



Geriatric Oral Health

Navigating chronic disease and oral dryness

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Facts: Older Adult Oral Health



- By 2060, according to the US Census, the number of US adults aged 65 years or older is expected to reach 98 million, 24% of the overall population.
- Older Americans with the poorest oral health tend to be those who are economically disadvantaged, lack insurance, and are members of racial and ethnic minorities.
- Being disabled, homebound, or institutionalized (e.g., seniors who live in nursing homes) also increases the risk of poor oral health.
- *Many older Americans do not have dental insurance because they lost their benefits upon retirement and the federal Medicare program does not cover routine dental care*

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Journal of Internal Medicine 255: 105–112

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- (continued)*

- For adults with this diagnosis, all treatment is to be given in addition with the following conditions:
 - Aspartame - 1 tablet per year
 - Sugars - limited for general health
 - Cholesterol - Statins that only control the cholesterol level with supporting interventions
 - Phosphorus, sodium and fiber Phosphorus and Potassium - two combinations of the 1st or 2nd month per year

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- *Internal validity* indicates whether the study design and methods are sound enough to allow for a causal interpretation of the results.
- *External validity* indicates whether the results of the study can be generalized to other groups of people, settings, and times.

[illegible]

- d* Statistics were two-tailed (df = 18) as a conservative measure.

1997年12月15日 星期三 晴

4. **Wavelength**

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Health Care Financing Administration

9-800-541-7022

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Health Care Frequency

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- Initial foreign investment from - short period, get started in 2016
 - Expected return - 4 years to 10 months
 - Current trend - as above
- **Warranty**
- Complete service from - 4 years to 10 years
 - Additional - early 10 months
 - Warranty - early 10 months to 10 years
 - Current trend - as above

- **Phagocytes** (1. destroy; 2. remove 22 months)
- **Macrophages** (macronutrients)
 - 1st and 2nd - 1. remove 22 months
 - Macrophages (1. destroy; 2. remove 22 months)

1000

- Journal of Management Education* 36(7) 809–824

- For adults with this diagnosis, all treatment is to be given in addition with the following conditions:
 - Acyclovir/valacyclovir - 1 tablet per day
 - Topiramate - correct for potential side
 - Clonazepam - 2 tablets 3x daily, correct the potential side with supporting interventions
 - Phenytoin, levetiracetam and free Phenytoin and Pools Maintenance - also combination of the 1st a 12 month ago

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- *Internal validity* indicates whether the study design and methods are adequate to test the hypothesis and control for confounding.

1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 2680, 26

- d* Statistic over threshold of 10 significant loci.

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- a. ☐ **Yes**
 b. ☐ **No**

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South East Queensland Catchment

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Edentulism

- There are about 35 million edentulous people in the US, and 178 million people are missing at least one tooth
 - Roughly 90% of the US edentulous population wears dentures
- 51% of Americans, ages 55 to 64, wear full or partial dentures
- 29% of Americans, ages 45 to 55, wear full or partial dentures
- 16% of Americans, ages 35 to 44, wear full or partial dentures
- *The number of partially edentulous people will continue to increase in the next 15 years to more than 200 million individuals. Partial edentulism affects the majority of adult Americans.*

Tooth loss

- As a result of *Caries* and *Periodontitis*
- Result of *Injury*, *Cancer*, or simply *Wear*
- *Edentulism affects our most vulnerable populations – the aging and the economically disadvantaged*
 - *and at the Center for Healthy Living I work with both of these populations*
- *Consequences of missing teeth include significant nutritional changes, obesity, diabetes, coronary artery disease, and some forms of cancer.*



Which groups of elderly are the most vulnerable?

- Homeless elderly (mental health issues)
- Dependent elderly with dementia.
- Community dwelling elderly in independent living without a strong support group, ie. a senior center, active social workers or family.

How do medical/dental insurance and financial constraints affect potential interventions?

- Apple health does not reimburse root canal therapy on molars and premolars (only on 1-rooted teeth), which means that extraction would be the best financial option if (root) caries reaches the dental pulp. At the SoD, an extraction is around \$100, while a root canal on a molar is in the range of \$1000.
- After multiple extractions in the premolar and molar regions, elderly without dental insurance lose the **vertical dimension** of their bite, and the bite “collapses”. As a result, the chewing capacity decreases. Antagonist teeth also supra-erupt, when there is no occlusal contact. This makes it very difficult to restore a patient’s dentition back to function. You might need both Orthodontic treatment and Surgery, which is not an option for most elderly.
- Apple health only reimburses all resin partial dentures, which is not the best quality dentures.

Oral disparities in older adult populations

- Across NIH, it has been recognized that there is an increasing need to support research that can address issues around aging, including the basic biology of aging to clinical studies focused on delivering best care to all older adults.
- The NIDCR Strategic Plan for 2014-2019 (<http://www.nidcr.nih.gov/research/ResearchPriorities/StrategicPlan/StrategicPlan14/goal3.htm>) describes four primary goals. Research to improve the oral health of older adults addresses three of these goals
- GOAL 1: Support the best science to improve dental, oral, and craniofacial health.
- GOAL 2: Enable precise and personalized oral health care through research.
- GOAL 3: Apply rigorous, multidisciplinary research approaches to overcome disparities and inequalities in dental, oral, and craniofacial health).
 - One objective of Goal 3 is to support multi-disciplinary, multi-level research and research training to overcome health disparities, including the oral health of the elderly.

Global oral health goals (65+)

- A 25% reduction in the present level of edentulous status
 - Presently (2006) 27% of Americans 65 years and older are edentulous
- WHO has an oral health goal of 20 teeth
 - Prevention of Caries is KEY!

Treatment goal

- Preserve and maintain dentitions throughout life.
 - “Teeth for life”
- Low indices of socio-economic status are associated with elevation in caries
 - Reduced access to care
 - Reduced oral health aspirations
 - Low self-efficacy
 - Health behaviors that may enhance caries risk

NIH: NIH consensus statement. Diagnosis and management of dental caries throughout life, 2000

Length of tooth survival in older adults with complex medical, functional and dental backgrounds

- Retrospective longitudinal study based on dental records.
 - University-affiliated, community-based geriatric dental clinic in Minnesota
 - Mean age 76 years; Range: 43 – 102; 491 patients
 - LTC and Community dwelling adults
 - 70% were enrolled in Minnesota's Medical Assistance program
 - Average of seven (7) medical conditions
 - Considerable Anti-Cholinergic side effects
- 1. Poor oral health at first exam
 - Multiple active carious teeth or retained roots (5 or more)
 - ~ 20% of participants with 5 or more carious teeth/retained roots loose an additional tooth within 12 months after their existing conditions were treated
- 2. Dental caries and the use of removable dentures synergistically impaired tooth survival in older adults
 - Pat who wore dentures were at a higher risk of losing teeth sooner at any given time during the follow-up period than were participants who did not wear removable dentures

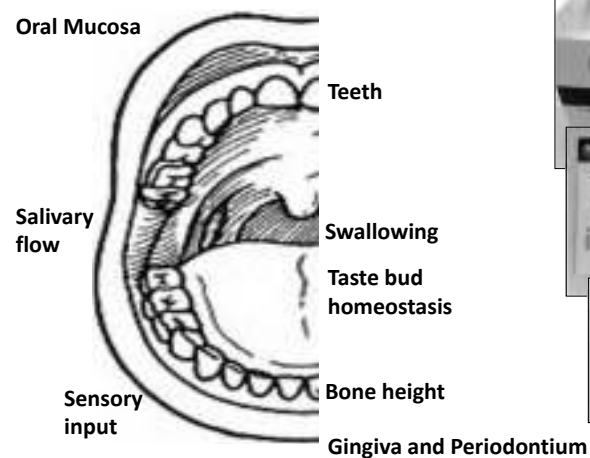
Chen et al. (2012)



Learning objectives

1. Compare and contrast normal and accelerated aging changes in the oral cavity
2. Describe how to compensate for effect of medications causing a dry mouth
3. Provide preventive oral care for community dwelling elderly and elderly in assisted living facilities

ORAL Function in the Elderly



Loss of “volume”



Loss of bone height
Retention of lower jaw dentures difficult

Thinning of collagen and elastic fibers
Fat atrophy

Source: Beer and Beer, 2009

Age influence on periodontal tissues

• Periodontal conditions of seniors

- *Oral mucosa*
 - Atrophic, satin-like and friable
 - Thin, smooth and dry
- *Gingiva*
 - Loses its stippling due to flattening of rete pegs
 - Epithelium:
 - Diminished keratinization, thinner
 - Parakeratosis is frequent
 - Inflammatory cells
 - Often signs of chronic inflammation
 - Connective tissue
 - Fewer connective tissue cells (fibroblasts)
 - Less elastic fibers – tissue loss of elasticity
 - Thicker collagen bundles = Fibrosis
 - Capillaries decrease in numbers
 - Blood supply is reduced
 - Clinically, gingiva is reduced, migrates to tooth apex, presents a reduced resilience
 - Becomes more sensitive to external factors

YOUNG ADULT

Epithelium

- Thick (250 µm)
- Stippled surface

Lamina Propria

- Long, narrow papillae
- Dense connective tissue – gingival ligament fibers



Source: Andreescu et al., 2013

Aging of the Immune response

- Gingival immune defense is diminished
 - Inflammation develops easier
 - Healing process is slower
 - Immuno-senesence – gradual deterioration of the immune system
- Ineffective protection against microbes at the muco-cutaneous junction
(Ongradi J and Kovesdi V, 2010)
- More rapid and severe development of gingivitis
(Fransson C et al., 1999)
- Number of dendritic cells (=antigen presenting) are significantly lower in older age groups
(Zavala WC and Cavicchia JC, 2006)

Aging of Mechanoreceptors

- Aging of sensory nerve endings (mechanoreceptors)
 - Ruffini's
 - Decrease in number
 - *Consequences?*
 - Free nerve endings
 - Decreased sensitivity
 - *Consequences?*

Aging of sensory innervation

- Elevation in sensory thresholds for multimodal somato-sensory nerve endings
 - Warming, cooling, pain, touch, 2-point discrimination
- Elevation in sensory thresholds for taste
 - 178 individuals: 45 y and younger, 65 y and older
 - Older adults (both genders) have a higher threshold for salt
 - Older adults have a higher threshold for sour, with older males having the highest threshold

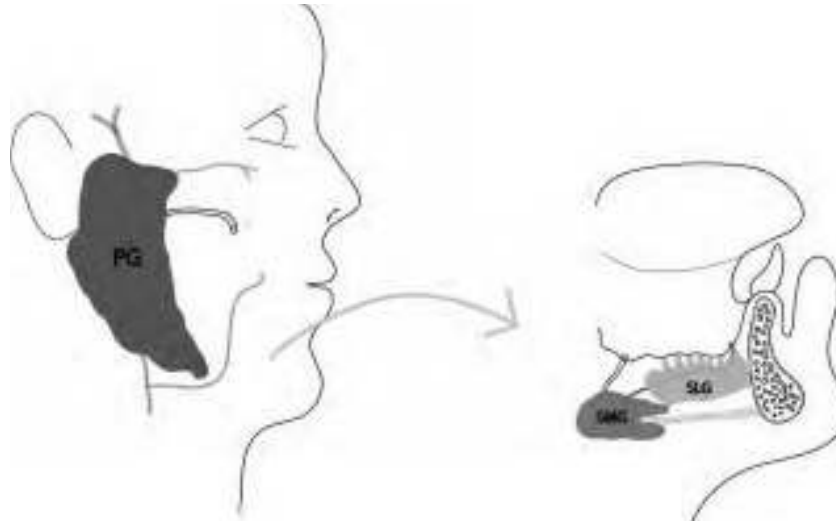
Source: Heft and Robinson, 2010 (Clinical study)



"... a world without saliva is a world without pleasure...
like living with a drought..."

Leo Sreebny (2000)

Major Salivary Glands



Parotid gland
PG

Submandibular gland
SMG

Sublingual gland
SLG

Minor Salivary Glands



Mucous

- Palatine glands
- Posterior lingual glands

Serous

- Glands of von Ebner

Mixed

- Anterior lingual glands
- Buccal glands
- Labial glands

“Whole saliva”

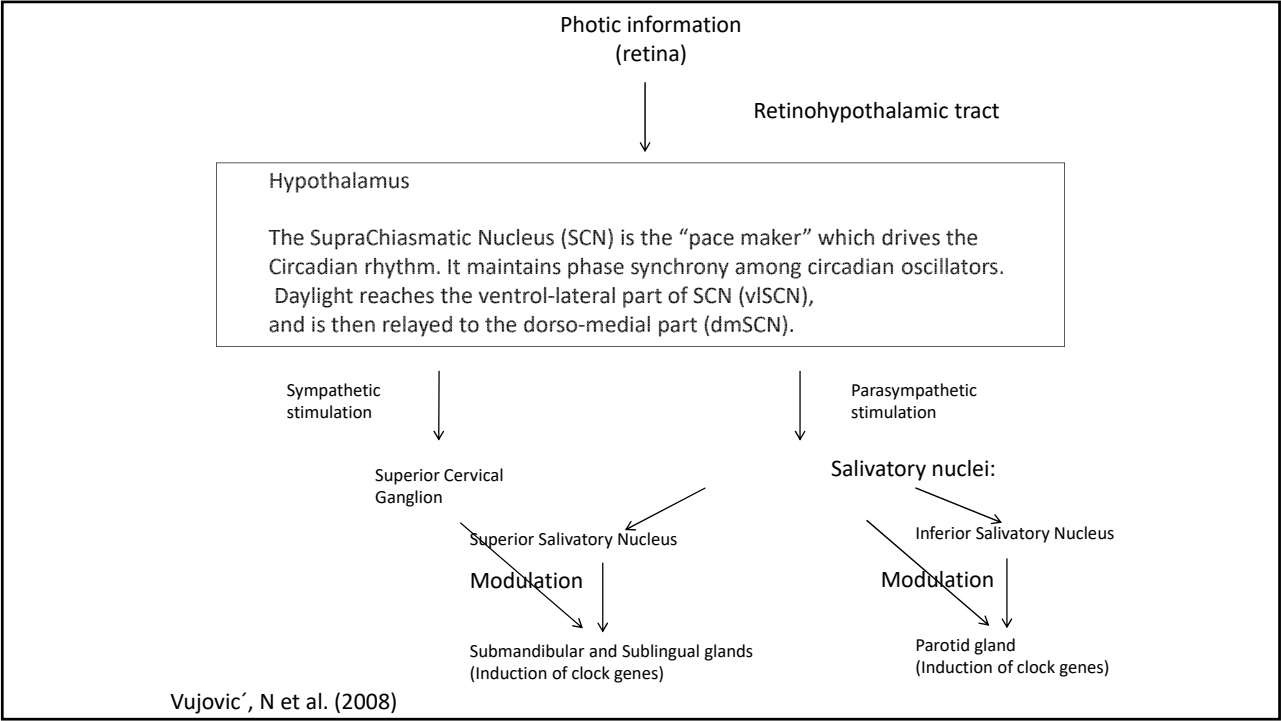
Glands	Resting saliva <i>DECREASES WITH AGING</i>	Stimulated saliva
Parotid glands	20% of saliva	50% of saliva
Submandibular	65%	30%
	} 80%	} 50%
Sublingual glands Minor glands	15%	20%
	0.3 ml/min 18 ml per hour	1.7 ml/min 102 ml per hour
	14 h/day + 8 h/night Important for protection of the oral mucosa and teeth	2 h/day Important for chewing, swallowing and digestion

Saliva production is stimulated by:

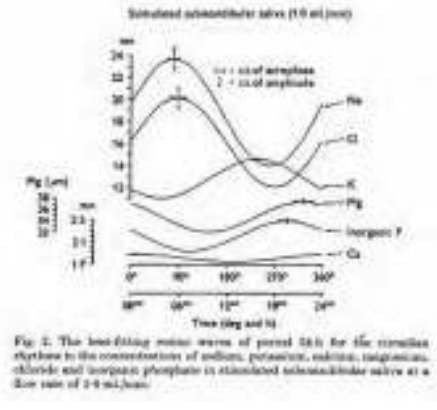
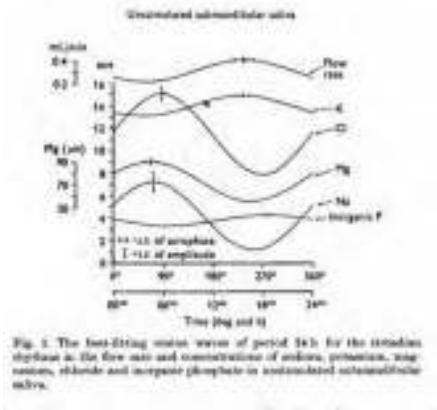
Unconditioned reflexes:

- Taste buds (neuroepithelial cells) and sensory receptor endings
 - Gustatory salivary reflex
 - Mechanoreceptor fibers sensitive when pinching the tongue.
- Masticatory stimulus
 - Sensory receptors within the periodontal ligament
- Olfactory stimulus
 - Area cribrosa
- Day light
 - Retina (Hypothalamus-Pituitary Axis, HPA)

