Halitosis

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Overview

Halitosis can be an important social problem in which the standard dental treatments and mouthwashes that are often recommended provide only temporary relief. Oral malodor is primarily the result of microbial metabolism. The mouth is home to hundreds of bacterial species with various nutritional preferences. These organisms digest proteins, and several fetid substances arise, leading to bad breath. Oral malodor from the overgrowth of proteolytic, anaerobic gram-negative bacteria on the crevices of the tongue dorsum can be successfully diagnosed and treated.

Epidemiology

The epidemiological studies suggest the prevalence of objectionable halitosis (bad breath) is about 2.4% of the adult population. According to the National Institute of Dental Research, about 65 million Americans suffer from halitosis (bad breath) at some point in their lives.[1]

Etiology

The mouth is home to hundreds of bacterial species with various nutritional preferences. These organisms usually enjoy proteins, and as they digest proteins several fetid substances arise. The role of volatile sulfur compounds (VSCs) in producing bacteria that colonize over the tongue was recently understood as a main cause of halitosis (bad breath). The most common VSCs, such as methylmercaptan and hydrogen sulfite, can be detected by using organoleptic and objective methods, which can identify and localize the source.[1]

History

Bad breath (halitosis) has been with us for thousands of years. The problem is discussed at length in the Jewish Talmud and has been described by Greek and Roman writers.[2, 3] Islam also stresses fresh breath in the context of good oral hygiene. Ancient folk remedies that are still in use abound. Chapter 37 of the book of Genesis mentions ladanum (mastic), a resin derived from the *Pistacia lentiscus* tree, which has been used in Mediterranean countries for breath freshening for thousands of years.

Other folk cures include parsley (Italy), cloves (Iraq), guava peels (Thailand), and eggshells (China).[4, 5] Experimental research on the subject dates back over 60 years.[6, 7] Since the 1960s, the preeminent researcher in this field has been Tonzetich. He and coworkers established that oral malodor (bad breath) is associated with the presence of volatile sulfur compounds, primarily hydrogen sulfide and methylmercaptan.[8, 9]

Pathogenesis

In most cases (perhaps 85%), bad breath (halitosis) comes from the mouth itself.[2, 5, 7, 8, 9] The simplest way to distinguish oral from nonoral etiologies is to compare the smell coming from the patient's mouth with that exiting the nose.[6] In people with rigorous oral hygiene, good dentition and a healthy periodontium, the main cause of bad breath (halitosis) is likely to be the back of the tongue.[6, 9] People whose tongues are deeply grooved or furrowed have more potential to accumulate the white coating than those with smoother tongue surfaces. A coating 0.1-0.2 mm thick can deplete an environment of oxygen. The bacteria that cause bad breath can flourish in this type of "anaerobic" environment.

Research has shown a direct correlation between the amount of coating on a person's tongue and the total number of anaerobic bacteria present in the coating. An improvement in the odor emanating from the mouth is usually seen as the anaerobic bacterial count on a person's tongue is reduced.

Dentures are another important cause of oral malodor (bad breath), particularly if they are worn overnight. Usually the odor has a somewhat sweetish but unpleasant typical character and is readily identifiable, particularly if the dentures are placed in a plastic bag and smelled after several minutes.[9]

Saliva plays a big role in bad breath (halitosis) elimination. Bad breath (halitosis) levels during the day are inversely related to saliva flow. When saliva flow is lowest during the night, following fasting and due to insufficient water intake, the intensity of bad breath (halitosis) rises. Conversely, mastication increases saliva flow, with concomitant cleansing of the oral cavity and reduction in malodor.[8] Despite these common observations, the data from 2 clinical studies did not support any association between saliva flow rate and malodor levels. One possible explanation for the latter observation is that malodor arises primarily in an alkaline microenvironment, whereas the saliva in patients with xerostomia is often acidic. The most common bacterium found among people with fresh breath was *Streptococcus salivarius*. This bacterium was present in only 1 out of 6 people with halitosis (bad breath), at extremely low levels.

The role of the tonsils in chronic bad breath (halitosis) is unclear. The appearance of a transient odor during tonsil infections in adults and children is common. Although they may appear normal upon visual examination, when tonsils are pressed with a tongue blade they can emit foul smelling exudates. Dilated and deep tonsillar crypts may contain tonsilloliths. These soft stones are usually several millimeters in diameter, rough edged, white or yellowish in color, and have a foul odor, particularly when pressed.[9]

Odors Originating Outside the Mouth

Among the nonoral etiologies of bad breath (halitosis), the nasal passages predominate. In such cases, the telltale odor can be smelled most strongly from the nose, rather than the mouth. Nasal odor may be indicative of nasal infection or a problem affecting airflow associated with thick mucous secretions. Typical nasal malodor (rhinohalitosis) usually has a slightly cheesy character and differs appreciably from other types of bad breath.[9] People who suffer from excessive postnasal drip with chronic sinus problems are more prone to bad breath.

