Halitosis is the general term used to describe any disagreeable odour in expired air, regardless of whether the odorous substances originate from oral or non-oral sources. It is a cause of concern for people as it affects their interpersonal communication with ensuing personal discomfort and social embarrassment. With introduction of various modalities it is possible to establish a quick diagnosis and thereby help solve the problem. This review article gives an overview of classification, etiology and diagnosis halitosis.

Keywords: Diagnosis, Halitosis, Periodontal disease

INTRODUCTION:
Halitosis is a concern for millions of people that affects their interpersonal communication with ensuing personal discomfort and social embarrassment. Even though its existence has been recorded in the literature for thousands of years; it has been a neglected quandary until recently. With the advent of exclusive malodor clinics and cosmetic industries specifically targeting this problem, the situation seems to be changing. Oral malodor ranks now only behind dental caries and periodontal disease as the cause of patient’s visit to the dentist. This review article gives an overview of classification, etiology and diagnosis halitosis.

Definition and Classification
Halitosis is the general term used to describe any disagreeable odour in expired air, regardless of whether the odorous substances originate from oral or non-oral sources. Oral malodor (also known as bad breath, fetor ex ore) specifically refers to such odor originating from the oral cavity itself. Breath malodor should not be confused with the momentarily disturbing odor caused by food intake or smoking, or ‘morning bad breath’ as habitually experienced on awakening, which disappears after oral hygiene.

A. Classification of halitosis (Yaegaki K & Coli M, 2000)
I. 1) Pseudo halitosis.
2) Genuine halitosis.
   - Physiologic
   - Pathologic
3) Halitophobia.
II. Halitosis due to local factors of pathological origin.
III. Halitosis due to local factors of non-pathological origin.
IV. Halitosis due to systemic factors of pathologic origin.
V. Halitosis due to systemic factors of non-pathologic origin.
VI. Halitosis due to systemic administration of drugs.
VI. Halitosis due to xerostomia.

B. Classification of halitosis (Miyazaki et al., 1999; Yaegaki and Coil, 2000)

1) Genuine halitosis
   a) Physiological halitosis
   b) Pathological halitosis
   2) Pseudo halitosis
   3) Halitophobia

C. Classification of halitosis by Miyazaki H et al., 1999

### Table 1: Classification of halitosis with corresponding treatment needs (TN)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Classification</th>
<th>Treatment Needs (TN)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>Genuine halitosis</td>
<td></td>
<td>1. Obvious malodour, with intensity beyond socially acceptable level, is perceived.</td>
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<tr>
<td></td>
<td>A. Physiologic halitosis</td>
<td>TN-1</td>
<td>1. Malodour arises through putrefactive process within the oral cavity. Neither specific disease nor pathologic condition that could cause halitosis is found. 2. Origin is mainly the dorso-posterior region of the tongue. 3. Temporary halitosis due to dietary factors (e.g., garlic) should be excluded.</td>
</tr>
<tr>
<td></td>
<td>B. Pathologic halitosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(i) Oral</td>
<td>TN-1 and TN-2</td>
<td>1. Halitosis caused by disease, pathologic condition or malfunction of oral tissues. 2. Halitosis derived from tongue coating, modified by pathologic condition (e.g., periodontal disease, xerostomia), is included in this subdivision.</td>
</tr>
<tr>
<td></td>
<td>(ii) Extra-oral</td>
<td>TN-1 and TN-3</td>
<td>1. Malodour originates from nasal, paranasal and/or laryngeal regions. 2. Malodour originates from pulmonary tract or upper digestive tract. 3. Malodour originates from disorders anywhere in the body whereby the odour is bloodborne and emitted via the lungs (e.g., diabetes mellitus, hepatic cirrhosis, uremia, internal bleeding).</td>
</tr>
<tr>
<td>II.</td>
<td>Pseudo-halitosis</td>
<td>TN-1 and TN-4</td>
<td>1. Obvious malodour is not perceived by others, although the patient stubbornly complains of its existence. 2. Condition is improved by counselling (using literature support, education and explanation of examination results) and simple oral hygiene measures.</td>
</tr>
<tr>
<td>III.</td>
<td>Halitophobia</td>
<td>TN-1 and TN-5</td>
<td>1. After treatment for genuine halitosis or pseudo-halitosis, the patient persists in believing that he/she has halitosis. 2. No physical or social evidence exists to suggest that halitosis is present</td>
</tr>
</tbody>
</table>