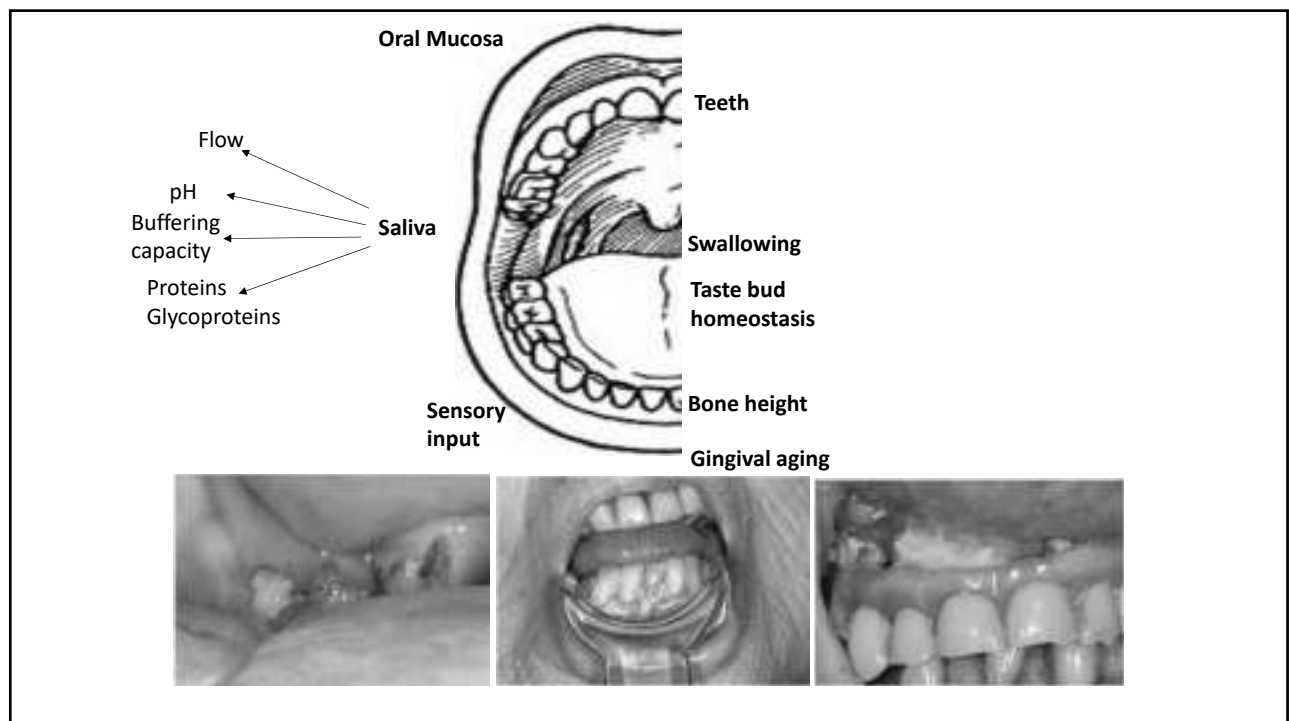
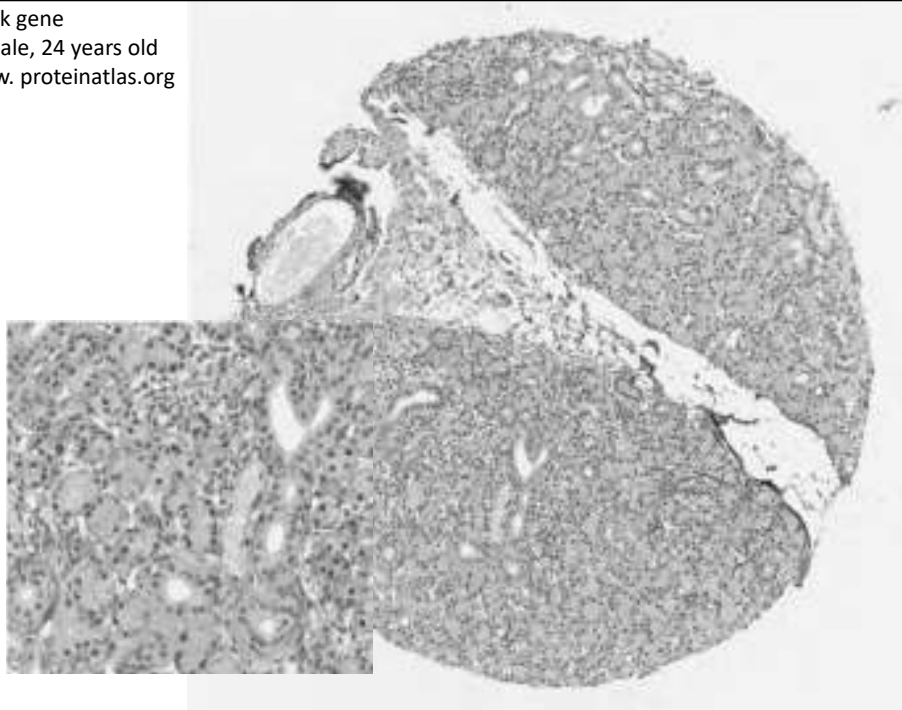
Conditioned reflexes, such as hearing, thinking about and looking at food




Salivary content of ions oscillates according to a circadian rhythm



Clock gene
Female, 24 years old
www.proteinatlas.org





Flow

pH




Buffering capacity


Proteins

Glycoproteins

Saliva

Flow	Cholinergic stimulation Aquaporin water channels are Testosterone -dependent
pH	H ions in Striated ducts
Buffering capacity	Three different buffer systems Striated ducts
Proteins	Serous acinar cells Adrenergic stimulation
Glycoproteins	Mucous acinar cells Cholinergic stimulation



Flow

pH

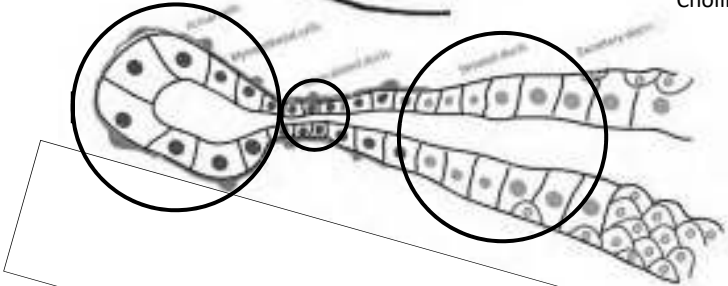
Buffering capacity

Proteins

Glycoproteins

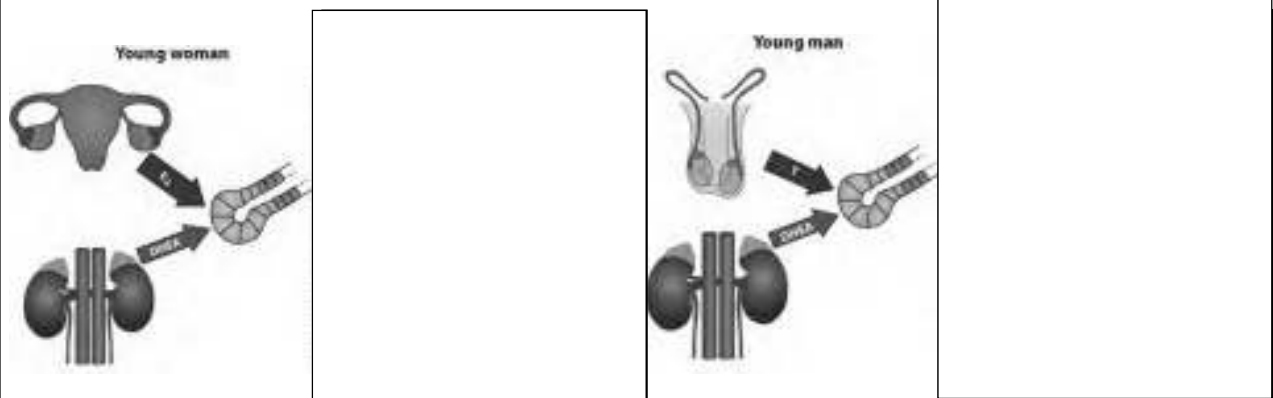
Saliva

Flow	Cholinergic stimulation Aquaporin water channels are Testosterone -dependent
pH	H ions in Striated ducts
Buffering capacity	Three different buffer systems Striated ducts
Proteins	Serous acinar cells Adrenergic stimulation
Glycoproteins	Mucous acinar cells Cholinergic stimulation



Endocrinology vs. Intracrinology

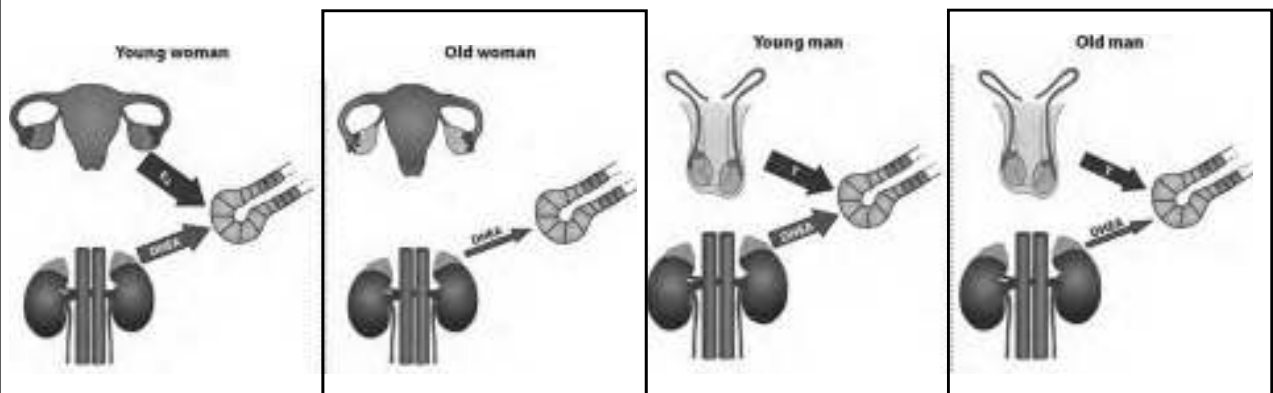
Effect of sex steroids on exocrine glands



F. Labrie (2015)

Endocrinology vs. Intracrinology

Effect of sex steroids on exocrine glands



F. Labrie (2015)

Normal localization of sex steroid converting enzymes

The diagram illustrates the normal localization of sex steroid converting enzymes in the human reproductive system. It shows a cross-section of the testes and the associated duct system (epididymis and vas deferens). The enzymes are localized in the following manner:

- Testes:** The enzymes are localized in the interstitial cells (Leydig cells) and the Sertoli cells of the seminiferous tubules.
- Epididymis and Vas Deferens:** The enzymes are localized in the Sertoli cells of the epididymis and the Sertoli cells of the vas deferens.

Chemical structures of the sex steroids are shown on the left, illustrating the conversion of cholesterol to androgens and estrogens.

SKJ Interpretation of Spaan et al., 2009

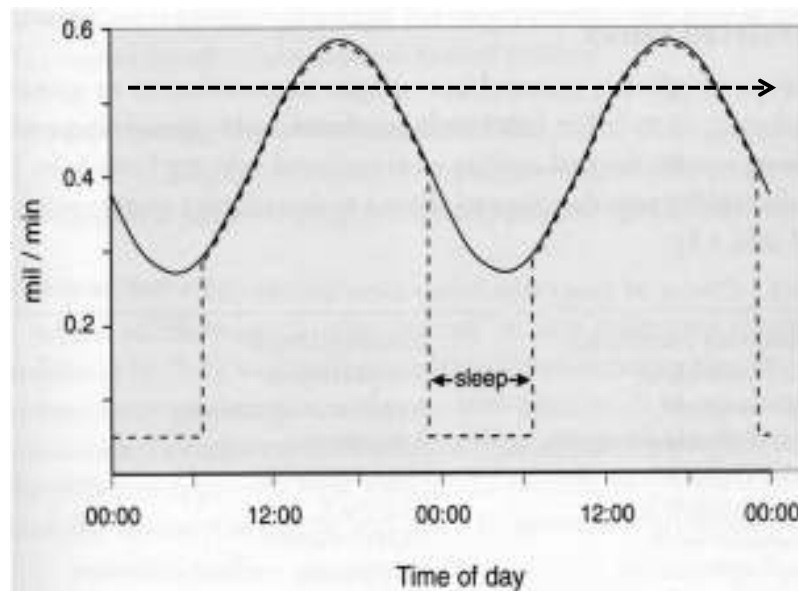
Sjögren's syndrome

The diagram illustrates the pathophysiology of Sjögren's syndrome. It features a large, stylized illustration of a salivary gland (likely the parotid gland) with a long, thin duct system. The glandular tissue is depicted with various cellular components, including nuclei and cytoplasmic organelles. To the left of the gland, there is a detailed biochemical pathway diagram showing the conversion of cholesterol to bile acids, involving several enzymatic steps and intermediates. Above the gland, there is a block of text in Dutch, which appears to be a translation of the English text provided in the caption. The text describes the role of the enzyme HMG-CoA reductase (HMG-CoA reductase) in the synthesis of cholesterol, which is a precursor for bile acids. It also mentions that in Sjögren's syndrome, there is a deficiency of this enzyme, leading to a decrease in cholesterol levels and, consequently, a decrease in bile acid production. This biochemical alteration is linked to the clinical manifestations of the disease, such as dry eyes and dry mouth.

HMG-CoA reductase (HMG-CoA reductase)
HMG-CoA reductase is the key enzyme in the synthesis of cholesterol.
In Sjögren's syndrome, there is a deficiency of this enzyme, leading to a decrease in cholesterol levels and, consequently, a decrease in bile acid production.

SKJ Interpretation of Spaan et al., 2009

Flattening of the circadian rhythm with aging



Salivary changes during normal aging?

1. Reduced flow rate?
2. Composition of saliva?
3. Increased oral dryness?
 - Decreased secretion of antimicrobial peptides

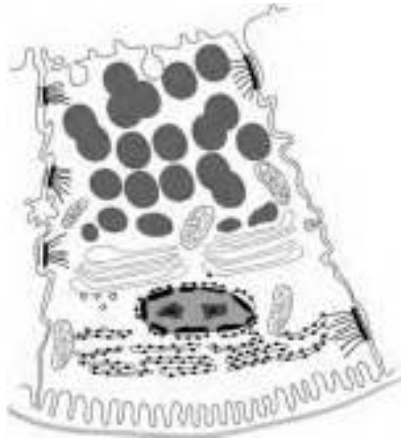
1. Reduced flow rate with Aging: Yes!

- The flow rate of resting whole saliva decreases with age (Sreebny, 2000)
 - A reduction in the flow rate from Submandibular/Sublingual glands with age. Resting parotid flow is very difficult to measure due to its small volume.
- Reduced stimulated flow rate from parotid glands as well (Yeh, 1998)
 - 1133 subjects
 - Other studies have shown contradictory results, this is due to the fact that most organs can compensate for a loss of parenchyma

2. Changes in composition of saliva with aging: YES!

- Synthesis of mucins decrease
 - Important glycoproteins in unstimulated salivary flow
 - Submandibular/sublingual glands and minor salivary glands
 - Aggregates bacteria
 - Forms pellicle
 - Protects against dehydration

Mucous acinar cell



Contents of secretory granules:

MUC5B, 130 kDa

Binds Ca^{2+} and Hydroxyapatite. Aids in lubrication.

MUC7, 100 kDa

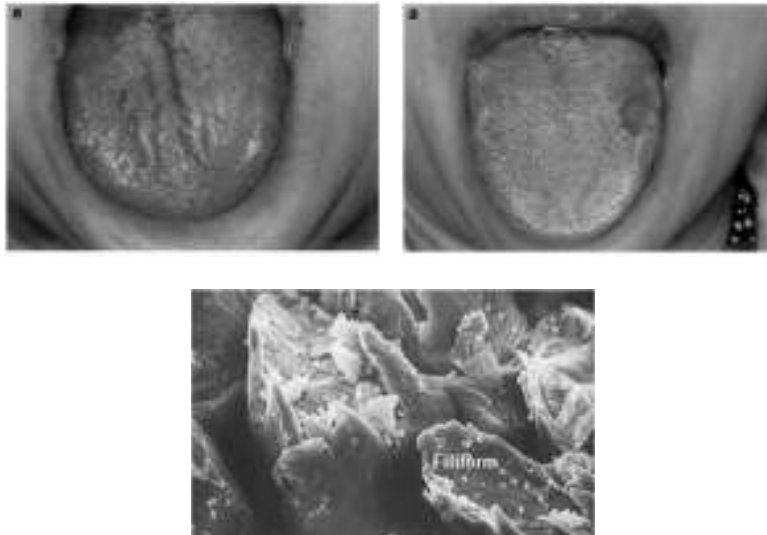
Interacts w/ bacteria, facilitates their removal. Aids in mastication, speech and swallowing.

