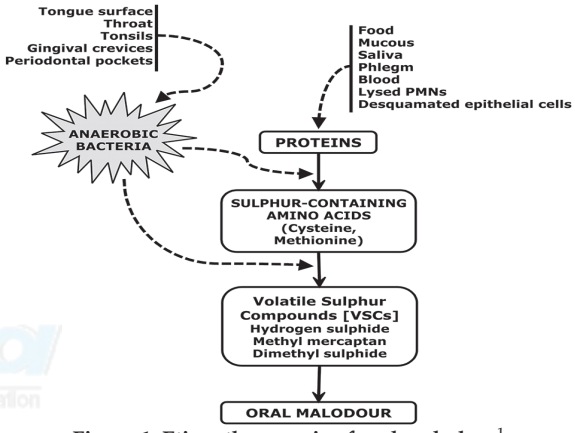

Figure 1: Etiopathogenesis of oral malodour[1]

Classification

I. NON-ORAL causes and Oral malodor types:

i) Physiological halitosis: is caused by dietary foods and drink, like garlic, onions, curries and spices such as cumin, mace, coriander, cinnamon, or turmeric. It is short lived, temporary and easily reversible.

ii) Pathological halitosis is caused by systemic disease.

a) Diabetes mellitus often produces ketones and a sweetish odour. Diabetic control is essential to eliminate this ketosis. Kidney disease may produce an ammoniacal smell, and liver disease has a musty odour.

b) Gastritis with mucosal pathology (like ulcers or neoplasia) may present with OM with a fetid foul odor. Early loss of smell (anosmia) may indicate early onset Alzheimer's, as the CNS connections become less functional.

iii) Psychological halitosis more accurately called delusional cacosomia.

a) This OM is subjectively, but falsely, perceived by patients who may have a brain dysfunction or tumor. Taste and smell changes frequently occur with people who are suffering from an intra-cranial neoplasia, either as a primary lesion, a metastasis, or from cancer therapy.

b) In epilepsy, psychological halitosis/delusional cacosomia may be perceived as an aura, which is a

subjective warning sign that a seizure is about to occur. The aura may be any smell but commonly burning rubber, smoke, or a pungent aroma. Once the CNS pathways are dysfunctional subjective reporting of OM remains highly impossible.

Other NON-ORAL causes and Oral Malodor Types

i) Ozostomia: OM caused above the carina. (The carina is the bronchial cartilage that divides the respiratory tree into upper respiratory tract URT and lower respiratory tract LRT) URT infections like pharyngitis, tonsillitis, tonsoliths, rhinitis or sinusitis often cause ozostomia. Blocked and runny noses frequently among children will produce typical ozostomia smells. This is also a pathological halitosis.

ii) Stomatodysodia: OM caused from the lungs below the carina. Tobacco addiction/abuse is the main cause of stomatodysodia, but also infective bronchitis, bronchiectasis, lung abscess, tuberculosis, pleurisy, and/or pneumonia, caused by viruses and/or microbes may also be responsible. This is also a pathological halitosis.

II. ORAL causes and Oral Malodor types:

Oral types are called fetor ex ore (FEO) and fetor oris (FO). FEO and FO are the same. FEO's are caused by odoriferous bacterial biofilms from effects of stagnated microbes with pathology of the mouth affecting teeth, gums and tongue. These conditions and biofilm stagnation areas include Gingivitis, Periodontitis ,Pericoronitis /Peri-implantitis, Dead spaces of stagnation on implants, Dorsum of Tongue Pathology, ANUG/NUG (trench mouth),Plaque & Calculus (Biofilm and Calcified Biofilm), Poor Oral Hygiene with stagnation areas, Inadequate brushing & flossing, Reduced salivary flow etc.[5]

Specific Character of Breath Odor

- A "rotten eggs" smell is indicative of VSCs.
- A sweet odor, as that of "dead mice" has been associated with liver insufficiency; besides VSCs, aliphatic acids (butyric, isobutyric, propionic) accumulate.
- The smell of "rotten apples" has been associated with unbalanced insulin-dependant diabetes, which leads to the accumulation of ketones.
- A "fish odor" can suggest kidney insufficiency characterized by uraemia and accumulation of dimethylamine and trimethylamine.[6]

Diagnosis of Oral Malodor

The proper diagnostic approach to a malodor patient starts with a thorough questioning about the medical, dental and halitosis history.[7] The clinician should ask about the frequency (e.g., every month), time of appearance within the day (e.g., after meals can indicate a stomach hernia), whether others (nonconfidants) have identified the problem (excludes imaginary breath odor), what medications are taken, and whether the patient has dryness of the mouth or other symptoms.[6]

