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THE UNIVERSITY OF
**WESTERN
AUSTRALIA**

Dry Mouth



Lecture outline

- Saliva
- Mouth dryness as a sign and a symptom
- Intra-oral and extra-oral implications of mouth dryness
- Management



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- **Management**



Why talk about dry mouth?



“Saliva is not one of the popular body fluids. It lacks the drama of blood, the sincerity of sweat and the emotional appeal of tears....”



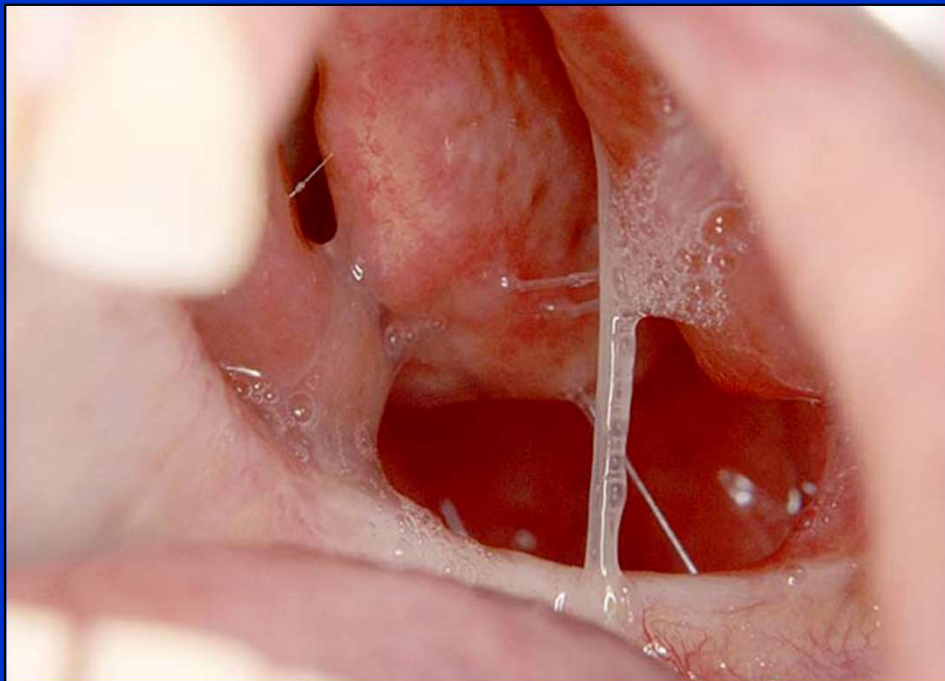
Saliva

“The salivary glands, like other secreting apparatus, are liable, per se, to become sluggish in their function...”

“.....knowing as we do the necessity of saliva...we at least are bound to employ the shortest, surest and easiest method for restoring a secretion, which in the animal system is indispensable to bodily health and energy.”



Saliva



CONSTITUENTS		
INORGANIC: <ul style="list-style-type: none">• Sodium• Potassium• Calcium• Magnesium• Chloride• Bicarbonate• Phosphate• Thiocyanate• Iodide• Fluoride	WATER 99.5%	ORGANIC: <ul style="list-style-type: none">• Secretory IgA• MUC5B• MUC7• Amylase• Lysozyme• Lactoferrin• Statherin• Albumin• Glucose• Lactate• Lipids• Amino Acids• Urea• Ammonia• Other
FUNCTIONS <ul style="list-style-type: none">LUBRICANTION RESERVOIRBUFFERCLEANSERANTIMICROBIAL FUNCTIONSAGGLUTINATIONPELLICLE FORMATIONDIGESTIONTASTEEXCRETIONWATER BALANCE		

Saliva

- About 600ml of saliva produced in 24h
- Stimulated saliva contributes up to 80-90% of the total daily volume
- The unstimulated saliva is most important for oral comfort