- Hydrophilic
 - Resist mucosal dehydration
- Pellicle formation
- Bind to bacterial surfaces
 - Limit their colonization
 - Crosslink and aggregate bacteria

2. Changes in composition of saliva with aging: YES!

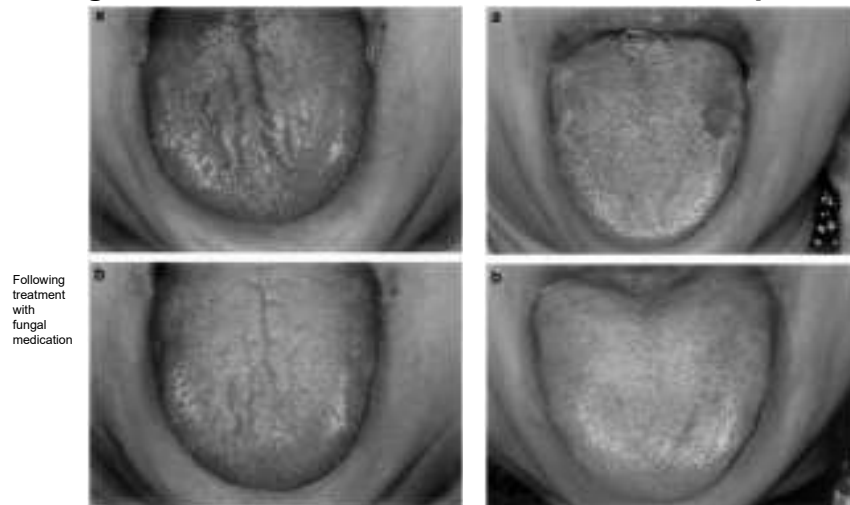
- Synthesis of mucins decrease
 - Important glycoproteins in unstimulated salivary flow
 - Submandibular/sublingual glands and minor salivary glands
 - Aggregates bacteria
 - Forms pellicle
 - Protects against dehydration
- Synthesis of Histatin 5 decreases
 - Higher frequency of Candida infections in the elderly (Sugimoto et al., 2006)
 - 124 healthy elderly, 65 years and older; 84% positive!
 - Correlated to
 - A. Type of denture
 - B. Histatin 5 concentrations in saliva
 - anti-fungal, bactericidal

A common consequence of reduced saliva secretion is an overgrowth of *Candida*, which will cause an Atrophic Tongue



Terai et al. (2005): Atrophic tongue associated with *Candida*

A common consequence of reduced saliva secretion is an overgrowth of *Candida*, which will cause an Atrophic Tongue



Following
treatment
with
fungal
medication

Figure 2 Glossal findings in the total atrophic case

- (a) Total atrophic change was seen at pre-treatment.
- (b) Regeneration of filiform papilla was seen in two weeks after treatment.

Figure 3 Glossal findings in the partial atrophic case (migratory glossitis)

- (a) Partial atrophic change was seen in the left dorsum of the tongue.
- (b) Regeneration was seen in a week after treatment.

Terai et al. (2005): Atrophic tongue associated with *Candida*

3. Increased oral dryness? Yes!

- First study conducted in 1984 in Sweden
 - 16% of 70 year old men, and 25% of 70 year old women suffered from oral dryness
- Sreebny and Valadini (1988)
 - “Does your mouth usually feel dry?”
 - 20.8% of men, and 33.3% of women
- All studies taken together
 - 14 – 46% of individuals suffer from oral dryness
 - Women more so than men

Osterberg et al. (1984); Sreebny (2000)

Lower salivary flow rate due to:

1. Reduction in acinar volume
2. “Flattening” of the Circadian rhythm

Changes in protein composition:

1. Lower levels of Mucins
2. Lower levels of Histatin 5

If subjective oral dryness:

1. Less fluid secretion, USF mL/min
2. Lower levels of Antimicrobial peptides from PG, SM, SL and minor glands

Masticatory Performance

- The ability to break foods down into discrete portions by chewing.
 - Number of **chewing cycles** needed to chew a standardized piece of food **increase with age**
 - Maintaining or restoring masticatory function - the ultimate goal of dental/oral care.
- *Factors that affect masticatory performance are*
 1. Loss and restoration of posterior teeth
 2. Tooth wear
 3. Occlusal force
 4. Salivary flow
 5. Oral motor function (accelerates masticatory dysfunction with ageing)

Medications with high dental impact

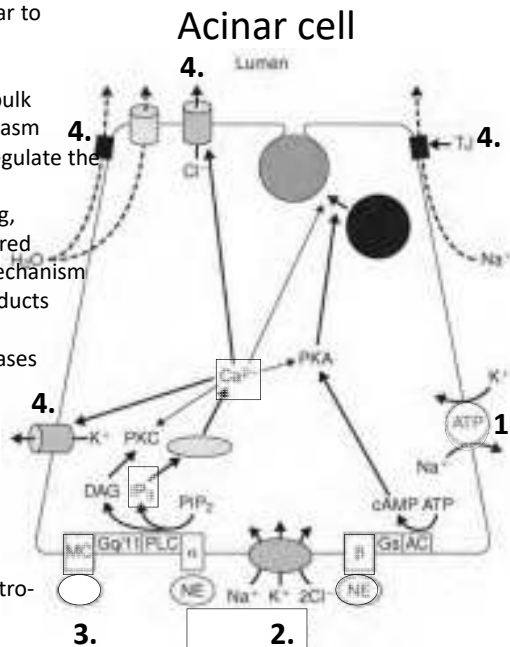


1. Na^+/K^+ ATPase creates an extracellular to intracellular gradient of Na^+

2. $\text{Na}^+\text{K}^+2\text{Cl}^-$ co-transporter drives the bulk of acinar Cl^- ions into the cytoplasm
 - β -adrenergic stimulation upregulate the co-transporter
 - When co-transporter is lacking, fluid secretion is severely impaired
 - A second Cl^- concentrating mechanism is HCO_3^- dependent, in salivary ducts

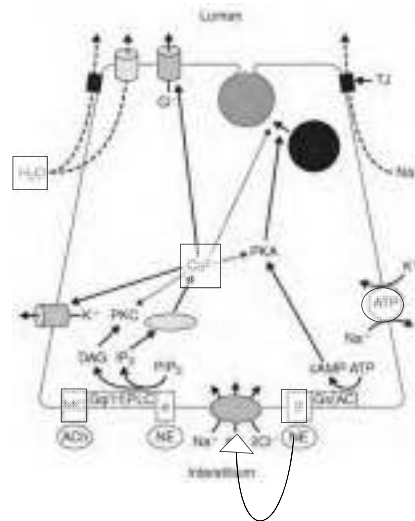
3. Stimulation of M_3R by ACh releases intracellular Ca^{2+} from ER
 - The IP_3 wave and the Ca^{2+} wave is shared betw/ the acinar cells within a unit.

4. Ca^{2+} opens Ca-dependent Cl^- and K^+ channels
 - Na^+ follows Cl^- to uphold electro-neutrality
 - H_2O follows osmotically
 - Presence of Androgens for function of AQ5



Important steps for saliva secretion

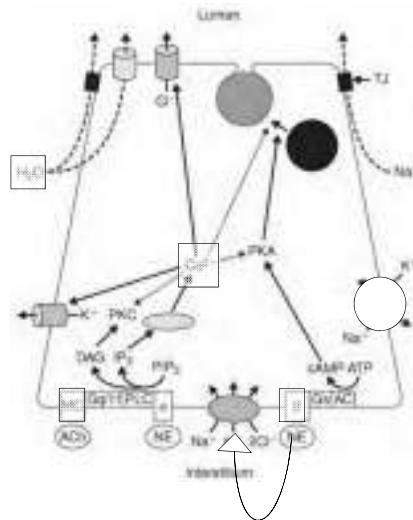
- Fluid secretion is dependent on gradient set up by Na^+/K^+ ATPase
- $\text{Na}^+/\text{K}^+/\text{Cl}^-$ – co transporter
- Muscarinic stimulation
 - IP_3 receptors on ER release Ca^{2+}
 - Ca^{2+} dependent ion channels drives fluid through the cell
- Aquaporin 5 channels
 - Androgen dependent



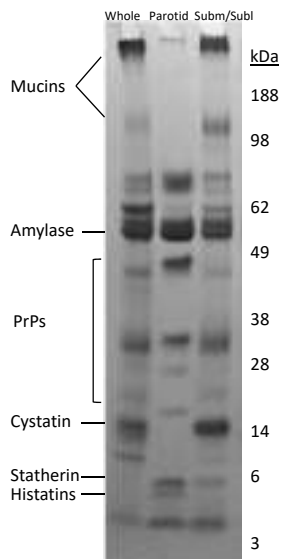
Reduced salivary flow

- Medications which affect salivary flow the most:

- Anti-cholinergic medication
- Beta-blockers
- Ca^{2+} antagonists
- Diuretics



Contents of saliva



Carpenter (2013)

- 99.5% water and 0.5% dissolved substances:

Salivary proteins and glycoproteins

- Amylase, Cystatins, Mucins, Proline-rich proteins (PrPs), Lysozyme, slg's, Lactoferrin, Peroxidase, Histatins, Statherin, Defensins etc.

- Mucins:
- PrPs:
- Statherin:
- Histatins:

- *Growth factors*: NGF, EGF, and other regulatory peptides

- *Antimicrobial*: Lysozyme, Lactoferrin, Lactoperoxidase, Histatins, Defensins

- *Digestion of starch and lipids*: Amylase and Lipase

Inorganic ions

- Bicarbonate, potassium, calcium and phosphate ions

Gases

- Oxygen, carbon dioxide and nitrogen

Saliva Testing

TEST 1: Saliva-Check Buffer

HYDRATION (*minor salivary glands, 15% of resting saliva*)

1. Visual inspection of hydration

UNSTIMULATED SALIVA (*minor and major salivary glands*)

1. Flow (mL/min)
2. Consistency
3. pH (may also measure buffer capacity)

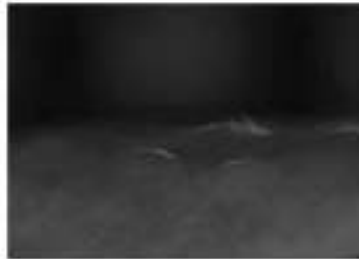
STIMULATED SALIVA (*minor and major salivary glands*)

1. Flow (mL/min)
2. pH
3. Buffer capacity

TEST 2: Saliva-Check Mutans

STIMULATED SALIVA

- 4. Str. Mutans test
(more or less than 500,000 CFU of Str. Mutans in 1 mL of stimulated saliva)



Saliva Testing

TEST 1: Saliva-Check Buffer

HYDRATION (*minor salivary glands, 15% of resting saliva*)

1. Visual inspection of hydration

UNSTIMULATED SALIVA (*minor and major salivary glands*)

1. Flow (mL/min)
2. Consistency
3. pH (may also measure buffer capacity)

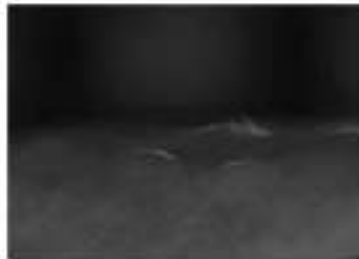
STIMULATED SALIVA (*minor and major salivary glands*)

1. Flow (mL/min)
2. pH
3. Buffer capacity

TEST 2: Saliva-Check Mutans

STIMULATED SALIVA

- 4. Str. Mutans test
(more or less than 500,000 CFU of Str. Mutans in 1 mL of stimulated saliva)



Saliva-Check BUFFER
Test for Saliva Quality, pH & Buffering Capacity



Saliva-Check BUFFER
An easy, fast test for checking the quality, pH and buffering capacity of saliva.

Used along with Saliva-Check BUFFER, it is a convenient and reliable method of testing.

RECOMMENDED INSTRUCTIONS
To check the procedure for testing pH and buffering capacity.

CONTRAINDICATIONS
No contraindications.

DIRECTIONS FOR USE

1. Place 3.51 mL of saliva into the collection cup. 2. Place the test strip into the saliva. 3. Wait 5 minutes. 4. Read the results. 5. Dispose of the test strip. 6. Wash the collection cup. 7. Repeat the test if necessary.

Saliva-Check BUFFER is a saliva testing examination tool that is used to educate patients, assist in preventative treatment planning and properly select dental materials in order to reduce changes in the patient's oral hygiene. This product plays a significant role in maintaining oral health. It identifies, measures and assesses the patient's saliva condition, which helps determine the body's possible risk of caries. It is also helpful for testing hydration, salivary consistency, resting saliva pH, stimulated saliva pH, stimulated saliva pH and saliva buffering capacity. The Saliva-Check BUFFER is ideal for use during routine oral examinations.

TEST 1 – Visual inspection of level of hydration

Visually assess the lower lip labial gland secretion. Evert the lower lip, gently blot the labial mucosa with a small piece of gauze and observe the mucosa under good light. Droplets of saliva will form at the orifices of the minor glands.

Assess the time for visible production of saliva as follows:

Greater than 60 seconds: resting flow: Low

Less than 60 seconds: resting flow: Normal

TEST 2 – Saliva consistency

Visually assess the resting salivary consistency in the oral cavity.

Sticky frothy saliva residues: increased viscosity

Frothy bubbly saliva: increased viscosity

Watery clear saliva: Normal viscosity

Salivary flow (mL/min)

Collect saliva during 5 minutes (drooling)

TEST 3 – pH measurement

Instruct the patient to expectorate any pooled saliva into the collection cup. Take a pH test strip, place this into the sample of resting saliva for 10 seconds, and then check the colour of the strip. This should be compared with the testing chart available in the package.

6.0	6.2	6.4	6.6	6.8		Highly acidic
6.0	6.2	6.4	6.6	6.8		Moderately acidic
6.8	7.0	7.2	7.4	7.6	7.8	Healthy saliva

Resting saliva



- 3.51 mL
- 5 minutes
- Flow = 0.7 mL/min



TESTING OF STIMULATED SALIVA

TEST 4 – Saliva quantity
Instruct the patient to chew the piece of wax to stimulate salivary flow. After 30 seconds, let the patient expel the wax into the spittoon. Continue chewing for a further 5 minutes, collecting all the saliva into the collection cup at regular intervals.

The quantity of saliva can be measured by measuring the markings on the side of the cup.

Quantity of saliva at 5 minutes:

< 3.8 mL

Between 3.8 – 5.2 mL

> 5.2 mL

Very low

Low

Normal

Note: Normal stimulated saliva flow rate may vary between patients – 1.5 mL/min

TEST 5 – Buffering capacity

a) Remove a Buffer strip from the packaging and place into an absorbent tissue with the test pad up.

b) Using a pipette, draw sufficient saliva from the collection cup and dispense one drop onto each of the 2 test pads. Immediately run the meter (C) to read up excess saliva on the absorbent tissue. This will prevent the patient's saliva from pooling on the test pad and possibly affecting the accuracy of the test result.

c) The test pads will begin to change colour immediately and after 2 minutes the test result can be measured by adding the points according to the final colour of each pad. See conversion table and example below.

Conversion table

Test pad colour at 2 minutes

Green

Orange/Yellow

Blue

Pink/Red

Red

4 points

3 points

2 points

1 point

0 points

Example:



Where a colour conversion provides an unclear result, use intermediate values.

Interpreting the result

Continued table

0.5

0.5

0.5

0.5

Very low

Low

Normal

High

Stimulated saliva



- 8.46 mL
- 5 minutes
- Flow = 1.7 mL/min

3. Collect the stimulated saliva sample in the mixing container. The volume collected must reach line A. Otherwise, the result is invalid.

NOTE: For small children or patients who have difficulty expelling saliva into the mixing container, it is recommended to use a collection device which is suitable for children. Refer to the respective manufacturer's instructions for use.

4. Holding the bottom of reagent #1 vertically, add 3 drops of reagent #1 to the saliva. Hold the opening of the mixing container tightly at mouth opening of saliva. Turn the mixing container 10 times over a period of 10 seconds with a finger to mix the saliva and reagent #1 thoroughly.

NOTE:

1) Reagent #1 is an alkaline solution which will break down and dissolve products (or proteins) in the saliva. This is an important step in the procedure. To ensure the collection sample is able to freely flow through the test device.

2) Do not use saliva samples that are collected in the mix of the mixing container as they can obstruct the action of Reagent #1 (Fig. 3). If saliva samples are present remove them, equilibrate with a moist swab to solution of Reagent #1.

3. Add 4 drops of reagent #2 (yellow) to the mixing container. Mix the saliva sample and reagent #2 thoroughly. Observe that the color change has changed to a light green color (change to neutral pH).

4. Using the graduated capillary, take sufficient saliva from the mixing container to fill to line C on the pipette and dispense into the sample window of the end of the test device.

5. Leave sitting on the bench for 15 minutes (room temperature). A test that has already been observed in the window (C) presents at the test device, indicating that the test is working properly. At the same time, check the test (T) window. The result is positive if a brown line appears in the T window indicating the salivary level of Streptococcus mutans are high (>20 x 10³ CFU/mL saliva) and that the patient has a potential high risk of dental caries activity. It is also possible to observe after 10 minutes. This indicates a low salivary level of Streptococcus mutans and a low potential risk of caries at this time.

NOTE:

1. Make sure to check the result at 15 minutes after dispensing the saliva into the sample window. The results read before or after 15 minutes may be inaccurate.

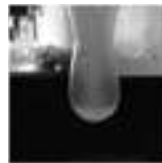
2. The test is not required at positive level of saliva of the test (T) window is very positive. Refer to discuss #10 in the technique guidebook in the package.

3. If the test line does not appear in the window (C) (yellow), the test is invalid. Please start the test again using a new test device.

4. The test will be positive when the number of Streptococcus mutans (bacteria) per mL of stimulated saliva is > 10³ CFU/mL, greater than 600,000 CFU per mL of saliva.

5. If negative results indicate that the number of Streptococcus mutans is < 10³ CFU/mL, less than 600,000 CFU per mL of saliva.