There are a number of methods, from simple to sophisticated, used to detect or diagnose the presence of oral malodor. These are:

Direct Methods

Self-examination

When an intraoral cause has been identified, involve the patient in monitoring the results of therapy by self-examination. The following self-testing can be used:

- Smelling a metallic or nonodorous plastic spoon after scraping the back of the tongue.
- Smelling a toothpick after introducing it in an interdental area.
- Smelling saliva spit in a small cup or spoon.
- Licking the wrist and allowing it to dry.[6]

Organoleptic Method (whole-mouth breath test, spoon test, floss odor test, salivary odor test)

Even though instruments are available, organoleptic assessment by a judge is still the "gold standard" in the examination of breath malodor. In organoleptic evaluation, a trained "judge" sniffs the expired air and assesses whether or not this is unpleasant using an intensity rating, normally from 0 to 5, as proposed by Rosenberg and McCulloch (1992)[8]. It is solely based on the olfactory organs of the clinician: 0 = no odor present, 1 = barely noticeable odor, 2 = slight but clearly noticeable odor, 3 = moderate odor, 4 = strong offensive odor, and 5 = extremely foul odor. The main disadvantage of this method is that it is subjective to the judge's olfaction.

Portable sulfide meter

The portable sulfide meter (Halimeter®) has been widely used over the last few years in oral malodor testing. The portable sulfide meter uses an electrochemical, voltametric sensor which generates a signal when it is exposed to sulfur gases (to be specific, hydrogen sulfide) and measures the concentration of hydrogen sulfide gas in parts per billion. The halimeter is portable and does not require skilled personnel for operation. The main disadvantages of using this instrument are it fails to detect other odorants which contribute to halitosis, such as volatile short-chain fatty acids, polyamines, alcohols, phenyl compounds, alkanes, ketones, and nitrogen-containing compounds.[9]

Figure 2: Halimeter

Gas chromatography

Gas chromatography is the preferable method if quantitative measurements of specific gases are required. This is a highly reproducible, objective, and reliable method in which the concentration of volatile sulphur-containing compounds in samples of saliva, tongue coating or expired breath is measured by producing mass spectra and analyzed by a gas chromatograph.[10]

The **Oral Chroma TM** portable gas chromatography device analyses individual concentrations of volatile sulphur compounds such as Hydrogen sulfide, Methyl mercaptan and Dimethyl sulfide and displays the concentrations on a display panel.[11] The main disadvantages of using this instrument are the equipment is expensive and requires skilled personnel to operate it.[10]

Figure 3: Gas chromatography (Oral chroma TM)

Electronic nose

Electronic noses are chemical sensors that have been in the recent times for a quantitative assessment of malodor associated with food and beverages. **The FF-1 odour discrimination analyser (Electronic nose, Shimadzu Corporation)** was used by **Tanaka et al (2004)**.[12]

Dark field / phase contrast microscopy

Gingivitis and periodontitis are typically associated with a higher incidence of motile organisms and spirochetes, so shifts in these proportions allow monitoring of therapeutic progress. Another advantage of direct microscopy is that the patient becomes aware of bacteria present in plaque, tongue coating, and saliva. High proportion of spirochetes in plaque has been associated with a specific acidic malodor **(Quirynen & Van Steemberghe, 2006).**[6]

Indirect Method

Bacterial culture, smears and enzyme assays are indirect methods of assessing oral halitosis. These methods will help in the identification of organisms that produce oral malodor. One such technique is **(Benzoyl- DL-arginine naphthyla-mide)** BANA test.

BANA test

Benzoyl-DL-arginine naphthylamide test is a chair side investigation that assesses the proteolytic activity of anaerobic bacteria. It is a rapid chair side test for evaluation of non-sulfurous malodorous compounds.

To detect malodor, the tongue or inter dental region is wiped with a cotton swab. The sample is placed on the BANA test strip, which is then inserted into a slot on a small toaster-sized incubator .The incubator automatically heats the sample to 55°C for 5 minutes. If P. gingivalis, B. forsythus or T. denticola is present, the test strip turns blue. The bluer it turns, the higher the concentration and the greater the number of organisms. A color guide is printed on the container. It can also be used to evaluate the prognosis of the condition.[13]

Other Methods

Quantifying β-galactosidase activity

Deglycosylation of glycoproteins is considered as an initial step in oral malodour production. β -Galactosidase is one

