Practical Issues in Geriatrics
Series Editor: Stefania Maggi

Anastassia Kossioni *Editor*

Gerodontology Essentials for Health Care Professionals

Springer

Practical Issues in Geriatrics

Series Editor
Stefania Maggi
Aging Branch
CNR-Neuroscience Institute
Padua
Italy

This practically oriented series presents state of the art knowledge on the principal diseases encountered in older persons and addresses all aspects of management, including current multidisciplinary diagnostic and therapeutic approaches. It is intended as an educational tool that will enhance the everyday clinical practice of both young geriatricians and residents and also assist other specialists who deal with aged patients. Each volume is designed to provide comprehensive information on the topic that it covers, and whenever appropriate the text is complemented by additional material of high educational and practical value, including informative video-clips, standardized diagnostic flow charts and descriptive clinical cases. Practical Issues in Geriatrics will be of value to the scientific and professional community worldwide, improving understanding of the many clinical and social issues in Geriatrics and assisting in the delivery of optimal clinical care.

More information about this series at http://www.springer.com/series/15090

Anastassia Kossioni
Editor

Gerodontology
Essentials for Health Care Professionals

Springer

Editor
Anastassia Kossioni
School of Dentistry
National and Kapodistrian University of Athens
Athens
Greece

ISSN 2509-6060 ISSN 2509-6079 (electronic)
Practical Issues in Geriatrics
ISBN 978-3-030-41467-2 ISBN 978-3-030-41468-9 (eBook)
https://doi.org/10.1007/978-3-030-41468-9

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Foreword

I am honoured and pleased to accept the invitation to write the foreword of a book dealing with such an important subject. Although relatively new, gerodontology is a rapidly growing discipline both in clinical settings and in public health.

Many are just now waking up to the importance of oral health in the elderly population as one of the most urgent health problems to be faced. In fact, caries, periodontal disease, denture-related problems, and oral pre- and cancerous conditions may lead to tooth loss, pain, local and systemic infections, impaired oral function, and poor quality of life of the aging population. Although the majority of oral diseases can be prevented or treated, oral problems in older adults are still often neglected and remain largely underdiagnosed due to a number of barriers and misconceptions, including an inadequate preparation of healthcare professionals and deficient health policy action plans.

Many outstanding authors have brought a wealth of clinical experience and scientific expertise in the field of gerodontology to their chapters. They have clearly outlined and discussed the most frequent oral diseases and their impact on the general health and well-being of senior citizens. They have explained the interconnection between diet, nutritional status, and oral health. They have also explored the most pressing clinical and public health issues related to oral health. The result is a book concisely and precisely presented, and it represents a wake-up call for geriatricians and for decision-makers: oral health assessment should be incorporated into general geriatric assessment, and oral healthcare should be integrated into public healthcare coverage, and its access should be ensured to every single older individual of our society.

I would like to congratulate Dr. Kossioni for courageously taking the lead of such an important initiative, and I am confident that this book will prove to be an invaluable tool for all healthcare professionals involved in the care of older patients.

Padua, Italy — Stefania Maggi

Preface

Oral health is an important element of general health and quality of life. It is however often neglected, particularly with regard to the most vulnerable sections of the population such as frail older persons who face an increased burden of oral pain and discomfort, impaired oral functions such as chewing, biting, swallowing, tasting, and speaking, and impairment in psychosocial domains linked to appearance, aesthetics, self-esteem, socialising, and communicating.

The discipline concerned with oral health and the dental care of older adults is called gerodontology (geriatric dentistry). Gerodontology focuses on patient-centred oral care for a population that has specific, often functional difficulties, concerns, and conditions endangering their oral health. It is a branch of dental science and part of the wider field of geriatric medicine that supports interprofessional collaborative practice in the care of older adults. Gerodontology is particularly concerned with the prevention of oral diseases as most oral conditions are preventable and treatable when they are detected early.

Poor oral health in frail, care-dependent older adults is associated with several barriers and risk factors that can be classified as: personal factors, lack of professional support, and lack of appropriate oral health policies. While there are a number of reasons explaining why care-dependent older people often have limited access to dental care, their contacts with other members of their geriatric healthcare team, including physicians, nurses, nursing assistants, physiotherapists, occupational therapists, dieticians/nutritionists, pharmacists, speech therapists, psychologists, etc. tend to increase. These care professionals should have some training in oral health-related questions, be able to perform an initial oral health assessment, be prepared to refer the patient to a dentist, and know and explain simple oral hygiene and preventive measures. This book is thus dedicated to all healthcare providers who have frequent contacts with older persons.

After reading the chapters of this book, readers should be able to:

- Explain the association between oral and general health
- Recognise oral health as an important element of general health and of quality of life in older adults
- Evaluate medication lists and identify the potential negative effects of drugs on oral health

- Describe the normal anatomy and functions of the stomatognathic system in older adults and distinguish between normal and abnormal findings
- Answer oral health-related questions and to perform an initial oral health assessment during a general geriatric assessment
- Decide when to refer a patient to a dentist
- Teach oral health preventive measures and offer oral health counselling to older adults and their caregivers
- Recognise the importance of interprofessional geriatric team-based practice.

The book is divided into nine chapters: (1) Introduction to gerodontology: demography, epidemiology, access to dental care. (2) The ageing mouth. (3) The association between oral and general health. (4) Medications and oral health. (5) Dietary habits, nutrition and oral health. (6) Quality of life and oral health. (7) Oral health assessment in primary and institutional care. (8) Oral health promotion in primary and institutional care. (9) Interprofessional collaborative practice in gerodontology. Although each chapter should be separate to itself, on some occasions links to other chapters for supplementary information are provided.

I would like to thank all the authors, world experts in gerodontology and geriatrics, who contributed their time and expertise to this book despite their many commitments. They all have served (or currently serve) in several councils and committees of the European College of Gerodontology and the European Geriatric Medicine Society who collaborate in promoting oral health in older adults; both societies encouraged and supported this difficult task. Finally, special thanks go to Prof. Stefania Maggi, Series Editor of the *Practical Issues in Geriatrics*, for her determination and contribution to the idea behind this book, for writing the foreword, and for critically reviewing its content.

Athens, Greece Anastassia Kossioni

Contents

1 Introduction to Gerodontology: Demography, Epidemiology, and Access to Dental Care

Anastassia Kossioni and Stefania Maggi

Abstract

The percentages of elderly individuals within their respective populations are increasing worldwide due to an increase in life expectancy and the falling fertility rates, but there continues to be a high variability in different world regions. The fact that multimorbidity, frailty, and care-dependency tend to increase with ageing means nevertheless that many will spend their last years living with disease and disability. Maintaining physical and mental well-being and high quality of life as well as building supportive environments for elderly citizens have become important goals for physicians and healthcare administrators. Oral health is an important, although neglected, element composing the general framework of overall health and well-being of elderly individuals. Oral health in older people, which tends to be quite poor, is linked to many physical and psychosocial functions such as chewing, biting, swallowing, tasting, speaking and communicating, smiling, appearance, aesthetics, and self-esteem, and it is an important part of the socialisation process. The most vulnerable, frail, and care-dependent persons tend to have higher rates of dental caries, periodontal disease, severe tooth loss, xerostomia, and oral cancer. Although most chronic oral diseases are largely preventable and treatable, various factors preclude keeping teeth and mouth healthy during old age. These include: care-dependency, socio-economic considerations, limited access to dental care and to professional assistance, as well as poor oral hygiene practices. Educational

A. Kossioni (✉)
School of Dentistry, National and Kapodistrian University of Athens, Athens, Greece
e-mail: akossion@dent.uoa.gr

S. Maggi
National Research Council, Neuroscience Institute-Aging Branch, Padova, Italy
e-mail: stefania.maggi@in.cnr.it

A. Kossioni (ed.), *Gerodontology Essentials for Health Care Professionals*, Practical Issues in Geriatrics, https://doi.org/10.1007/978-3-030-41468-9_1

interventions addressing healthcare providers' knowledge about oral health, appropriate oral health policy action plans, as well as citizen empowerment and involvement can each and all promote oral health in old age. From this perspective, the role of interprofessional collaborative healthcare teams and particularly of non-dental healthcare providers in promoting oral health can be considered crucial.

Learning Objectives
After reading this chapter, readers should be able to:

- Describe the characteristics of the demography of ageing.
- Define healthy life expectancy and healthy ageing.
- Advocate oral health as an important element of general health and quality of life in older adults.
- Describe the barriers and enablers to good oral health and access to dental care among older adults.
- Describe the role of non-dental healthcare providers in promoting oral health for older adults.

1.1 The Demography of Ageing

More persons than ever can expect to achieve longevity due to a variety of factors including better nutrition, the development of vaccinations, the decline in infant mortality, and medical progress [1]. In 2018, for the first time in human history and at a global level, persons over 65 years outnumbered children under five [2]. According to estimates, moreover, by 2050 the number of persons over 65 will globally surpass the number of persons between 15 and 24 [2]. Although the proportion of persons over 65 years is increasing worldwide, there is nevertheless significant variations in the rates registered in different regions of the world. According to the Sustainable Development Goals (SDG) report, the percentage of persons 65 and older in 2019 ranged between 3% in Sub-Saharan Africa and 18% in Europe and Northern America. At the same time, the overall global estimate of persons over 65 was 9.1% in 2019, and it is expected to increase significantly in the years to come [2] (Fig. 1.1).

In the European Union (EU), there were 4.2 working-age persons for every individual over 65 in 2001. According to estimates, there were 3.3 in 2018 and there will be 1.9 by 2080 [3]. The old-age dependency ratio (people aged 65 or above relative to those aged 15–64) in the EU is projected to increase from 43.1% in 2016 to 68.5% by 2070 [4]. The same pattern is expected for the employment rate of older workers, and many governments are proposing to further raise the retirement age [4]. The highest old-age dependency ratio in the world in 2019 was registered in

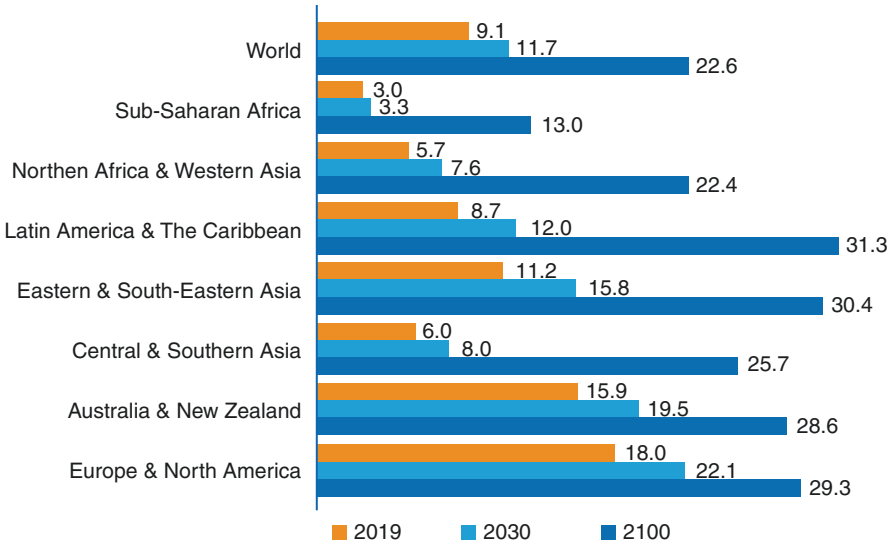

Fig. 1.1 The percentage of the population over 65 years in the world divided into seven regions according to the Sustainable Development Goals Report [2]

Japan (51%); it was followed by seven European countries, Martinique, and the US Virgin Islands [5]. But the fastest rate of population ageing between 2019 and 2050 has been projected for Eastern and South-Eastern Asia, particularly the Republic of Korea, Singapore, and Taiwan/China, countries that are expected to be included in the list of the ten countries with the highest old-age dependency ratio [5].

These demographic changes are primarily a consequence of increased longevity and low fertility rates. Global fertility, which was approximately 2.5 births per woman in 2019, is projected to fall to 1.9 in 2100 [2]. Life expectancy is increasing globally although with wide variations between countries and regions [2] (Fig. 1.2). Registering 64.2 years in 1990 at a global level, it reached 72.6 years in 2019, and it is expected to increase to 77.1 by 2050 (in the medium-variant projection) [2]. According to SDG indicators, the highest mean life expectancy at birth is now found in Australia/New Zealand (83.2 years) and the lowest one in Sub-Saharan Africa (61.1 years) [2] According to the WHO, life expectancy at birth in 2016 ranged between 61.2 in Africa and 77.5 years in Europe, while life expectancy at the age of 60 (the average number of years that a 60-year-old can expect to live) ranged between 16.6 in Africa and 22.7 in the Americas [6].

Although at the global level in 2015–2020 women's life expectancy at birth exceeded that of men by 4.8 years, this difference is projected to shrink in the coming years [5]. The largest gender difference has been registered in Latin America and the Caribbean regions and the lowest in Oceania, excluding Australia and New Zealand.

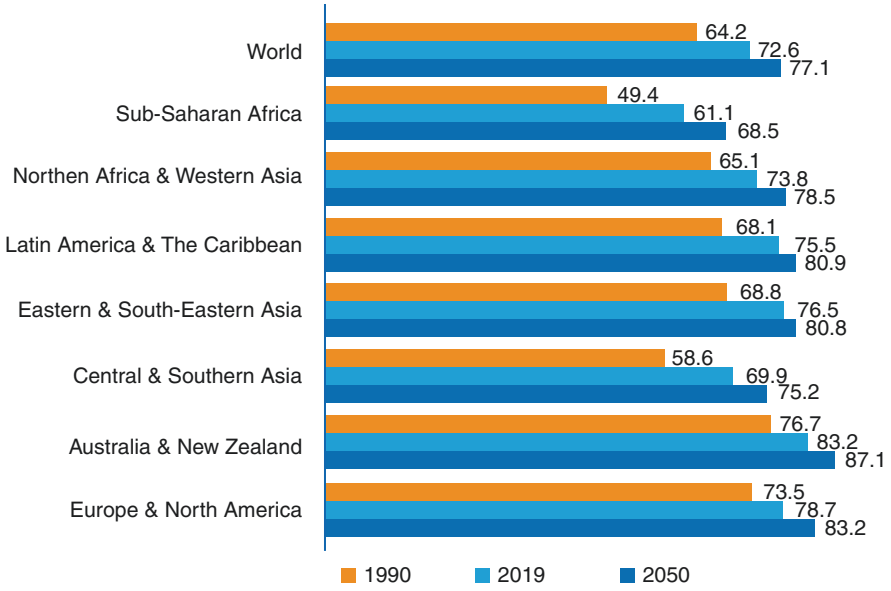

Fig. 1.2 Life expectancy at birth in seven world regions according to the Sustainable Development Goals Report (medium-variant projection) [2]

1.2 Healthy Life Expectancy and Healthy Ageing

Since multiple pathology, frailty, and care-dependency increase as individuals age, healthy life expectancy at birth is now considered a more sensitive indicator of the numbers of years at birth an individual can expect to live without disabilities. This measure of population health, which estimates the average number of years that a person can expect to live in "full health", is computed by taking into consideration disability and mortality weights [7]. Healthy life expectancy at birth at a global level was 63.3 years in 2016 (it was 64.8 for women and 62 for men) compared to 58.5 in 2000; the highest value was registered in the Western Pacific and the lowest one in Africa [8] (Fig. 1.3). Healthy life expectancy at the age of 60 in 2016 was 15.8 years globally (16.8 for women and 14.8 for men) [8]. According to these estimates, many years will be spent with disease and disability depending on where the individual lives; the number ranged between 7.4 years in Africa and 9.4 years in Eastern Mediterranean regions. The most common causes of years living with disability in older populations include sensory impairments, back and neck pain, chronic obstructive respiratory disease, depressive disorders, falls, diabetes, dementia, and osteoarthritis [9].