6. Replace the cap of the reagent after use.



Str Mutans



Your Test results

- **HYDRATION**

- Low: Over 60 s for visible production of saliva
- Normal: Less than 60 s for visible production of saliva

- **UNSTIMULATED SALIVA**

- Flow Less than 0.1 mL/min 0.1 – 0.25 mL/min Above 0.25 mL/min
- Consistency:
 - Sticky,
 - frothy,
 - watery/clear
- pH pH: 5.0 – 5.8 Highly acidic pH: 6.0 – 6.6 Moderately acidic pH: 6.8 – 7.8 Healthy

- **STIMULATED SALIVA**

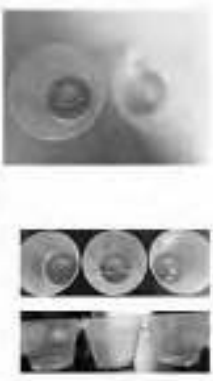
- Flow Less than 0.7 mL/min 0.7 mL/min – 1.0 mL/min Over 1.0 mL/min
- pH pH: 5.0 – 5.8 Highly acidic pH: 6.0 – 6.6 Moderately acidic pH: 6.8 – 7.8 Healthy
- Buffer capacity Very low Low Normal/High

- **STIMULATED SALIVA - MUTANS**

- Positive (over 500,000 CFU/mL saliva)
- Negative (below 500,000 CFU/mL saliva)

	Dental students	Dv. patients
Minor salivary gland hydration		
Low		
Normal	Normal	Normal
Resting salivary secretion		
Flow	0.8 mL/min	0.1 mL/min
Consistency		
Sticky		
Frothy		
Watery/clear	Watery/clear	Watery/clear
pH	6.8 – 7.8	6.8
Stimulated salivary secretion		
Flow	2.8 mL/min	1.7 mL/min
pH	7.8	7.8
Buffer capacity	13	12
Quantification of Str. Mutans		
Positive (over 500,000 CFU/mL saliva)	Positive	Positive
Negative (below 500,000 CFU/mL saliva)		

	Dental phobics	Dr. (a) Day	High caries risk Olan patient	Diabetic patient
Minor salivary gland hydration				
Low				
Normal	Normal	Normal		
Resting salivary secretion				
Flow	PO LS			
	0.8 ml/min	0.7 ml/min	0.05 ml/min	0.04 ml/min
Consistency				
Sticky				
Frothy				
Watery/clear	Watery/clear	Watery/clear	Watery/clear	Watery/clear
pH	5.5 - 7.0	5.5	5.4	5.4
Stimulated salivary secretion				
Flow	2.6 ml/min	1.7 ml/min	0.44 ml/min	0.2 ml/min
pH	7.8	7.8		
Buffer capacity	12	12	12	Very Low
Quantification of Str. Mutans				
Positive (over 500,000 CFU/ml. saliva)				
Negative (below 500,000 CFU/ml. saliva)				
	Positive	Positive	Positive	




	Dental phobics	Dr. (a) Day	High caries risk Olan patient	Diabetic patient
Minor salivary gland hydration				
Low				
Normal	Normal	Normal		
Resting salivary secretion				
Flow	PO LS			
	0.8 ml/min	0.7 ml/min	0.05 ml/min	0.04 ml/min
Consistency				
Sticky				
Frothy				
Watery/clear	Watery/clear	Watery/clear	Watery/clear	Watery/clear
pH	5.5 - 7.0	5.5	5.4	5.4
Stimulated salivary secretion				
Flow	2.6 ml/min	1.7 ml/min	0.44 ml/min	0.2 ml/min
pH	7.8	7.8		
Buffer capacity	12	12	12	Very Low
Quantification of Str. Mutans				
Positive (over 500,000 CFU/ml. saliva)				
Negative (below 500,000 CFU/ml. saliva)				
	Positive	Positive	Positive	




2013 - Younger diabetic patient



Year	Country	Population (millions)	Urban population (millions)	Urban population (%)	Urban population (millions)	Urban population (%)
1950-54	U.S.S.R.	167	3	1.8	164	98.2
1955-59	U.S.S.R.	169	3	1.8	166	98.2
1960-64	U.S.S.R.	176	3	1.7	173	98.3
1965-69	U.S.S.R.	181	3	1.6	178	98.3
1970-74	U.S.S.R.	186	3	1.6	183	98.4
1975-79	U.S.S.R.	191	3	1.5	188	98.4
1980-84	U.S.S.R.	196	3	1.5	193	98.5
1985-89	U.S.S.R.	201	3	1.4	198	98.5
1990-94	U.S.S.R.	206	3	1.4	203	98.6
1995-99	U.S.S.R.	211	3	1.4	208	98.6
2000-04	U.S.S.R.	216	3	1.4	213	98.6
2005-09	U.S.S.R.	221	3	1.4	218	98.7
2010-14	U.S.S.R.	226	3	1.4	223	98.7
2015-19	U.S.S.R.	231	3	1.4	228	98.7
2020-24	U.S.S.R.	236	3	1.4	233	98.7
2025-29	U.S.S.R.	241	3	1.4	238	98.8
2030-34	U.S.S.R.	246	3	1.4	243	98.8
2035-39	U.S.S.R.	251	3	1.4	248	98.8
2040-44	U.S.S.R.	256	3	1.4	253	98.8
2045-49	U.S.S.R.	261	3	1.4	258	98.9
2050-54	U.S.S.R.	266	3	1.4	263	98.9
2055-59	U.S.S.R.	271	3	1.4	268	98.9
2060-64	U.S.S.R.	276	3	1.4	273	98.9
2065-69	U.S.S.R.	281	3	1.4	278	98.9
2070-74	U.S.S.R.	286	3	1.4	283	98.9
2075-79	U.S.S.R.	291	3	1.4	288	98.9
2080-84	U.S.S.R.	296	3	1.4	293	98.9
2085-89	U.S.S.R.	301	3	1.4	298	98.9
2090-94	U.S.S.R.	306	3	1.4	303	98.9
2095-99	U.S.S.R.	311	3	1.4	308	98.9

	Female	Male	1-4 years	5-14 years	15-64 years	65+ years
Age						
0-14 years	10.1	10.1	10.1	10.1	10.1	10.1
15-64 years	69.9	69.9	69.9	69.9	69.9	69.9
65+ years	20.0	20.0	20.0	20.0	20.0	20.0
Marital status						
Married	69.9	69.9	69.9	69.9	69.9	69.9
Single	20.0	20.0	20.0	20.0	20.0	20.0
Employment						
Employed	69.9	69.9	69.9	69.9	69.9	69.9
Unemployed	20.0	20.0	20.0	20.0	20.0	20.0
Income						
Low	10.1	10.1	10.1	10.1	10.1	10.1
High	89.9	89.9	89.9	89.9	89.9	89.9
Health						
Good	69.9	69.9	69.9	69.9	69.9	69.9
Poor	20.0	20.0	20.0	20.0	20.0	20.0
Education						
High school or less	10.1	10.1	10.1	10.1	10.1	10.1
College or more	89.9	89.9	89.9	89.9	89.9	89.9

2015–Younger diabetic patient



06/15/15	S. Katers	C001	21	W	A	0	Primary Care
06/15/15	S. Katers	C002	3	L	A	0	Insurgent Care
06/15/15	S. Katers	C003	9	D	A	0	Insurgent Care
06/15/15	S. Katers	C002	12	M	A	0	Insurgent Care
06/15/15	S. Katers	C003	13	B	A	0	Insurgent Care
06/15/15	S. Katers	C002	26	J	A	0	Insurgent Care
06/15/15	S. Katers	C003	21	M	A	0	Secondary Care
06/15/15	S. Katers	C009	5	B	B	0	Watch for decay
06/15/15	S. Katers	C008	7	M	A	0	Watch for decay
06/15/15	S. Katers	C009	11	D	A	0	Watch for decay
06/15/15	S. Katers	C009	12	B	A	0	Watch for decay
06/15/15	S. Katers	C009	16	L	A	0	Watch for decay
06/15/15	S. Katers	C009	18	D	A	0	Watch for decay
06/15/15	S. Katers	C009	19	B	A	0	Watch for decay

	Variable	Number	Unit	Unit	Unit
	Symbol	Symbol	Symbol	Symbol	Symbol
1. General information					
1.1. Project name	Project name				
1.2. Project description	Project description				
1.3. Project objectives	Project objectives				
1.4. Project results	Project results				
1.5. Project impact	Project impact				
1.6. Project budget	Project budget				
1.7. Project timeline	Project timeline				
1.8. Project risks	Project risks				
1.9. Project stakeholders	Project stakeholders				
1.10. Project evaluation	Project evaluation				
1.11. Project conclusion	Project conclusion				
1.12. Project appendix	Project appendix				
1.13. Project references	Project references				
1.14. Project glossary	Project glossary				
1.15. Project index	Project index				
1.16. Project table of contents	Project table of contents				
1.17. Project list of figures	Project list of figures				
1.18. Project list of tables	Project list of tables				
1.19. Project list of references	Project list of references				
1.20. Project list of stakeholders	Project list of stakeholders				
1.21. Project list of risks	Project list of risks				
1.22. Project list of objectives	Project list of objectives				
1.23. Project list of results	Project list of results				
1.24. Project list of impact	Project list of impact				
1.25. Project list of budget	Project list of budget				
1.26. Project list of timeline	Project list of timeline				
1.27. Project list of risks	Project list of risks				
1.28. Project list of stakeholders	Project list of stakeholders				
1.29. Project list of objectives	Project list of objectives				
1.30. Project list of results	Project list of results				
1.31. Project list of impact	Project list of impact				
1.32. Project list of budget	Project list of budget				
1.33. Project list of timeline	Project list of timeline				
1.34. Project list of risks	Project list of risks				
1.35. Project list of stakeholders	Project list of stakeholders				
1.36. Project list of objectives	Project list of objectives				
1.37. Project list of results	Project list of results				
1.38. Project list of impact	Project list of impact				
1.39. Project list of budget	Project list of budget				
1.40. Project list of timeline	Project list of timeline				
1.41. Project list of risks	Project list of risks				
1.42. Project list of stakeholders	Project list of stakeholders				
1.43. Project list of objectives	Project list of objectives				
1.44. Project list of results	Project list of results				
1.45. Project list of impact	Project list of impact				
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1.47. Project list of timeline	Project list of timeline				
1.48. Project list of risks	Project list of risks				
1.49. Project list of stakeholders	Project list of stakeholders				
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1.52. Project list of impact	Project list of impact				
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1.55. Project list of risks	Project list of risks				
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1.59. Project list of impact	Project list of impact				
1.60. Project list of budget	Project list of budget				
1.61. Project list of timeline	Project list of timeline				
1.62. Project list of risks	Project list of risks				
1.63. Project list of stakeholders	Project list of stakeholders				
1.64. Project list of objectives	Project list of objectives				
1.65. Project list of results	Project list of results				
1.66. Project list of impact	Project list of impact				
1.67. Project list of budget	Project list of budget				
1.68. Project list of timeline	Project list of timeline				
1.69. Project list of risks	Project list of risks				
1.70. Project list of stakeholders	Project list of stakeholders				
1.71. Project list of					

Xerostomia inventory

- The xerostomia inventory (adapted from Thomson et al., 1999b).
- - 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 lollies to relieve dry mouth
 - I have difficulties 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
- MacEntee, Michael I. (2011-06-09). Oral Healthcare and the Frail Elder: A Clinical Perspective (Kindle Locations 2147-2158). Wiley. Kindle Edition.

Reduced salivary flow as a result of disease:

- Sjögren's syndrome
 - Systemic Lupus Erythematosus
 - GvHD
 - Irradiation
- + *as a result of medications*



Measurements made simple

Visually inspect minor gland secretion:
a. Hydration (Low/Normal)

Measure unstimulated whole saliva (UWS)
a. Flow (ml/min)
b. pH

Measure stimulated whole saliva (SWS)
a. Flow (ml/min)
b. pH

Medicine cups
+



Hydrion pH test paper

Digital scale with TARE function



How to help with oral dryness?

Cochrane Review (2011)
Thirty-six randomized controlled trials involving 1597 participants met the inclusion criteria

Oxygenated glycerol tri-ester (OGT) (oxygenated oil) saliva substitute spray shows evidence of effectiveness compared to an electrolyte spray, which corresponds to approx. a mean difference of 2 points on a 10-point visual analogue scale (VAS) for mouth dryness.



<http://www.aquoral.com/>



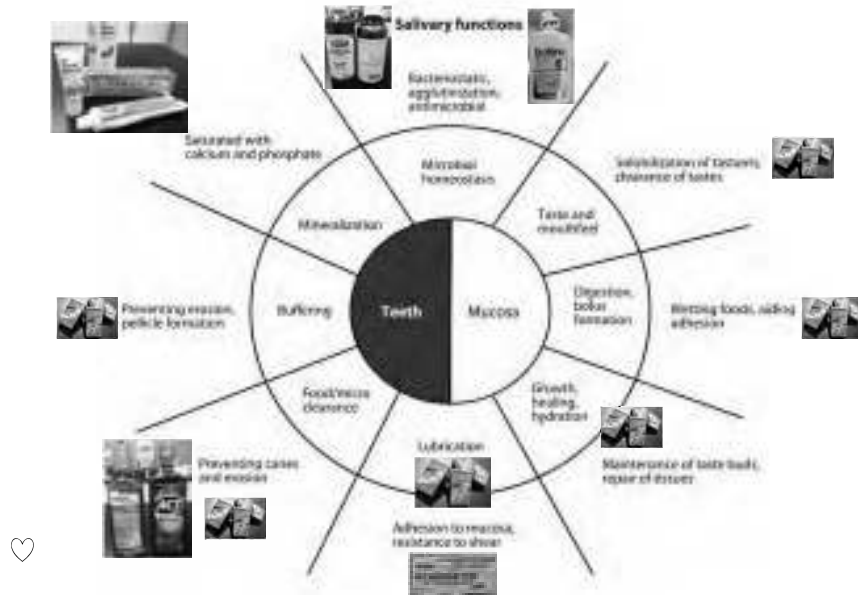


Summary

Aging changes in the Oral Cavity

- *Enamel* is stable, but prone to demineralization at the gingival margin and proximal
- Biological changes for women at menopause are drastic. Loss of 25% of *bone mass* (750g/3000g), men lose less (450g/4000g). This loss of bone mass is esp. evident in the mandible.
- *Gingiva and PDL*: Decreased barrier function, more prone to gingivitis, slower collagen turn-over, chronic inflammation.
- Loss of *sensory input* from nerve endings and mechanoreceptors
- Flattening of the *circadian rhythm* reduces protein synthesis in oral mucosa and salivary glands
- *Menopause* affects oral mucosa and salivary glands to a yet not fully known extent.
 - Women no longer have active estrogen circulating in plasma. Instead dependent on local conversion of DHEA into bioactive estrogens and androgens for tissue metabolism.
- Lower secretion of *Aldosterone* affects salivary gland striated ducts and result in a lesser uptake of NaCl from saliva.
- Loss of *stem cell* activity: In salivary glands a 20-40% decrease in number of acinar cells (serous and mucous) with aging.
- *Salivary glands*:
 - Reduced flow rate with aging, decreased levels of mucins, histatins; increased oral dryness which is accompanied by decreased levels of antimicrobials
- Accelerated oral aging as a result of *medications*: Anti-cholinergic, beta-blockers, Ca²⁺ antagonists, diuretics
- Cochrane review: Only an oxygenated oil was effective in reducing oral dryness; 2 points on a 10-points visual analogue scale
 - AQUORAL

How can we prevent the effects of decreased flow/impaired salivary gland function?



Caries and Preventive Care in the Elderly



Tooth lesions in the elderly

- 1. Root caries
 - Fast progression; easy to overlook during caries registration
 - Crown margins or Subgingival
 - RMGI (will take up and release NaF from fluoride varnish/rinse); very sensitive to moisture
 - Amalgam (Ag is toxic for bacteria)
- 2. Dental erosion and NCCL
 - GERD
 - Diet
 - High erosive potential: Citrus fruits, Apples, Cranberries and Grapes
 - Medium erosive potential: Colas, Vinegar, White and red wine
 - Low erosive potential: Beer, carbonated water (Bartlett, 2007)
 - Tooth brushing habits
- 3. Deep enamel/dentin caries lesions
 - Step-wise excavation
 - Condense CaOH paste ; LC'd CaOH liner; Temporary filling; Wait 3 months
 - Indirect overcapping/Direct overcapping
 - Condense CaOH paste; LC'd CaOH liner; Permanent filling
 - Debridement is covered in Apple Health (and RCT for anterior teeth)



1. Root caries in Elderly

- Elderly are more at risk for root caries due to
 - Dentures
 - Plaque retention
 - Lack of dexterity
 - Electric toothbrushes when necessary
 - Diet: Shift from complex to simple sugars
 - Poor oral hygiene (loss of sensitivity)
 - Decreased SubM/SubL salivary flow (un-stimulated; 0.16 mL/min)

Root caries is the major source of tooth loss in older adults!

Tooth loss is the most significant oral health-related negative variable of quality of life for elderly!