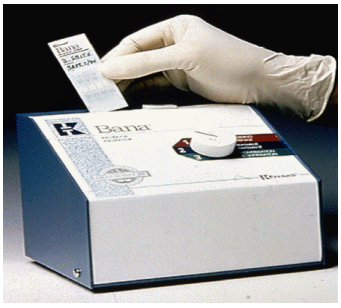

Figure 4: BANA test kit and BANA-Zyme reagent stripes

of the important enzymes in deglycosylation. The activity of a galactosidase can be easily quantified with the use of a chromogenic substrate absorbed onto a chromatography paper disc. Saliva applied to the paper disc, may induce a colour change of the paper, which can be recorded by an examiner.[14]

Salivary incubation test

The salivary incubation test uses saliva collected in a glass tube. After incubating the tube at 37.8°C in an aerobic chamber under an atmosphere of 80% nitrogen. 10% carbon dioxide, and 10% hydrogen for several hours, the odour can be measured by an examiner.[15]

Ninhydrin Method

Amines or polyamines cannot be measured by using sulphide monitoring. The Ninhydrin colorimetric reaction is a simple, rapid, and inexpensive method. A sample of saliva and isopropanol is mixed and centrifuged. The supernatant is diluted with isopropanol, buffer solution (pH 5), and ninhydrin reagent. The mixture is refluxed in a water bath for thirty min, cooled to 21.8 °C, and diluted with isopropanol to a total volume of 10ml. Light absorbance readings are determined using a spectrometer.[15]

Polymerase chain reaction

Real-time polymerase chain reaction (PCR) using the TaqMan system can be used for quantitative analysis of volatile sulphur-containing compounds - producing oral bacteria (e.g. Tannerella forsythensis).[16]

OraTest

This test provides quantitative assessment of the level of microbial activity in the oral cavity. The test involves oral rinsing with a sterile milk sample, followed by expectoration into a test tube containing a oxidation-r. Education indicator (methylene blue). The higher level of micro-organisms, the faster the color changes from blue (aerobic condition) to white (anaerobic condition) at the bottom of the test tube. In addition to co-relation with microbial counts, the OraTest exhibits significant co-relation with plaque and gingival indices.[17]

Current Approaches in Diagnosis

a) Recent VSC monitors introduced are Tanita breath alert, Osmoscope and diamond probe.

b) Another chair side test kit (Halitox reagent kit) measures the halitosis linked toxins. It is quick, simple colorimetric test that detects both volatile sulphur compounds as well as polyamines.

c) The diamond Probe/Perio 2000 system is a dental device designed to detect sulphide concentration of various forms (S,HS, H2S and CH3SH) in gingival sulci. The system combines a conventional Michigan "O" Probe style dental probe with a sulphide sensor, which measures probing depth, bleeding on probing and sulphide levels.[18]

Figure 5: Diamond probe

Halitosis Assessment Protocol

Halitosis associated life-quality test (HALT)

A model used by many for health status is dictated by the Institute for Medical Rehabilitation and Research hierarchy. The Halitosis Associated Life-quality Test (HALT) is a de novo designed tool based on patient interviews and literature review. This new tool is devised to measure oral malodor (halitosis) and associated quality of life (QOL). HALT is a QOL questionnaire with 20 items, each item graded on the commonly accepted Likert scale of 0–5; a higher score indicated a worsening of that single measure. This questionnaire consists of 20 questions covering functional limitation, physical discomfort, psychological discomfort, physical disability and social disability.[19]

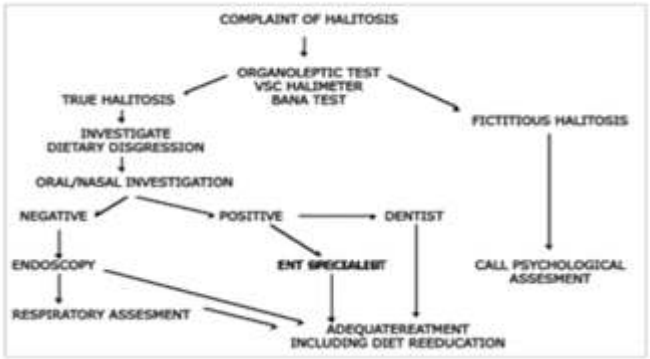

Figure 6: Flowchart suggested for Halitosis Assessment[20]

Questions
Q1. Mainly mouth breathing
Q2. Frequent tonsillar infections
Q3. Frequent sinus infections
Q4. Worrying about or self conscious about your mouth breath
Q5. Miserable or tense due to halitosis
Q6. Difficulty chewing or limiting certain food due to halitosis
Q7. Change of taste
Q8. Problems speaking (or mouth covering) due to halitosis
Q9. Appearance affected due to halitosis
Q10. Depressed due to mouth breath
Q11. Problems concentrating due to halitosis
Q12. Embarrassed due to halitosis
Q13. Spending time related to halitosis
Q14. Talking from afar due to halitosis
Q15. Avoid going out due to halitosis
Q16. Communication problems due to halitosis
Q17. Mentioned about halitosis
Q18. Suffer financial loss due to halitosis
Q19. Suffer social/personal loss due to halitosis
Q20. Reduced life satisfaction due to halitosis