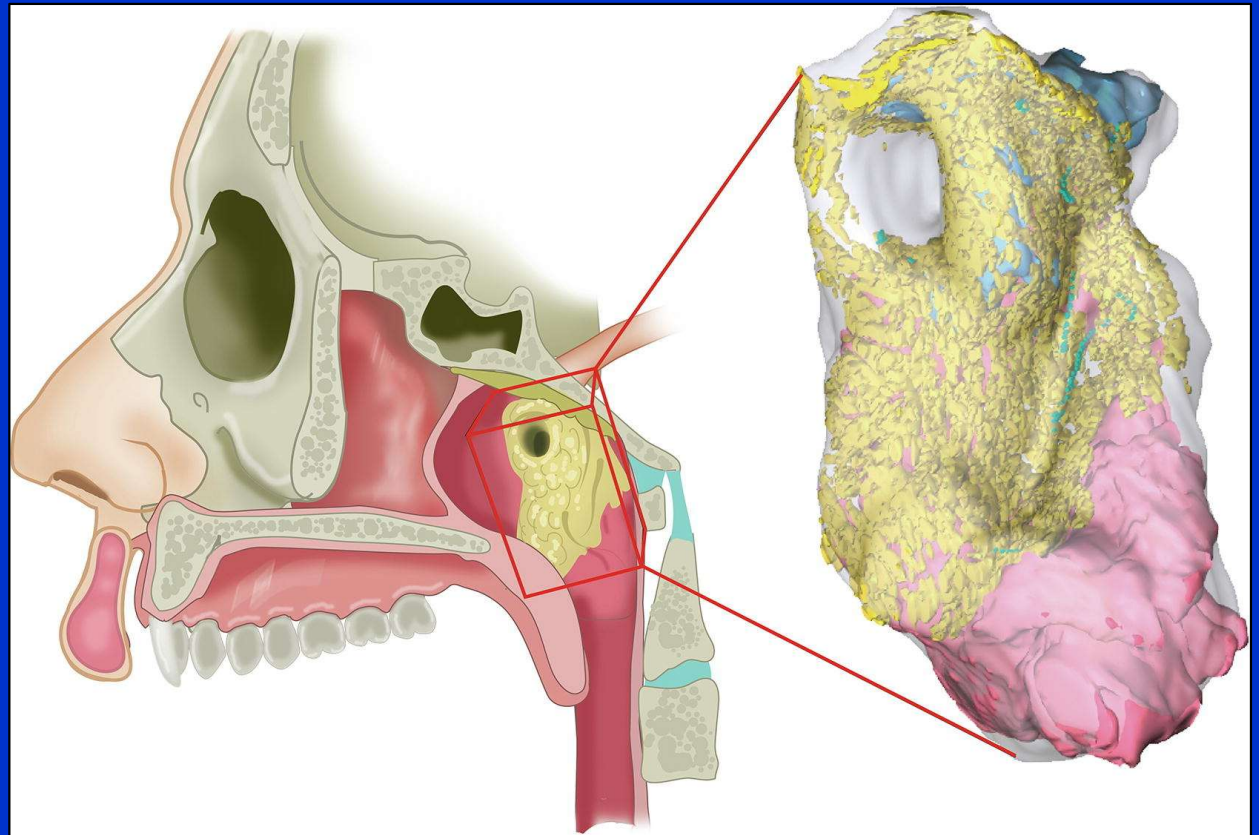


Saliva

- Tubarial salivary glands



Valstar MH et al 2021



Saliva

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Saliva

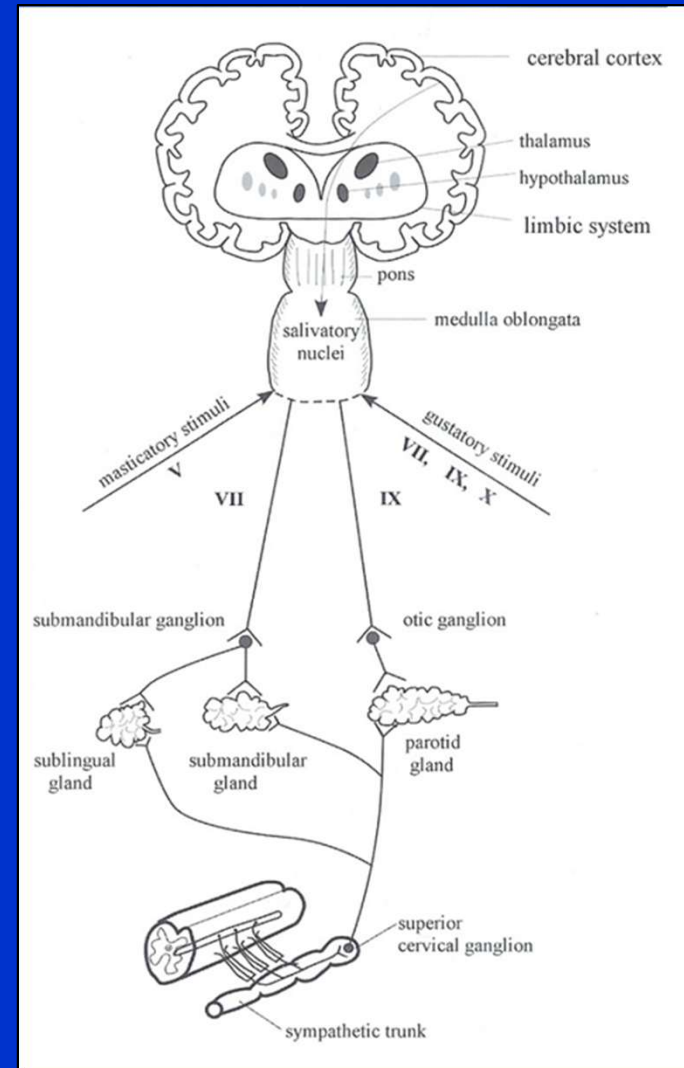
Table 1
Relative (%) contribution of different gland types to whole saliva under various conditions

Salivary Gland	Sleep	Unstimulated Whole Saliva	Stimulated (Mechanical) Whole Saliva	Stimulated (Acid) Whole Saliva
Parotid	0	21	58	45
SM	72	70	33	45
SL	14	2	2	2
Minor glands	14	7	7	8



Saliva

- Secretion of saliva is regulated by reflexes involving the autonomic nervous system



Source: *Clinical Oral Physiology*. Quintessence Publishing

Saliva

- Minor salivary glands:
 - Parasympathetic innervation
 - Little or no sympathetic innervation



Saliva

- Minor salivary glands:



- Parasympathetic innervation

- Little or no sympathetic innervation

~70% MUC5B

Saliva

- Parasympathetic stimulation generates abundant saliva with low protein concentration
- Sympathetic stimulation produces little saliva with high protein concentration and viscosity



Saliva

- Many factors influence salivary flow rates!



Saliva

- Factors influence salivary flow rates

- 💧 Circannual rhythm
- 💧 Circadian rhythm
- 💧 Degree of hydration
- 💧 Emotional state
- 💧 Exposure to light
- 💧 Body position
- 💧 Mechanical stimuli
- 💧 Vomiting
- 💧 Gustatory and olfactory stimuli
- 💧 Gland size



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- 💧 **Gland size**



Saliva

- Salivary composition will also vary!



Significance.....?

- ?? Value of a single point in time assessment
- Salivary flow rate measurements need standardization



Significance.....?



- What is normal?



What is dry mouth?



What is dry mouth?

✓ Salivary gland hypofunction

✓ Xerostomia

✓ Hyposalivation



What is dry mouth?

- **Xerostomia** - subjective experience of oral dryness



What is dry mouth?

- **Salivary gland hypofunction** - diminished salivary flow and is based on objective measures of saliva production
 - 💧 *Unstimulated whole saliva 0.1-0.3ml/min (Normal >0.3)*
 - 💧 *Stimulated whole saliva 1-0.7 ml/min (Normal >1)*



What is dry mouth?

- **Hyposalivation** – low end of salivary gland hypofunction (pathologically low)
 - 💧 *Unstimulated whole saliva ≤ 0.1 ml/min (Normal > 0.3)*
 - 💧 *Stimulated whole saliva $\leq 0.5-0.7$ ml/min (Normal > 1)*



What is dry mouth?

- Salivary flow rates necessary for oral health are individual specific
- Change may be more important



What is dry mouth?

- What is the relationship between salivary gland hypofunction, hyposalivation and xerostomia?

→ Not just a question of volume!



What is dry mouth?

- SGH / hyposalivation \neq xerostomia



What is dry mouth?

- Prevalence of hyposalivation: 20%
- Prevalence of xerostomia: 23%



What is dry mouth?

- Prevalence of hyposalivation: 20%
- Prevalence of xerostomia: 23%
- Hyposalivation & xerostomia: 2-6%



The dry mouth patient

- Hyposalivation and xerostomia



The dry mouth patient

- Hyposalivation
minus xerostomia



The dry mouth patient

- Xerostomia minus
Hyposalivation





Causes of hyposalivation and xerostomia



Causes of hyposalivation and xerostomia

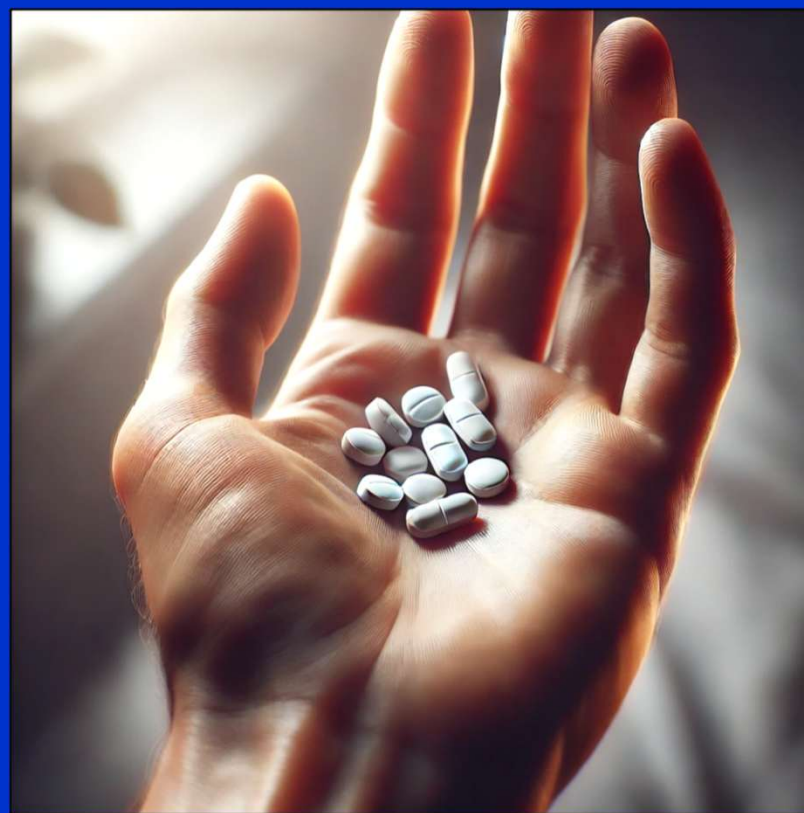
- Medications
- Disease
- Radiation therapy to the head and neck
- Other



Causes of hyposalivation and xerostomia

- Medication

- Anticholinergics
- Sympathomimetics
- Other
- Note polypharmacy!