1. Root caries in Elderly

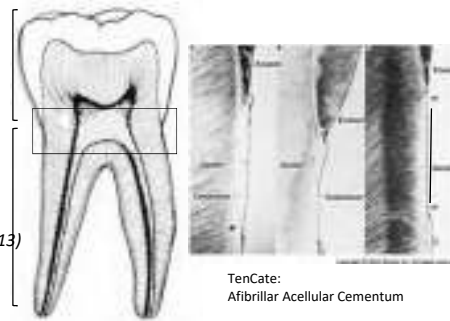
- 50% of older adult over 65 y/75 y have root caries
 - Patients who have lived in fluoridated areas throughout most of their lives have a lower prevalence of root caries (Center for Disease Control and Prevention, 1992)

- Demineralization

- Enamel: pH 5.2

- *Cementum: pH 6.7*

- (T. Donovan, CDE course: Worn dentition, 2013)



Poor Oral Hygiene

- Gingival recession exposes root surfaces
- Presence of *Str Mutans*, *Lactobacilli* and *Actinomyces* are increased in root caries patients (Preza et al., 2008)

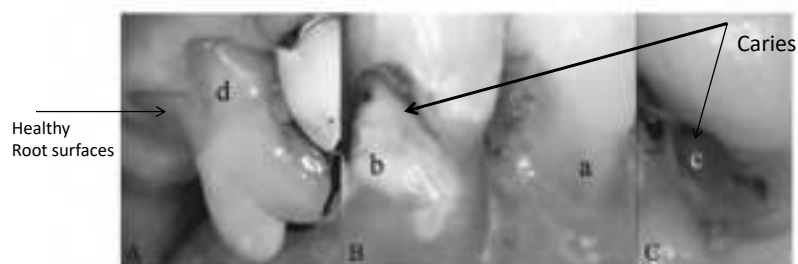


FIG. 5. (A) Control subject: d, plaque; healthy root. (B and C) HC subject: (B) a, plaque; healthy root; (C) b, plaque; carious root. (D) c, plaque; carious root.

2. Non-Caries Cervical Lesions due to Dental erosion DENTIN FORMATION (Sclerotic dentin)

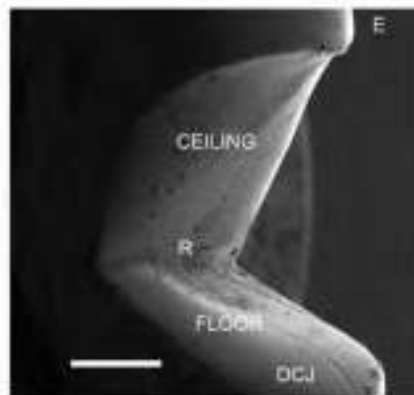


Fig 2. A mandibular central incisor with a facial wedge-shaped cervical lesion. The enamel edge (E) overhangs the ceiling dentine which makes a right angle junction (H) with the floor. The floor is featureless dentine down to the relief edge of the dentine-enamel junction (DEJ) that is 1 mm.

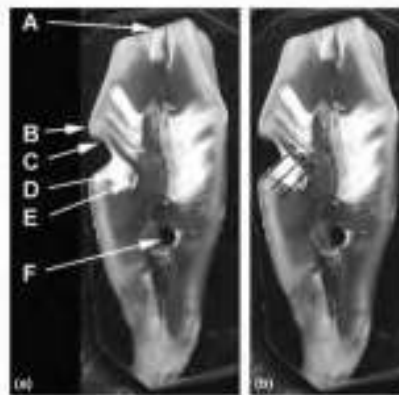
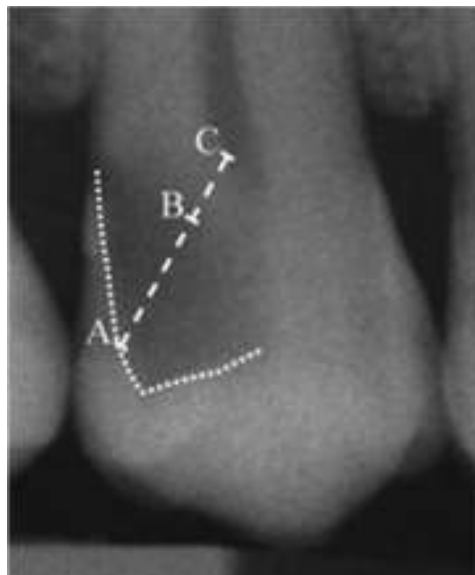


Fig 3. (a) A longitudinal ground section of the incisor shown in Fig 2. Red dye has penetrated parent tubules from within the tooth. (A) Attrition wear facet with underlying tract of white tubules. (B) Thinned facial enamel edge overhanging the lesion. (C) Ceiling of the lesion, a tract of white tubules follows the path of primary curvature of dentinal tubules. (D) Tract of sclerotic tubules extending from the lesion floor to the pulp. (E) Reparative dentine. (F) Hole drilled for dye penetration. (b) Oblique transverse sections, Level 1: the horizontal floor of the wedge-shaped lesion. Level 2: between the floor of the lesion and the pulp. Level 3: through reparative dentine.

Daley et al., 2009

© 2009 Australian Dental Association

3. Deep caries lesions leading to step-wise excavations



I. Stepwise excavations result in fewer pulp exposures (17.5%) compared with direct complete excavations (28.9%).

II. At 1 yr follow-up, stepwise excavations had a higher success rate (74.1%) compared to direct complete excavation (62.4%)



Consider using a self-etching bonding system, i.e. no need to etch w/ 37% Phosphoric acid, and no need to rinse following etching.

Bjorndal et al. (2010): Treatment of deep caries lesions in adults: Randomized clinical trials comparing stepwise vs. direct complete excavation; and direct pulp capping vs. partial pulpotomy

ADA: Caries Assessment Form

ADA, American Dental Association
Dental Caries Assessment Form (Age 6-8)

Patient Name: _____ Date: _____
 Birth Date: _____ Sex: _____
 Age: _____

	Age 6-8	Age 9-11	Age 12-15
1. Patient's exposure to sugary foods/beverages	11-14	11-14	11-14
2. History of dental visits (last 12 months)	11-14	11-14	11-14
3. Current exposure to fluoride (toothpaste, water, etc.)	11-14	11-14	11-14
4. Dental history (last 12 months)	11-14	11-14	11-14
5. General health (last 12 months)	11-14	11-14	11-14
6. Oral hygiene (last 12 months)	11-14	11-14	11-14
7. Diet (last 12 months)	11-14	11-14	11-14
8. Oral care (last 12 months)	11-14	11-14	11-14
9. Oral care (last 12 months)	11-14	11-14	11-14
10. Oral care (last 12 months)	11-14	11-14	11-14
11. Oral care (last 12 months)	11-14	11-14	11-14
12. Oral care (last 12 months)	11-14	11-14	11-14
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14. Oral care (last 12 months)	11-14	11-14	11-14
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96. Oral care (last 12 months)	11-14	11-14	11-14
97. Oral care (last 12 months)	11-14	11-14	11-14
98. Oral care (last 12 months)	11-14	11-14	11-14
99. Oral care (last 12 months)	11-14	11-14	11-14
100. Oral care (last 12 months)	11-14	11-14	11-14

Overall assessment of dental caries risk: 11 Low 12 Moderate 13 High

Notes (optional): _____

Chronic disease

Accelerated aging changes

Americans die from Chronic disease

- About half of all adults—117 million people—have one or more chronic health conditions.
- One of four adults has two or more chronic health conditions
- 1.7 million Americans die from a chronic disease each year, this accounts for 7 out of 10 deaths in the United States.
- Five chronic diseases: Heart disease, Cancer, Stroke, Chronic Obstructive Pulmonary Disease (COPD), and Diabetes account for *more than 2/3 of all deaths in the US*.
- The average 75-year-old suffers from 3 chronic conditions and takes 5 prescription medications.

*Health conditions and Drugs marked with * affects Dental Treatment and Oral Health*

Chronic Health Conditions

1. Arthritis*
2. Hypertension*
3. Heart disease*
4. Any cancer*
5. Diabetes*

Top generic drugs 2014:

1. Hydrocodon
2. Lisinopril*
3. Levothyroxine*
4. Atorvastatin*
5. Amlodipine*

The five most Common drugs for elderly:

1. Lipitor*
2. Novasc*
3. Fosamax*
4. Prilosec*
5. Celebrex*

Source: Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion.

Hypertension
~ 70%



Source: <http://www.bodymad.com>

Senior Center clinic patient

- 1st visit (March, 2014)
 - M73
 - Extremely scared (anxiety/panic) for dental treatments; “crossed nerves”
 - Needs full mouth extraction for CD/CD
 - HBP - BP: 165/92, pulse 102
- **3 Problems**
 - 1. Patient is extremely scared
 - 2. Needs full mouth extraction
 - 3. Blood pressure is much too high to accommodate 1 and 2

Hypertension

**Usual recommendation is no elective procedure if BP is over 160/100
(= Stage 2 Hypertension)**

If BP is between 160/100 and 180/110 dental procedures could still be carried out, if BP is not accompanied with symptoms of severe hypertension: Headache, shortness of breath, nosebleeds, severe anxiety.

However, there are no recognized or published criteria, based on absolute BP levels, to indicate when the urgent dental care should proceed (Muzyka & Glick, 1997; Glick, 1998; Aubertin, 2004; Herman, Konzelman, & Prisant, 2004).

Local Anesthesia

- **2% Lidocaine 1:100,000 EPI**
 - Lidocaine is a natural vasodilator
- **4% Prilocaine (Citanest Forte) 1:200,000 EPI**
- **4% Articaine (Septocaine) 1:200,000 EPI**
- **3% Mepivacaine (Carbocaine) plain**



Senior Center clinic patient

- **1st visit (March, 2014)**
 - M73
 - Accompanied by daughter
 - Extremely scared (anxiety/panic) for dental extractions; “crossed nerves”
 - Needs full mouth extraction for CD/CD
 - HBP - BP: 165/92, pulse 102

Premedication with Xanax (Alprazolam; Benzodiazepine)

0.5 mg the night before
0.5 mg in the morning of the procedure
2 x 0.5 mg 1 hr before procedure

- **2nd visit (April, 2014)**
 - BP 117/90, pulse 102
 - 7 teeth extracted (Maxilla)
 - 4.0 mL 4% Citanest Forte 1:200,000

Diabetes
~ 30%



Source: <http://theubpost.mn>

Dental treatment of Diabetic patients

- The well-controlled diabetic can usually be managed conventionally to include most surgical procedures. Maintenance of a normal postsurgical diet is important.
 - *Patients may require reduction of insulin dose immediately prior to oral surgical procedures that will result in reduced calorie oral intake so as to prevent unintended hypoglycemia.*
- Marginally or poorly controlled diabetics should be treated with caution.
 - Elective dental treatment should be avoided until the patient is stabilized.
- Patients should be encouraged to maintain *excellent oral hygiene and comply with recall appointments.*
 - Usually low salivary flow, with decreased levels of calcium, phosphate and fluoride. If dental caries is a potential problem, use 1.1% NaF toothpaste and/or gels and ACP-containing products. Xerostomia should be managed on a case-by-case basis.

3: 70min presents for Caries Susceptibility Test (Saliva Testing) and EXT Root Tip #30

PMH: Diabetes, High Cholesterol, Overactive Bladder

Meds: Lipitor, Metformin, Torvaz

O: BP 137/67, Pulse 65.

A: Low end Unstimulated and Stimulated Flow Rate, Positive S. Mutans.

#17MO - Defective Restoration - Place MO Amalgam

#29 - Class III Mobility - Evaluate - Likely EXT

#30 - Root Tip - EXT

P: Saliva Testing and Caries Susceptibility Test:

- Unstimulated Flow Rate: 0.2ml/min (1ml/5min)

- Unstimulated pH: 6.6

- Stimulated Flow Rate: 0.7ml/min (3.5ml/5min)

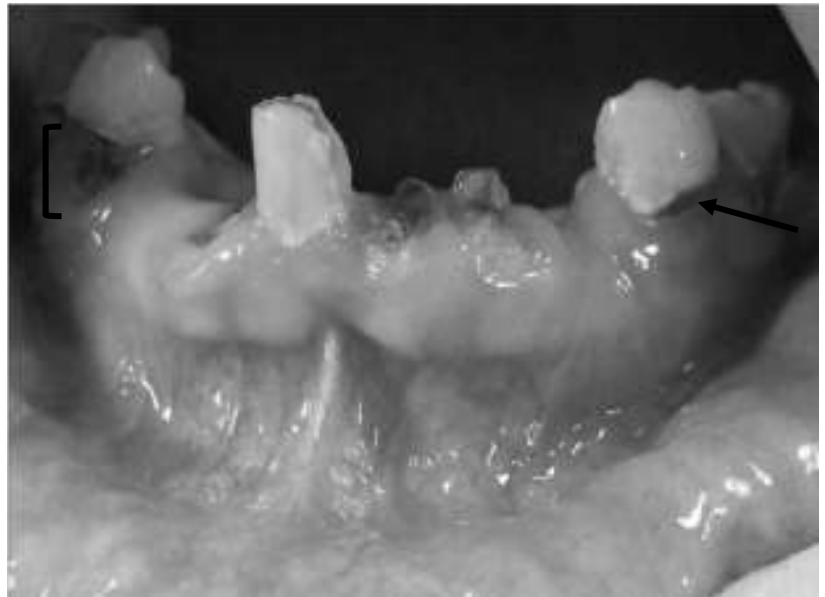
- Stimulated pH: 7.2

- Buffer (stimulated): Normal/High

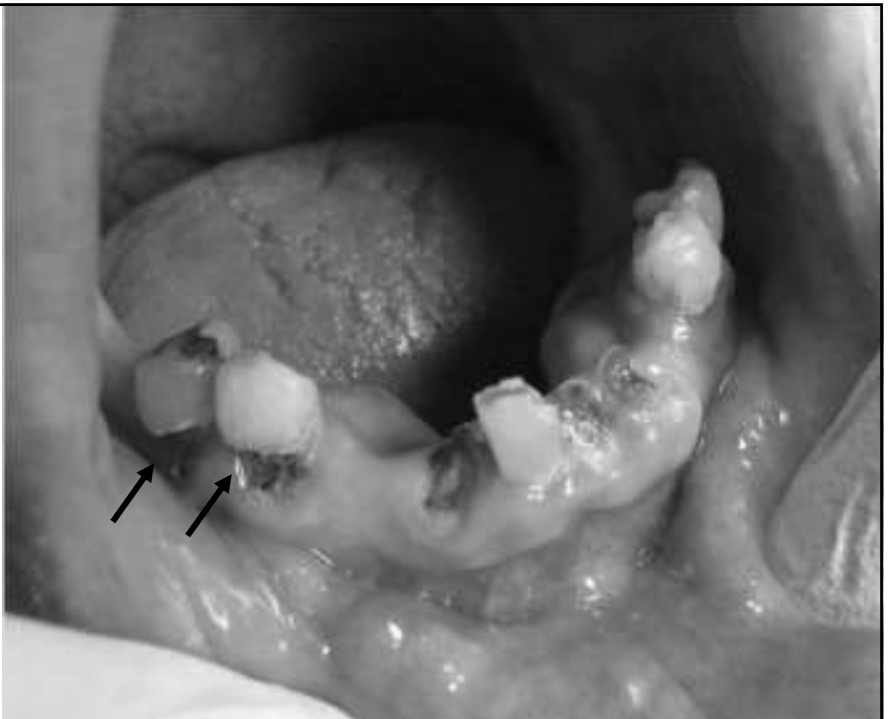
- S mutans Test: Positive

Recommendations: 1) Drink Lots of Water (>1.7L/day), 2) Chew Sugar-free Gum, 3) 4-day Diet Diary 4) Brush 3x Daily 5) Chlorhexidine Rinse





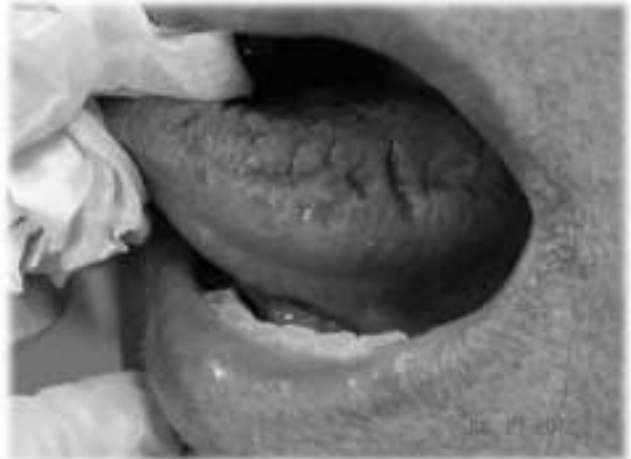
Root caries



Oral mucosal changes in Diabetic patients



Tongue is smooth and fissured
Keratinized epithelium has lost its keratinization



Migratory glossitis

“Atraumatic” extractions

- Luxators
 - Perioste-like “knife”
 - If at all possible, avoid surgical extractions
 - Use of Luxator for extractions



Senior Center Geriatric Dental Clinic

Diabetic patients

- **Caries**

- Root caries
- ACP-containing toothpaste (Arm & Hammer: Enamel strengthening toothpaste, Enamelon)
- Preventive home care: 5,000 ppm NaF gel or toothpaste (Rx), Xylitol gums
- Professional application: NaF varnish (22,500 ppm)
- DIET – Refer to Senior Services Dietician

- **Mucosa**

- Migratory glossitis

- **Periodontitis**

- 1 – 2 months recall
- 0.12% Chlorhexidine gluconate rinse (may cause excessive formation of calculus and discoloration)
- Electric toothbrush
- Interproximal brushes

- **Extractions**

- Slow healing
- Need antibiotics following extractions
- If root canal treated, roots “crumble”
- Use of luxators to avoid surgical flap (due to poor healing)
- Schedule procedures in the morning following a normal meal!