Figure 7: Halitosis QOL Questionnaire[19]

Management of Oral Malodor

General measures

- Identification and treatment of contributing factor
- Avoid foods like onions, garlic and spices
- Avoid habits that may worsen breath odor such as alcohol and tobacco
- Brush your teeth regularly and after meals and keep oral hygiene regular and good
- Rinse at least twice daily with chlorhexidine, triclosan, essential oils or other mouthwashes
- Brush your tongue with tongue scraper.
- Keep your mouth as moist as possible
- Dentures should be kept out at night in hypochlorite or chlorhexidine[21]

The first step towards effectively managing oral .halitosis is to determine the cause for halitosis (oral or systemic) and the nature of halitosis. The therapy consist of: (i) Mechanical reduction of the intra-oral nutrients and micro-organisms; (ii) Chemical reduction of microorganisms; (iii) Inverting volatile fragrant gasses into non-volatile components or (iv) Masking of the malodour.[22]

1. Mechanical reduction of the intra-oral nutrients and micro-organisms:

a) Tongue cleaning, interdental cleaning and toothbrushing are essential mechanical means of dental plaque control.[23]

b) A systemic review by Van der Sleen et al[24] demonstrated that tongue brushing or tongue scraping have the potential to successfully reduce breath odour and tongue coating. Due to tongue cleaning, the taste seems to improve again. Interdental cleaning and toothbrushing are also necessary to control plaque and oral microorganisms.

2. Chemical reduction of oral microbial load:

a) Mouthwashes have been used as chemical approach to combat oral malodor. Antibacterial components in oral rinses such as cetylpyridinium chloride (CPC), chlorhexidine (Halita), triclosan, essential oils, quaternary ammonium compounds, benzalkonium chloride and hydrogen peroxide have been considered along with mechanical approaches to reduce oral m.alodour.[25]

b) In a recent Cochrane review by Fedorowicz (2008)[26] only five randomized controlled trials could be found, involving 293 participants. In view of the clinical heterogeneity between the trials, pooling of the results and a meta-analysis of the extracted data was not feasible. Compared to placebo, 0.05% chlorhexidine10.05% cetylpyridinium chloride 0.14% zinc lactate mouthrinse significantly reduced the organoleptic scores, but showed significantly more tongue and tooth staining. It is concluded that this mouthrinse plays an important role in reducing the levels of halitosis producing bacteria on the tongue and can be effective in neutralization of odoriferous sulphur compounds.

3. Rendering malodorous gases non-volatile:

a) Zinc salt containing mouthwashes , baking soda dentifrices and chewing gum formulated with antibacterial agents and tea extracts like epigallocatchin are used.[21]

b) Supanee et al in 2012[27] determined the effect of green tea mouthwash on oral malodor, plaque, and gingival inflammation stating that green tea mouthwash could significantly reduce VSC level in gingivitis subjects after rinsing for 4 weeks.

4. Masking the malodour with mouth sprays and lozenges containing volatiles with a pleasant odor:
a) The use of probiotics to suppress oral malodor is now being recognized. Probiotics, as defined by the Food and Agriculture Organization (FAO), are live microorganisms administered in adequate amounts that confer a beneficial health effect on the host.[28]
b) Kazor et al (2008)[29] compared the bacterial populations on the dorsal surface of the tongue in healthy subjects and people with halitosis. Streptococcus salivarius was found to be the predominant species in healthy subjects, but was typically at low levels or absent in those subjects suffering from halitosis. Hence, probiotic bacteria may have potential application as adjuncts for the prevention and treatment of halitosis.
5. Other methods of managing malodor include chewing parsley, mint, cloves, or fennel seeds. Some herbs like alfalfa, cardamom, chamomile, myrrh, rosemary, and sage are also known to reduce halitosis.[30]

Conclusion

Halitosis or breath malodor may be an indicator for medical problem and in many cases may cause significant social problem. A proper diagnosis and determination of the etiology allows initiation of proper etiologic treatment. Recent developments in the understanding of the etiologies of breath malodor have spawned new techniques for its assessment and management. Hence, dental physicians should take up the responsibility of ruling out the etiology and follow a multiphase approach and redirect the patient accordingly. The role of periodontist/ physician in treating halitosis is ineluctable.

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