Just as for life expectancy, women tend to have a longer healthy life expectancy. If we look at gender differences in life expectancy and healthy life expectancy, in many regions of the world women will live longer but with more disease and

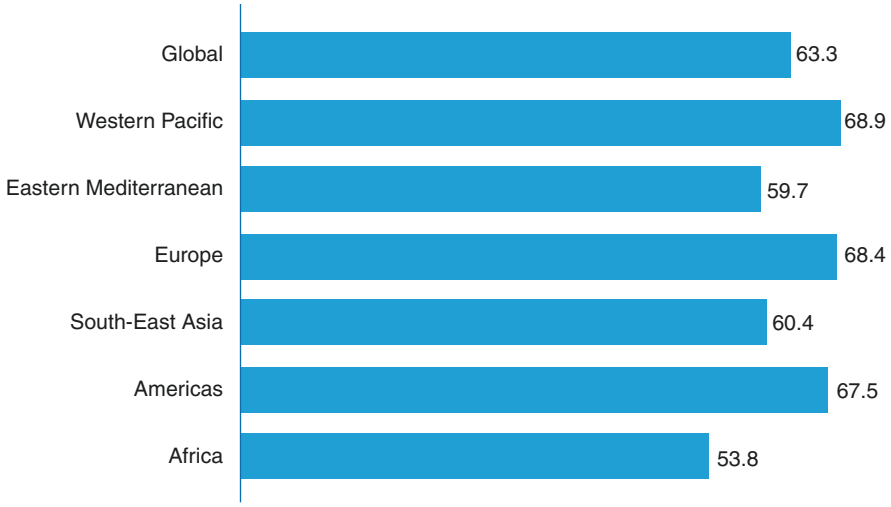

Fig. 1.3 Healthy life expectancy at birth in the various WHO regions at 2016 [8]

disability. In Europe in 2016, at the age of 65, people were expected to live 50% of their remaining years free of disability, 47% for women and 54% for men [10].

These wide discrepancies from region to region highlight the importance of the effect of environmental factors on human longevity and well-being. Chronological age is not, in fact, linearly related to biological age or intrinsic capacity (the composite of all the physical and mental capacities upon which the individual can draw), as social and environmental factors also play an important role [1]. In the effort to focus on more realistic functional perspectives rather than on disease per se, the WHO defined "healthy ageing" as the "process of developing and maintaining the functional ability that enables well-being in older age". Functional ability must be enabled and maintained throughout an individual's lifetime and barriers should be removed for those persons with low capacity levels [1]. In this context, developing supportive environments can help to maintain well-being and quality of life in older persons independently from the presence of disease and disability.

1.3 Oral Health: An Important Element of Healthy Ageing

Oral health, which is an essential element of "healthy ageing", is one of the dimensions of health that affects the individual's overall health status and well-being. The definition of oral health proposed by the FDI World Dental Federation highlights its multifaceted character given its importance for speaking, smiling, smelling, tasting, touching, chewing, swallowing, and conveying a range of emotions through facial expressions with confidence, and without pain, discomfort, and disease of the craniofacial complex [11].

The most common oral diseases, which include dental caries, periodontal disease, severe tooth loss, xerostomia, denture-related problems, and oral cancer, frequently affect the most vulnerable, frail, and care-dependent members of society [12, 13]. The social and economic factors affecting oral health are powerful determinants. Although largely preventable, untreated oral conditions are among the most prevalent non-communicable diseases (NCDs) that affected more than 3.5 billion people globally in 2015 [14]. The number of individuals with oral diseases increased by 40% from 1990 to 2015, while the oral disability-adjusted life years (DALYs) due to oral conditions increased by 64%, mainly due to demographic changes such as population growth and ageing [14].

Oral health shares risk factors with other NCDs such as following an unhealthy diet, smoking, abusing alcohol, and diabetes. It is influenced not only by an individual's own health behaviours, attitudes, expectations, and adaptive capacities but also by the environment where he/she lives. The local environment and culture with their policies and regulations, infrastructures, services, values, ethics, and attitudes can act as a barrier or enabler in maintaining and promoting oral health. For example, if domiciliary dental care is not available in a community, that means that care-dependent older persons with reduced mobility, nursing home residents, and housebound individuals may not have access to dental care. The same could be said for older people with low incomes particularly in those countries where dental care is prevalently private.

Oral and general health are closely linked entities. Poor oral health, and in particular periodontal disease, has been associated to atherosclerotic vascular disease, diabetes mellitus, and aspiration pneumonia. At the same time, periodontal pockets, poor oral hygiene, and wearing dentures during sleep have been associated with aspiration pneumonia in frail elderly persons; and some studies have described an association between tooth loss, the ability to chew, and nutrition [15]. At the same time, a compromised general state of health associated with functional problems (i.e. cognitive disorders) limits the ability to practise good oral hygiene, to follow a healthy diet, and to make regular visits to the dentist, which can lead to severe, rapid oral health deterioration in those individuals living in a non-supportive environment.

In the past and particularly in developed countries, a number of preventive policies primarily focusing on children proved to be very effective. But implementing these oral health promotion policies exclusively in children has not proven to be successful in reducing oral disease in adulthood. As the prevalence of dental caries continues to increase in adulthood and particularly in older age groups [16, 17], innovative long-term oral health policies and specific interventions for care-dependent persons need to be implemented. It should also be remembered that severe periodontal disease, one of the major causes of tooth loss in middle and older ages, peaks at 55–70 years [14]. Severe periodontal disease is frequent among older people in developed countries, as more periodontally involved teeth are now being retained instead of being extracted with respect to the past. In 2015, severe periodontal disease affected 538 million people globally, while severe tooth loss affected almost 276 million persons [14]. Complete tooth loss (edentulism), a condition frequently found in older individuals, peaking at the age 75–79 years, was the leading

cause of oral disability in 2015, and accounted for more than 7.6 million disability-adjusted life years (DALYs) [14].

While tooth loss in adulthood is mainly attributed to dental caries and periodontal disease, its prevalence is decreasing, at least in the developed countries [14, 16, 18]. Some of the factors contributing to this tendency is progress in dental science which manages to save heavily damaged teeth or retain, for longer periods of time, teeth affected with severe periodontal disease. One of the consequences of this practice is that many frail, care-dependent older people now retain a significant number of heavily restored natural teeth making more complex and time-consuming to effectively clean them and professionally treat them. While there is only limited data available concerning oral health in people over 75 years or those who are care dependent, the information that does exist indicates that those individuals with cognitive problems or living in institutional care or who are housebound have poorer oral health and oral hygiene [12, 18–21].

The increasing percentages of older adults living in developed countries who have a significant number of natural teeth that require complex daily oral hygiene and frequent professional dental care clearly indicates that innovative and effective oral health policies need to be developed and implemented. The future trends in the less developed countries of the world are not as clearly marked because of various confounders that may increase the rates of severe tooth loss, dental caries, and periodontal disease; these include dietary changes, limited exposure to fluoride, and limited availability of preventive, curative, and restorative dental care with respect to emergency dental care. These factors will almost surely lead to more teeth extractions in a context lacking effective oral health promotion policies [16].

In the light of these considerations, we can only conclude that oral diseases should be effectively prevented, detected precociously, and efficiently managed using a collaborative interprofessional approach in order to reduce their correlated disabilities and to support "healthy ageing".

1.4 Barriers and Enablers to Oral Health and Care in Old Age

Although the major chronic oral diseases such as caries, periodontal disease, tooth loss, and many mucosal lesions are largely preventable and treatable, there are many barriers to keeping oral tissues healthy and functional throughout the elderly years [22].

1.4.1 Barriers to Oral Health

In accordance with the joint expert opinion document published by the European College of Gerodontology and the European Geriatric Medicine Society, the barriers to good oral health in older people outlined in this chapter have been grouped into three areas: they are person-related, related to a lack of professional support,

and related to a lack of appropriate oral health policies [22]. The observations that follow aim to highlight the complexity of the factors involved in promoting the oral health of older people and the important role that non-dental healthcare providers play. The full range of structural, commercial, intermediate, and proximal determinants of oral health in vulnerable older adults will be discussed in details in Chap. 8.

1.4.1.1 Personal Barriers

Several medical conditions such as Parkinsonism or arthritis can limit an individual's mobility and impair manual dexterity in practising oral hygiene as well as his/her ability to visit the dental office. Impaired vision may impede the individual's ability in practising meticulous dental and denture hygiene. Mental illnesses such as dementia and depression can likewise limit and impair self-care ability. Polypharmacy due to multimorbidity can also lead to a range of oral side effects and in particular xerostomia, one of the leading causes of rapid oral health deterioration. Unhealthy habits such as following an unhealthy diet, smoking, and drinking too much alcohol can affect both general and oral health. Sugar-containing and acidic foods and beverages, carbonated beverages, between-meal cariogenic snacks induce caries and may cause dental erosion. Use of alcohol and tobacco may induce precancerous and cancerous oral lesions.

Socio-economic factors are major determinants of poor oral health and self-care. Low educational levels as well as poor oral health literacy of patients and caregivers can largely explain poor oral health. Economic considerations constitute a significant factor as public dental care coverage is limited in most countries, and most dental care provision is private [13, 22–25]. Large percentages of the populations of most EU countries agree that the average person has less access to dental treatment with respect to medical care, mainly due to differences in how these systems are financed [10]. Only 30% of dental care costs are covered by government programmes or compulsory insurance in Europe with significant variations across the continent [10]. Access to dental care may also be limited due to an older individual's living conditions: living in a nursing home, in a higher floor apartment without an elevator, or in a rural area where there is a shortage of dentists.

Finally, older individuals who were brought up at a time during which there was little oral health literacy and only a few conservative dental treatment options available may have negative attitudes and prejudices against dental care.

1.4.1.2 Lack of Professional Support

Dental Professionals

Many practising dental professionals around the globe have received little or no basic training in gerodontology or in managing the dental care of frail and care-dependent older persons during their undergraduate or continuing education studies [26, 27]. In Europe and the United States where the majority of dental schools teach gerodontology at an undergraduate level, clinical training in treating care-dependent older people within dental school clinics or at extramural facilities (i.e. nursing homes) is often inadequate [26, 28]. Moreover, the current orientation in dental

education and practice continues to be treatment-geared and is insufficiently committed to prevention or to meeting the needs of the population and, in particular, of those who are frail and care dependent.

Inadequate training and lack of self-confidence are two of the main reasons explaining dentists' negative attitude towards domiciliary dental care; other factors include financial aspects, unfavourable working conditions, and lack of time or appropriate equipment [29, 30]. Another factor explaining the negative attitude towards older patients is ageism. Some questionnaires filled out by dentists have uncovered modestly positive, moderate, or negative attitudes towards older patients [31].

Non-dental Healthcare Professionals

Although seniors tend to visit the dentist less frequently with increasing age and disability [29], their contacts with non-dental healthcare providers such as physicians, (geriatricians, general practitioners/family physicians, internists, physical rehabilitation specialists, psychiatrists, etc.), nurses, physiotherapists, dieticians/nutritionists, pharmacists, speech therapists, and others generally increase. The role of non-dental care professionals in promoting seniors' oral health can thus be considered crucial. Few of them are nevertheless adequately trained or prepared to carry out an initial assessment of oral problems or to make recommendations aiming to improve oral health [22].

Moreover, in nursing homes (or in home care), a common finding is the inadequate training and the negative attitudes of formal carers in providing daily oral hygiene to older people, combined with the lack of time and staff [32]. The same may apply to family and friends given the low level of oral health literacy among the citizens in most communities.

1.4.1.3 Lack of Appropriate Health Policies and Legislations

Although there is no denying that oral health is an important element of general health and healthy ageing, it is generally not provided for by healthcare services, and public coverage is limited or non-existent.

The Survey of Health, Ageing, and Retirement in Europe (SHARE), a multidisciplinary, cross-national panel data-base investigating the views of persons 50 and over in 14 European countries, has shown that there is a wide cross-country variation in the use of dental services even in relatively young and functionally independent older people [33]. In fact, dental service utilisation over the past 12 months ranged between 23.8% in Poland and 80.4% in Denmark [33]. Interestingly, these differences can only partially be explained by current oral healthcare needs and accessibility to dental care, once again confirming the complexity of the barriers and enablers in accessing dental care in different communities.

There are significant inequalities in access to dental care services and oral healthcare measures at a global level, but irrespective of a country's economic level, it is the poorer, less educated, marginalised and vulnerable members of the society who have more oral diseases and problems [13, 25, 34]. Many seniors and in particular care-dependent individuals tend to fall into the most vulnerable groups. Although

oral health in individuals in institutional care tends to be very poor, there are few provisions or regulations seeking to rectify this situation. Moreover, in those countries where oral health prevention and promotion policies have been adopted and implemented, they mainly address the problem of children's oral health; interventions for older people have only been occasional and limited. Public transport accessibility for people with disabilities or with limited mobility can only be found in certain areas. As a result, it may be quite difficult to reach a dentist's office. At the same time, domiciliary dental care, be it private or public, is often unavailable altogether.

The magnitude and complexity of the multiple barriers to oral healthcare for seniors are illustrated in the following example of a typical case report.

Case 1.1

"Ms. XX is an 87-year-old widow with a moderate pension. When necessary, her daughter helps her out financially. She presents symptoms of moderate Alzheimer's disease, urinary incontinence, and hypertension and requires assistance in her daily activities. Eighteen months ago she moved from her city to the town when her daughter lives. She had a hip fracture 16 months ago, and she has been living in a nursing home near her daughter's house during the past 14 months.

She is dentate with 24 natural, heavily restored teeth. When she was living at her original home, she cleaned her teeth meticulously twice a day and visited her dentist at least once a year because she valued her oral health highly. She has never gone to the dentist since she moved. Due to her impairments she can no longer independently perform her routine oral hygiene. The nursing home staff does not have adequate knowledge or skills to help her brush her teeth, and they are too busy with other daily duties (brushing the patients' teeth has low priority). Between meals Ms. XX loves drinking tea and lemonade sweetened with two spoonfuls of sugar and she also loves eating the candies that her daughter brings her on a daily basis.

Poor oral hygiene, a sugary diet, and lack of dental consultations have led to rapid deterioration in her oral health. She now has active dental decay with deep cavities in five teeth, causing pain when chewing; she also has high levels of dental plaque and gingival inflammation causing bleeding and oral halitosis. However, her oral problems remain undiagnosed. Although Ms. XX needs dental care, she is unable to independently visit a dentist. The nursing home does not collaborate with any of the local dentists who might be willing to examine her in her room. Actually, some dentists in the area were hesitant about going to the nursing home to provide dental care to its residents. Paying for dental care is itself a major barrier as little remains of her income after she has paid the nursing home fees. Dental care in her country is usually private, and patients pay dental practitioners directly. She could be transferred to a public hospital for emergency care, but that too would be a

complicated affair. Therefore, as the patient was not screened and does not have access to professional help, her oral health is rapidly deteriorating and seriously affecting her oral function and quality of life".

This is a typical case of an older, frail, care-dependent person facing barriers to oral health due to personal reasons (cognitive and mobility problems, living conditions, difficulty in performing daily oral hygiene, low income, unhealthy diet), lack of professional support (the nursing home does not provide for oral examinations of any type, efficient daily oral hygiene and access to dental care are not available/accessible), and lack of effective oral health policies (no public dental care coverage, absence of domiciliary dental care, lack of legislation for oral health promotion in nursing homes).

1.4.2 Enablers to Oral Health Promotion in Older Adults

Three major areas of immediate action have been identified in the expert opinion document published by the European College of Gerodontology and the European Geriatric Medicine Society on oral health promotion in older age: educational action plans, health policy action plans, and citizen empowerment and involvement [22].

1.4.2.1 Gerodontology Education and Research

Education for Dental Professionals

Given the increasing proportion of older population and the serious shortage of dental professionals specialised in gerodontology, it is important that all graduates of dental schools have the necessary knowledge, skills, and attitudes to manage the complex oral problems of frail older people. Gerodontology should be included as a compulsory subject in the undergraduate/predoctoral curriculum of all dental schools, and clinical training in the comprehensive management of oral problems for frail, care-dependent older people should be provided. Compulsory gerodontology training should also be provided at the continuing education level to all practising dental professionals. There are few gerodontology advanced/postgraduate courses being offered worldwide; more are needed to prepare expert professionals and trained academics [26, 27, 29].

Education for Non-dental Healthcare Professionals

The curricula of healthcare professionals should be reviewed to integrate oral health topics at an undergraduate, advanced/specialty and continuing education levels [22]. At a specialty level, oral health assessment and promotion competences should be incorporated into requirements for specialty accreditation, particularly in geriatrics, general medicine/family medicine, internal medicine, and geriatric nursing.

Table 1.1 Oral health promotion competences for non-dental healthcare professionals treating older people. Adapted from Kossioni et al. [22]

The healthcare provider should be competent to:
Recognise oral health as an important element of the general health and quality of life of older adults
Evaluate medication lists to identify their potential effect on oral health and to limit their oral side effects, such as xerostomia
Perform an initial oral health assessment and discriminate normal from abnormal findings in the oral cavity
Identify and treat common oral diseases and conditions
Demonstrate and teach oral hygiene measures to older adults and their caregivers and assist the patient when necessary
Develop strategies to overcome barriers to oral health maintenance and access to dental care
Decide when to refer a patient to a dentist
Efficiently communicate and collaborate with the other members of the healthcare team to promote the patient's oral health

At a continuing education level, oral health assessment and promotion should be included in its mandatory requirements. Dedicated hands-on training sessions in oral health in hospital and residential care should be offered for physicians, nurses, and other care professionals.