D. Classification of halitosis (Patil SH et al. 2012)

I. True halitosis
   a) Physiological (Transient or temporary)
   b) Pathologic.
ETIOLOGY
A. INTRA ORAL CAUSES - Halitosis occurs in patients with conditions that favour the accumulation of food and bacterial plaque on intraoral surfaces (teeth, gingiva and mucosal tissues, especially the dorsum of the tongue) and the development of anaerobic ecosystems. Predisposing factors include poor oral hygiene, dental plaque, dental caries, gingivitis, stomatitis, periodontitis, tongue coating, dry mouth (xerostomia), oral carcinoma, acute necrotizing ulcerative gingivitis (ANUG), dry sockets, ulcers and healing wounds, tongue coating osteomyelitis, osteonecrosis, malignancy and wearing dental appliances.\(^1,2,8\)

B. EXTRA ORAL CAUSES - Halitosis is less frequently associated with extra-oral causes i.e. conditions and diseases that do not affect primarily the oral cavity. These include:
1. Respiratory system (microbial etiology) Sinusitis, Antral malignancy, Cleft palate, Foreign bodies in the nose, Nasal malignancy, Tonsilloliths, Tonsillitis, Pharyngeal malignancy, Lung infections, Bronchitis, Bronchiectasis, Lung malignancy, etc.
2. Gastrointestinal tract Esophageal diverticulum, Gastro-esophageal reflux disease and Malignancy.
4. Drugs (blood borne) such as Amphetamines, Chloeral hydrate, Cytotoxic agents Dimethyl sulphoxide, Disulfiram, Nitrates and nitrites, Phenothiazines, Solvent abuse
5. Psychogenic causes

DIAGNOSIS
A persistent breath malodor, by definition, does reflect some pathology. Hence only a proper diagnosis and determination of the etiology allow initiation of the proper etiologic treatment.\(^5\) Much as in any other diagnosis, patient history and physical examination are valuable tools. Questions directly pertaining to the malodor should be related to
1) duration of the odor, 2) if it occurs at particular times during the day, 3) if others have noticed it, 4) if it is completely self-recognized and 5) whether the patient is taking any medications that cause dry mouth.\(^2\)

**Various test for diagnosis includes:**

a) SELF-EXAMINATION: When an intraoral cause has been identified, involve the patient in monitoring the results of therapy by self-examination by • 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.\(^9\)

b) ORGANOLEPTIC ASSESSMENT: Organoletic or hedonic assessment is considered a kind of reference standard of oral malodor measurement.\(^10\) Organoletic measurement is a sensory test scored on the basis of the examiner’s perception of a subject’s oral malodor. The clinician sniffs the air exhaled from the mouth and nose and subjectively defines the presence or absence of malodor. Smelling both nose and mouth air is important as malodor
detectable from the nose alone (asking the patient to breathe while the mouth is closed) is likely to come from the nose or the sinuses, or from respiratory or gastrointestinal tracts. The organoleptic evaluation of oral malodor also includes other simple tests such as tongue odor test, dental floss odor test and saliva odor test.

c) PORTABLE VOLATILE SULPHIDE MONITOR It is an apparatus that is designed to measure volatile odorous substances (sulphur gases) in a semi-quantitative manner. It uses an electrochemical gas sensor cell and has become the primary tool in chronic halitosis research and diagnosis. It is approximately twice as sensitive to H2S as it is to CH3SH. It is compact, relatively inexpensive portable, easy to use. Few of them are Tanita breath alert, Osmoscope, Halimeter and diamond probe. Rosenberg M et al. elucidated that although assessment of steady-state sulphide levels by the sulphide monitor does not constitute a direct measure of oral malodor, its relation to organoleptic measurement, superior reproducibility, objectivity, and sensitivity support the use of the sulphide monitor in clinical studies.

d) GAS CROMATOGRAPHY It is by far the most appropriate method to detect halitosis of different origins and is an objective means to obtain exact values for the various odorous volatiles and is considered as a method of choice for differentiating and quantifying the volatile sulphur compound and (especially if it runs with a Mass Spectrometry Detector) can also distinguish other classes of compound (e.g. indole). It can thus be of considerable value in controlled clinical studies of malodor, and might also be a valuable diagnostic tool within a specialised malodor clinic environment.

e) HLITOX REAGENT KIT: A chair side test kit (Hlitox reagent kit) measures the halitosis linked toxins. It is quick, simple colorimetric test that detects both volatile sulphur compounds such as hydrogen sulphide and methyl mercaptan as well as polyamines like putrescine and cadaverine.