Causes of hyposalivation and xerostomia

- Disease

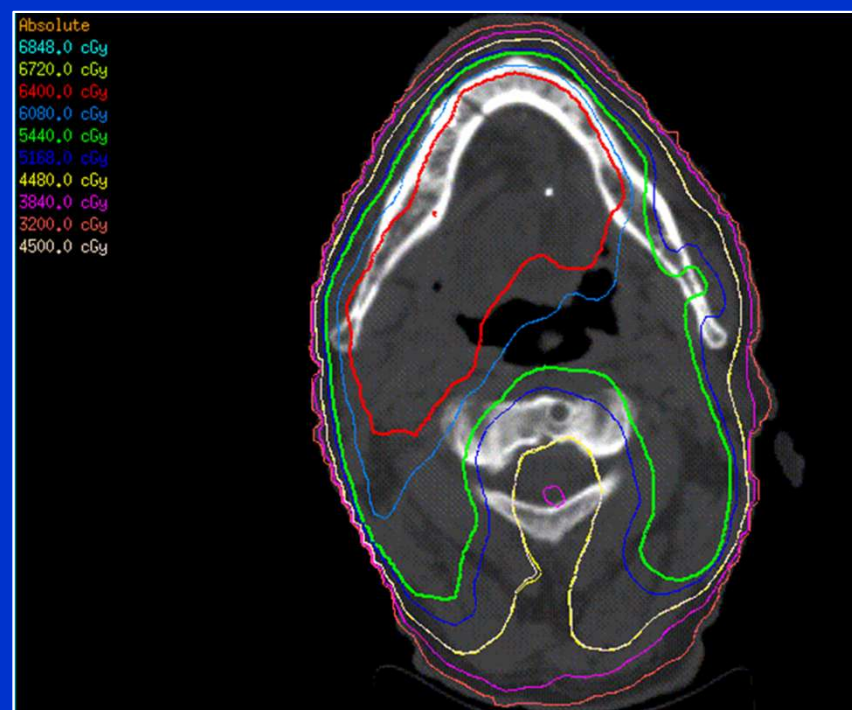
- Autoimmune / chronic inflammatory disease
 - ✓ Sjögren's syndrome
 - ✓ Systemic lupus erythematosus
 - ✓ Rheumatoid arthritis
 - ✓ Systemic sclerosis (scleroderma)
 - ✓ Mixed connective tissue disease
 - ✓ Primary biliary cirrhosis
 - ✓ Sarcoidosis
 - ✓ Graft versus host disease
 - ✓ Inflammatory bowel disease
- Endocrine / metabolic disorders
 - ✓ Diabetes mellitus I and II
 - ✓ Diabetes insipidus
 - ✓ Hypothyroidism
 - ✓ End-stage renal disease
 - ✓ Eating disorders
 - ✓ Malnutrition
 - ✓ Alcohol abuse
- Neurological / behavioural / psychiatric disorders
 - ✓ Cerebral palsy
 - ✓ Parkinson's disease
 - ✓ Alzheimer's disease
 - ✓ Anxiety
 - ✓ Depression
- Genetic
 - ✓ Salivary gland aplasia
 - ✓ Ectodermal dysplasia
 - ✓ Cystic fibrosis
- Infectious diseases
 - ✓ HIV / AIDS
 - ✓ HCV
 - ✓ EBV / CMV
- Other
 - ✓ GERD
 - ✓ Hypertension
 - ✓ Amyloidosis



Causes of hyposalivation and xerostomia

- Radiation therapy

- Radiation therapy to the head and neck
- Radioactive iodine



Causes of hyposalivation and xerostomia

- Menopause

- Post menopausal women often complain of xerostomia
 - Changes in salivary flow rates
 - Composition changes
- HRT may improve xerostomia



Causes of hyposalivation and xerostomia

- Ageing

- Structural salivary gland changes
- Salivary changes
 - Flow rate
 - Composition



Implications of hyposalivation and xerostomia

- Generalized oral discomfort
- Difficulty tolerating dentures
- Dysphonia
- Dysphagia
- Dysgeusia
- Sleep disturbances



