Volatile sulfur compounds (such as hydrogen sulfide, methyl mercaptan, dimethyl sulphide) and certain acids and amines (propionic and acetic acids, cadaverine and putrescine) are occasional ingredients in the gas mixture which is exhaled air. These substances arise primarily from putrefaction of the sulphur-containing amino acids within large proteins through the action of host and bacterial proteases, with Gram-negative anaerobes featuring in the latter. Many practitioners will recall the unique sulphurous odour of tissue fragments removed from necrotic teeth on a barbed broach or endodontic file, since the same bacterial putrefaction processes occur within the root canal space of non-vital teeth.

Although nocturnal salivary hypofunction; thick deposits of supra and sub-gingival dental plaque; and long-standing untreated periodontitis are common contributors to halitosis, recently the emphasis has shifted to accumulations of bacterial plaque and debris on the posterior aspects of the tongue. Most studies link one or more of these oral causes to nearly 90% of cases of halitosis, with the remainder being systemic in nature (e.g. postnasal drip and ENT disease, liver cirrhosis, and untreated diabetes mellitus).

Find it
Salivary dysfunction can be screened for readily using the Saliva Check Buffer kit (GC Corporation), while the maturity of plaque deposits in the mouth can be rapidly assessed using the 2-tone plaque disclosing system in the GC Plaque Check + pH kit. This stains mature plaque blue and thin, immature plaque red. A more high technology approach is the Morita Penscope (Penviewer), which in addition to a conventional white LED-illuminated miniature intraoral camera has an additional camera with 4 visible violet/blue short wavelength LEDs and a filter on the corresponding CMOS sensor which shows mature plaque deposits in red because of their fluorescence properties.

Measure it
Sulphide monitors have been used widely for halitosis assessment. Interscan’s Halimeter®, which was the first unit specifically designed to measure VSC in clinical dental practice, shows an aggregate of all VSCs (in parts per billion, ppb) rather than a breakdown of the main components. It has a low sensitivity for methyl mercaptan (which has been linked to periodontitis) but high sensitivity for hydrogen sulphide. The Halimeter does however allow a rather useful recording of the total VSC level to be obtained in the form of a chart recording which is appropriately named a Haligram®.

Feeling somewhat behind the scene, the author admits to having in his possession a stationary industrial gas measurement system (Draeger) which measures upwards of 200 ppb for hydrogen sulphide, but without the digital readouts or data recording of the OralChroma or Halimeter. It employs a chemical reaction which gives a visible reaction product rather than an electronic sensor.

The latest technology for assessing oral malodour is the portable gas chromatograph. Seasoned airline travelers will be familiar with the use of these devices at airline security checkpoints for detecting explosives and illicit drugs. The same technology has now recently become available for dental practice in the form of the OralChroma™, a portable gas chromatograph which measures in a sample of mouth air the levels of three key VSCs, namely hydrogen sulfide, methyl mercaptan, and dimethyl sulfide. The role of these VSCs in oral malodour has been shown in many studies, but previous gas chromatography equipment was so bulky that its use was confined to research, where it has appropriately served for many years as the “gold standard”.

OralChroma data can be downloaded to a personal computer via a serial or USB cable, and OralChroma Data Manager software will graphically display the sensor responses on a computer screen, and save the data. An interesting feature is that Data Manager software allows individual values for the “halitosis perception threshold” to be set in the range of 0 to 1,000 for each gas component (most individuals will notice objectional mouth odour at VSC levels above 75 ppb). The manufacturers suggest that in cases where the causes are not apparent, the differential assessment of the three components can be worthwhile, for...
example, unusually high levels of methyl mercaptan have been linked to untreated periodontitis. This of course cannot substitute for a thorough history and careful clinical examination (including periodontal probing!). Nevertheless, measuring each major component also allows cases of pseudo-halitosis (imaginary halitosis) to be identified and formally excluded, so that the patient can be referred for appropriate psychological or psychiatric care if indicated.

Treat it

1. **Tongue cleaners** - The range of treatments and remedies currently available for halitosis continues to expand, with tongue cleaners now included on a number of “mainstream” toothbrushes. These are used to clean the dorsal surface of the tongue thoroughly, specifically to remove the protease-producing anaerobic bacteria that produce VSCs, along with other bacteria, epithelial squames and foreign matter. This is not as simple a task as it first appears, since the dorsum of the tongue is irregular and its fissures are ideal low-oxygen ecological niches for anaerobic bacteria, which are protected there from the antimicrobial systems present in saliva.

2. **Replacement therapy with *Streptococcus salivarius* (BLIS K12)** - The term BLIS is an abbreviation for bacteriocin-like inhibitory substances, molecules which are produced by many bacteria as a means for establishing and maintaining microbial microenvironments. *S. salivarius* is the only probiotic that can live in high numbers on the dorsal surface of the tongue. Moreover, laboratory testing has shown that a naturally occurring strain of *S. salivarius* (K12) suppresses the growth of Gram negative anaerobic (black-pigmented) bacteria which have been implicated in halitosis. Healthy individuals with low levels of VSCs have a high proportion of *S. salivarius* on the dorsum of the tongue (up to 40% of the cultivable flora), whereas sufferers of chronic halitosis have very low levels.

The concept of using BLIS K12 as a probiotic agent was developed by Professor John Tagg, a microbiologist at the University of Otago. Based on his work, there are now a range of BLIS K12 products, which are also known as KForce™. Treatment for halitosis involves using a chlorhexidine pre-rinse to alter the oral microbial ecology before introducing the *S. salivarius* (via lozenges). A recent placebo-controlled clinical study has shown that using BLIS K12 used in chronic halitosis sufferers resulted in the majority of subjects (85%) achieving a significant reduction in VSCs and in bacterial proteolytic (BANA) activity.

Of interest, the same probiotic approach may also have value in altering the ecology of dental plaque to prevent dental caries, given that a number of oral bacteria are known to produce BLIS activity against *Streptococcus mutans*. Clinical approaches that are under investigation in this regard by the group in Otago include the regular oral administration of the purified BLIS molecules, and the genetic modification of existing plaque bacteria such that they produce significant quantities of the anti-mutans BLIS in situ.

3. **Biocides** - Antimicrobial agents which have been used successfully include chlorhexidine, Triclosan products such as Colgate Total™, essential oils (Listerine™), and cetylpyridinium chloride (BreathRx™).

4. **Zinc ions** - Topical therapies can deliver bio-available zinc ions which bind to protein receptors on the surface of oral bacteria, preventing the proteins binding and being metabolized. Such products are generally formulated with stabilized chlorine dioxide (e.g. Tri-Oral™ rinse, Oxygene™).

5. **Oxidizing mouthrinses and sprays** - These agents convert VSCs chemically into non-odourous harmless compounds and exert actions against the strictly anaerobic bacteria which lack catalase and thus find oxygen based molecules toxic to their normal metabolism. Examples of oxidizing products include sodium chlorite and “stabilized” chlorine dioxide (Therabreath™, CloSYST™, ProFresh™, DixoCare™), other oxychlorine compounds, hydrogen peroxide mouthrinses (Colgate Peroxyl™, Listerine Whitening™), and freshly ozonated water. Of these, recent interest has focused on the latter, since water can be ozonated on demand at the chairside for use in mouthrinsing. Ozonated water has been shown by the Belfast research group of Professor Ed Lynch (inventor of the Healozone) to oxidize the sulphur-containing amino acids cysteine and methionine, which serve as chemical precursors for VSCs, into their corresponding primary oxidation products cystine and methionine sulfoxide.

**Recommended reading**