f) BANA Test: It is an effective test kit in identifying the main odoriferous periodontal microorganisms. It is a rapid chair side investigation that assesses the proteolytic activity of anaerobic bacteria and for evaluation of non-sulfurous malodorous compounds.

g) ELECTRONIC NOSE: The FF-1 odor discrimination analyser (Electronic nose, Shimadzu Corporation) was used by Tanaka et al. The set up comprised of a pre-concentrator, an array of 6 metal oxide semiconductor sensors selected for their different sensitivities and selectivity’s to fragrant substances, and a pattern recognition software. The instrument can be set to various modes such as the “all note measurement mode” which is the standard setting used for measuring all volatile substances and the “top note measurement mode” which primarily measures volatile substances with a low boiling point.

h) DARK FIELD/PHASE CONTRAST MICROSCOPY: since intra oral causes of halitosis include Gingivitis and periodontitis both of which are associated with a higher incidence of motile organisms and spirochetes, so shifts in these proportions allow monitoring of therapeutic progress.

i) BACTERIAL CULTURING: 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.  

j) DIAMOND PROBE/PERIO 2000: It is a dental device designed to detect sulphide concentration of various forms 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. The micro-sulphide sensor responds to sulphide ions and measures metabolic products of many anaerobic bacteria and, indirectly bacterial activity. The reaction of the sulphide ions with the sensor generates a measurable voltage that is proportional to the sulphide concentration. Since sulphides are continually cleared from the pockets by crevicular fluid flow, the presence of high sulphide levels indicates a higher level of anaerobic bacterial activity.  

k) UTILIZING CHEMILUMINESCENCE One of the most recent methods for detecting the compounds associated with bad breath. Method was introduced in 1999. When a sample containing sulfur compound is mixed with the tests mercury compound, the resulting reaction causes fluorescence. It provides better selectivity and sensitivity when measuring low levels of sulfur compounds as compared to halimeters.  

l) SALIVA INCUBATION TEST: The analysis of the headspace above incubated saliva by gas chromatography reveals hydrogen sulfide, methyl mercaptan, dimethyl sulfide, indole, skatole, lactic acid, methionaline, diphenylamine, cadaverine, putrescine, urea, ammonia, dodecanol, tetradecanol, and others. These components are elevated in the presence of periodontitis, although this does not necessarily prove they play a role in odor production. By adding some proteins, such as lysine or cysteine, the production of cadaverine or hydrogen sulphide is dramatically increased. Organoleptic evaluation of the saliva headspace offers promising perspectives for monitoring treatment results. It is a less invasive test, especially for the patient, than smelling breath in front of the oral cavity.  

m) β-GALACTOSIDASE TEST: Among the most common sources of protein for malodor production are salivary mucins and epithelial cell components, both of which contain numerous glycoproteins. Since the proteolysis of glycoproteins depends on initial removal of the carbohydrate side-chains, deglycosylation is an initial step in oral malodor production. β-galactosidase is one of the important enzymes responsible for the removal of both O- and N-linked carbohydrate side-chains. Salivary levels of this enzyme were found to be correlated with oral malodour.  

n) PCR It is rapid, inexpensive, and simple and can produce relatively large numbers of DNA copies, even if the source DNA is of relatively poor quality (e.g. from saliva or the tongue coating). PCR methodologies have been optimized for quick and accurate determination of bacterial gene expression from different sites in the oral cavity. Real-time PCR provided quantitative analysis of 5 common bacteria responsible for oral malodor in saliva and lingual dorsum, namely Porphyromonas gingivalis, Tannerella forsythia, Fusobacterium nucleatum, Prevotella intermedia, and Treponema denticola. These results suggest PCR may be a helpful tool for
analyzing the relationship between oral bacteria and halitosis, and for monitoring the effectiveness of various therapeutic modalities.14

CONCLUSION
Oral disease can lead to impairments on several dimensions in the physical, the psychological and the social domain. Bad breath also has a significant impact on social life to those who suffer from it. Since bad breath usually comes from the mouth itself, the dentist should be the first professional whom individuals turn for help. In recent years, there has been a growing awareness that bad breath is a problem that the dental profession should recognize and address. Oral malodor is a phenomenon that is often oversimplified by the commercial dental industry, misunderstood by the general society, and not completely understood by the scientific community. A plethora of qualitative and quantitative methods for the measurement of oral malodor employed routinely and only proper diagnosis and determination of the etiology allow initiation of the proper treatment.

REFERENCES