The European expert opinion document [22] has identified a number of oral care skills for non-dental healthcare professionals who regularly treat older patients (Table 1.1).

Education for Formal Caregivers

Formal caregivers of older people living at home or in nursing homes should be trained to assist or provide daily oral hygiene to care-dependent older people.

Interprofessional Education and Collaborative Practice

Special attention should be dedicated to interprofessional education promoting interprofessional collaborative practices in the care of older people. This is necessary due to the shortage of specialists and the difficulty in caring for older persons with complex health problems [35, 36]. Many healthcare professions, including medicine, dentistry, nursing, pharmacy, social work and others, share common geriatric competences; this would make it possible to include interprofessional education courses into their curricula [37]. An extended discussion on interprofessional collaborative practice in geriatric care is provided in Chap. 9.

Research and Development of Good Practice Guidelines for the Dental Management of Older People

More research on the prevalence and incidence of oral disease in old age, on good practice examples and management guidelines for the preventive, curative, restorative, and palliative dental treatment in geriatric patients is warranted.

Table 1.2 Legislative and policy strategies for oral health promotion for residents in institutional care. Adapted from Kossioni et al. [22]

Oral health assessment should be incorporated into the medical entry assessment
Assistance in daily oral and denture hygiene should be provided to residents
All caregivers should be trained in providing residents daily oral hygiene assistance
The accessibility of oral healthcare products should be ensured (i.e. fluoride toothpaste, toothbrush)
A healthy diet protective of oral health should be ensured
Access to emergency and routine dental examinations and comprehensive dental care should be ensured
Regular oral screenings using appropriate validated tools should be provided to residents

1.4.2.2 Health Policy Actions

Appropriate health policies for geriatric oral health promotion taking into consideration the social, economic, physical, and commercial determinants of health should be implemented. Oral healthcare should be integrated into general healthcare systems and particularly into primary care. Oral health assessment and promotion should be included in routine medical assessments [22, 38]. As the cost of dental care is a major barrier, essential dental services should be integrated into public healthcare coverage [22, 25, 39].

As most oral conditions/problems share common risk factors with other NCDs such as cardiovascular disease, oral health prevention and promotion should be integrated into wider preventive strategies targeting all NCDs [34]. Clinical preventive interventions and chair-side advice may not be adequate and population-wide upstream strategies should be developed [13].

Oral health promotion strategies need to be supported by targeting food systems and companies developing oral care products, advertising campaigns, urban design, and citizen empowerment and involvement [22, 25, 34, 38]. For example, policies regarding food products, nutrition supplements, and medications containing sugars should be promoted and implemented [13, 40].

Oral health literacy should be promoted in the general public, and local authorities should support oral health prevention campaigns [22, 38].

The joint European expert opinion document has provided a specific protocol for oral health promotion for residents in institutional care that should be supported by legislative and policy strategies (Table 1.2) [22].

1.5 Conclusion

Although oral health is an important element of general health and well-being in all individuals, in older people and in particular those who are frail and care dependent it tends to be very poor. The reasons for poor oral health in old age can be found in person-related factors, limited professional support, and lack of appropriate oral health policies. As many older people have limited access to dental care, the role of

non-dental healthcare providers in promoting oral health in seniors has become crucial. The members of geriatric healthcare teams should be competent to carry out initial oral health assessments, identify oral pathologies, refer the patient to the dentist when necessary, and provide oral health counselling and diet advice to the patients and their caregivers.

References

1. WHO. World report on ageing and health. Geneva: World Health Organization; 2015.
2. United Nations, Department of Economic and Social Affairs, Population Division. World population prospects 2019: highlights (ST/ESA/SER.A/423).
3. Eurostat. Key figures on Europe, 2019 edition, European Union; 2019. https://ec.europa.eu/eurostat/documents/3217494/10164469/KS-EI-19-001-EN-N.pdf/33ab6c0c-a0c6-5294-3948-b1fb9973d096.
4. European Commission, Directorate-General for Economic and Financial Affairs. The 2018 ageing report. Underlying assumptions and projection methodologies. https://ec.europa.eu/info/sites/info/files/economy-finance/ip065_en.pdf.
5. United Nations, Department of Economic and Social Affairs, Population Division. World population ageing 2019: highlights (ST/ESA/SER.A/430).
6. WHO. Life expectancy and Healthy life expectancy. Data by country. http://apps.who.int/gho/data/node.main.688?lang=en.
7. WHO. Healthy life expectancy (HALE) at birth. https://www.who.int/data/gho/indicator-metadata-registry/imr-details/66.
8. WHO. Healthy life expectancy (HALE). Data by WHO region. http://apps.who.int/gho/data/view.main.HALEXREGv?lang=en)%20are.
9. Beard JR, Officer A, de Carvalho IA, Sadana R, Pot AM, Michel JP, Lloyd-Sherlock P, Epping-Jordan JE, Peeters GMEEG, Mahanani WR, Thiyagarajan JA, Chatterji S. The world report on ageing and health: a policy framework for healthy ageing. Lancet. 2016;387:2145–54.
10. OECD/European Union. Health at a glance: Europe 2018: state of health in the EU cycle, OECD Publishing, Paris/European Union, Brussels; 2018. https://doi.org/10.1787/health_glance_eur-2018-en.
11. Glick M, Williams DM, Kleinman DV, Vujicic M, Watt RG, Weyant RJ. A new definition for oral health developed by the FDI World Dental Federation opens the door to a universal definition of oral health. Int Dent J. 2016;66(6):322–4.
12. Kossioni AE, Kossionis GE, Polychronopoulou A. Oral health status of elderly hospitalised psychiatric patients. Gerodontology. 2012;29(4):272–83.
13. Peres MA, Macpherson LMD, Weyant RJ, Daly B, Venturelli R, Mathur MR, Listl S, Celeste RK, Guarnizo-Herreño CC, Kearns C, Benzian H, Allison P, Watt RG. Oral diseases: a global public health challenge. Lancet. 2019;394:249–60.
14. Kassebaum NJ, Smith AGC, Bernabé E, Fleming TD, Reynolds AE, Vos T, Murray CJL, Marcenes W, GBD 2015 Oral Health Collaborators. Global, regional, and national prevalence, incidence, and disability-adjusted life years for oral conditions for 195 countries, 1990-2015: a systematic analysis for the global burden of diseases, injuries, and risk factors. J Dent Res. 2017;96(4):380–7.
15. Kossioni AE, Hajto-Bryk J, Janssens B, Maggi S, Marchini L, McKenna G, Müller F, Petrovic M, Roller-Wirnsberger RE, Schimmel M, van der Putten GJ, Vanobbergen J, Zarzecka J. Practical guidelines for physicians in promoting oral health in frail older adults. J Am Med Dir Assoc. 2018;19(12):1039–46.
16. Kossioni AE. Current status and trends in oral health in community dwelling older adults: a global perspective. Oral Health Prev Dent. 2013;11(4):331–40.

17. Bernabé E, Sheiham A. Age, period and cohort trends in caries of permanent teeth in four developed countries. Am J Public Health. 2014;104:e115–21.
18. Tonetti MS, Bottenberg P, Conrads G, Eickholz P, Heasman P, Huysmans MC, López R, Madianos P, Müller F, Needleman I, Nyvad B, Preshaw PM, Pretty I, Renvert S, Schwendicke F, Trombelli L, van der Putten GJ, Vanobbergen J, West N, Young A, Paris S. Dental caries and periodontal diseases in the ageing population: call to action to protect and enhance oral health and well-being as an essential component of healthy ageing—consensus report of group 4 of the joint EFP/ORCA workshop on the boundaries between caries and periodontal diseases. J Clin Periodontol. 2017;44 Suppl 18:S135–44.
19. De Visschere L, Janssens B, De Reu G, Duyck J, Vanobbergen J. An oral health survey of vulnerable older people in Belgium. Clin Oral Investig. 2016;20(8):1903–12.
20. Müller F, Shimazaki Y, Kahabuka F, Schimmel M. Oral health for an ageing population: the importance of a natural dentition in older adults. Int Dent J. 2017;67(Suppl 2):7–13.
21. Marchini L, Ettinger R, Hartshorn J. Personalized dental caries management for frail older adults and persons with special needs. Dent Clin North Am. 2019;63(4):631–51.
22. Kossioni AE, Hajto-Bryk J, Maggi S, McKenna G, Petrovic M, Roller-Wirnsberger RE, Schimmel M, Tamulaitienè M, Vanobbergen J, Müller F. An expert opinion from the European College of Gerodontology and the European Geriatric Medicine Society: European policy recommendations on oral health in older adults. J Am Geriatr Soc. 2018;66(3):609–13.
23. Manski RJ, Goodman HS, Reid BC, Macek MD. Dental insurance visits and expenditures among older adults. Am J Public Health. 2004;94(5):759–64.
24. Borreani E, Wright D, Scambler S, Gallagher JE. Minimising barriers to dental care in older people. BMC Oral Health. 2008;8:7.
25. Mathur MR, Williams DM, Reddy KS, Watt RG. Universal health coverage: a unique policy opportunity for oral health. J Dent Res. 2015;94(3 Suppl):3S–5S.
26. Kossioni A, McKenna G, Müller F, Schimmel M, Vanobbergen J. Higher education in gerodontology in European universities. BMC Oral Health. 2017;17(1):71.
27. Marchini L, Ettinger R, Chen X, Kossioni A, Tan H, Tada S, Ikebe K, Dosumu EB, Oginni FO, Akeredolu PA, Butali A, Donnelly L, Brondani M, Fritzsch B, Adeola HA. Geriatric dentistry education and context in a selection of countries in 5 continents. Spec Care Dentist. 2018;38(3):123–32.
28. Ettinger RL, Goettsche ZS, Qian F. Curriculum content in geriatric dentistry in USA dental schools. Gerodontology. 2018;35(1):11–7.
29. Kossioni AE. Is Europe prepared to meet the oral health needs of older people? Gerodontology. 2012;29(2):e1230–40.
30. Bots-VantSpijker PC, Vanobbergen JN, Schols JM, Schaub RM, Bots CP, de Baat C. Barriers of delivering oral health care to older people experienced by dentists: a systematic literature review. Community Dent Oral Epidemiol. 2014;42(2):113–21.
31. Kossioni AE, Ioannidou K, Kalyva D, Marchini L, Hartshorn J, Kaufman L, Smith B, Barlow PB. Translation and validation of the Greek version of an ageism scale for dental students (ASDS_Gr). Gerodontology. 2019;36(3):251–7.
32. Janssens B, De Visschere L, van der Putten GJ, de Lugt-Lustig K, Schols JM, Vanobbergen J. Effect of an oral healthcare protocol in nursing homes on care staffs' knowledge and attitude towards oral health care: a cluster-randomised controlled trial. Gerodontology. 2016;33(2):275–86.
33. Listl S. Income-related inequalities in dental service utilization by Europeans aged 50+. J Dent Res. 2011;90(6):717–23.
34. Watt RG, Daly B, Allison P, Macpherson LMD, Venturelli R, Listl S, Weyant RJ, Mathur MR, Guarnizo-Herreño CC, Celeste RK, Peres MA, Kearns C, Benzian H. Ending the neglect of global oral health: time for radical action. Lancet. 2019;394(10194):261–72.
35. World Health Organization Department of Human Resources for Health. Framework for action on interprofessional education & collaborative practice. Geneva: WHO; 2010. https://www.who.int/hrh/resources/framework_action/en/

36. Kossioni AE, Marchini L, Childs C. Dental participation in geriatric interprofessional education courses: a systematic review. Eur J Dent Educ. 2018;22(3):e530–41.
37. Mezey M, Mitty E, Burger SG, McCallion P. Healthcare professional training: a comparison of geriatric competencies. J Am Geriatr Soc. 2008;56:1724–9.
38. Hummel J, Phillips KE, Holt B, et al. Oral health: an essential component of primary care. White paper. Qualis Health: Seattle; 2015. http://www.niioh.org/sites/default/files/Oral_Health_white_paper_final.pdf
39. FDI World Dental Federation. Universal oral health coverage. Oral health for all. Geneva: FDI; 2019. https://www.fdiworlddental.org/sites/default/files/media/resources/fact_sheet-2019-universal_health_coverage.pdf
40. Guideline: sugars intake for adults and children. Geneva: World Health Organization; 2015. https://apps.who.int/iris/bitstream/handle/10665/149782/9789241549028_eng.pdf?sequence=1.

The Ageing Mouth

2

Martin Schimmel and Samir Abou-Ayash

Abstract

The oral cavity is not only the beginning of the digestive tract with a particularly sensitive tactile equipment but also the place of food comminution, mixing and salivating of the food bolus. All tissues of the oral cavity undergo physiological age-related changes that lead to altered morphology and function. Pathological processes like caries, periodontal disease, tooth loss, and oral cancer have a large impact on oral function. Ideally, a minimum of 20 natural teeth with antagonist contact should be maintained for adequate mastication and quality of life. Tooth loss often requires the replacement of lost teeth with dental prostheses to maintain oral function. The oral food processing (chewing, bolus formation, swallowing) takes place in the oral cavity as a partially conscious movement process. It largely depends on teeth, muscle force, and coordination, as well as the sensitivity of the tissues and input from the peripheral and central nervous system. Towards the pharynx, the process overlaps with the involuntary swallowing reflex that is coordinated with the respiratory act in a coordinated fashion. Furthermore, the oral cavity serves in the speech formation and the perception of taste. The mechano- and thermoreceptors are most closely aligned at the tip of the tongue and highly specialized mechano- and vibration receptors are located in the periodontal ligament. In addition to the sensory/physiological tasks, the mucosa of the oral cavity has the function of a secretory organ with its large and small salivary glands. There

M. Schimmel (✉)
Division of Gerodontology, Department of Reconstructive Dentistry and Gerodontology, University of Bern, School of Dental Medicine, Bern, Switzerland
e-mail: martin.schimmel@zmk.unibe.ch

S. Abou-Ayash
Section for Digital Implant- and Reconstructive Dentistry [DIRecD], Department of Reconstructive Dentistry and Gerodontology, University of Bern, School of Dental Medicine, Bern, Switzerland

A. Kossioni (ed.), *Gerodontology Essentials for Health Care Professionals*, Practical Issues in Geriatrics, https://doi.org/10.1007/978-3-030-41468-9_2

are age-related physiological changes in an ageing mouth that do not necessarily lead to functional loss as the physiological spare capacity of the oro-facial system seems to be very large; most pathological changes are associated with external factors, such as lifestyle choices and socio-economic factors.

Learning Objectives
After reading this chapter, readers should be able to:

- Describe the normal anatomy of the oral cavity.
- Recognize the age-related physiological changes of the oral structures.
- Discuss oral function.
- Recognize pathological processes in the mouth.
- Distinguish the different types of dental prostheses.

2.1 Introduction

The mouth together with the oro-facial system undergoes ageing processes like any other organ system of the body. The knowledge of the anatomical structures and physiological ageing processes are the foundation to understand pathological processes that might occur parallel to the physiological ageing process.

Ageing is the irreversible alteration of any living being with time; it is progressive, generalized, and irreversible. It comprises every biological structure and leads inevitably to structural, functional, and psychological changes that occur from birth to death of the organism. In the course of the ageing process, damage to cells and tissues accumulate which reduces the capacity for adaptive changes and make them more susceptible to develop a disease [1].

The physiological ageing process of an otherwise healthy mouth does not necessarily lead to a degree of functional loss that would compromise Oral Health-Related Quality of Life (OHRQoL) or nutritional state as the physiological spare capacity of the oro-facial system seems to be very large. As long as a set of more than 20 teeth with antagonist contact (teeth in function) are preserved, with otherwise intact oro-facial functions (e.g. salivary gland function, intra-oral sensitivity, intact muscle function) nutritional state and OHRQoL can be maintained until the end of life. An exception from this rule would be a loss of masticatory force or age-related dysphagia due to sarcopenia of the involved muscles in very old individuals [2].

Factors for the successful ageing of the mouth may be in part genetic, like in the case of certain forms of periodontitis, but are mainly related to lifestyle choices and hence often depend on socio-economic status. For example, the number of remaining teeth is higher in persons of high socio-economic status compared to poorer social classes. Consequently, in the western world, edentulism has been decreasing for many decades and now has the highest prevalence in very old persons with multiple diseases and low socio-economic status [3].