Implications of hyposalivation and xerostomia



- Halitosis

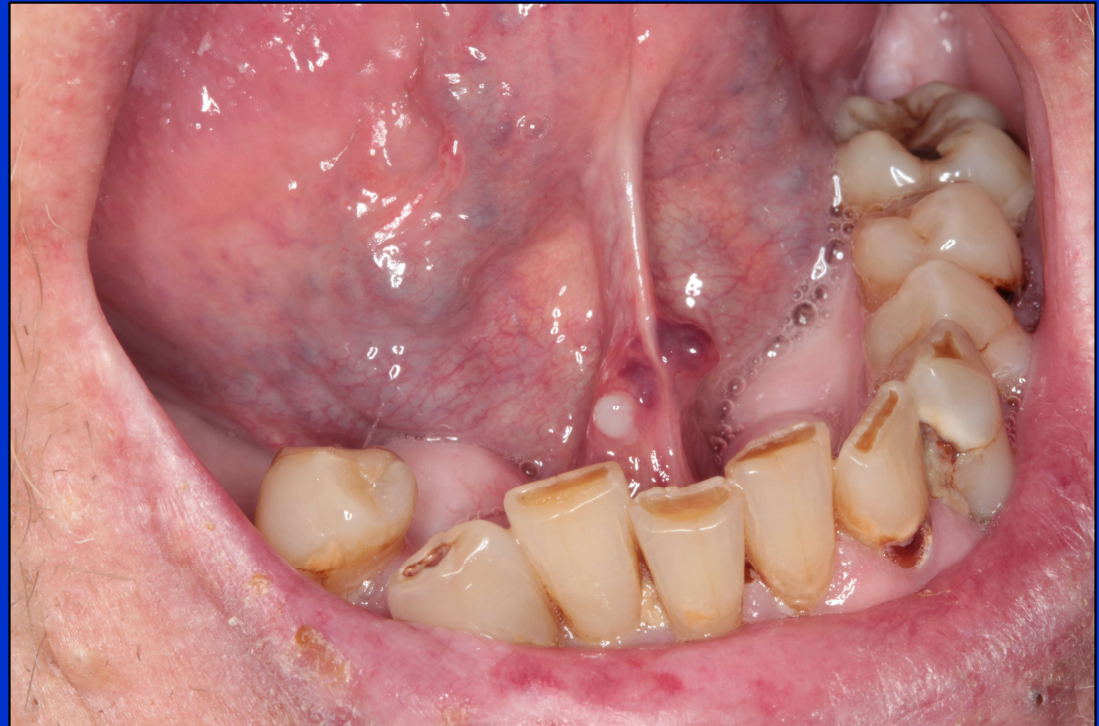


- Mucosal disease



Implications of hyposalivation and xerostomia

- Sialadenitis
- GORD



Implications of hyposalivation and xerostomia

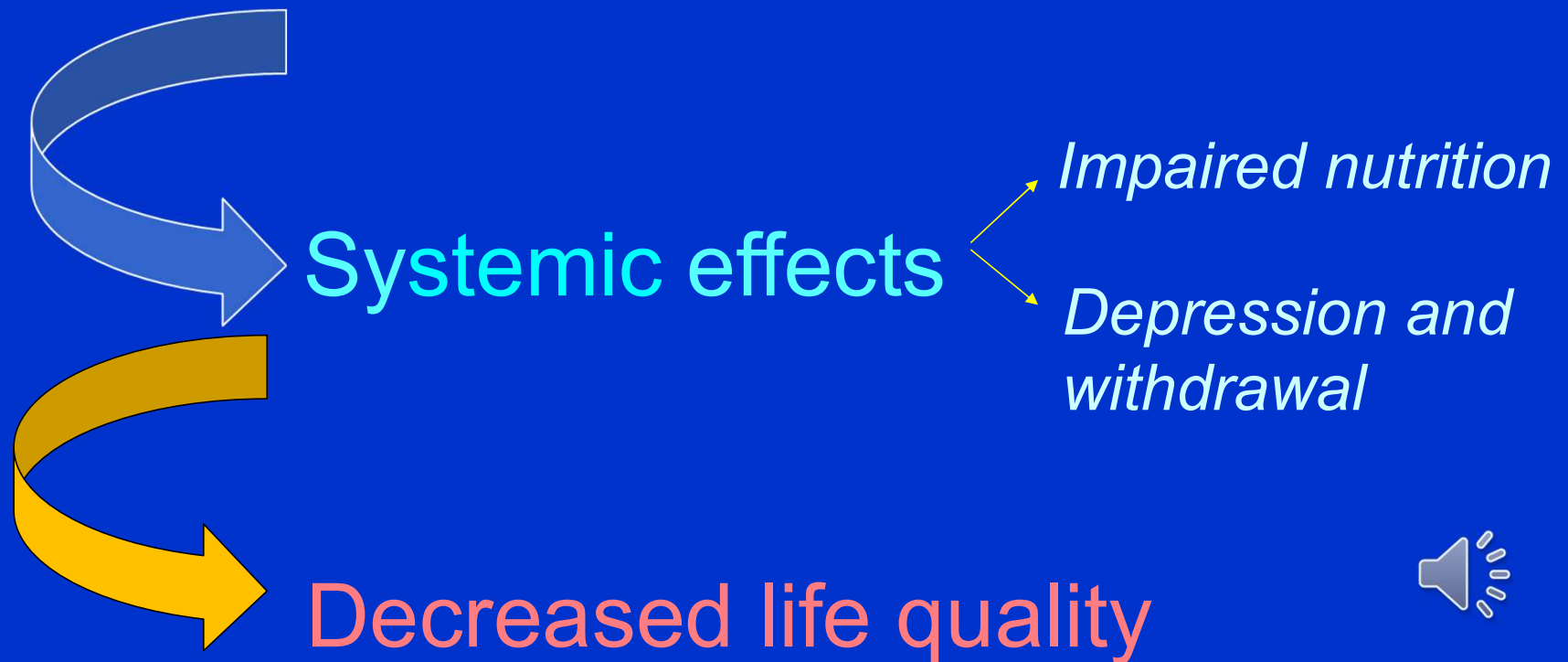
- Dental caries and non-carious tooth loss



- Periodontal disease

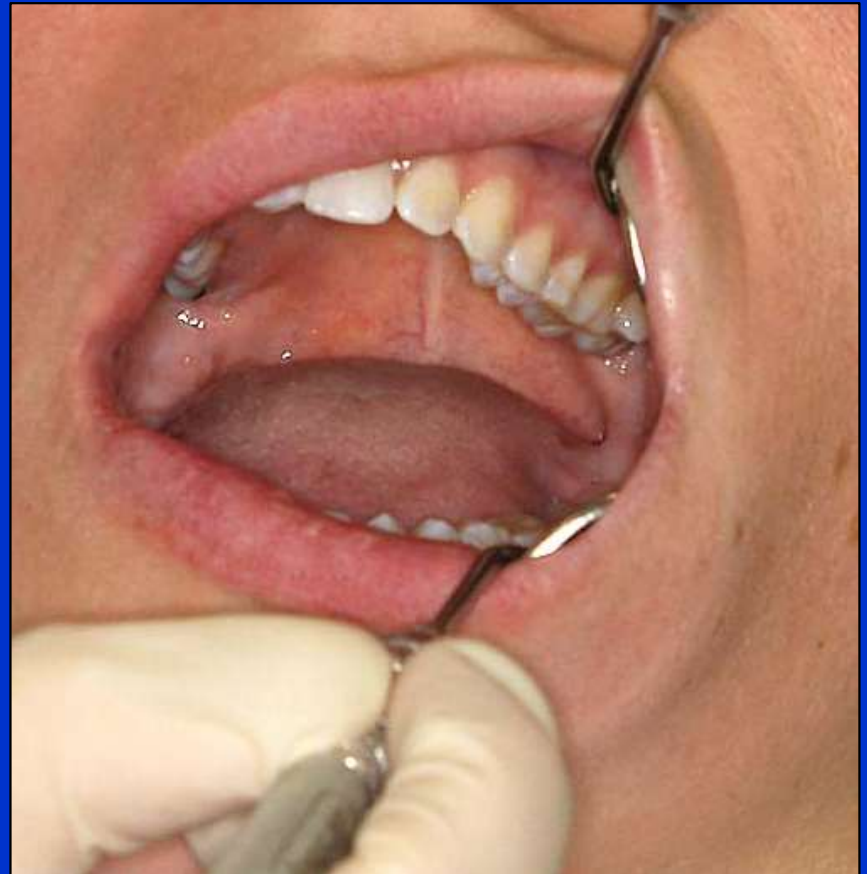


Implications of hyposalivation and xerostomia



Diagnosis

- Medical history
- Dental History
- Clinical examination



Diagnosis



Diagnosis



Diagnosis

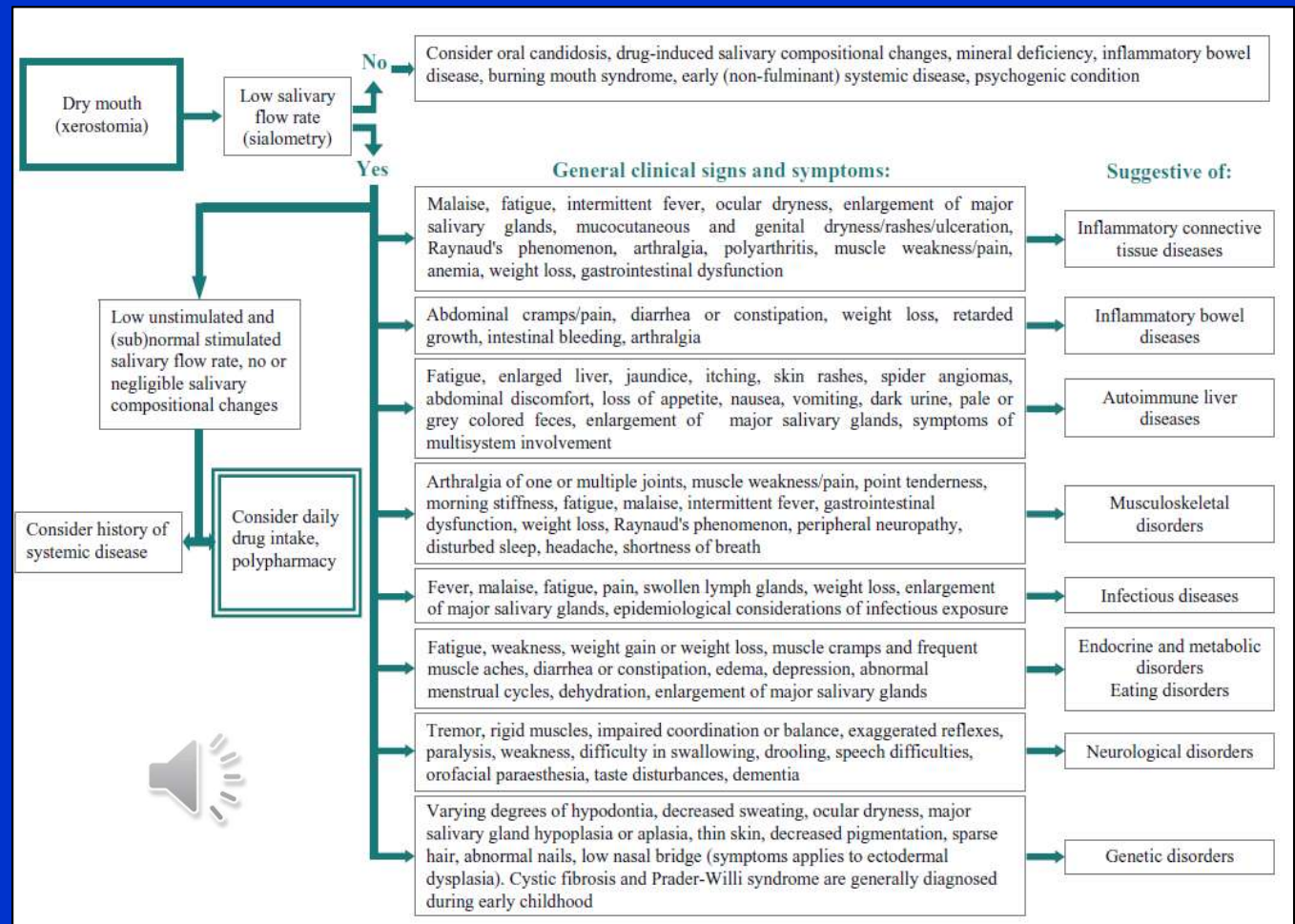


Diagnosis

■ Investigations



Sreebny LM, Vissink A 2010



Diagnosis

■ Investigations

→ Sjogren's
Syndrome



ACR-EULAR Classification Criteria for primary Sjögren's syndrome (pSS)