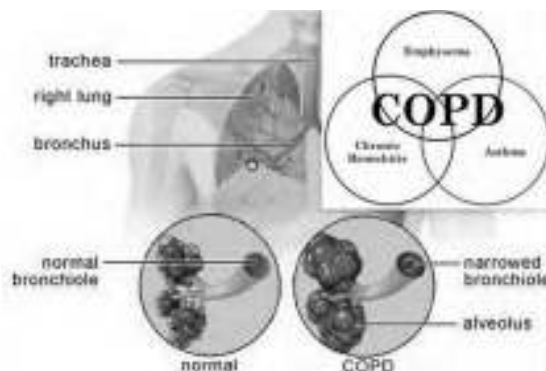
GERD
~ 10%



Dental Treatment of patients with GERD

- Promote adequate saliva production
- Dental erosion with possible thermal sensitivity occurs in many individuals. There is a strong association between GERD and dental erosion.
- Use remineralization protocols such as
 - Fluoride varnish or gels
 - Gels containing 0.4% Stannous fluoride: Enamelon (OTC)
 - High NaF toothpaste 1.1% Sodium fluoride (Rx)
 - Toothpaste containing extra Calcium
- Encourage diet changes

COPD
~ 10%





1. Establish contact with patients physician
2. Patients should be treated in a semisupine or upright position
3. Limit epinephrine if significant cardiovascular disease is present. (Avoid bilateral mandibular or palatal blocks – may cause unpleasant airway constriction in some patients).
4. Stress reduction including use of low-dose oral lorazepam (Ativan ®) or nitrous oxide delivered at an overall rate of 3 L/ min can be used with caution in anxious patients.
5. Ask patient to bring oxygen tank to clinic if supplemental oxygen is needed (less than 95%), low flow rates of 2– 3 L/ min should be used. Use Pulse oximeter during appointment.
6. If patient displays shortness of breath, a productive cough, upper respiratory infection, or oxygen saturation below 91% - Reschedule patient.

Key questions to ask the patient's physician

1. Is the patient on home oxygen therapy?
2. Is the patient's COPD stable?
3. What is the patient's baseline oxygen saturation level (on pulse oximeter) on room air or on supplemental oxygen?
4. Does the patient have frequent bacterial infections?
5. Does the patient have hypertension or heart failure?



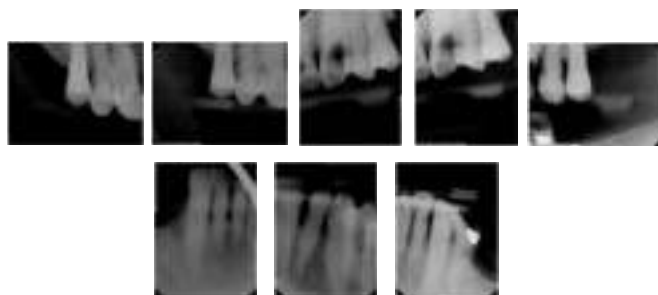
M78

OSCAR: Oral tissues, Capability (Self-care), Autonomy

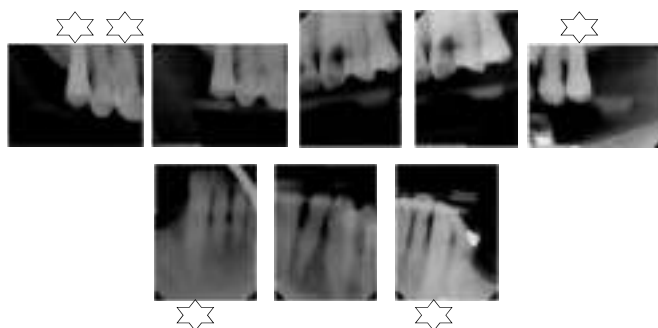
- EM presents to Senior Center clinic in December 2014
- Is bringing brand new ICD/ICD with him
 - Denturist-made
 - Has just paid \$1,700 for his dentures
- CC: Wants full mouth extractions
 - Does not want to be bothered by his teeth any longer
 - Doesn't know if he has made the right decision
- *Dental observation: Lower ridge, non-tooth supported, is resorbed*



EM (M78)



EM (M78)



ICD turned into RPD



Do not extract teeth that can be saved by simple
restorative treatment!

Update Sept, 2016

- We continuously see EM, approx. every 3-6 months for Adult prophylaxis and NaF varnish
- Relined RPD/RPD with Coe-Soft (~ 6 months)
- Next, we will reline with Tokuyama Rebase II (in clinic hard reline material).

MHC (F62)

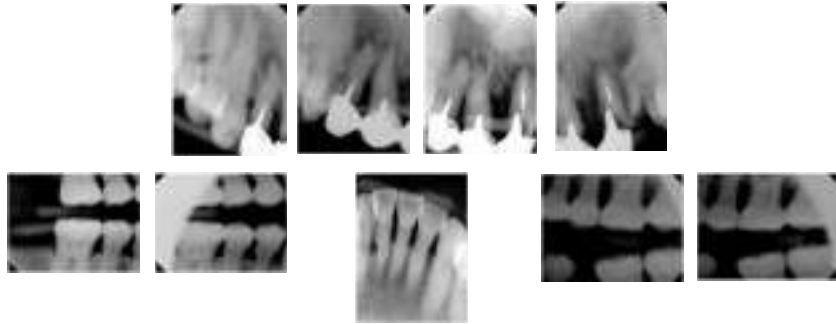
OSCAR: Oral, Reality - Financial

- MHC presents to the Senior Center clinic in November 2013
- CC: Her front bridge is failing, #9 and #10 has fractured, bridge is very loose.
- She was terrified to loose her appearance
- We extracted the root tip
- Cemented the bridge back using RelyX (lasted for approx. 6 month)



MHC (F62)

November 2013



MHC

Treat PARL

Treat Abscesses
Treat Soft tissue lesions

Teach Preventive care

Extraction of non-restorable teeth

Treat Gingivitis/Periodontitis
Excavation of deep caries lesions

Re-evaluation

Permanent restorations

Re-evaluation

Crowns/bridges/RPD/CD

Extraction of non-restorable teeth

Treat Gingivitis/Periodontitis



MHC (F62)

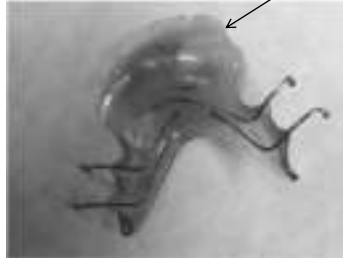
- MHC presents to the Senior Center clinic in November 2013
- CC: Her front bridge is failing, #10 has fractured, bridge is very loose.
- She was terrified to lose her appearance
- We extracted #9 and #10
- Re-cemented the bridge (#10 hanging pontic) using RelyX (lasted for approx. 6 months)



MHC (F62)

- She said she had a tRPD to replace the fractured #10 – it had been given to her previously. She did not like it and didn't want to use it.
- After the bridge came loose again, she finally agreed to let me use the tRPD and to have the abutment teeth extracted.

MHC (F62)



Previously inserted #10

I inserted #7, #8 and #9
using our hard reline
material Tokuyama rebase II



Soft reline
of tRPD
using
CoeSoft

Update Sept 2016

- *I have needed to re-insert the front anterior denture teeth and we have adjusted the soft reline to fully cover her gingiva*
- *She has been part of the Dental Hygiene clinic this Spring*
 - *I have waited for her bone to heal following extractions*
- *Re-evaluate her dentition (#15 has furcation involvement)*
 - *Due to Endo/Perio communication, #4 has needed antibiotic treatment and pulpectomy*
- *We now have funding for RPD/RPD*

VH (F97)

OSCAR: Autonomy, Capability, Reality (Life Span)

- VH presents in Faculty Practice for oral pain and difficulties chewing
- CD/CD
- Pain: Raspberry red oral mucosa and raspberry red smooth tongue, Keratinized denture wound due to overextended dentures
 - Rx: Nystatin ointment and solution (continue 2 weeks after symptoms disappear)
 - Tx: Adjusted flanges
 - Rx: Following check-up visit, I prescribed 0.12% Chx rinse (Sat/Sun)
- Difficulties chewing: Food trapped underneath denture
 - Tx: Soft reline using CoeSoft
 - NV: Hard reline in 6 months

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OSCAR: Autonomy, Capability, Reality (Life Span)

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- CD/CD
- Pain: Raspberry red oral mucosa and raspberry red smooth tongue, Keratinized denture wound due to overextended dentures
 - Rx: Nystatin ointment and solution (continue 2 weeks after symptoms disappear)
 - Tx: Adjusted flanges
 - Rx: Following check-up visit, I prescribed 0.12% Chx rinse (Sat/Sun)
- Difficulties chewing: Food trapped underneath denture
 - Tx: Soft reline using CoeSoft
 - NV: Hard reline in 6 months

Update Sept 2016

- VP has been in hospice
- Her health returned, and she is now in assisted living
- She is using 0.12% Chlorhexidine gluconate rinse every day
- Time for a new check up, and exchange of the soft reline (Coe-Soft)

TJ (M66)

OSCAR: Oral Tissues, Systemic, Capability, Reality



TJ has been our patient at the Senior Center Geriatric Clinic since 2013. His hypertension has previously been out of control (200/100), and we have occasionally needed to refuse dental care. His BP is now under control. He has received preventive care, restorative care and extractions of non-restorable teeth. He does not prioritize his home care, and is now in a situation where all teeth are non-restorable.

Last visit: August 2016

Vital signs: BP: 111/72, P:98

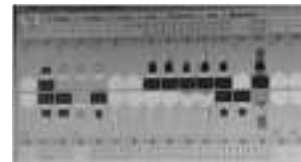
Medications: Metoprolol, Metformin, Hydrochlorothiazide

Diagnosis: Generalized chronic periodontitis, Rampant caries, Xerostomia

He does not have any means to pay for dental care. What would you do?

MP (F93)

OSCAR: Oral Tissues, Autonomy, Reality

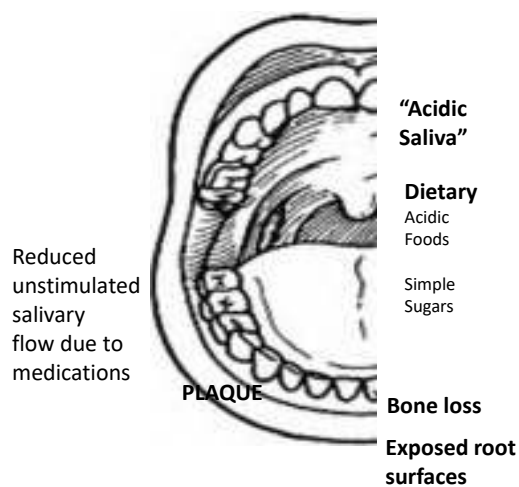


- MP is very conscious about her appearance, and came to the Senior Center Clinic due to a failing bridge, #7 - #2. She did not want to be without front teeth, and did not want to leave the house when the bridge came loose.
- We cemented the failing bridge temporarily 2x with RelyX before we found a way to finance a tRPD.




Summary

- Keep as many natural teeth as possible
 - Better masticatory function with fixed prosthetics (crown/bridge) compared to RPD or CDs
- Re-evaluate the initial treatment before start of more definitive dental care
- Remember OSCAR when you treatment plan!
 - *O – Oral tissues: Status of oral tissues*
 - *S – Systemic: Medical diagnoses, IP communication, Medications*
 - *C – Capability to self-care, oral hygiene, transportation to appointments*
 - *A – Autonomy, Decision-making ability, Co-dependence*
 - *R – Reality: Prioritization of oral care, financial ability, life-span*



Preventive Care



Reduced unstimulated salivary flow due to medications

PLAQUE

Bone loss

Exposed root surfaces

“Acidic Saliva”

Dietary

Acidic Foods

Simple Sugars

STRATEGIES

1. **Strengthen enamel and root cement/dentin w/**
 - a. NaF (Toothpaste, rinse, varnish, SDF)
 - b. Aid in remineralization with Ca^{2+} -containing toothpaste and/or cream, if low salivary flow
2. **Compensate for loss of saliva**
 - a. Drink water
 - b. Lubricate oral mucosa
3. **Compensate for low pH of saliva (or loss of buffer capacity)**
 - a. Alkalize water with baking soda, avoid carbonated drinks
 - b. Brush with baking soda-containing toothpaste (Arm & Hammer)
 - c. Change of diet to foods with a more neutral pH
4. **Reduce glucose intake**
 - a. Instead use Xylitol (Sorbitol)
5. **Reduce bacterial growth**
 - a. Antimicrobial rinse, 0.12% Chlorhexidine gluconate (or brush teeth and tongue with Chx)
 - b. Chx varnish

1. Strengthen enamel and root cement/dentin

- Sodium Fluoride
- ACP

EVIDENCE

NaF

- In erupted teeth, fluoride is known to reduce caries in three ways:
 - 1. Inhibiting bacterial metabolism of fermentable carbohydrates;
 - 2. Enhancing re-mineralization by incorporation of available fluoride into the tooth structure during acid attacks;
 - 3. Reducing the tooth's solubility during subsequent acid attacks.

EBD: Gibson, G et al., 2011

EVIDENCE

NaF toothpaste

- 1100 ppm (Every day toothpaste ~ 1100 ppm)
 - An RCT involving 810 adults aged 54+ years reported that a dentifrice containing 1100 ppm F **reduces *coronal caries by 41%* and *root caries by 67%*** when compared with a non-fluoride dentifrice
- **5,000 ppm (ex. Prevident gel or paste)**
 - A recent RCT demonstrated that **57% of adults** with one or more root caries lesions who had, for 6 months, used a dentifrice/gel containing 5000 ppm F had reversal of root caries compared with 29% of those who had used a dentifrice containing 1100 ppm F.

Increase of 500 ppm NaF --- a further 6 – 7% reduction in caries (in young people)

EBD: Davies, 2004

EVIDENCE

Daily rinse with 0.05% NaF



- RCT, 164 adults, aged 60+ years living in a non-fluoridated area. They were all supplied with toothpaste containing 1500 ppm F; one group was requested to rinse twice a day with 10 ml of a 0.05% NaF solution in addition to brushing.
- After 2 years the caries increments were 0.3 (coronal) and 0.4 (root) in the test group compared with 1.0 and 1.4, respectively, in the control.
- They also reported that 67% of those in the rinsing group developed no new carious lesions compared with 16% in the control.
- RCT, individuals aged 60+ years living in a fluoridated area, focus: root caries lesions
- Over a period of 4 years one group used a 0.05% NaF rinse once a day whilst the control used a placebo rinse
- The increment in root caries after 4 years was 0.26 in the fluoride rinse group compared with 0.91 in the control. The fluoride rinse group also had significantly more reversals (1.53) than the control group (1.11).

EBD: Davies, 2004; Gibson, G et al., 2011

EVIDENCE

NaF Gels – irradiated patients

- A study by Spaak et al. involved subjects following head and neck radiation therapy, which is a high risk population
- 5,000 ppm NaF gel (as in Prevident gel) was sufficient to *inhibit caries almost completely* in *compliant* xerostomic patients that had an unstimulated salivary flow rate of <0.1 mL/min



EBD: Davies, 2004; Gibson, G et al., 2011

Amorphous calcium phosphate (ACP)

ACP

- Normally saliva is supersaturated with Calcium and phosphate
- Xerostomia patients (many diabetic patients and patients on HBP medication) and patients who have undergone head and neck radiation therapy
 - Calcium phosphate-based remineralization systems commercially available
 - 1. Amorphous Calcium Phosphate stabilized by a Casein phosphopeptide (CPP-ACP): *Recaldent (Australia)*; Trident Xtra Care chewing gum; line of preventive care products
 - Slowing progression of enamel caries
 - 2. unstabilized Amorphous Calcium Phosphate (ACP, science supported by ADA, US); *Enamelon*; Arm&Hammer's *Complete care Enamel strengthening toothpaste*; Premier Dental line of preventive care products
 - Preventive effect on root caries
 - 3. Bioactive glass containing Calcium Sodium Phospho silicate (NovaMin)
 - No published studies supporting remineralization
- Recommended as preventive therapy for root caries in dry mouth patients



EC Reynolds (2008): Calcium phosphate-based remineralization systems: Scientific evidence?
Papas et al.(1999 and 2008): Double blind study and Clinical trial; See website

MI Paste



PREVENTION OF ROOT CARIES IN OLDER ADULTS: A SUMMARY

Table 4. Recommendations for Clinicians for use of root caries preventive agents or combination of agents in vulnerable elderly.

Preventing root caries					
1 st Prevention	Agents or combination of agents ^{a,b}	EFFECTIVENESS in Preventing Root Caries	FEASIBILITY for use in Vulnerable Elderly	Current Evidence	Overall Rating
	38% SDF solution ^c Fluoridally	72% ↓ vs placebo for 1 st root caries	Very high; professionally applied annually	only 1 study on root caries ^d	BEST CHOICE for 1 st prevention
→	ACP toothpaste + 250 ppm NaF rinse ^e Daily	88% ↓ vs NaF toothpaste + NaF rinse combination	requires daily use by patient	only 1 study	best alternative if no professional application possible



Tan et al. (2010): 200 elderly followed over 3 yrs.