Numerous diseases of the mouth share common risk factors with other non-communicable diseases (NCD) like cardiovascular diseases or cancer, which comprises a high intake of sugar, smoking, and regular alcohol consumption. Age-related diseases, like dementia, cancer and pre-cancerous lesions, cardiovascular disease, or geriatric depression, are frequent in elderly persons and might have a direct impact on oral health or indirectly through neglected oral hygiene or medication-induced hyposalivation. Hence, the most frequent typical oral age-related diseases are caries, periodontitis, cancer, hyposalivation, and pre-cancerous lesions. Furthermore, problems with unstable removable dentures, insufficient chewing, and dysphagia are factors related to the low OHRQoL and nutritional state in geriatric individuals [1, 4].

2.2 Normal Anatomy and Physiologic Age-Related Changes in the Oro-Facial System

The mouth and the oro-facial system comprise numerous structures to ensure normal function. Specifically important for maintaining a healthy oral environment and subsequently intact oral function and OHRQoL are teeth, periodontium, alveolar bone, gingiva, and mucosa as well as the involved muscles and the temporomandibular joint. Further structures like receptors, peripheral and central nerve fibres as well as nucleii and central representation areas play an important role but are difficult to reach for disease-preventive measures (Fig. 2.1).

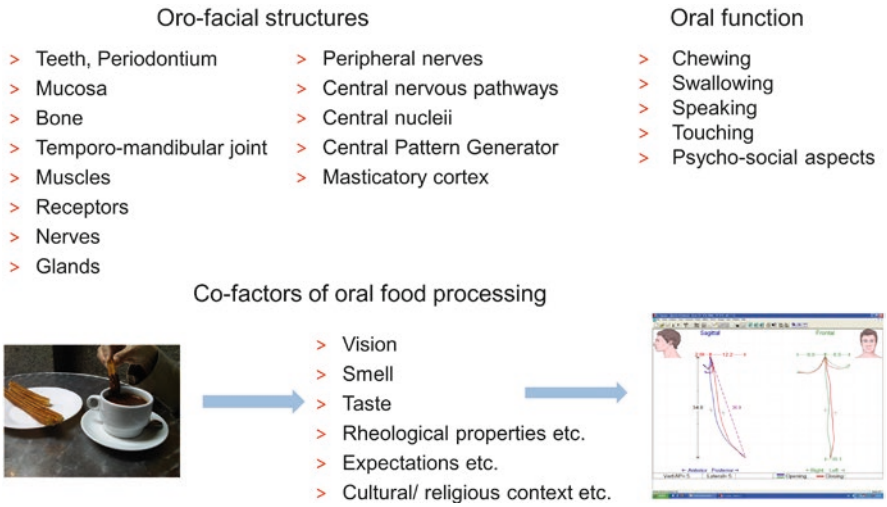

Fig. 2.1 Components and functions of the oro-facial system. The oro-facial system comprises numerous structures in the oral cavity, but also parts of the central and peripheral nervous system play an important role to maintain oral function. The predominate function is oral food processing that also depends on many co-factors to ensure sufficient nutritional state and psycho-social aspects

2.2.1 Teeth

The human dentition comprises 32 teeth, including four wisdom teeth. The wisdom teeth often do not erupt or are removed early in life as they may cause infections or root resorptions of the remaining teeth. Hence, 28 teeth are regarded as a complete dentition. In this case, there are four incisors, two canines, four premolars, and four molars in each jaw.

The tooth comprises macroscopically of a root and a clinical crown [5] (Fig. 2.2).

The clinical crown has an outside enamel layer that covers the dentin layer. Enamel is the hardest tissue of the body. It has a very high mineral content (approx. 96%) and is whitish/bluish/transparent in colour with varying thickness. The thickest part is on the incisal edge and the thinnest part on the transition to the root at the cemento-enamel junction.

Inside the clinical crown lays the pulp chamber that carries the pulp—a tissue that comprises nerve fibres, blood- and lymphatic vessels as well as dentin-building cells (odontoblasts), cells of the immune system, and stem cells. Odontoblasts keep the life-long capacity to build tertiary (repair) dentin. From the odontoblasts that cover the outside of the pulp chamber, processes reach into the dentin through dentin tubules that end at the junction to the enamel. Dentin is a calcified tissue of the body, but only approx. 70% is mineral content. The colour of dentin is yellow to dark yellow. Due to the odontoblast processes in the dentin tubules, the organic component is relatively high.

The root of the tooth consists mainly of dentin but is covered with cementum. The cementum has a mineral content of about 60% and is attached to the alveolar bone (bundle bone) by periodontal fibres, anchoring the tooth in the jaw [6, 7].

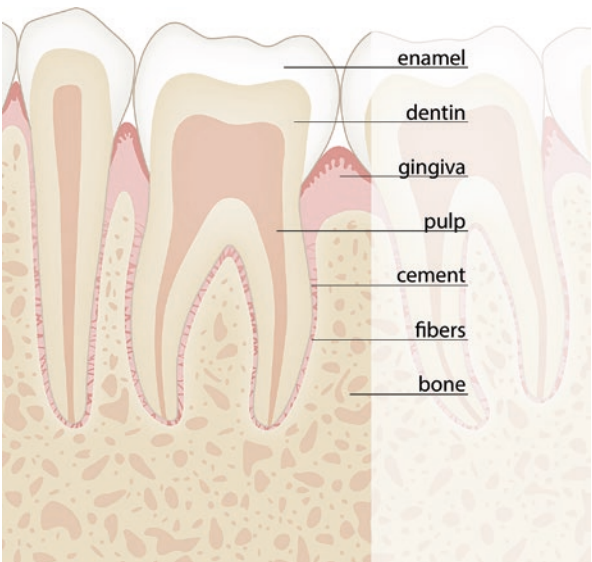

Fig. 2.2 Schematic drawing of the normal tooth anatomy

Through lifetime, teeth are exposed to mechanical wear during the normal function (chewing) and parafunction (e.g. tooth grinding, habits). Furthermore, chemical impacts like acid from food and drink as well as from intrinsic acid reduces enamel thickness. This, in turn, will expose deeper enamel layers, or even dentin, that are much more susceptible for developing caries. This is also the reason why teeth appear to be darker and more yellow in old age, as the dentin layer becomes more and more visible. The enamel of elderly persons also often shows cracks and chippings because of increased brittleness [8].

Age-related changes in the dentine comprise the reduction of the diameter of the dentinal tubules and the reduction of the volume of the pulp chamber through the apposition of tertiary dentine. There is a reduction in organic content and an increase in mineral content. The sclerosis of the dentin and the pulp are age-related, but can also be part of a defence mechanism against extrinsic factors such as carious lesions [9] (Fig. 2.3a, b).

The pulp may lose some of its reactive capacity as part of the general immunescence [10]. The connective tissue shows signs of fibrosis and frequently, calcifications are found.

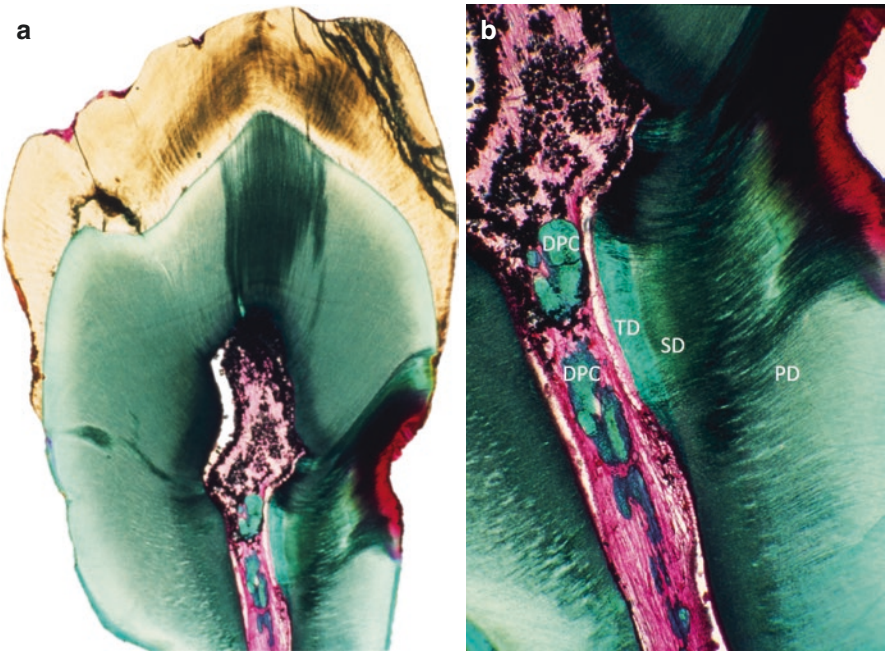

Fig. 2.3 (**a**) Histological cross-section of a tooth with root caries lesion extending into dentine and pulp. (Reprint from [9] with permission from John Wiley and Sons). (**b**) Magnification of (**a**), showing the dental pulp calculi (DPC), as well as the different kinds of dentine: primary dentine (PD), secondary dentine (SD), and tertiary dentine (TD); the latter presenting reparative and reactionary dentine. (Reprint from [9] with permission from John Wiley and Sons)

2.2.2 Periodontium and Alveolar Bone

The periodontium is a specialized tissue that surrounds the root surface and anchors the tooth in the jaw. It consists of the gingiva, periodontal ligament, cementum, and the alveolar bone.

The gingiva can be divided into three parts: the marginal gingiva, the attached gingiva, and the interdental gingiva (interdental papilla). The healthy gingiva is pink in colour, firm, and has a surface similar to an orange peel (stippling). The marginal gingiva surrounds the tooth like a collar in the area of the cemento-enamel junction. In elderly individuals, there is often a migration of the marginal gingiva apically which results in an exposition of cementum to the oral cavity (Fig. 2.4), which plays a major role in the pathogenesis of root caries, as the exposed cementum is a prerequisite for developing root caries. The healthy marginal gingiva varies in width from 0.5 to 2 mm from the gingival crest to the attached gingiva. The attached gingiva adheres tightly to the underlying alveolar bone. It withstands mechanical forces, which may be important for the health of the marginal gingiva. Its width varies in the mouth from approx. 2–4 mm.

The periodontal ligament (PDL) consists of various connective tissues that attach the tooth to the alveolar bone. The principal fibres, the Sharpey fibres, transfer the vertical force on the tooth during mastication into tensile forces that are transferred to the alveolar bone (Fig. 2.2). This tensile force is very important for the health and the constant remodelling of the alveolar bone, which is demonstrated by the fact that after tooth loss, the alveolar bone experiences continuously resorption in height and width [11]. Furthermore, the periodontal ligament is heavily innervated. For example, the minimum thickness threshold between

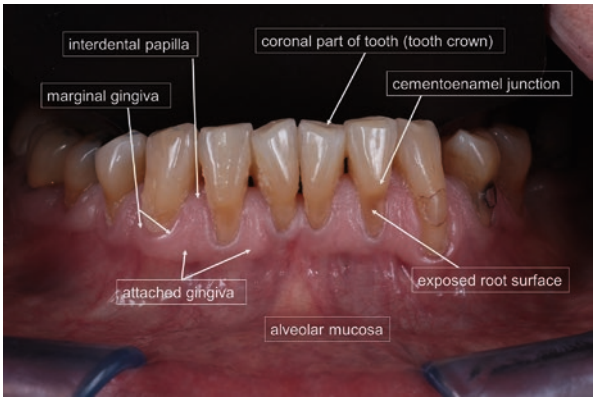

Fig. 2.4 Normal oral anatomy of the oral cavity in a patient with advanced age. Anterior part of the lower jaw of a 93-year-old man. There are age-related physiological changes like the recessions of the marginal gingiva that lead to an exposure of the root surfaces below the cemento-enamel junction. This exposure is a prerequisite of root caries. There is a composite filling on the lower left canine's root surface. The interdental parts open and root surfaces are exposed as the papilla recesses

the incisor teeth is as little as 4 μm and forces as little as 1 N can be used effectively when holding and splitting a nut [12]. The width of the PDL ranges from 0.15 to 0.38 mm and seems to decrease progressively during ageing, however, without proven functional limitations.

There is very little evidence on age-related changes to the periodontium, besides the thickening of the cementum and a reduced turnover of the periodontal ligament. Furthermore, a reduction of the stippling on the surface of the gingiva is described [13].

The bony compartment of the periodontium is the alveolar bone. The bony ridges of the maxilla and mandible contain dental alveoli with the bundle bone in which the teeth are anchored through parts of the periodontal ligament. The crests of the tooth sockets, i.e. dental alveoli, are the most coronal parts in relation to the tooth and are slightly apical to the cemento-enamel junction. In healthy individuals, the alveolar crests of neighbouring teeth are similar in height [14]. As the bone metabolism heavily depends on hormone status, the alveolar bone changes with age, approximately starting with the fourth live decade. The osteoclastic activity might increase whereas osteoblastic cells are reduced in number and function, resulting in structural changes like thinning of bone trabecula and the reduction of bone density [15].

The pronounced changes in terms of bone resorption following tooth extraction are well documented but are not specifically age related. However, as this resorption is progressive and irreversible, very old edentulous patients might show severe alveolar bone atrophy, depending on the time span of edentulism. Generalized osteoporotic processes seem to have little influence in the alveolar ridges [11, 16].

2.2.3 Oral Mucosa

The oral mucosa may be divided into the lining mucosa, the masticatory mucosa, and the specialized mucosa [17] (Fig. 2.5).

The lining mucosa represents the basic design of the oral mucosa. It is a stratified squamous, non-keratinized epithelium with various thicknesses, depending on the area of the mouth. The lining mucosa can further be subclassified as labial mucosa at the inside part of the lips, as the buccal mucosa which lines the cheeks and the floor of the mouth as well as the alveolar mucosa between the buccal and labial mucosae in the floor of the mouth, underside of the tongue. The lining mucosal membrane of the floor and cheek further performs resorption tasks, whereby the ingested substances, bypassing the portal circulation, reach the heart via the superior vena cava and from there to the periphery. This mechanism is of clinical importance for the administration of emergency medications (sublingual administration).

The alveolar mucosa is not attached to the underlying tissue and is partially mobile in the region of the mucobuccal fold, the soft palate, and the cheeks. The masticatory mucosa is found in areas of increased mechanical stress like on the hard palate and the attached and free gingiva. Different from the lining mucosa, it consists of a keratinized stratified squamous epithelium.

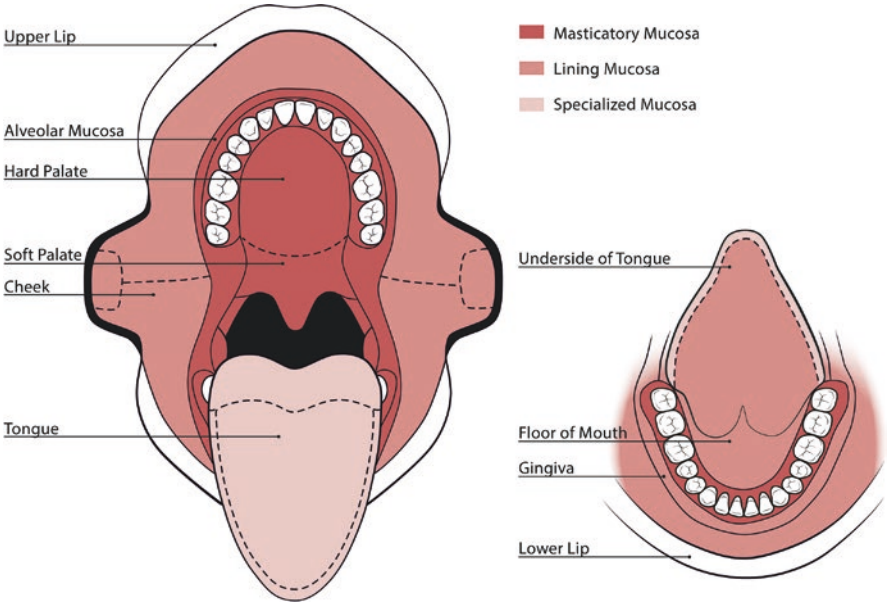

Fig. 2.5 The oral mucosa. The oral mucosa is classified into the lining mucosa, the masticatory mucosa, and the specialized mucosa. The current scheme may also be used to document changes in the oral cavity in a systematic fashion

The specialized mucosa exists on the dorsum of the tongue. Its thick immovable keratinized stratified squamous epithelium carries the tongue papillae together with the taste receptors [18].