The classification of SS applies to any individual who meets the inclusion criteria,¹ does not have any condition listed as exclusion criteria,² and who has a score ≥ 4 when summing the weights from the following items:

Item	Weight / Score
Labial salivary gland with focal lymphocytic sialadenitis and focus score ≥ 1 . ³	3
Anti-SSA (Ro) +	3
Ocular staining score ≥ 5 (or van Bijsterveld score ≥ 4) on at least one eye ⁴	1
Schirmer ≤ 5 mm/5min on at least one eye	1
Unstimulated whole saliva flow rate ≤ 0.1 ml/min ⁵	1

¹Inclusion criteria: these criteria are applicable to any patient with at least one symptom of ocular or oral dryness (defined as a positive response to at least one of the following questions: 1) Have you had daily, persistent, troublesome dry eyes for more than 3 months? 2) Do you have a recurrent sensation of sand or gravel in the eyes? 3) Do you use tear substitutes more than 3 times a day? 4) Have you had a daily feeling of dry mouth for more than 3 months? 5) Do you frequently drink liquids to aid in swallowing dry food?); or suspicion of SS from ESSDAI questionnaire (at least one domain with positive item)

²Exclusion criteria: Prior diagnosis of any of the following conditions would exclude diagnosis of SS and participation in SS studies or therapeutic trials because of overlapping clinical features or interference with criteria tests:

- History of head and neck radiation treatment
- Active Hepatitis C infection (with positive PCR)
- Acquired immunodeficiency syndrome
- Sarcoidosis
- Amyloidosis
- Graft versus host disease
- IgG4-related disease

Note: Patients who are normally taking anticholinergic drugs should be evaluated for objective signs of salivary hypofunction and ocular dryness after a sufficient interval off these medications for these components to be a valid measure of oral and ocular dryness

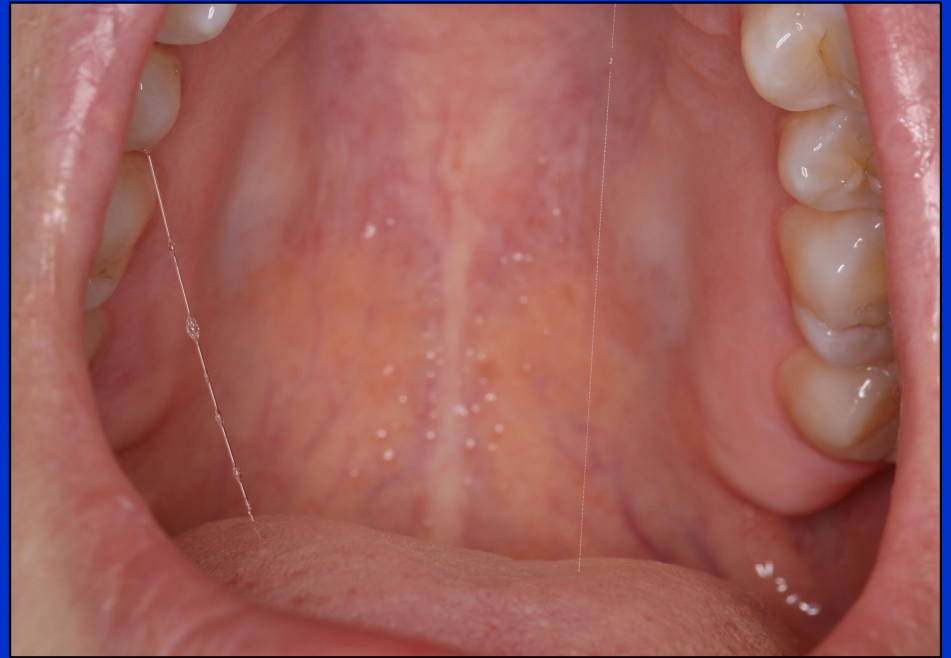
³The histopathologic examination should be performed by a pathologist with expertise in the diagnosis of focal lymphocytic sialadenitis, and focus score count (based on number of foci per 4 mm^2) following a protocol described in Daniels et al 2011 (26)

⁴Ocular staining score described in Whitcher et al 2010 (30), van Bijsterveld score described in van Bijsterveld 1969 (29)

⁵Unstimulated whole saliva described in Navazesh & Kumar, 2008 (27)

Diagnosis

- Xerostomia / Salivary gland hypofunction / hyposalivation?



Diagnosis

- Xerostomia

Does your mouth usually feel dry?



Diagnosis



■ Xerostomia

The xerostomia inventory (XI) - Original

- I sip liquids to aid in swallowing food
- My mouth feels dry when eating a meal
- I get up at night to drink
- My mouth feels dry
- I have difficulty in eating dry foods
- I suck sweets or cough lollies to relieve dry mouth
- I have difficulty swallowing certain foods
- The skin of my face feels dry
- My eyes feel dry
- My lips feel dry
- The inside of my nose feels dry

Responses and (scores): Never (1), hardly ever (2), occasionally (3), fairly often (4) and very often (5)

The xerostomia inventory (XI) – Shortened version

- My mouth feels dry when eating a meal
- My mouth feels dry
- I have difficulty in eating dry foods
- I have difficulty swallowing certain foods
- My lips feel dry

Responses and (scores): Never (1), occasionally (2), and often (5)

Diagnosis

- Salivary gland hypofunction / hyposalivation



Diagnosis



The Challacombe Scale of Oral Dryness
10 features of oral dryness
<input type="checkbox"/> mirror sticks to buccal mucosa
<input type="checkbox"/> mirror sticks to tongue
<input type="checkbox"/> frothy saliva
<input type="checkbox"/> no saliva pooling in floor of mouth
<input type="checkbox"/> tongue shows loss of papillae
<input type="checkbox"/> altered/smooth gingival architecture
<input type="checkbox"/> glassy appearance of other oral mucosa, especially palate
<input type="checkbox"/> tongue lobulated/fissured
<input type="checkbox"/> active or recently restored (last 6 months) cervical caries (2 teeth)
<input type="checkbox"/> debris on palate (excluding under dentures)
Total score 1 – 10: Score 1-3 : Mild dryness Score 4-6: Moderate dryness Score 7-10: Severe dryness

Management



Xerostomia



Hyposalivation



Xerostomia and
hyposalivation

Management

- Understand the problem
- Address the cause or contributing factors
- Symptomatic treatments / commercial saliva substitutes
- Stimulation of salivary glands (gustatory / pharmaceutical / mechanical)
- Other
- Manage associated complications