Three groups:

Reduction in root caries:

SDF

71%

NaF varnish

64%

Chx varnish

57%

ACP toothpastes: ex. Arm & Hammer: Complete care + Enamel Strengthening, approx. \$4
Walmart Generic NaF rinse 0.05%, approx. \$3



PREVENTION OF ROOT CARIES IN OLDER ADULTS: A SUMMARY

Table 4. Recommendations for Clinicians for use of root caries preventive agents or combination of agents in vulnerable elderly.

1 st Prevention:				
Agents or combination of agents ^a	EFFECTIVENESS in Preventing Root Caries	FEASIBILITY for use in Vulnerable Elderly	Current Cautions	Overall Rating
38% SCF solution ^b Annually	73% ↓ vs placebo for 1 st root caries	Very High: professionally applied annually	only 1 study on root caries ^c	BEST CHOICE for 1 st prevention
ACP toothpaste + 256 ppm NaF rinse ^d Daily	98% ↓ vs NaF toothpaste + NaF rinse combination	requires daily use by patient	only 1 study	best alternative if no professional application possible
2 nd Prevention:				
Agents or/and their combinations ^a	EFFECTIVENESS in Preventing Root Caries	FEASIBILITY for use in Vulnerable Elderly	Current Cautions	Overall Rating
22,500 ppm NaF varnish ^{e,f,g,h,i,j,k} Every 3 mo with or without NaF rinse or toothpaste	~75% arrested	Moderately High: professionally applied at 1-3 mo	none	BEST CHOICE for 2 nd prevention
4,500-5,500 ppm NaF toothpaste/gel ^{l,m,n} Daily	~54% arrested	requires daily use by patient	none	best alternative if no professional application possible

Arresting root caries

Gluzman et al., 2013



- Drink water
- Lubricate oral mucosa

Seattle water sources: Analysis of Cedar and Tolt's water supply, May 24, 2011: pH 7.75 – 8.54, Target is 8.2

Two different Biotene products

- “Green”

- OLD FORMULATION
- pH: 5.2
- Purified water, propylene glycol, xylitol, hydrogenated starch hydrolysate, poloxamer 407, hydroxyethylcellulose, sodium benzoate, flavor (peppermint oil), benzoic acid, disodium phosphate, zinc gluconate, lactoferrin, lysozyme, lactoperoxidase, potassium thiocyanate, aloe vera, calcium lactate, glucose oxidase.
- Enzyme System: Lysozyme, Lactoferrin, Lactoperoxidase



- “Blue”

- NEW FORMULATION
- pH: 7
- Water, Glycerin, Xylitol, Sorbitol, Propylene Glycol, Poloxamer 407, Sodium Benzoate, Hydroxyethylcellulose, Methyparaben, Propylparaben, Flavor, Sodium Phosphate, Disodium Phosphate



Saliva substitutes w/ “workable” pH

- | | | |
|-----------------------|----|---|
| • Biotene | pH | 5.15 (Note that enamel demineralizes below pH 5.2, and root surfaces below 6.7) |
| • Saliveze spray (UK) | pH | 6.88 (Aqueous solution of electrolytes) |
| • Artisial (FR) | pH | 6.66 (Carboxymethylcellulose and electrolytes) |
| • Oralube (AU/NZ) | pH | 6.89 (Carboxymethylcellulose and electrolytes) |
-
- *Cochrane Review (2011) Thirty-six randomized controlled trials involving 1597 participants met the inclusion criteria*
 - Oxygenated glycerol triester (OGT) (oxygenated oil) saliva substitute spray shows evidence of effectiveness compared to an electrolyte spray, which corresponds to approx. a mean difference of 2 points on a 10-point visual analogue scale (VAS) for mouth dryness.
 - *Aquoral: 2 sprays PO TID/QID PRN* (launched Oct 15, 2014 by pharmaceutical company in San Antonio, TX; Made in France)
 - Chewing gum: Xylitol (Sorbitol)-containing (No evidence that gum is more or less effective than saliva substitutes)



Kielbassa et al., 2000; Smith et al., 2001; Furness et al., 2011 (Cochrane database for systemic reviews)

3. Compensate for loss of pH (and buffer capacity)

- Alkalize water and use baking soda-containing toothpaste
- Diet

Alkalize

- Alkalize water with baking soda

- pH: 9
- 2 tsp in 1 glass of water



- Use toothpaste containing baking soda

- pH: 8
- Arm & Hammer



Diet

- Frequency of sugar intake, ie. sweetened snacks
- Chewy and sticky foods
 - Dried fruits
 - Candy
 - Sweet rice
- Sour (combination of sweet and sour)
 - Vinegar
- Individuals with root caries eat a greater number of meals/day, and have higher sugar intake
 - Higher lactobacilli counts (Dentocult LB)
 - Lower salivary buffering capacity (GC Saliva check BUFFER)
 - Higher amounts of Str. Mutans in saliva (GC Saliva check MUTANS)

Sour Spray	1.6	White Wine	3.7
Mango Sours	3.0	diet Lemon Lime Soda	3.7 - 3.8
Lemon Juice	2.0 - 2.5	Tomatoes	3.7 - 4.0
Wine	2.5 - 3.8	Roast Beef	5.8 - 6.0
Sports Drinks	2.5 - 4.4	Orbit Apricots	3.9
Coffee	4.4 - 5.5	Wanam C. Fluorescent Tablet	3.0
Vinegar	2.4 - 3.4	Vegetables	5.0 - 5.2
Coconut Oil	4.8	Seedling Raising	4.4
Soda	2.7 - 3.5	Bone	4.4
Oranges	2.8 - 4.0	Organic Blue Yogurt (Strawberry)	4.1
Plums	2.8 - 4.6	Yogurt Blue	4.1
Red Tea	2.9 - 3.0	Yogurt Lemon	4.1
Grapefruit	3.0 - 3.8	Tea (Black)	4.0
Strawberries	4.0 - 4.2	Roast Beef	4.0
Slice Orange	3.1	Carrot Juice	4.4
Grapefruit Juice Fresh Squeezed	3.1	Low Milk	4.2
Blueberries	3.0 - 3.3	Yogurt Natural	4.0
Apples	3.2 - 3.4	Yogurt Drink Orange	4.5
Grapefruit Juice	3.2	Wine	4.5 - 5.8
Vinegar	3.2	Carrot Juice	5.0 - 5.2
Lemon Lime Soda	3.4 - 3.5	Bread	5.8 - 6.2
Pickles	3.4 - 3.7	Natural Cheese	5.2
Orange Juice	3.5 - 4.8	Fruit	5.2
Apple Sauce	3.4	Cheddar Cheese	5.0 - 6.0
Pineapple Juice	3.4	Strawberry Flavored Milk	6.4
Apple Juice	3.5	Milk	6.4 - 6.8
Low Fruit Juice Squeezed	3.5	Egg	6.6
Multifruit Juice	3.6	Whole Milk	6.7
Salad Dressing	3.0	Water	7.5

Favourable
pH
for enamel

Favourable
pH
for root
cement/
dentin

Copyright: SmithGlaxoKline:

Low acidity foods – High acidity foods

pH above 6

- Asparagus
- Broccoli
- Clams
- Corn
- Kale
- Milk
- Peas
- Shrimp
- Avocado
- Chicken
- Crabmeat
- Hominy
- Lentils
- Mushrooms
- Rice
- Tea

pH below 6

- Most fruits and vegetables:
 - Carrots
 - Beans
- Potatoes
- Most meats

Source: www.pickyourown.org/ph_of_foods.htm



4. Xylitol

Xylitol

Chewing gums and mints are ADA approved

- Lozengers have caries preventive effect on root surfaces (Ritter et al., 2013)
 - OraMoist (1.5 gm Xylitol/mint)
 - Ice Breakers FROST (0.31 gm Xylitol/mint) = Grocery stores
- Xylitol containing chewing gum 5x daily x 5 min
 - Ice Breakers Ice Cubes (1.15 gm Xylitol/gum) = Grocery stores
 - Epic (1.06 gm Xylitol/gum)
 - Need 5 – 10g daily to be effective in reducing Str. Mutans levels



5. Reduce bacterial growth

Chlorhexidine

- 0.12% Chlorhexidine gluconate (Rx in US; OTC in Europe – 2% solution, 1% gel)
- Potent antiseptic antibacterial agent
 - Destabilizes bacterial membranes
 - Outer membrane ruptured
 - Inner membrane's functionality breached
 - Inhibits oxygen utilization of bacteria
 - Inhibits outgrowth of bacterial spores
- If possible, swish 15 mL (.5 fluid ounce) CHX for at least 30 sec (1 minute), OR
- Brush both gums and tongue with CHX solution for 1 minute 2x daily



EVIDENCE

Chlorhexidine

- Mouth rinses, containing either 0.12 or 0.2% Chlorhexidine digluconate, are very effective in reducing plaque and improving gingival health. Their effectiveness, either as an adjunct to mechanical oral hygiene procedures or when used alone, has been extensively documented in RCTs but, in most instances, their long-term use is precluded by the development of extrinsic tooth stain.
- “Non-staining” protocols:
 - Rinsing 1 week /month
 - Rinsing every other week
 - Rinsing every weekend (Saturday and Sunday)
- *Caries reducing effect in high-caries-risk patients, but not in low-caries-risk.*
- *SLS in tooth paste inactivates Chlorhexidine – 30 min to 120 min betw/ applications*
- *Combine with Sodium fluoride; Monofluorophosphate (MFP) precipitates Chlorhexidine and renders its useless*

EBD: Davies, 2004; Walls and Meurman, 2012

Base prophylaxis

- Removal of soft plaque (biofilm):
 - Tooth brushing (2x or 3x daily)
 - Battery/Electric driven tooth brush with a small round brushing head
 - Interproximal cleaning
 - Flossing
 - Interproximal brushes
 - Soft picks

EVIDENCE

Toothbrushes

- A recent Cochrane Review (Type 1) concluded, following a systematic review of 29 studies involving 2547 participants, that *powered toothbrushes with a rotation-oscillation action are more effective than manual brushes*.



- Toothbrushes with this mode of action reduced *plaque by 7%* and *gingival bleeding by 17%* when compared with manual brushes.

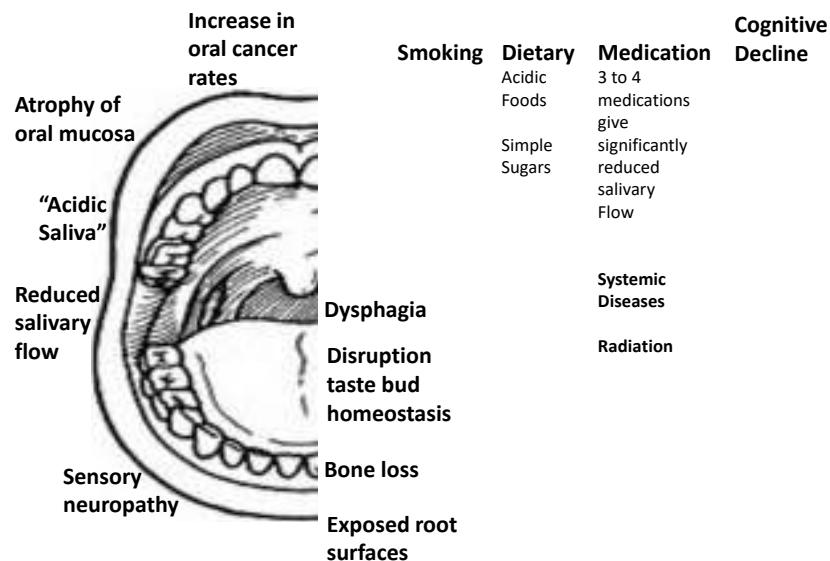
EBD: Davies, 2004

Dietary Interventions



Dietary interventions –Teeth for life

- *LOW IN SODIUM* - Hypertensive patients
- *LOW ACIDITY* - Patients with GERD
- *HIGH IN CALCIUM AND VITAMIN D* - Women following Menopause
- *LOW RISK FOR DEVELOPING CANCERS* – Adventists Health Study - 2
- Caries active patients
 - *LOW IN FERMENTABLE CARBS, LOW ACIDITY* - Patients with High Caries risk
 - *LOW ACIDITY* - Patients with Root surface caries
 - *LOW ACIDITY* - Patients with Hypersensitive teeth
 - *HYDRATION, LOW ACIDITY* - Patients experiencing a Dry mouth



The Tokyo Metropolitan Institute of Gerontology Index of Competence

- **Instrumental self-maintenance (0-5 points)**
 - Can you use public transportation by yourself?
 - Are you able to shop for daily necessities?
 - Are you able to prepare meals by yourself?
 - Are you able to pay bills?
 - Can you handle your own banking?
- **Intellectual activity (0-4 points)**
 - Are you able to fill out forms for you pension?
 - Do you read newspapers?
 - Do you read books or magazines?
 - Are you interested in news stories or programs dealing with health?
- **Social role (0-4 points)**
 - Do you visit the homes of friends?
 - Are you sometimes called on for advice?
 - Are you able to visit sick friends?
 - Do you sometimes initiate conversations with young people?

Total points possible: 13

Moriya et al. (2013)

The Tokyo Metropolitan Institute of Gerontology Index of Competence

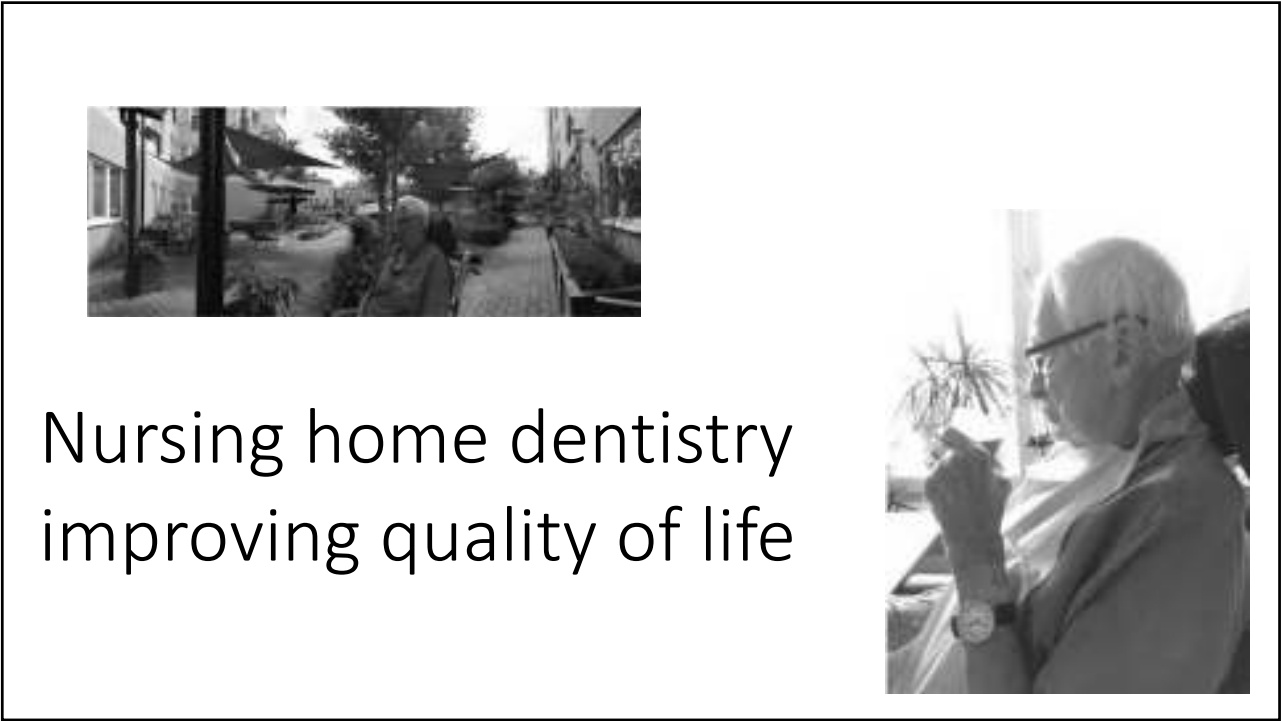
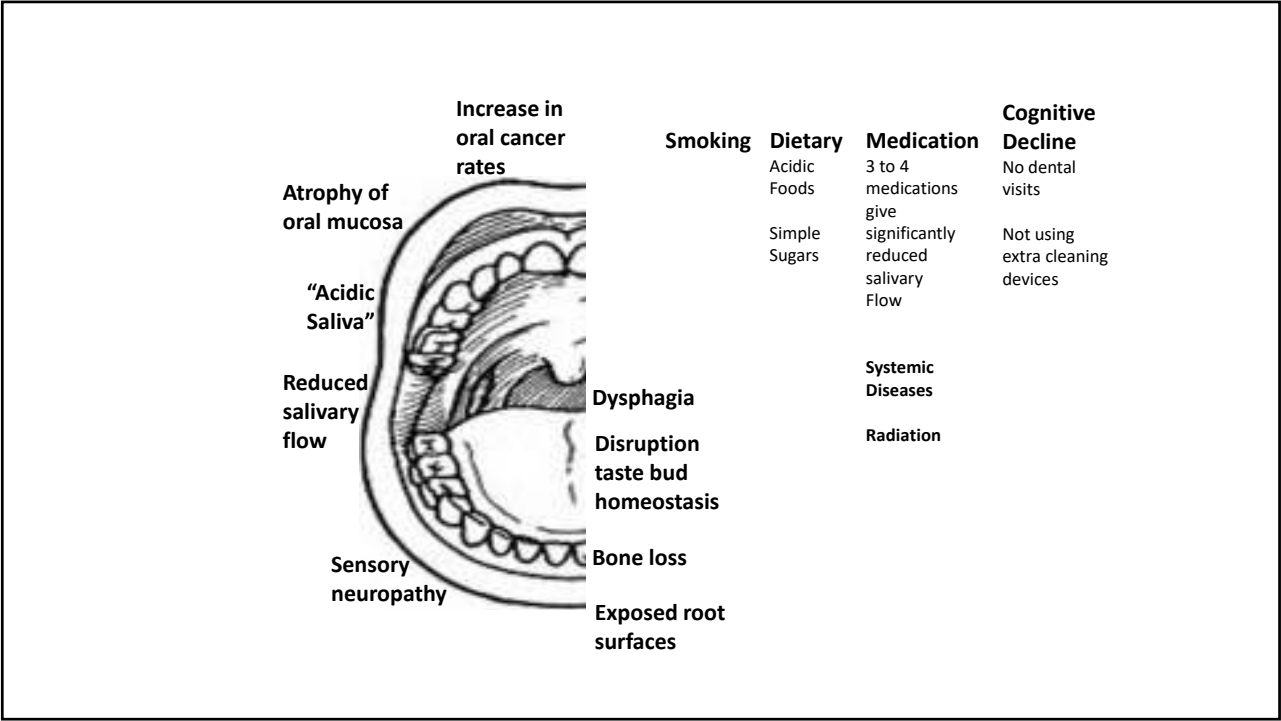
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- **Social role (0-4 points)**
 - Do you visit the homes of friends?
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 - Are you able to visit sick friends?
 - Do you sometimes initiate conversations with young people?