There are few findings related to the age-correlated changes of the oral mucosa. The varying histological structure of the oral mucosa and their different biomechanical load, e.g. chewing, has to be taken into account [19]. It was stated that the oral mucosa in older people shows little macroscopic and physiological differences compared to younger people if there are no local or systemic diseases [20]. In contrast to the skin of the outer body surface, the oral mucosa is not subject to photoaging, UV radiation, but also other environmental influences. There are reports on age-related atrophy of the oral mucosa which may result in decreased mean epithelium thickness, decreased cell density, mitotic activity, and a slowdown in tissue regeneration and healing rates.

Wound healing of the oral mucosa appears to be slower above the age of 50 compared to younger years. Furthermore, some neurophysiological functions, such as touch or vibration, seem to be slightly reduced in old age. There are generally no changes in the pain perception in the elderly, which also applies to the oral cavity [21].

Whether there are fundamental changes to the oral mucosa that is covered with removable dentures remains subject to controversy. In terms of epithelium thickness, resilience or load-bearing capacity, regional differences can be assumed. The age-related changes of the mucosa on the hard palate comprises a flattening of the physiological horizontal elevations (Palatine rugae), macroscopically. Histologically,

the marginal and median fibrous areas enlarge at the expense of gland-bearing zones. Hyperkeratosis of the hard palate is more common in old age as well [22, 23].

2.2.4 Salivary Glands

There are three symmetrically distributed major salivary glands on each side and as many as several hundreds of minor salivary glands in the oral cavity [14].

- The parotid glands are located anterior to the ear and around the mandible. The duct enters the oral cavity in the region of the cheek opposing the first molar of the upper jaw.
- The submandibular glands sit beneath the lower jaw and secrete saliva through ducts that end on the floor of the mouth (Wharton duct).
- The sublingual glands are located anterior to the submandibular gland and are much smaller.
- The minor salivary glands are located directly in the oral mucosa. They are approximately 1–2 mm in diameter and produce mainly mucous saliva.

  Saliva plays an important role in cleansing and lubricating oral cavity, protecting from microorganisms overgrowth, facilitating bolus formation and swallowing, enhancing speaking and taste. It also neutralizes pH and prevents demineralization of teeth protecting from dental caries and erosion.

Every day, between 0.5 and 1.5 L of saliva are produced. The saliva production can be enhanced by parasympathetic stimulation. Increased salivation is mediated by the neurotransmitter acetylcholine which binds to muscarinic receptors in the glands. Also in younger individuals, salivary glands often show significant pathological changes. In addition to a general involution, distinct fibrosis or fatty degeneration of the parenchyma with a reduction of the terminal pieces can often be observed. The duct system may show irregularities with extensions and epithelial growths and inflammatory processes with obstructions of the ducts may occur. These striking histopathological changes are in contrast to the only minor age-related physiological changes of the salivary glands. The physiologic parameters of saliva secretion are very similar between younger and older adults. The quantity and composition of saliva remain almost unchanged, only the proportion of mucous components may be slightly increased in elderly subjects. Hence, the phenomenon of a dry mouth is almost exclusively of a pathological origin [24].

2.2.5 Oral Function

Chewing and swallowing is divided into the oral, the pharyngeal, and the oesophageal phase. During the oral phase, foodstuff is fragmented into chewable sized portions by the incisors and subsequently transported in the oral cavity. During the masticatory process, the food is fragmented and moistened with saliva in order to form a coherent bolus that can be swallowed safely without choking [25] (Fig. 2.6).

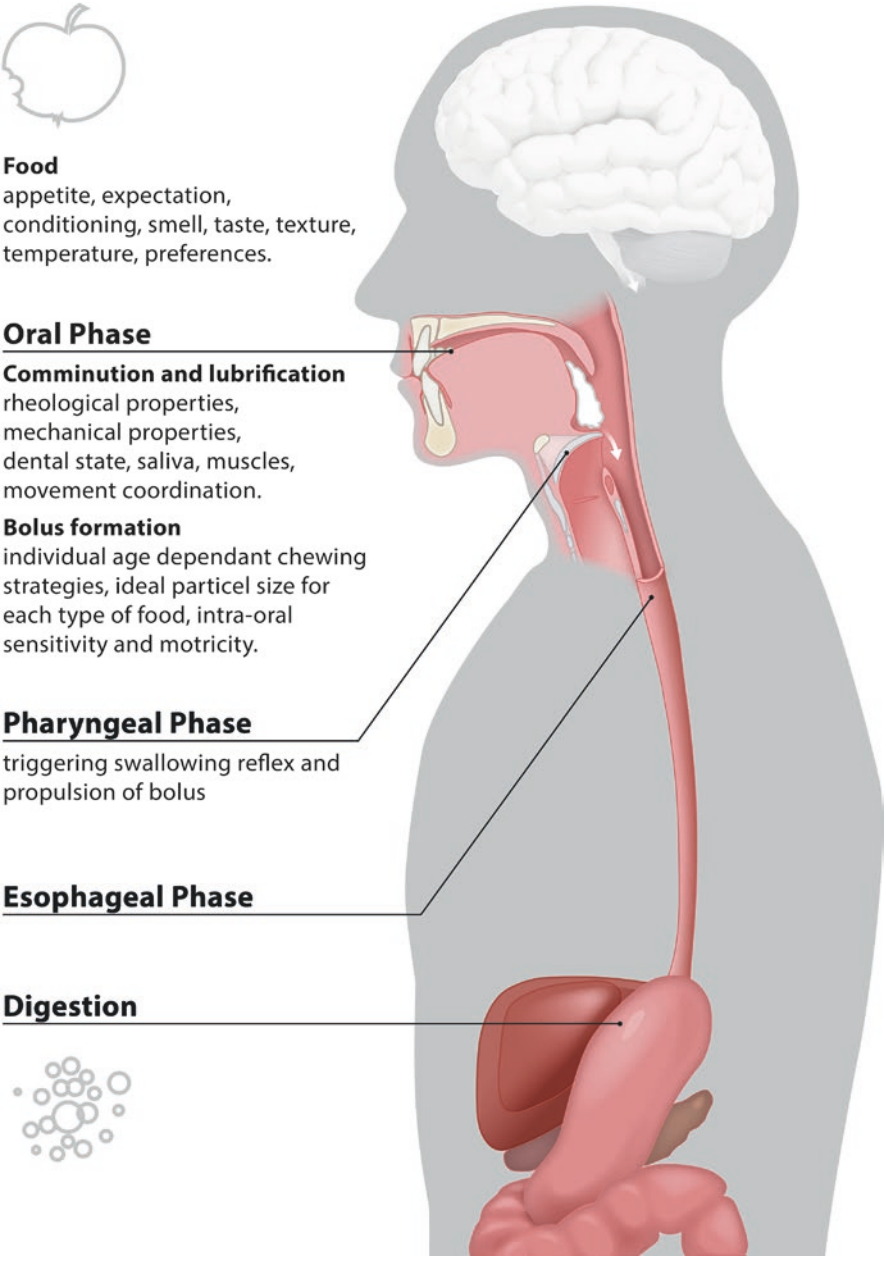

Fig. 2.6 Diagram of factors associated with oral food processing. There is a complex sequence that starts with the selection of food, integrates structural and functional aspects of the oro-facial and digestive system which ultimately leads to an individual nutritional state

Hence, oral food processing is a complex interaction between tooth- and denture-related factors, as well as central and peripheral control of the muscles, and other oral structures.

There is little evidence if oral functions like chewing, bolus formation and transportation, or speaking change, as a consequence of age alone. However, these problems are very frequent in the presence of pathological changes of the oral environment like tooth loss or cancer. If the oral structures are preserved in a healthy way, there seems to be little age-related impairment as the oro-facial system processes large physiological spare capacities [26–28].

Age-related sarcopenia of the masticatory muscles which is further aggravated by complete tooth loss has been well documented [29]. This reduces the maximum available force for chewing foodstuff, but it is unclear at which point the reduced force results in a change in dietary habits. A study from Japan showed that in the seventh decade of life, the ability to chew hard food decreases, even if the number of functional teeth, i.e. teeth with antagonist contact, remains the same [30].

There seems to be an age-related decline in the sensory function, but there is no obvious consequence. The bolus formation and transportation might be impaired, and it could be speculated if decreased sensory function also plays a role in the longer oral phase in very old individuals' comminution process [31]. The prevalence of dysphagia increases with age and it is estimated that up to 69% of institutionalized elders experience signs of dysphagia to varying degrees [32]. This could be related to age-related sarcopenia of the involved muscles, but is more likely a consequence of underlying neurological disease processes like stroke or dementia [33, 34].

2.3 Common Oral Diseases in the Elderly

The main challenges of oral health in older people described by the World Health Organization are tooth loss, denture-related conditions, coronal dental caries and root surface caries, periodontal disease, xerostomia as well as oral pre-cancer and oral cancer [4]. From a functional point of view, impaired oral food processing capacity and dysphagia also play an important role, as they might lead to nutritional deficiencies or may foster aspiration pneumonia.

2.3.1 Caries and Pulpitis

Despite the evident progress in oral hygiene and successful preventive measures over the last decades, tooth-related disease is still a reality in the elderly population [35]. Dental caries is the most common non-communicable disease and will affect all hard tooth tissues (enamel, dentine, and cementum). A high-carbohydrate diet, especially in the form of simple fermentable carbohydrates such as sugar, provides the substrate to ensure the activity of bacteria (e.g. Streptococcus mutans) from the intra-oral microbiome that builds a biofilm (plaque) on the intra-oral surfaces. A high bacterial activity lowers the local pH, and the exposure time of the generated acid to the hard tissues plays an important role in caries formation. Thus, dental caries has major co-factors like poor oral hygiene, a reduced buffer capacity of the saliva, or a reduced amount of

saliva, i.e. hyposalivation. However, the main factors for developing caries is today described by the ecological plaque hypothesis that explains the occurrence of caries as a disturbance in the homeostasis of the oral microflora, caused by the selective favouring of (potentially) pathogenic microorganisms by a sugar-rich diet (Fig. 2.7) [37].

In elderly individuals, especially those depended on care and with a sugary diet, caries of the root surfaces is very common and can destroy the dentition in a short period, as little as few months (Fig. 2.8). Root surface caries can often be difficult to detect and very challenging to treat for a dentist (Fig. 2.9a–c). Active root caries can usually be differentiated from inactive root caries by the colour (black versus brownish), the consistency (hard versus soft), and the surface (clean versus covered with debris and possibly cavitation) (Fig. 2.10).

Once the progressive carious lesion approaches the dental pulp, an inflammatory response of the pulp tissue will result. This response may be chronic and the dentin-building cells build tertiary dentine as a defence mechanism (Fig. 2.3a, b). However, often the inflammation is acute leading to the symptoms of an irreversible pulpitis. These symptoms include severe pain, dull aching, sensitivity to cold and hot. For irreversible pulpitis or necrosis of the pulp, the only two treatment modalities are root canal treatment or tooth extraction (Fig. 2.11a, b).

Another mechanism of the loss of tooth structure is erosion, which refers to the loss of enamel or dentine due to the direct exposure to acid. Frequent mechanisms may involve acidic beverages and food, gastric reflux, and acidic medications.

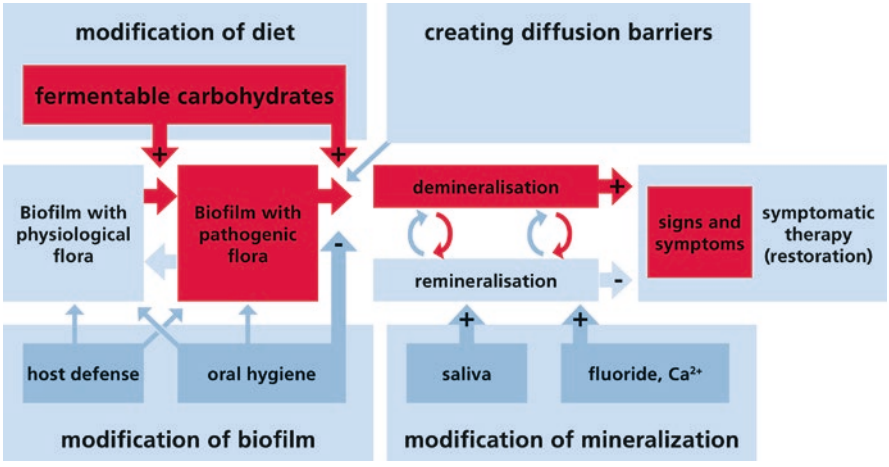

Fig. 2.7 Current model for the aetiopathogenesis of caries. The caries process is due to the excessive consumption of fermentable carbohydrates that cause an ecological shift in oral microflora and modifies the physiological oral biofilm to an aciduric and acidogenic pathogenic biofilm. This, in turn, produces fermentable carbohydrates acids, which lead to the demineralization of hard tooth substances and ultimately cause the symptoms of carious lesions. Contrasting the pathogenic factor "fermentable carbohydrates", there are several protective factors that affect the biofilm or remineralization of dental hard tissues. Thus, phases of demineralization and remineralization alternate several times a day, and ultimately, the complex interplay between pathogenic and protective factors determines whether the de- or remineralization predominates, thus forming carious symptoms or not. In addition to these direct factors, there are associations with indirect factors such as education and socio-economic status. (Figure redrawn from: [36])

Fig. 2.8 Oral status of a wheel chair bound 65-year-old man living in a long-term care facility

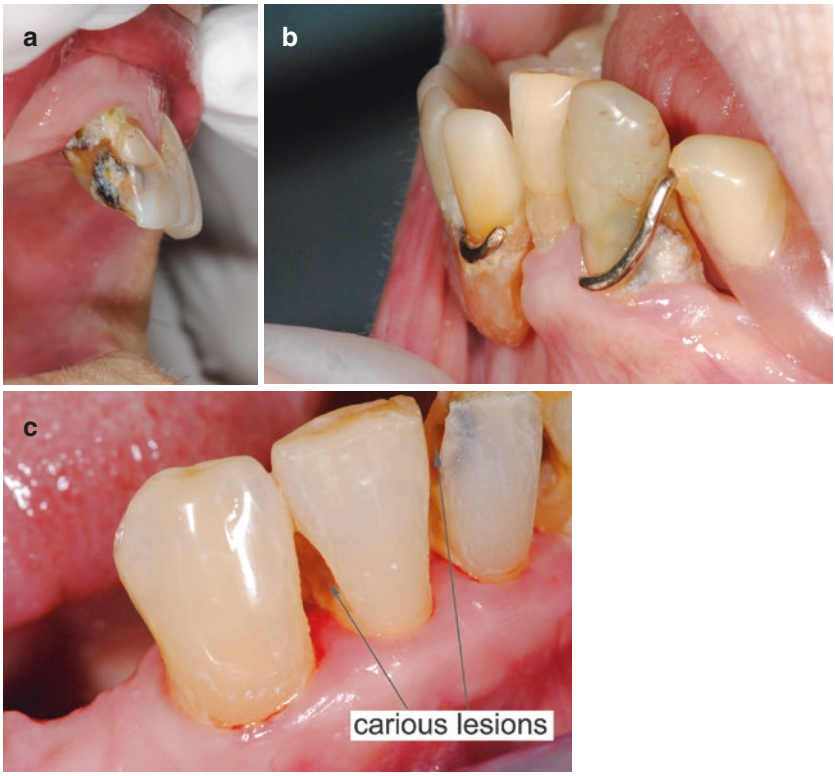

Fig. 2.9 (**a**) Active and easily detectable root caries lesion on an upper incisor. (**b**) Active root caries lesion that is hidden underneath a clasp. (**c**) Caries lesions are often hidden in between the lower incisors. These lesions can progress very quickly and often lead to pain and, ultimately, to the fracture of the weakened tooth

Fig. 2.10 Inactive root caries lesions are often dark, not covered with plaque and show a hard surface

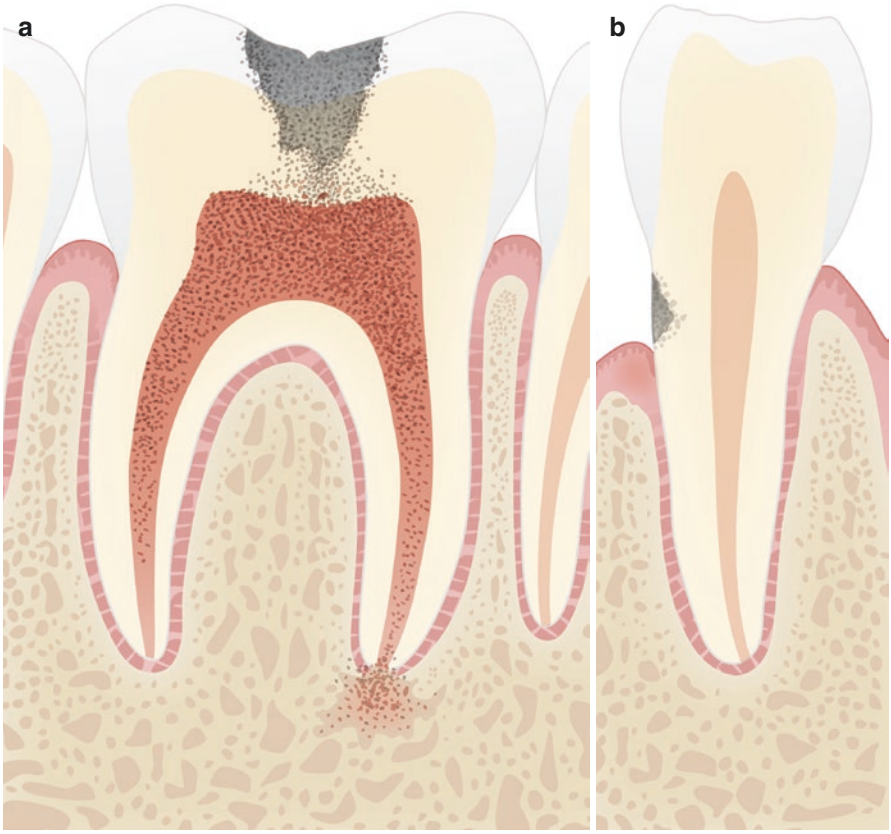

Fig. 2.11 (**a**) The bacteria in the carious lesion may cause an inflammation of the pulp (pulpitis). Through the apical foramen of the tooth, the infection ultimately will also affect the alveolar bone. (**b**) Root carious lesions develop below the cemento-enamel junction. As the lesion is very close to the dental pulp, symptoms may develop very quickly

Fig. 2.12 (**a**, **b**) Erosion/attrition in an 83-year-old man. Especially in the lower jaw, the teeth have lost a significant amount of tooth structure. There are no caries or periodontal disease. The dentin is exposed but because of the age-related redressing of the dental pulp, he experiences no pain

Attrition refers to the loss of tooth structure due to mechanical wear. Attrition is very common in elderly patients and can be seen as natural signs of function over lifetime and the differentiation to abnormal wear in very old patients can be challenging [38] (Fig. 2.12a, b).