Management – symptomatic treatments

- Water

- Important to prevent dehydration

- Frequent consumption can increase dry mouth symptoms



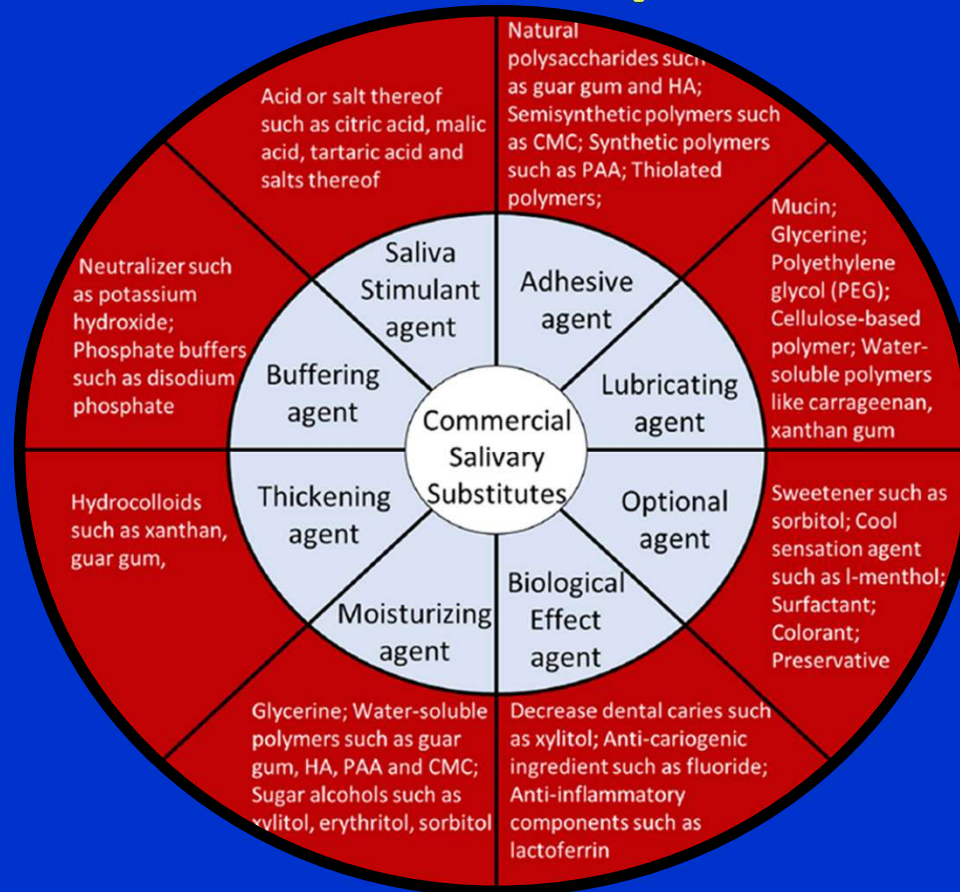
Management – symptomatic treatments

- Oil

- 💧 E.g. olive oil

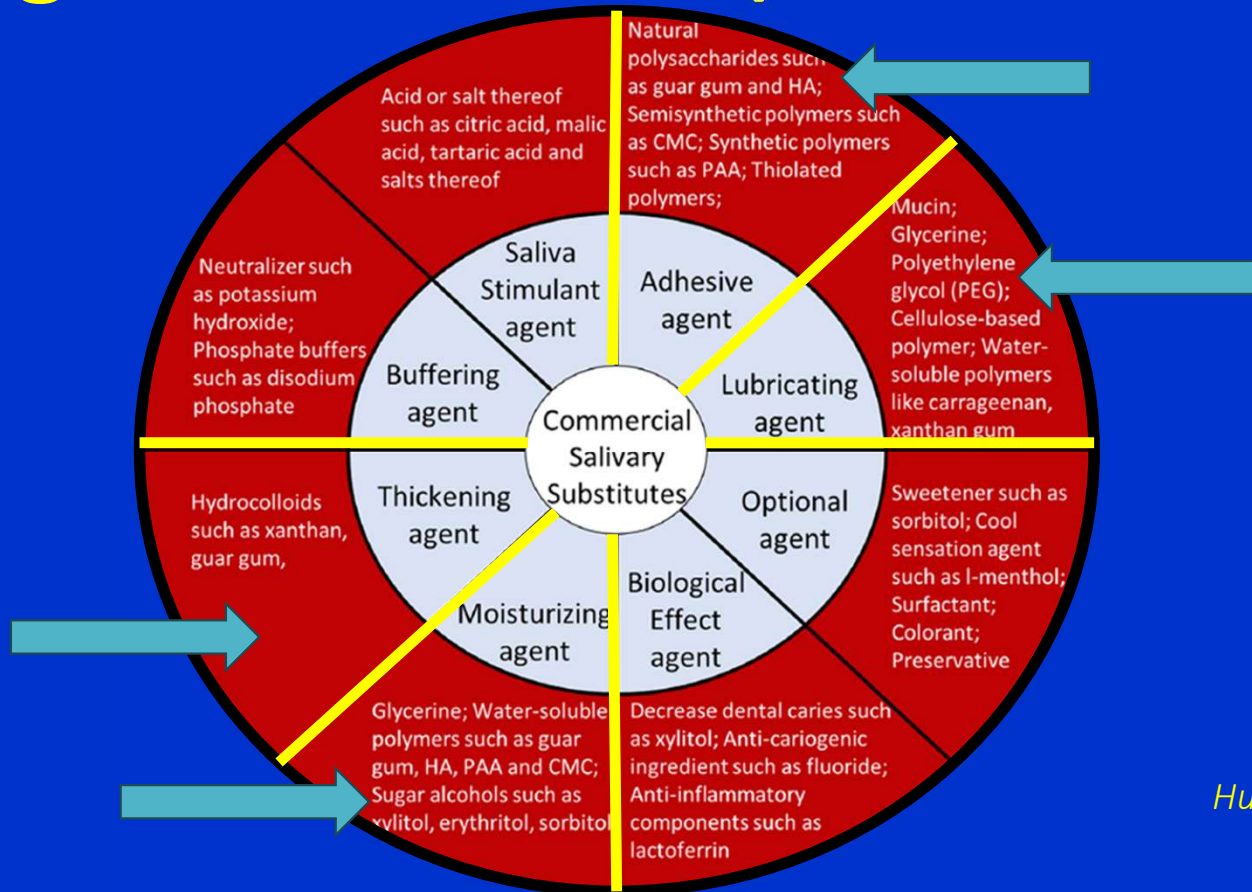


Management – salivary substitutes



Hu J et al 2020

Management – salivary substitutes



Hu J et al 2020

Management – salivary substitutes

- **Thickening agents** – increase product viscosity e.g. hydroxyethyl cellulose
- **Lubricating agents** – protect mucosal surfaces e.g. animal derived mucin, glycerine, polyethylene glycol, other



Management – salivary substitutes

- **Adhesive agents** – facilitate formation of a coating to protect oral tissues from irritation (natural / semi-synthetic / synthetic)
- **Moisturising agents** – e.g. carboxymethyl cellulose



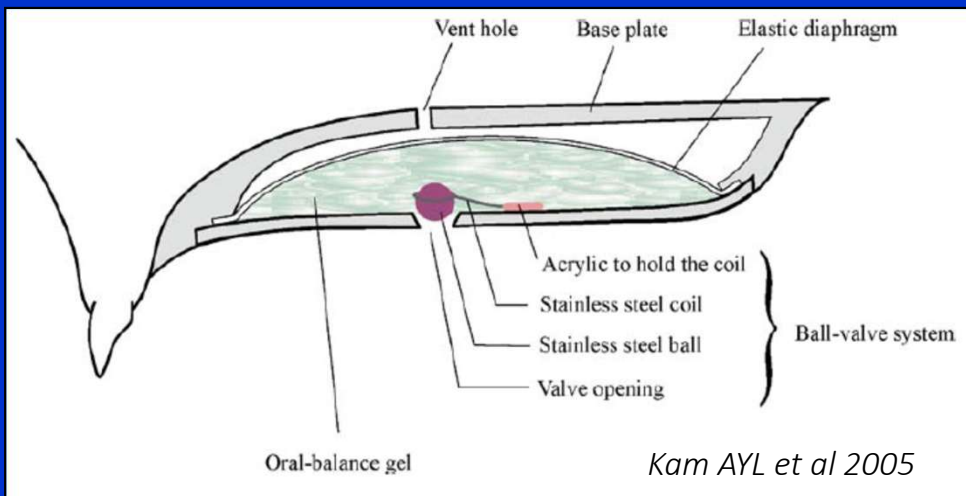
Management – salivary substitutes

■ Other agents

- Antimicrobial proteins (e.g., lysozyme, lactoferrin and lactoperoxidase)
- Buffering agents
- Anti-cariogenic agents
- Salivary stimulants
- Other