Many nonoral systemic conditions, such as bronchial and lung infections, kidney failure, various carcinomas, metabolic dysfunctions, and biochemical disorders, can result in bad breath, but all these taken together account for only a very small percentage of those who suffer from the general problem of halitosis (bad breath). One interesting rare metabolic condition that leads to a perception of foul fishy odor and/or taste is trimethylaminuria. Whereas "acetone" breath was once considered a diagnostic indication for uncontrolled diabetes, very few cases are currently encountered.

Contrary to common thinking, bad breath (halitosis) from the gastrointestinal tract is considered to be extremely rare.[6, 7, 9, 10] The esophagus is normally collapsed and closed, and whereas the occasional belch may carry some odor up from the stomach, the possibility of gastric air reflux continuously escaping from the mouth and nose is very remote.

Generally, the incidence of systemic disorders causing for oral malodor (bad breath) amounts to only 1-2% of the halitosis clinic visits.

Diagnostic Methods

Oral malodor (bad breath) can be measured in a number of ways, including studies using organoleptic intensity and organoleptic hedonic indices and instruments that quantitate the amount of volatile compounds or bacterial enzymes that contribute to the production of odiferous compounds.

Organoleptic measurements or the use of one's nose to smell and rank the intensity of odors are considered the criterion standard for the measurement of malodor. However, these tend to be subjective and are uncomfortable for both the examiner and the test subject. Either a 5-point or a 10-point scale can be used and, usually, 2 separate judges evaluate the degree of halitosis (bad breath). The intensity of halitosis (bad breath) is based on the Rosenberg scale, which rates odor intensity and is as follows:

- 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

Instrumental Analysis

The level of intraoral volatile sulfur compounds (VSCs) can be estimated chairside, using portable sulfide monitors such as the Halimeter (Interscan Corp, Chatsworth, California). Sensors for VSCs have been incorporated into probes and paddles, which can be placed directly on the tongue for measurement (Diamond Probe, Ann Arbor, Michigan). The recent advances are in the field of a VSC monitor, which uses a zinc oxide sensor (electronic nose) for an objective quantification of halitosis.

Despite the advantages of the tests mentioned above, clinicians interested in diagnosing bad breath must still rely on their noses to distinguish the main types of oral odors. These include the following:

- Periodontal-type odor that usually comes from periodontal pockets and interdental spaces
- Odor from the posterior tongue dorsum
- Denture odor
- Characteristic nasal odor

With practice and experience, these odors become distinct and recognizable, even when found in various combinations.

Bacteriologic Analysis

Given the multiple sites of malodor production, a complete head and neck examination including nasal endoscopy, flexible laryngoscopy, and site-directed cultures are indicated, as well as measurement and quantification of malodor.

Bacteriologic analysis from the biofilm and scraped specimens obtained from the tongue dorsum or other oral sites can identify the VSC-producing bacteria. *Porphyromonas, Prevotella, Actinobacillus,* and *Fusobacterium* species were the most common organisms identified from cultures. These were primarily on the tongue dorsum, gingival pockets, and tonsil crypts.

The culture from the tongue is different than the culture from the periodontal plaques. *Treponema denticola*, *Porphyromonas gingivalis*, and *Bacteroides forsythusare the odor-causing bacteria found on the teeth*, whereas anaerobic asaccharolytica species such as *Prevotella* (eg, *Prevotella oralis*) are found on the tongue.

Pathogens are usually detected using culturing techniques. Because there is an inherent bias in detecting organisms by traditional culturing techniques, polymerase chain reaction (PCR) is now used to detect bacterial species. PCR methodologies have been optimized for quick and accurate determination of bacterial gene expression in different sites of the oral cavity.

PCR has rapidly become one of the most widely used techniques in molecular biology; it is rapid, inexpensive, simple, and can produce relatively large numbers of copies of DNA molecules, even when the source DNA is of relatively poor quality (ie, saliva or tongue coating). Recent studies using real-time PCR provided quantitative analysis of 5 common bacteria responsible for oral malodor in saliva and on tongue coat. These are as follows: *P gingivalis, Tanerella forsythia, Fusobacterium nucleatum, Prevotella intermedia, and T denticola.* The results suggest that this assay system for analyzing the relationship between oral bacteria and halitosis (bad breath) is a helpful tool for monitoring the effectiveness of different therapeutic modalities.