Elderly people and especially patients with dementia prefer a sugary diet as one of the few pleasures life has to offer. Consequently, patients with dementia may develop rampant caries whenever oral hygiene is neglected. Poor oral hygiene combined with a sugary diet will ultimately result in rapid destruction of the teeth, discomfort, infection of the alveolar bone, abscesses, pain, and tooth loss (Fig. 2.13). This tooth loss may appear very quickly and the more elderly people are depended on help for the Activities of Daily Living (ADL), the poorer the oral hygiene [39, 40] (Fig. 2.14a, b).

2.3.2 Gingivitis and Periodontitis

The classic experiment of Silness and Loe demonstrated that the inflammation of the gingiva is caused most of the time by dental plaque, i.e. the biofilm formation on the tooth structure adjacent to the gingiva. The inflammation of the gums is a bacterial disease and is reversible once a good oral hygiene is established. The same

Fig. 2.13 A broken tooth has led to an abscess related to it in the lower jaw (left side) of this patient with Parkinson's disease

Fig. 2.14 (**a**, **b**) Dental state of a 63-year-old patient with severe dementia. He resisted all oral hygiene measures, but the care-providers suspected toothache as he refused to eat his favourite food. During the dental examination under general anaesthesia, a squamous cell carcinoma on the back of the tongue was detected which was most likely the reason for his pain

mechanisms of inflammation apply in elderly patients. A multitude of periodontal pathogens has since been identified, such as Aggregatibacter actinomycetemcomitans, Porphyromonas gingivalis, Prevotella spp., to name a few [41, 42].

The inflammatory burden of periodontal disease may furthermore comprise specific risks for diabetic patients, and patients with dementia and may

Fig. 2.15 Periodontitis. Final stage of periodontal disease in this 55-year-old patient. The gingiva is highly inflamed—the surface is red and swollen. The teeth are loose, and there is halitosis

negatively influence the overall ageing process. Poor oral hygiene not only poses a threat to general health through the haematogenous spread but also locally to the oral tissues [13].

Nevertheless, besides caries, periodontitis is the main factor for tooth loss. The inflammation not only affects the gingiva but the inflammatory response of the body often also leads to the destruction of the alveolar bone. The destruction of the alveolar bone is then an irreversible process. As the supporting tissues of the teeth are progressively destroyed, teeth become loose and are lost eventually. These inflammatory processes are sometimes silent; hence, the patient does not experience problems until teeth become loose. However, the inflammation can also be painful with swellings and bleeding of the gums as the most common clinical signs (Fig. 2.15).

There is a specific form of simultaneous existence of pulpal problems and inflammatory periodontal disease. There the inflammatory process in the presence of the bacterial plaque formed by aerobic and anaerobic microorganisms reaches the apical and/or lateral foramen of the tooth and may cause a pulpitis in a tooth that may not even have a carious lesion or a filling. These so-called periodontal-endodontic lesions lead to a very poor prognosis of the tooth and result often in the removal of the tooth [43].

A further medication-related form of gingivitis is the hyperplastic gingivitis that may be related to changes in haemostasis of hormones or may be a side effect of medications like cyclosporine A or diphenylhydantoin.

2.3.3 Replacement of Lost Teeth with Dental Prostheses

Once tooth loss occurred, there are various ways of tooth replacement. Fixed and removable dental prostheses for tooth replacement are very prevalent in the elderly population. At the age of 85 years or older almost 100% of the population in developed countries is restored with some kind of dental prostheses. However, this prevalence varies significantly between countries, especially for complete dentures and dental implants [35, 44].

Fig. 2.16 Clasp-retained removable partial denture in the lower jaw

Fig. 2.17 (**a**, **b**) An example of a partial removable prostheses with gold copings on the canines and dental implant carrying ball attachments in the posterior region of the lower jaw. The attachments are well hidden underneath a difficult-to-detect denture

Removable prostheses may replace some or all teeth as well as bony- and soft-tissue structures that have been lost by atrophy, disease, or trauma. These prostheses may rest directly on the oral mucosa or be attached to the remaining teeth (Fig. 2.16). Recently, the stabilization of removable partial prostheses with endosseous oral implants becomes more frequent (Fig. 2.17a, b). If all teeth are lost, patients may be restored with complete dentures. These dentures rest on the mucosa and are mostly

Fig. 2.18 (**a**, **b**) Edentulous patient with conventional mucosa-borne complete dentures

stabilized with the oral and peri-oral muscles. Especially the lower denture is often very loose due to advanced atrophy of the bony tissues (Fig. 2.18a, b). The lower dentures are increasingly often stabilized with endosseous implants with varying attachment systems (Fig. 2.19a, b), as this kind of treatment has been described as the minimum standard of care for the edentulous mandible [45]. Endosseous dental implants can be described as false roots that are biologically integrated into the alveolar bone, by direct contact of the bone to the implant surface (osseointegration). Implants are mostly made out of titanium and serve to support crowns and bridges or to retain dentures. Even though implants made of ceramics, such as zirconium dioxide, have gained increasing popularity in recent years, they are still not widely employed. Recently, treatment concepts focusing on single midline implants, stabilizing mandibular complete dentures have been introduced [46].

Removable prostheses must be removed from the mouth to be physically cleaned, however, in elderly dependently living patients, this goal is rarely met. Pathologies often recorded in denture wearers are denture stomatitis, irritative hyperplasia, sore spots, traumatic ulcers, and angular cheilitis. They are related to ill-fitting dentures or inappropriate dentures' maintenance. Especially remainders of denture adhesive must be removed on a daily basis, both on denture and mucosa (Fig. 2.20). Ill-fitting

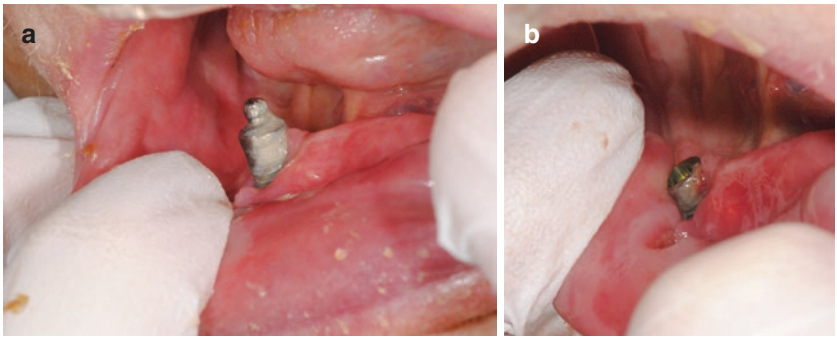

Fig. 2.19 (**a**) Ball attachment on a dental implant in an edentulous woman in long-term care. There is abundance of plaque on the implant and the attachment which causes inflammation of the mucosa. (**b**) Same patient as in (**a**); she suffered from severe dementia and a pathologic tonus of the peri-oral muscles. This led to a chronic trauma of the soft tissue, caused by the implant

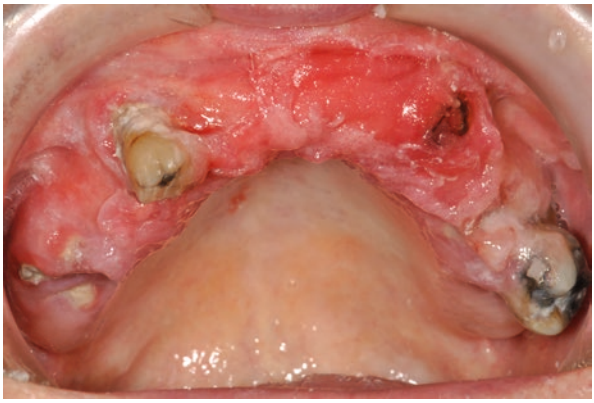

Fig. 2.20 Denture adhesive should be used sparsely and must be removed completely from the mucosa and teeth at least once a day. Otherwise, inflammation if the mucosa will occur

removable prostheses and colonization with fungi and bacteria increase the ability of Candida albicans to colonize both the denture and oral mucosal surfaces and may cause local inflammation (Fig. 2.21). Besides local factors, candidiasis may have predisposing systemic factors (antibiotic therapy, immunosuppressive drugs, radiation, malignancy, neutropenia, iron-deficiency anaemia, cellular immunodeficiency, endocrine disorders, uncontrolled diabetes mellitus), which is common in denture wearers, particularly when they continuously wear the maxillary denture, day and night. Angular cheilitis is usually associated with infection from Candida Albicans, Staphylococcus aureus, and Streptococci, but also with iron-deficiency anaemia, and riboflavin deficiency [47] (Fig. 2.22).

Fixed dental prostheses, i.e. “bridgework”, may rest on natural teeth, or implants. Mostly, they are used to replace fewer teeth than with removable prostheses (Fig. 2.23), but also completely edentulous patients may be restored with bridges fixed on implants (Fig. 2.24).

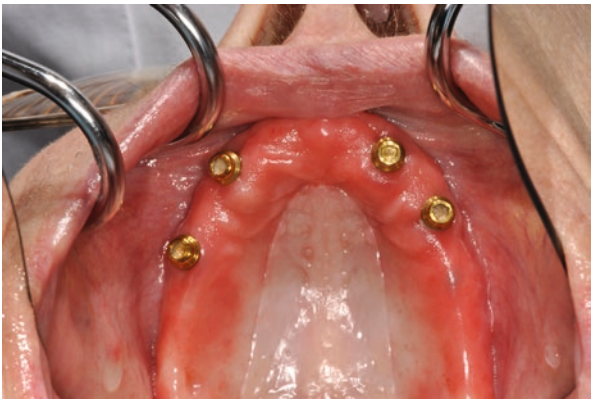

Fig. 2.21 Denture stomatitis in the upper jaw. The mucosa is red, and the surface is altered in the region of the denture. There are so-called locator attachments of golden colour on implants to retain an "implant-overdenture"

Fig. 2.22 Angular cheilitis in the patient in Fig. 2.12. The chronic inflammation is very often associated with discomfort and bleeding

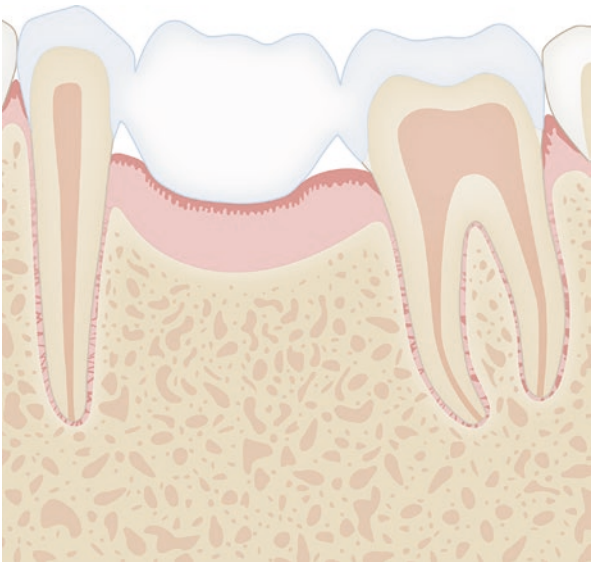

Fig. 2.23 Schematic drawing of a tooth supported bridge. They are often "invisible" in the mouth if they are made of tooth-coloured ceramic

Fig. 2.24 Clinical picture of a 66-year-old female, edentulous patient. She is restored in the upper jaw with a complete denture and in the lower jaw with a screw-retained fixed bridge on dental implants

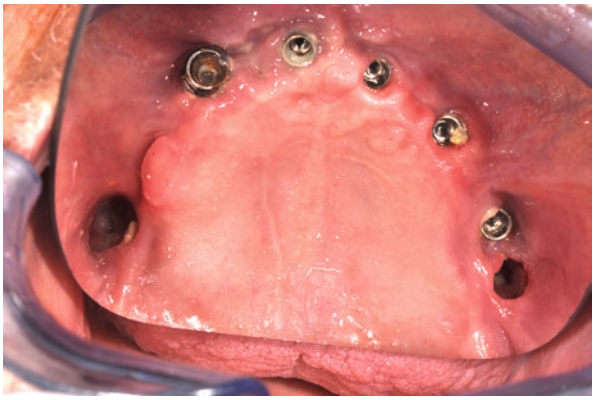

Fig. 2.25 Severe inflammation around dental implants with pus, bleeding, and swelling of the mucosa. The local destruction of the bone has led to a communication to the maxillary sinus

Independent of their material, implants do not develop caries, but the peri-implant mucosa and bone can be inflamed, similar to the periodontium of teeth. The inflammation around implants is called peri-implant mucositis or if the alveolar bone is involved, peri-implantitis (Fig. 2.25).

The patient's manual force and dexterity should be evaluated within the context of treatment planning, assuring autonomous handling of the dental prosthesis and the possibility of oral, implant, and denture hygiene. Rheumatoid arthritis and arthrosis/osteoarthritis are common conditions in elderly patients that may preclude denture management; the prevalence of osteoarthritis was found to be around 30% in women between the ages of 70 and 100 years [48].

Caregivers and family members should also be involved in treatment planning to ensure aftercare. They need to be informed that dental implants and prostheses need adequate cleaning and that short recall intervals are needed for maintenance and helping to prevent biological complications [49].