Management – salivary substitutes



Management – salivary substitutes

- Limitations:

- Limited duration of action

- Specific environmental conditions

- Cost



Management – salivary substitutes

- In summary:
 - 💧 Limited evidence that salivary substitutes are of benefit
 - 💧 Should be offered



Management – salivary stimulation

- Chewing sugar-free gum
 - 💧 Can increase unstimulated salivary flow rate
 - 💧 Can provide relief from xerostomia



Management – salivary stimulation

- Sugar-free confections
 - 💧 Limited literature
 - 💧 Sugar substitutes are not all the same (sorbitol, mannitol)
 - 💧 Note addition of acids to improve taste (dental erosion risk)



Management – salivary stimulation

- Secretagogues

- 💧 **Pilocarpine** (cholinergic parasympathomimetic agent, acting as a non-selective muscarinic agonist)

- 💧 **Cevimeline**

- 💧 **Other**



Management – salivary stimulation

- Salivary neuro-electrostimulation
 - TENS (Transcutaneous Electric Nerve Stimulation)
 - Intraoral electrostimulators
 1. *Removable*
 2. *Fixed (Implant supported)*

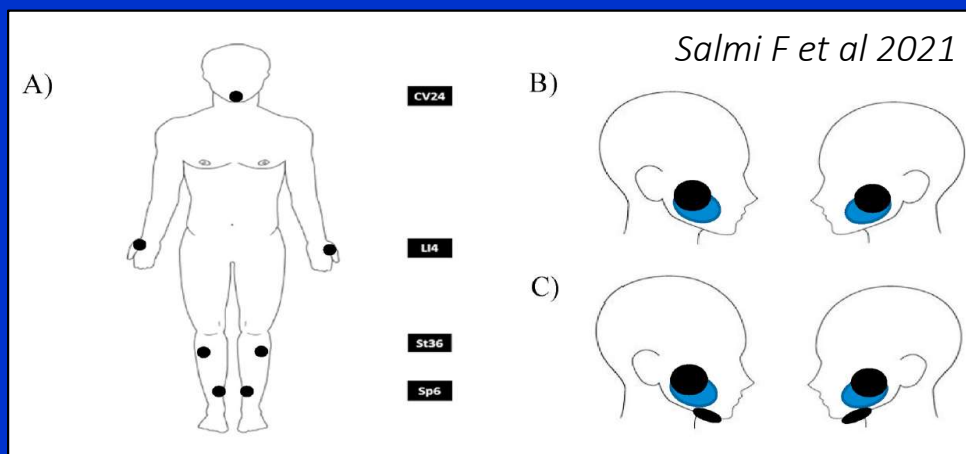


Management – salivary stimulation

■ Salivary neuro-electrostimulation

→ TENS (Transcutaneous Electric Nerve Stimulation)

→ ALTENS (Acupuncture-like TENS)



Management – salivary stimulation

- Salivary neuro-electrostimulation

→ Intraoral electrostimulators

1. *Removable (GenNarino, SaliPen)*
2. *Implant supported (Saliwell Crown, MICROSAL)*



Management – salivary stimulation

- Salivary neuro-electrostimulation



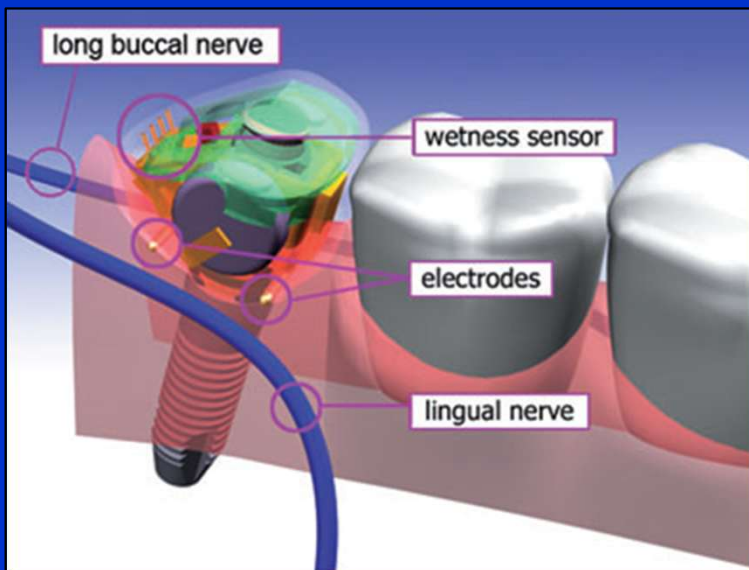
Management – salivary stimulation

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Management – salivary stimulation

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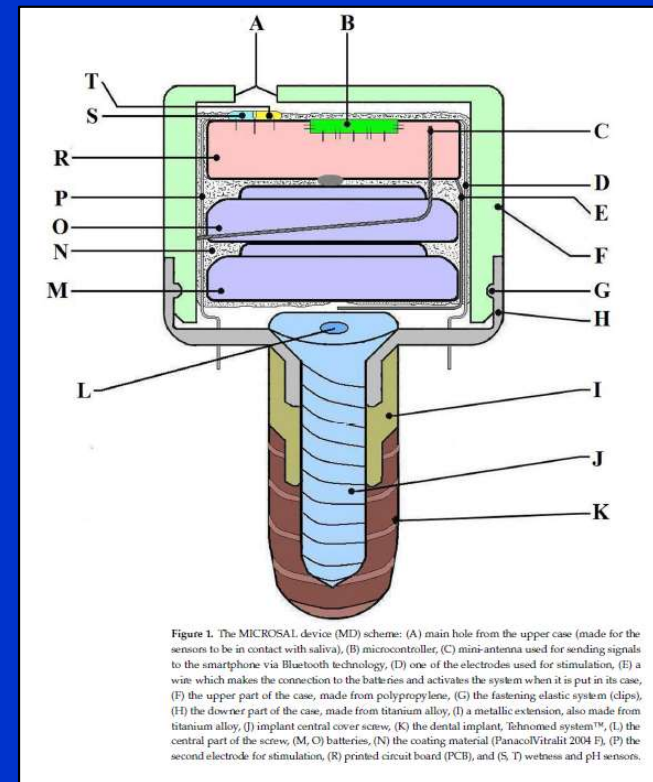


Ami S, Wolf A 2010

Management – salivary stimulation



- Salivary neuro-electrostimulation



Management – salivary stimulation

- In summary:
 - 💧 Limited evidence to determine the effects of electrostimulation devices on dry mouth symptoms or saliva production