The bacteriology of the oral cavity in halitosis with regards to VSC production is as follows:

- H_2 S from cysteine
  - *Peptostreptococcus anaerobius*
  - *Micros prevotii*
  - *Eubacterium limosum*
  - *Bacteroides* species
  - *Centipedia periodonti*
  - *Selenomonas artermidis*
- CH_3 SH from methionine
  - *Fusobacterium nucleatum*
  - *Fusobacterium periodontium*
  - *Eubacterium* species
  - *Bacteroides* species
- H_2 S from serum
  - *Prevotella intermedia*
  - *Prevotella loescheii*
  - *Porphyromonas gingivalis*
  - *Treponema denticola*
- CH_3 SH from serum
  - *Porphyromonas gingivalis*
  - *Treponema denticola*
  - *Porphyromonas endodontalis*

Treating Bad Breath

The best way to treat bad breath (halitosis) is to instill patients with good oral hygiene practices.[8, 11] Although patients often balk at using dental floss, compliance improves once the connection is made between flossing and fresh breath (eg, just by asking the patients to smell their own floss following each passage). In one study, subjects who flossed were found to have significantly less mouth odor (P =0.016), saliva odor (P < 0.001), and salivary cadaverine levels (P =0.011) than those who did not.[7] Furthermore, one year following the initial oral malodor examination, the percentage of subjects who flossed their teeth rose from 31% to 65%. Other interdental cleaners (eg, anatomic plastic toothpicks) can also be effective in identifying and cleaning sites of odor production.

Mechanical reduction of malodor (bad breath) can be achieved by reducing the intraoral bacterial count by disrupting the tongue biofilm, thus decreasing the production of volatile sulfur compounds (VSC) or volatile organic compounds (VOCs). The common methods used include tongue brushing, tongue scraping, and chewing gum. Gentle but effective deep tongue cleaning should be an important daily routine. A variety of tongue brushes and scrapers have been produced in recent years. The tongue should be brushed in a gentle but thorough manner, in a posterior to anterior direction, keeping in mind that the least accessible posterior portion smells the worst.[6, 7, 9, 12] Even patients with a significant gagging reflex can get used to cleaning the back of their tongue with some practice. Because bad breath is worse when the mouth dries out (eg, at night, while fasting), subjects should be encouraged to maintain a good hydration.

Many people continue to have malodor of oral origin, even after carrying out oral hygiene practices. In such instances, rinsing and gargling with an efficacious mouthwash may be advised. Keep in mind, however, that many mouthwashes contain components that may have a nonbeneficial effect on oral soft tissues (eg, alcohol, sodium dodecyl sulfate, strong oxidizing agents). The best time to use a mouthwash is probably before bedtime because the residue of the mouthrinse may remain in the mouth for a longer period of time and have a greater effect and because the bacterial activity leading to bad breath (halitosis) is greatest during the nighttime, when saliva flow is practically zero and microbial activity is highest.[8]

Although an individual's bad breath (halitosis) following consultation and treatment may dramatically reduce, the patient may find it difficult to sense the improvement. This problem can be addressed with the help of a "confidant," who can help monitor changes over time.

In addition to mechanical means and normal oral hygiene procedures, the reduction of oral malodor (bad breath) is achieved by the use of active chemical agents. Active chemical means includes the delivery of the active antimicrobial compounds via mouth rinses, dentifrices, or lozenges. These compounds decrease the bacterial load and thus decrease the VSC and VOC production.

Other methods to reduce halitosis (bad breath) include changes in diet (reducing substrate for VOC production), especially in a high-protein diet. Preventing the drying of the oral mucosa by hydration and stimulation of salivary flow can improve oral malodor (halitosis) due to the presence of lysozymes in saliva, causing inhibition of bacterial growth.

The volatile organic compounds in the oral cavity are as follows:

- Sulfur compound set
    - Hydrogen sulfide - $H_2 S$
    - Methylmercaptan - $CH_3 SH$
    - Methanethiol
    - Allyl mercaptan
    - Dimethyl sulfide
    - Dimethyl disulfide
    - Dimethyl trisulfide
- Short-chain fatty acid
    - Propionic acid
    - Butyric acid
    - Valeric acid
    - Isocaproic acid
    - Capric acid
    - 2- and 3- Methyl butyric acid
    - Lauric acid
    - Myristic acid
- Polyamines
    - Cadaverine
    - Putrescine
    - Alcohols
    - 1-peopoxy-2-propanol
- Phenyl compounds
    - Indole
    - Skatole
    - Pyridine
- Alkanines (eg, 2-methypropane)
- Ketones
- Nitrogen-containing compounds
    - Urea
    - Ammonia

Areas of Future Research

The future of oral malodor diagnosis and treatment includes the production of an electronic nose for quantification of all volatile organic compounds (VOCs) and not volatile sulfur compounds (VSCs) alone to properly quantify malodor-causing compounds. In the treatment arena, the use of ultrasonic disrupters of the biofilm, laserlike light devices, and lasers hold good promise when used in isolation or in conjunction with photoactive chemical compounds.

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