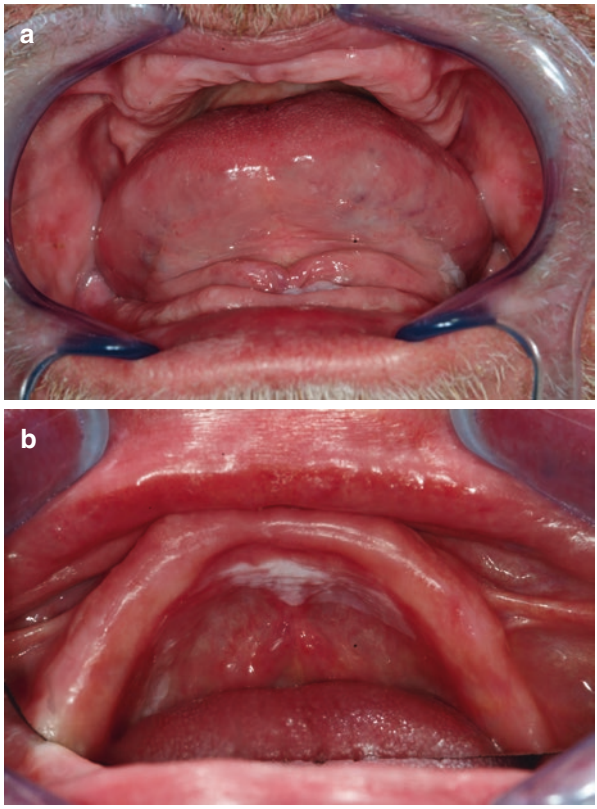

Fig. 2.26 (**a**) Lesions of the oral mucosa like leukoplakia may be precursors to oral cancer. Often, these lesions are hidden on the floor of the mouth/lateral part of the tongue. (**b**) Same lesion as in (**a**), on the lingual part of the lower alveolar process

2.3.4 Pathologies of the Oral Mucosa

Age-correlated pathological changes of the oral mucosa are of great importance in daily practice. They are often associated with a general medical condition and may have an early diagnostic role. Common oral pathologies in the elderly are squamous cell carcinoma, candidiasis, lichen planus, mucosal pemphigoid, pemphigus vulgaris, burning mouth syndrome, denture-related lesions, and xerostomia.

The risk of developing pre-neoplasia (leukoplakia, erythroplakia), squamous cell carcinoma, and generalized diseases (lichen planus, pemphigoids, stomatitis) increases with age.

Leukoplakia is clinically defined as a whitish patch of the oral mucosa and presents a facultative pre-cancerous lesion. It cannot be wiped off and usually does not cause discomfort or pain. It may comprise smaller or larger areas, often in the buccal area. As it may be a precursor to squamous cell carcinoma, it should be monitored regularly [18] (Fig. 2.26a, b).

The squamous cell carcinoma is a malignant tumour of the oral mucosa. The risk factors for developing such a carcinoma are similar to those of leukoplakia and

Fig. 2.27 This 89-year-old woman with mild cognitive impairment after a stroke lived in a long-term care facility. She was seen in primary dental consultation in the residence because she complained of pain for many weeks. The nursing staff mistook the ulcerous squamous cell carcinoma on the right side of the tongue for a denture ulcer. The tumour was inoperable and the patient was admitted to palliative care

comprise smoking, alcohol, deficient oral hygiene, mechanical factors like sharp edges of dentures and destroyed teeth and lately, previous infection with Human Papilloma Virus was discussed. It is usually developed in the lateral margin of tongue, the floor of the mouth, gingivae, and palate [50]. Although oral cancer can be easily detected at an early stage with a routine visual inspection, this rarely happens. However, primary healthcare practitioners' level of training and confidence may play an important role [51]. Most of the time, the ulcerous form predominates with a central ulceration and, depending on the location, may have a poor prognosis. A squamous cell carcinoma can easily be mistaken for a denture-related ulcer. Hence, if an ulcer in the mouth persists over 2 weeks, and denture abstention did not improve the situation, an oral pathologist, oral surgeon, or oral and maxilla-facial surgeon must be consulted. It should also be kept in mind that in early stages, cancerous lesions might not be painful (Fig. 2.27).

2.3.5 Xerostomia and Hyposalivation

Hyposalivation is very frequent among geriatric patients, mainly as a consequence of polypharmacy. The term hyposalivation refers to an objective reduction in salivary flow rate, whereas the term xerostomia describes the subjective feeling of a dry mouth. One speaks of hyposalivation in older people when saliva flow rates are below 0.1 mL/min (unstimulated) or 0.5 mL/min (stimulated), respectively. There is no sound evidence that the function of the salivary glands and the

composition of saliva may change during a lifetime as a consequence of age alone [23].

However, hyposalivation may result from systemic diseases, medications intake, radiotherapy in the region of head and neck, and chemotherapy. An extensive discussion on the causes and therapeutic interventions of xerostomia is included in Chaps. 3, 4, and 8.

The main cause of hyposalivation and xerostomia in older individuals is the intake of medications, e.g. those with an effect on the autonomic nervous system. Moreover, various systemic diseases may cause hyposalivation and xerostomia including diabetes mellitus, chronic inflammatory rheumatic disorders (e.g. Sjogren's syndrome, rheumatoid arthritis, systemic lupus erythematosus), lymphoma, depression, end-stage renal disease, dehydration, and infections. The diseases that are most commonly associated with a reduced salivary flow are the Sjögren syndrome and diabetes. Last but not least, a low intake of liquid may lead to hyposalivation in the elderly [52].

A frequent symptom of hyposalivation is the sensation of dry mouth (xerostomia), and difficulties with speaking, eating, and swallowing. The Clinical Oral Dryness Score (CODS) may be used to objectify and score the symptoms like: "(1) Mirror sticks to the buccal mucosa. (2) Mirror sticks to the tongue. (3) Tongue lobulated/fissured. (4) Tongue shows the loss of papillae. (5) Frothy saliva. (6) No saliva pooling in the floor of the mouth. (7) Glassy appearance of other oral mucosae, especially palate. (8) Debris on the palate (excluding debris under dentures). (9) Altered/smooth gingival architecture. (10) Active or recently restored (last 6 months) cervical caries (>2 teeth)" [53]. Higher values (>7) indicate severe oral dryness. Moreover, specialized questionnaires like the xerostomia inventory (XI) have also been validated in older populations and their rating score is related to the severity of the symptoms of dry mouth [54].

The consequences of hyposalivation on oral health can be significant and comprise drastically increased incidence of caries, gingivitis, periodontitis, oropharyngeal infections, ulcers, dental plaque formation, oral candidiasis, dental erosion, inability to wear dentures, infected and bleeding lips, difficulties in chewing, swallowing, and speaking, halitosis, taste disturbance, burning sensation, and subsequent reduced quality of life (Fig. 2.28a, b).

It should also be noted that tumours of the salivary glands are not uncommon and may be associated with swelling and a change in the quantity and quality of the salivary output.

2.3.6 Impairment of Oral Food Processing, Dysphagia

2.3.6.1 Oral Phase

In the oral phase (Fig. 2.6), food oral processing depends on the key factors: (1) occluding tooth units, (2) tooth replacement strategies (fixed/removable on teeth/mucosa/implants), (3) maximum available bite force and movement coordination, (4) quality and quantity of saliva, (5) intra-oral sensitivity, (6) age, and (7) gender. While some factors like age, gender and, to a certain degree, saliva cannot be

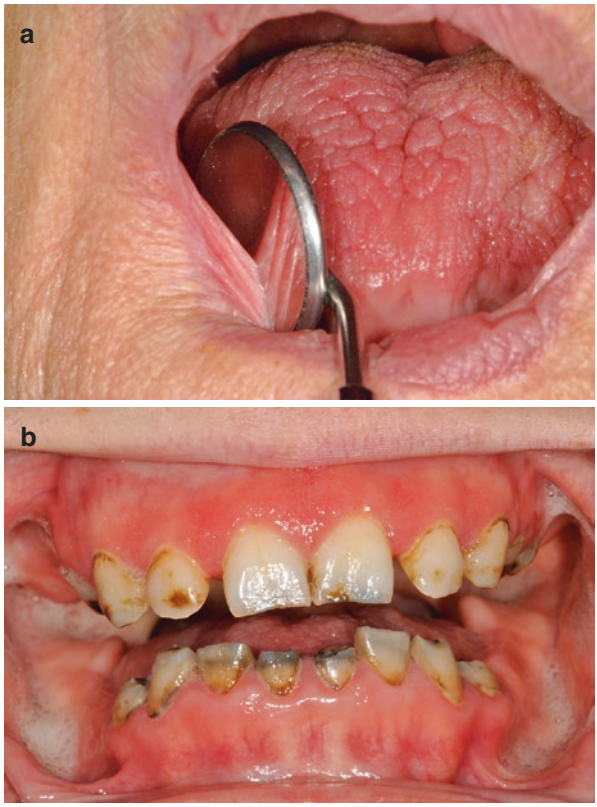

Fig. 2.28 (**a**) An instrument sticks to the mucosa of the 81-year-old woman with dementia who suffers from severe hyposalivation. (**b**) Increased caries activity in a patient with a milder form of hyposalivation following radiotherapy. Note the foamy saliva in the buccal corridor

influenced, there are numerous ways to positively maintain and increase an individual's capacity to process food effectively.

Effective strategies have been described to replace teeth with implants, which will also lead to higher bite forces, and even counteract the age-related muscle loss [55]. However, the best chewing function can still be maintained with natural teeth. Therefore, preventive strategies to avoid tooth loss are the key to prevent certain aspects of oral frailty and oral hypofunction. It was demonstrated that maximum available force, movement coordination, and muscle mass of the mouth closing muscles can most likely be maintained by keeping natural teeth, or even natural roots supporting overdentures [56]. Implants are a very effective method to restore oral function, satisfaction, and OHRQoL if teeth are lost, even in old and very old individuals [57] (Fig. 2.29). The preservation, or establishment, of an adequate number of occluding units, plays a major role. Ideally, a minimum of 20 natural teeth with antagonist contact should be maintained for adequate oral function. It was also demonstrated that elderly partially edentate individuals should preferably be restored with fixed rather than removable prostheses, also taking long-term aspects of OHRQoL into consideration [2, 58] (Fig. 2.30).

Neurocognitive and neurodegenerative disorders also lead to impairment of oral muscle co-ordination. In the initial stages of the disease dental implants may be beneficial to add to denture retention. However, these diseases are progressive and

Fig. 2.29 Schematic drawing of a mandibular implant-overdenture. The stabilization of the instable lower denture with dental implants improves satisfaction as well as functional, structural, and psycho-social aspects in edentulous individuals. The comminution and food bolus handling are facilitated

Fig. 2.30 Example of an 80-year-old man with "functional occlusion". The preservation/establishment of at least ten pairs of teeth with antagonist tooth contact provides sufficient function for adequate nutrition and the concept is superior to removable dentures in relation to quality of life and tertiary prevention. Even with large tooth gaps, appropriate function can be assured. It is key to keep up good oral hygiene to prevent caries or inflammation of the soft tissues

irreversible and often lead to a state where patients refuse access to the oral cavity, even for simple oral hygiene measures. In Parkinson patients, the stabilization of a removable denture or the rehabilitation with fixed restorations may be indicated, as motor control is severely impaired. However, it has to be kept in mind that patients in later phases of the disease might refuse oral hygiene measures or even opt to not wear their denture anymore [57].

In stroke patients, debilitating neurological deficiencies might frequently result in sensory deficits, motor impairment, muscular atrophy, cognitive deficits, and psycho-social impairment. Oro-facial impairment frequently occurs due to the frequent involvement of the cranial nerves' cortical representation areas, central nervous system pathways, or motoneuron pools. Stroke patients demonstrate impaired chewing efficiency, possibly due to reduced tongue forces and disturbed oral sensitivity. A direct impact of stroke on the oral food processing capacity was demonstrated. Those

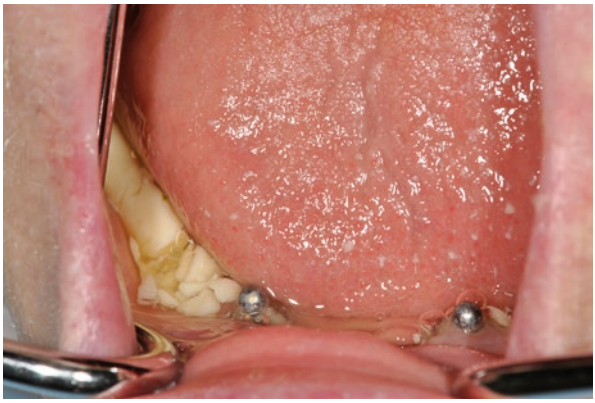

Fig. 2.31 An 86-year-old female patient in her final stage of life, approximately 3 months before she passed away. Food residue remains in the mouth after her lunch that is a clear sign for oral-phase dysphagia. It should also be noted that she does not wear her denture to increase oral comfort—this behaviour can be observed frequently in geriatric patients with low peer pressure (e.g. in a long-term care facility). The ball attachments that are screwed into implants were removed during the same visit—also for comfort [49]

patients usually lose much of their sensory ability and hence show impaired bolus control and swallowing disorders, leading to frequent feeding problems, low OHRQoL and aspiration pneumonia (Fig. 2.31). Furthermore, facial asymmetry is common but mostly discrete and lip force is reduced which may lead to drooling from the mouth and complex changes in feeding and oro-facial function [59].

2.3.6.2 Pharyngeal Phase

Swallowing disorders are very frequent among geriatric individuals and even more prevalent in stroke survivors or patients that underwent treatment for head and neck cancer. Reports state a prevalence of up to 69.5% in nursing home residents [32]. It is a consequence of muscular and sensory impairment or structural deficiencies of the oral and pharyngeal structures. Patients might experience problems in controlling and comminuting foodstuff during the oral phase and experience subsequent insufficient swallowing of solid food or liquids. For example, impaired tongue function in stroke patients is a contributing factor to the frequently observed difficulty in swallowing and functional recovery might not always be possible. Signs and symptoms might comprise choking, a "wet voice", coughing, stuck food and drooling of liquids. Liquids or foodstuff might penetrate as deep as larynx or enter the broncho-alveolar system.

Dysphagia is associated with increased mortality, malnutrition, and aspiration pneumonia. The diagnosis and treatment are performed by specialist physicians and comprise swallowing assessment, for example, with video-fluoroscopy. As inadequate chewing sometimes fosters difficulties in swallowing, a complimentary dental assessment might be useful.

2.3.6.3 Evaluation of Oral Function

The goals of mastication comprise fragmenting foodstuffs to increase the surface area and mixing the aliment with saliva to form a cohesive bolus that is safe to

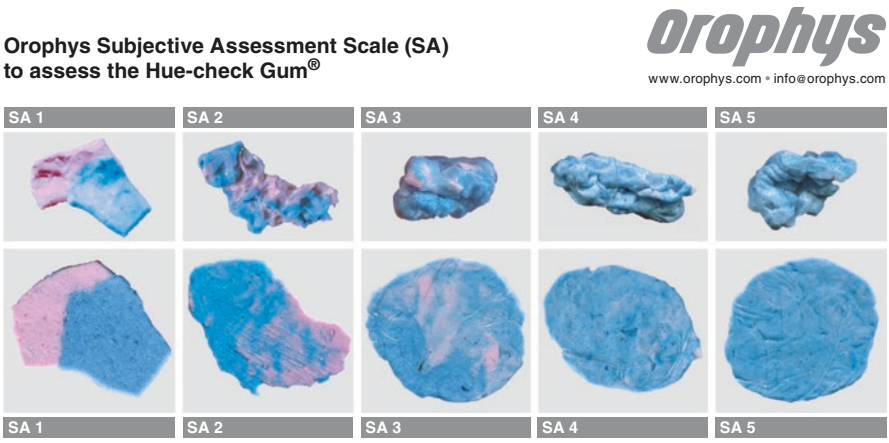

Fig. 2.32 The Hue-Check Gum® was developed to estimate the chewing capacity in elderly individuals. It is a colour-mixing ability test that is quick and easy to perform. The Subjective Assessment Scale allows simple evaluation of the bolus forming capacity in a clinical setting [61]. For research purposes, an opto-electronic scanning method is available [62]. The Subjective Assessment Scale (SA) allows for the quick and simple evaluation of the chewing efficiency by judging colour mixture and bolus formation. If the patient shows a degree of mixing of SA 1 or SA 2, it can be assumed that he/she has difficulty in enjoying normal meals. SA 1: chewing gum not mixed, impressions of cusps or folded once. SA 2: large parts of chewing gum unmixed. SA 3: bolus slightly mixed, but bits of unmixed original colour. SA 4: bolus well mixed, but colour not uniform. SA 5: bolus perfectly mixed with uniform colour

swallow. Effective oral food processing, that is chewing efficiency, may be evaluated by objective clinical tests or by evaluating the individual's perception of his/her chewing ability. In general, a combination of objective and subjective measures should be used to evaluate the masticatory function, aiming to further evaluate possible coping mechanisms of an individual like swallowing of large particles, the increase in chewing cycles or even food refusal [25]. A simple and quick test was proposed to test chewing efficiency objectively using the so-called colour-mixing ability test [60]. Here, the ability to knead and form a bolus is assessed by means of a two-coloured chewing gum. In a clinical environment, a five-point scale can be used to assess the chewing function (Fig. 2.32) and to evaluate if a dental professional might be able to improve the chewing efficiency. This information could also serve to judge if a person dependent on care might need texture modified food or not [63]. Furthermore, the test can be used in a research protocol as a compound measure for oral function [61, 62, 64].