An overall score of 11 points or less OR an intellectual activity score of 3 or less was significantly related to poor oral health behaviours:

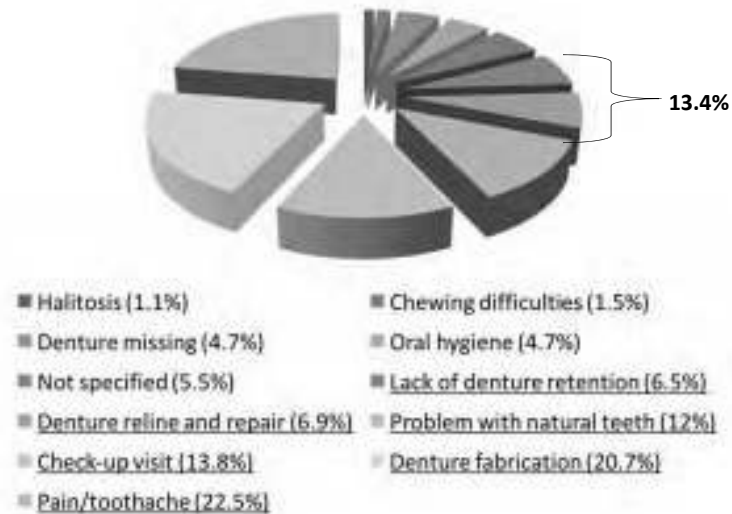
1. Lack of regular visits to a dentist
2. Not using extra cleaning devices

Total points possible: 13

Moriya et al. (2013)



Motives for dental consultations in a palliative care unit



After Schimmel et al. (2008)





Dementia

- 10 to 20% of Americans over 65 show mild to moderate mental impairment
- 17.9% of American over 65 are severely dement
 - Of these, 70% show pathological findings consistent with AD (12.5%)
- Approx. 30% of Americans over 80 show significant dementia

Does dementia and type of newly diagnosed dementia influence caries prevalence?

	Coronal and root surface caries (DS)	Root surface caries (DS)	
No dementia	2.7	1.7	
Dementia	7.0	2.3	
Alzheimer's dementia	7.8	4.9	

The prevalence of caries was related to both the type of dementia and to severity of cognitive decline.

A linkage between cognitive decline and oral health.

Ellefsen et al., 2008

Barriers?

- Are the barriers to good oral hygiene in nursing homes within the care-givers or the patients?
- Dementia is one of the toughest barriers! Main focus is plaque control.



Development of instrument to support oral care in dement nursing home patient.

Oral B toothbrush +
Extra tubing to supply
mouthwash

Pace and McCullough (2010); Sumi et al. (2003)



WILEY Blackwell

Learning to Speak Alzheimer's

- Early
 - Not remembering appointments
 - Not recognizing familiar faces
 - Losing track of time
 - Not storing recent information
 - Getting lost
 - Having difficulties finding words
 - Misplacing needed items
- Middle Early
 - Being unable to make decisions
 - Finding it hard to concentrate
 - Acting paranoid
 - Being unable to separate fact from fiction
 - Being unable to translate thoughts into actions
 - Misunderstanding what is being said
 - Making mistakes in judgment
- Late Early
 - Withdrawing, being frustrated and/or angry
 - Losing ability to sequence tasks
 - Speaking in rambling sentences
 - Misusing familiar words
 - Having difficulty writing
 - **Requiring supervision for ADL**
 - Reacting less quickly
- Early Middle
 - Losing fine motor skills (buttoning a shirt)
 - **Not recognizing objects for what they are**
 - **Being unable to understand written words**
- Middle Middle
 - Repetitious speech and action
 - Having hallucinations and delusions
 - Altered visual perception
 - Frequent changes of emotions
 - Minimal attention span
 - Overreacting, having outbursts
 - **Assistance with all ADL**
- Late Middle
 - Incontinent
 - Unable to separate or recognize sounds
- Late or Final
 - Losing all language
 - Losing gross motor skills (sitting, walking)
 - Having swallowing difficulties
 - Needing total care

By Joanne Koenig Coste

Oral health concerns increase with severity of Dementia

Severity of Dementia →

- ***Use of dentures***

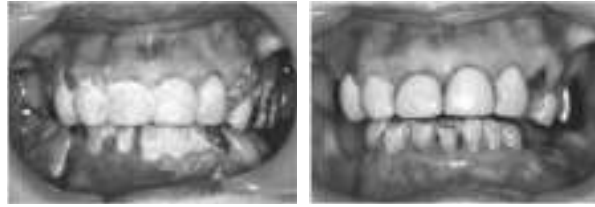
+ ***Denture-related oral mucosal lesions***

+ ***Plaque accumulation***

+ ***Prevalence of coronal and root caries***

+ ***Decayed root tips***

Changes in composition of biofilm?



- Plaque **accumulation** may be due to:
 - Less control of muscular activity/Less muscular activity (Facial muscles)
 - Difficulty swallowing (Dysphagia)
 - Loss of sensitivity (Sensory neuropathy)
 - Unable to brush teeth (Inability to perform ADL)
- Association between poor oral hygiene and respiratory disease, such as aspiration pneumonia
- Aspiration pneumonia occur when oropharyngeal secretions are directed into the trachea and subsequently into the lungs. Results in either bi- or unilateral pneumonia.

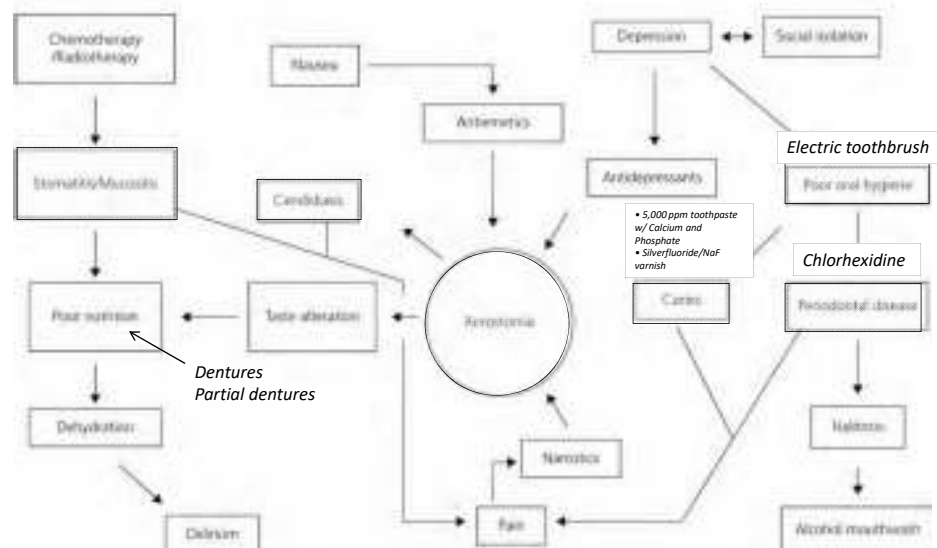
***Aspiration Pneumonia is the leading cause of death in Nursing home residents.
10% of deaths may be prevented by increased oral hygiene***

Indicators for aspiration

INDICATORS	SIGNIFICANCE
Repeated coughing or clearing of the throat	Insensitive reflex or weak muscles
Choking, cyanosis or teary eyes	Respiratory distress
Constant swallows during a meal	Residue from food or liquid in the mouth or throat
Change in respiration	Inhaling food
Gurgling voice	Food liquid (incl. saliva) in the larynx
Food pocketing in the mouth	Reduced awareness of food in the mouth
Food stuck in the throat after swallowing	Food in the pharynx
Drink or food from the nose	The soft palate is incompetent
Missing teeth or poorly fitting dentures	Food is inadequately chewed and moistened

Dysphagia

- **Poor nutritional status**
 - Weight loss
 - Leads to dehydration
- **Droping, choking, and coughing after drinking fluids or eating**
 - Signs of dental plaque and residues of food around the mouth
- **Dehydration disturbs swallowing and nutrition intake and increases dependency on others for eating**
 - 30 mL of fluid/kg body weight to maintain hydration and good health.
 - A 55 kg (121 lbs) person need to consume ~ 1,680 ml of fluid per day (1,7 L)
 - Tea, coffee and alcohol all have diuretic effects



^aValues are the mean of three replicates.

Genetic History—Living in the Anthropocene. First Edition. Edited by Paula S. Hackett.
© 2018 John Wiley & Sons, Inc. Published 2018 by John Wiley & Sons, Inc.
Companion website: www.wiley.com/go/genetic-history-in-the-anthropocene

WILEY Blackwell

Two different patient scenarios, showing treatment of AD patients

- *F76, AD for 10 years*

- Unable to walk or to feed herself
- Non-verbal, non-responsive (to words)
- Cared for by her husband

- *F98, AD Recent memory changes – F100, AD Middle stage*

- Walks every day
- Daughter has responsibility for her care (does not want care to be costly)
- Last seen by a dentist in Oral Medicine in 2010

Lisa(F76)

- S: Lisa and her husband David presents for a problem-focused exam. A previous dentist has recommended full mouth extraction. L has fractured restorations, but L seems not to be in obvious pain. Last cleaning 3 yrs ago.
- O: Medical
 - Diabetes
 - BP well controlled
 - AD was diagnosed in late 2005, about 10 yrs ago. Advanced AD: non-responsive, non-verbal
 - Drug allergy: Sulfa, Opiates/Codeine



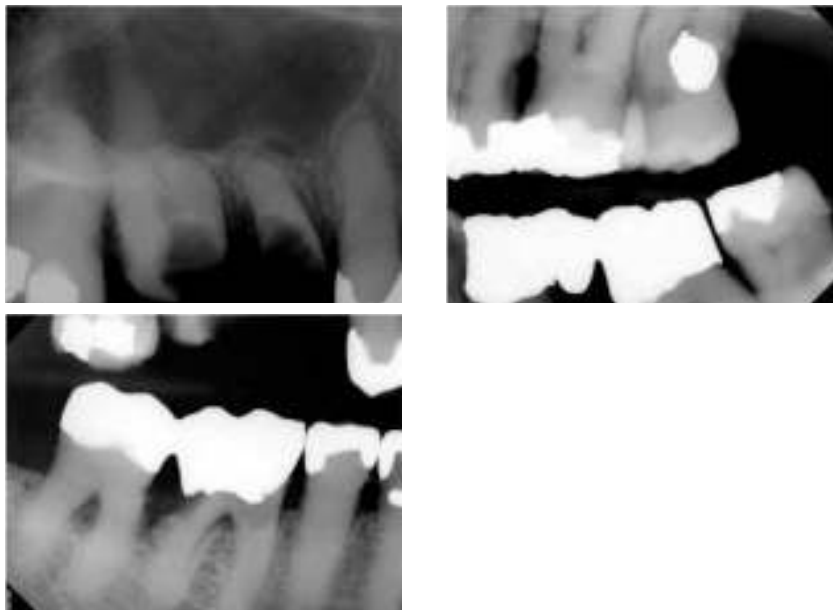
Patient moved her head when Pano was taken. Multiple radiographic lesions notes: #2, #13, #19, #31 (From Radiology)

Lisa (F76)

- P: Limited exam, problem-focused. I was able to open L's mouth and to brush her teeth with 0.12% Chx without any difficulties. She has been to the dentist frequently in the past, and her motor reflexes are still intact. She reacts well to movements in her mouth, and opening reflexes are functioning.
- Discussed the need for extractions with her husband. A full mouth extraction at this point seems to be doing more harm than good. L is still eating and chewing, and a full mouth extraction would put her into a situation that she has not known in the past, which would not serve her well in terms of reflexes and coping with the extractions. I could not notice that any probing that I did was painful for her.
- NV: Regular cleanings with Dr. Jeffrey
- Rx: 0.12% Chx solution for antimicrobial cleaning of gums and teeth 1-2x daily.

Sara (F98): February, 2014

- S:
 - Sara presents for a new patient comprehensive exam. She has walked to the clinic together with her caregiver. Started review of health history. Sara was last seen by us in 2010.
- O:
 - Sara has AD, and presently hypotension (102/50) and is needing additional help with ADL. Daughter will help complete health history form. Care giver was unaware that Sara has a trPD, and she needs additional help with her oral hygiene.
 - EO and IO exam. Oral mucosa and tongue – wnl. Oral cancer screen – wnl.
 - Radiographic findings:
 - Primary caries: #2M, #5M, #8D, #9M, #13D, #14MFD, #15M, #28M, #30MBD – not deemed restorable, #31M;
 - Fractured teeth: #3, #4



Sara (F98): February, 2014

- P:
 - EO and IO exam. Heavy plaque and calculus throughout. Brushed teeth with Chx solution to facilitate visibility. #3 and #4 are fractured to gum-line and needs extraction.
 - Recommended OralB electric toothbrush, and to rinse and brush with 0.12% Chx solution 2x daily, every other week. Recommended use of Xylitol gum and mints as additional help to keep teeth clean. Also not to wear “flipper” over-night; clean with Polident/Soap and water.
- NV: Tx plan:
 - 1. SRP 4 quadrants with dental hygienist – to reduce bacterial load
 - 2. #8 and #9 Composite restorations – to see how Sara responds to dental treatment.
 - 3. Further restorative needs and necessary extractions

Sara (F100): May, 2016

- May, 2016: Sara presents for limited exam. #13 fractured to gumline.
 - IO: General soft plaque interproximal. High plaque levels. General supra- and sub-gingival calculus. Removed upper tRPD, which had build-up of plaque on the palatal side. Pink attached gingiva in hard palate, and normal keratinization on dorsal part of tongue. General root caries lesions on all exposed root surfaces.
 - Tooth mobility: Unremarkable
 - Tooth percussion: Unremarkable
 - Tooth and root palpation: Unremarkable
- Advised caregiver to ask Sara to brush 3x daily (after each meal), and to brush with Chx at night. To minimize intake of sugar, and substitute with Xylitol, and less cookies.
- Sara was able to handle tx well until she felt some discomfort, then she started to be negative, and she said no to taking x-rays.
- NV: Use vaseline for lips. Show Sara the prophy cup before we start. Use Oraquix as LA for scaling. I used the hydroform suction and cotton rolls. We also said to talk as little as possible.

Sara (100): Aug, 2016

- Aug 2016:
 - Gave Sara a head pillow. Applied vaseline to lips. Started by polishing her lower teeth with Colgate Sensitive. Continued by applying Oraquix to premolars and molars. Interproximal and buccal scaling. Huge blocks of semihard/hard calculus removed. Applied Oraquix to incisors and continued scaling. Rinsed with water to removed debris. At this point Sara said that she had enough. Was able to finish by polishing her teeth one more time with Colgate sensitive. Cleaned her tRPD.
 - NV: Treat Sara in a room with a door, so that we do not disturb other patients.

Summary

- If patients are non-cooperative, there is not much that the dentist can do. The dentist need to work through a person that they trust, being present in the operatory during the appointments. A good way is to teach the caregiver how to care for the dental needs of the patient.
- Rinses or brushing with 0.12% Chlorhexidine gluconate, either 1 daily or every other day, will help prevent aspiration pneumonia, and keep the gums from bleeding.
- To prevent caries, brush with Prevident 5,000 ppm toothpaste (Rx)
- 38% SDF applications and/or NaF varnish are also good treatments that the patient might find easy to tolerate, and also regular cleanings.
- Try to keep the diet as free from sugar and really soft foods as much as possible.
- AD patients usually have a very short treatment window, ca 30 mins or less, before they have had enough and walk away.
- For more advanced dentistry, need to use General anesthesia. This may be a very stressful experience for the patient. Most important is their home care and the relationship the dentist can build with the patients caregiver.