Management – other approaches

- Acupuncture

- 💧 Limited evidence in the management of hyposalivation and xerostomia



Management – other approaches

- Photobiomodulation

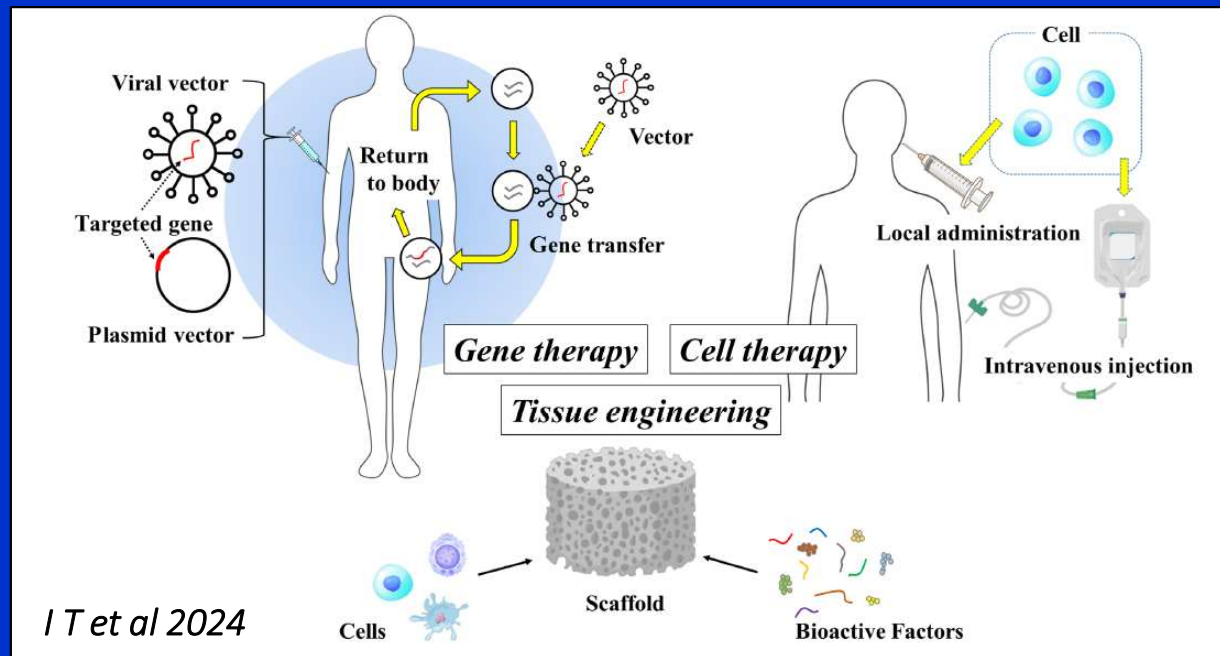
- **Radiation therapy** (630-830nm, *radiant exposure from 2-10 J/cm², 1-3 times a week*)

- **Other**



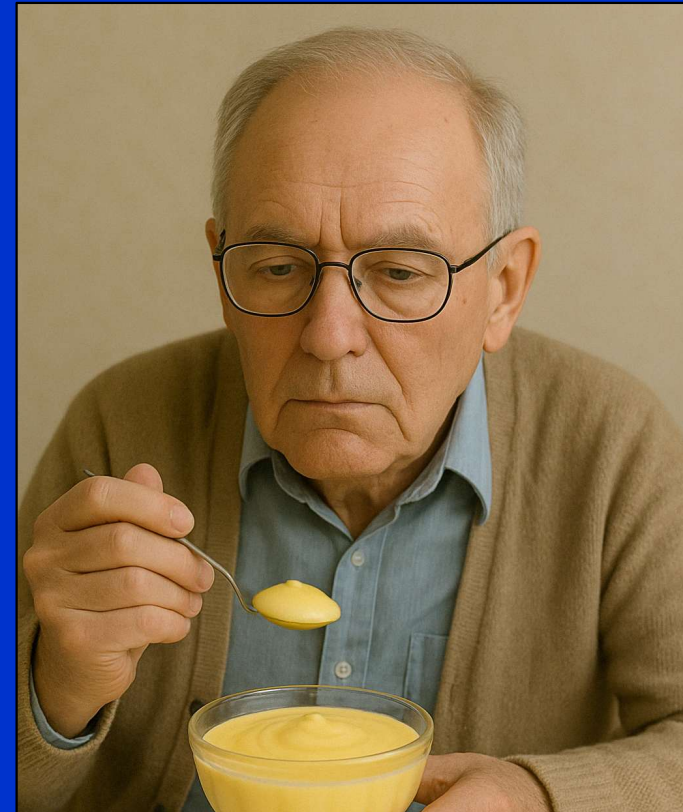
Management

- Experimental Approaches



Management

- Increased risk of dental caries
 - ✓ DIET
 - ✓ Oral hygiene
 - ✓ Fluoride
 - ✓ Re-mineralizing agents
 - ✓ Antimicrobial agents
 - ✓ Regular dental care



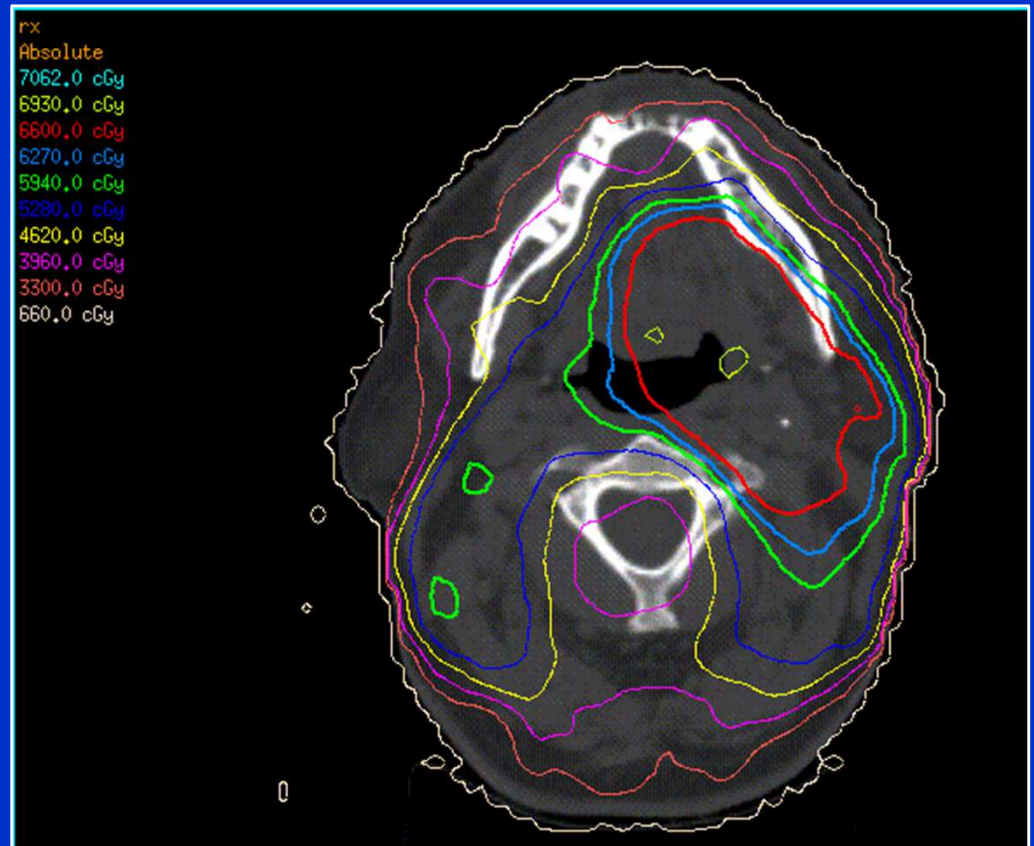
Management

- Mucosal disease
 - ✓ Mucositis
 - ✓ Candidiasis
- Sialadenitis
- Halitosis



Prevention

- Head and cancer patients
- Sjogren syndrome



Dry mouth: In Summary

- Common problem
 - ✓ Correct diagnosis
- Complex problem
- Growing problem
- Management of dry mouth
 - ✓ Address the cause
 - ✓ Symptomatic management
 - ✓ Salivary Stimulation
 - ✓ Manage complications