2.4 Conclusion

The oro-facial structures and functions are responsible for chewing, swallowing, speaking, touching, and expressing emotions. Age-related physiological changes affect oral structures but do not necessarily lead to functional loss. Severe changes are associated with external factors, such as the various social determinants of

health. The most common pathological oral conditions in older adults include tooth loss, caries, periodontal disease, xerostomia, and oral pre-cancer and cancer. Oral conditions can be prevented if early diagnosed and most of them can be efficiently managed by conservative or restorative approaches by the dental professionals.

References

1. WHO. World report on ageing and health. Geneva: WHO Press; 2015.
2. McKenna G, Allen PF, O'Mahony D, Cronin M, DaMata C, Woods N. The impact of rehabilitation using removable partial dentures and functionally orientated treatment on oral health-related quality of life: a randomised controlled clinical trial. J Dent. 2015;43(1):66–71. https://doi.org/10.1016/j.jdent.2014.06.006.
3. Slade GD, Akinkugbe AA, Sanders AE. Projections of U.S. edentulism prevalence following 5 decades of decline. J Dent Res. 2014;93(10):959–65. https://doi.org/10.1177/0022034514546165.
4. Petersen PE, Yamamoto T. Improving the oral health of older people: the approach of the WHO global oral health programme. Community Dent Oral Epidemiol. 2005;33(2):81–92. https://doi.org/10.1111/j.1600-0528.2004.00219.x.
5. Standring S, Gray H. Gray's anatomy: the anatomical basis of clinical practice. Edinburgh: Churchill Livingstone; 2008.
6. LeFevre M, Manly R. Moisture, inorganic and organic contents of enamel and dentin from carious teeth. J Am Dent Assoc. 1938;24:233–42.
7. Strub J, Kern M, Türp C, Witkowski S, Heydecke G, Wolfart M. Prothetik band I. Curriculum prothetik. Berlin: Quintessenz Verlag; 2011.
8. Lussi A, Ganss C. Erosive tooth wear. Monographs in oral science. Basel: Karger; 2014.
9. Carvalho TS, Lussi A. Age-related morphological, histological and functional changes in teeth. J Oral Rehabil. 2017;44(4):291–8. https://doi.org/10.1111/joor.12474.
10. Hajishengallis G. Too old to fight? Aging and its toll on innate immunity. Mol Oral Microbiol. 2010;25(1):25–37. https://doi.org/10.1111/j.2041-1014.2009.00562.x.
11. Araujo MG, Sukekava F, Wennstrom JL, Lindhe J. Ridge alterations following implant placement in fresh extraction sockets: an experimental study in the dog. J Clin Periodontol. 2005;32(6):645–52.
12. Lobbezoo F, Trulsson M, Jacobs R, Svensson P, Cadden SW, van Steenberghe D. Topical review: modulation of trigeminal sensory input in humans: mechanisms and clinical implications. J Orofac Pain. 2002;16(1):9–21.
13. Papapanou PN, Sanz M, Buduneli N, Dietrich T, Feres M, Fine DH, et al. Periodontitis: consensus report of workgroup 2 of the 2017 world workshop on the classification of periodontal and peri-implant diseases and conditions. J Periodontol. 2018;89(Suppl 1):S173–S82. https://doi.org/10.1002/JPER.17-0721.
14. Logan B, Reynolds P, Rice S, Hutchings R. McMinn's color atlas of head and neck anatomy. 5th ed. Amsterdam: Elsevier; 2017.
15. Demontiero O, Vidal C, Duque G. Aging and bone loss: new insights for the clinician. Ther Adv Musculoskelet Dis. 2012;4(2):61–76. https://doi.org/10.1177/1759720X11430858.
16. Tallgren A. The continuing reduction of the residual alveolar ridges in complete deture wearers: a mixed-longitudinal study covering 25 years. J Prosthet Dent. 1972;27:120–32.
17. Orban B, Sicher H. The oral mucosa. J Dent Educ. 1946;10:163.
18. Strassburg M, Knolle G. Farbatlas und Lehrbuch der Mundschleimhauterkrankungen. 3rd ed. Berlin: Quintessenz-Verlag GmbH; 1991.
19. Lamster I, Asadourian L, Del Carmen T, Friedman P. The aging mouth: differentiating normal aging from disease. Periodontology 2000. 2016;72(1):96–107.
20. Wolff A, Ship J, Tylenda C, Fox P, Baum B. Oral mucosal appearance is unchanged in healthy, different-aged persons. Oral Surg Oral Med Oral Pathol. 1991;71(5):569–72.
21. Abu Eid R, Sawair F, Landini G, Saku T. Age and the architecture of oral mucosa. Age (Dordr). 2012;34(3):651–8.

22. Schumacher GH. Anatomische Hinweise zum morphologischen Strukturwandel der Mundschleimhaut und der knöchernen Kieferanteile im Alternsablauf. Dtsch Stomatol. 1965;15:11–27.
23. Götz W. Die Mundhöhle des älteren Menschen. Strukturelle und funktionelle Veränderungen. In: Müller F, Nitschke I, editors. Der alte Patient in der zahnärztlichen Praxis. Berlin: Quintessenz Verlags-GmbH; 2010.
24. Vissink A, Spijkervet F, Van Nieuw Amerongen A. Aging and saliva: a review of the literature. Spec Care Dentist. 1996;16(3):95–103.
25. Woda A, Hennequin M, Peyron MA. Mastication in humans: finding a rationale. J Oral Rehabil. 2011;38(10):781–4. https://doi.org/10.1111/j.1365-2842.2011.02235.x.
26. Prinz JF, Lucas PW. An optimization model for mastication and swallowing in mammals. Proc Biol Sci. 1997;264(1389):1715–21. https://doi.org/10.1098/rspb.1997.0238.
27. Prinz JF, Lucas PW. Swallow thresholds in human mastication. Arch Oral Biol. 1995;40(5):401–3.
28. Peyron MA, Woda A, Bourdiol P, Hennequin M. Age-related changes in mastication. J Oral Rehabil. 2017;44(4):299–312. https://doi.org/10.1111/joor.12478.
29. Newton J, Yemm R, Abel R, Menhinick S. Changes in human jaw muscles with age and dental state. Gerodontology. 1993;10(1):16–22.
30. Sato N, Ono T, Kon H, Sakurai N, Kohno S, Yoshihara A, et al. Ten-year longitudinal study on the state of dentition and subjective masticatory ability in community-dwelling elderly people. J Prosthodont Res. 2016;60(3):177–84. https://doi.org/10.1016/j.jpor.2015.12.008.
31. Koshino H, Hirai T, Ishijima T, Ikeda Y. Tongue motor skills and masticatory performance in adult dentates, elderly dentates, and complete denture wearers. J Prosthet Dent. 1997;77(2):147–52.
32. Sarabia-Cobo CM, Perez V, de Lorena P, Dominguez E, Hermosilla C, Nunez MJ, et al. The incidence and prognostic implications of dysphagia in elderly patients institutionalized: a multicenter study in Spain. Appl Nurs Res. 2016;30:e6–9. https://doi.org/10.1016/j.apnr.2015.07.001.
33. Paciaroni M, Mazzotta G, Corea Caso V, Venti M, Milia P, et al. Dysphagia following stroke. Eur Neurol. 2004;51:162–7.
34. van der Maarel-Wierink CD, Vanobbergen JN, Bronkhorst EM, Schols JM, de Baat C. Meta-analysis of dysphagia and aspiration pneumonia in frail elders. J Dent Res. 2011;90(12):1398–404. https://doi.org/10.1177/0022034511422909.
35. Stock C, Jurges H, Shen J, Bozorgmehr K, Listl S. A comparison of tooth retention and replacement across 15 countries in the over-50s. Community Dent Oral Epidemiol. 2016;44(3):223–31. https://doi.org/10.1111/cdoe.12209.
36. Paris S, Meyer-Lueckel H, Schwendicke F. Karies–Wie wissenschaftliche Theorien zur Pathogenese das zahnärztliche Handeln beeinflussen. Quintessenz. 2018;69(10):1164–71.
37. Meyer-Lueckel H, Paris S. When and how to intervene in the caries process. Oper Dent. 2016;41(S7):S35–47. https://doi.org/10.2341/15-022-O.
38. Lussi A, Carvalho TS. Erosive tooth wear: a multifactorial condition of growing concern and increasing knowledge. Monogr Oral Sci. 2014;25:1–15. https://doi.org/10.1159/000360380.
39. Chalmers JM, Carter KD, Spencer AJ. Oral diseases and conditions in community-living older adults with and without dementia. Spec Care Dentist. 2003;23(1):7–17.
40. Ikeda M, Brown J, Holland AJ, Fukuhara R, Hodges JR. Changes in appetite, food preference, and eating habits in frontotemporal dementia and Alzheimer's disease. J Neurol Neurosurg Psychiatry. 2002;73(4):371–6.
41. Holm-Pedersen P, Agerbaek N, Theilade E. Experimental gingivitis in young and elderly individuals. J Clin Periodontol. 1975;2(1):14–24.
42. Meyer S, Giannopoulou C, Courvoisier D, Schimmel M, Müller F, Mombelli A. Experimental mucositis and experimental gingivitis in persons aged 70 or over. Clinical and biological responses. Clin Oral Implants Res. 2017;28(8):1005–12. https://doi.org/10.1111/clr.12912.
43. Al-Fouzan K. A new classification of endodontic-periodontal lesions. Int J Dent. 2014;2014:919173.
44. Schneider C, Zemp E, Zitzmann NU. Oral health improvements in Switzerland over 20 years. Eur J Oral Sci. 2017;125(1):55–62. https://doi.org/10.1111/eos.12327.

45. Feine JS, Carlsson GE, Awad MA, Chehade A, Duncan WJ, Gizani S, et al. The McGill consensus statement on overdentures. Mandibular two-implant overdentures as first choice standard of care for edentulous patients. Montreal, Quebec, May 24-25, 2002. Int J Oral Maxillofac Implants. 2002;17(4):601–2.
46. Nogueira TE, Aguiar FMO, Esfandiari S, Leles CR. Effectiveness of immediately loaded single-implant mandibular overdentures versus mandibular complete dentures: a 1-year follow-up of a randomized clinical trial. J Dent. 2018;77:43–50. https://doi.org/10.1016/j.jdent.2018.07.006.
47. Laskaris G. Pocket atlas of oral diseases. New York: Georg Thieme Verlag; 2006.
48. Zhang Y, Niu J, Kelly-Hayes M, Chaisson CE, Aliabadi P, Felson DT. Prevalence of symptomatic hand osteoarthritis and its impact on functional status among the elderly: the Framingham study. Am J Epidemiol. 2002;156(11):1021–7.
49. Müller F, Schimmel M. Revised success criteria: a vision to meet frailty and dependency in implant patients. Int J Oral Maxillofac Implants. 2016;31(1):15.
50. Petersen PE. Oral cancer prevention and control—the approach of the World Health Organization. Oral Oncol. 2009;45(4–5):454–60. https://doi.org/10.1016/j.oraloncology.2008.05.023.
51. Patton LL, Ashe TE, Elter JR, Southerland JH, Strauss RP. Adequacy of training in oral cancer prevention and screening as self-assessed by physicians, nurse practitioners, and dental health professionals. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2006;102(6):758–64. https://doi.org/10.1016/j.tripleo.2005.10.072.
52. Gil-Montoya JA, Silvestre FJ, Barrios R, Silvestre-Rangil J. Treatment of xerostomia and hyposalivation in the elderly: a systematic review. Med Oral Patol Oral Cir Bucal. 2016;21(3):e355–66. https://doi.org/10.4317/medoral.20969.
53. Jager DHJ, Bots CP, Forouzanfar T, Brand HS. Clinical oral dryness score: evaluation of a new screening method for oral dryness. Odontology. 2018;106(4):439–44. https://doi.org/10.1007/s10266-018-0339-4.
54. Thomson WM. Measuring change in dry-mouth symptoms over time using the xerostomia inventory. Gerodontology. 2007;24(1):30–5.
55. Müller F, Duvernay E, Loup A, Vazquez L, Herrmann FR, Schimmel M. Implant-supported mandibular overdentures in very old adults: a randomized controlled trial. J Dent Res. 2013;92(12 Suppl):154S–60S. https://doi.org/10.1177/0022034513509630.
56. Newton JP, McManus FC, Menhenick S. Jaw muscles in older overdenture patients. Gerodontology. 2004;21(1):37–42.
57. Schimmel M, Srinivasan M, McKenna G, Müller F. Effect of advanced age and/or systemic medical conditions on dental implant survival: a systematic review and meta-analysis. Clin Oral Implants Res. 2018;29(Suppl. 16):311–30.
58. Wallace M, Samietz S, McKenna G, Woodside JV, Schimmel M. Impact of prosthodontic rehabilitation on the masticatory performance of partially dentate older patients: can it predict nutritional state? Results from a RCT. J Dent. 2018;68:66–71.
59. Schimmel M, Ono T, Lam OL, Müller F. Oro-facial impairment in stroke patients. J Oral Rehabil. 2017;44(4):313–26. https://doi.org/10.1111/joor.12486.
60. Schimmel M, Christou P, Herrmann F, Müller F. A two-colour chewing gum test for masticatory efficiency: development of different assessment methods. J Oral Rehabil. 2007;34(9):671–8. https://doi.org/10.1111/j.1365-2842.2007.01773.x.
61. Elsig F, Schimmel M, Duvernay E, Giannelli SV, Graf CE, Carlier S, et al. Tooth loss, chewing efficiency and cognitive impairment in geriatric patients. Gerodontology. 2015;32(2):149–56. https://doi.org/10.1111/ger.12079.
62. Buser R, Ziltener V, Samietz S, Fontolliet M, Nef T, Schimmel M. Validation of a purpose-built chewing gum and smartphone application to evaluate chewing efficiency. J Oral Rehabil. 2018;45(11):845–53.
63. Schimmel M, Katsoulis J, Genton L, Müller F. Masticatory function and nutrition in old age. Swiss Dent J. 2015;125(4):449–54.
64. Schimmel M, Leemann B, Herrmann FR, Kiliaridis S, Schnider A, Müller F. Masticatory function and bite force in stroke patients. J Dent Res. 2011;90(2):230–4. https://doi.org/10.1177/0022034510383860.

The Association Between Oral and General Health

3

Gert-Jan van der Putten

Abstract

Increasing evidence reveals significant interactions between oral health and general health that are unidirectional and often bidirectional, making the challenges of poor oral health considerable. In this chapter, the associations between oral health and (aspiration) pneumonia, diabetes mellitus, cardiovascular diseases, dementia, nutrition, frailty, and other disorders in older people are discussed. A bidirectional association has been shown between periodontitis and diabetes and related guidelines have been developed, addressed to healthcare practitioners. The presence of oral biofilm may increase the risk of respiratory tract infections in frail older people. Poor oral health has been associated with cognitive decline and oral infections with cardiovascular disorders. Poor oral health may also be associated with dietary changes and malnutrition. However, a causal correlation between oral health and most of these disorders has too little scientific evidence. When assessing potential causing pathways between oral health and general health, common risk factors play an important role. More research is needed to confirm most of the previous associations. Given the fact that oral health is an integral part of general health and well-being, oral health prevention and promotion strategies should be embedded within routine medical assessment and care provision.

G.-J. van der Putten (✉)
Orpea Dagelijks Leven, Apeldoorn, The Netherlands

Department of Oral Function and Rehabilitation, Radboud University Medical Centre, Nijmegen, The Netherlands
e-mail: Gert-Jan.vanderputten@radboudumc.nl

A. Kossioni (ed.), *Gerodontology Essentials for Health Care Professionals*, Practical Issues in Geriatrics, https://doi.org/10.1007/978-3-030-41468-9_3

Learning Objectives
After reading this chapter, readers should be able to:

- Describe the association between oral and general health in older people.
- Describe the pathophysiological mechanisms that underlie the association of general with oral health.
- Recognise oral health as an important component of general health of (frail) older people.

3.1 Introduction

Good oral health is important for maintaining adequate oral function, preventing pain and discomfort, controlling localised or systemic inflammation, sustaining social interaction, and preserving quality of life. Poor oral health is common among frail older people, but remains largely underdiagnosed and undertreated. It is an important care issue in primary care practices, hospitals, residential care homes, and in-home care. The combination of poor oral health and reduced access to dental care means that non-dental healthcare providers face a major social challenge to maintain or improve the oral health of (frail) older people. This challenge becomes more urgent considering the increasing evidence of a close association between general and oral health that will be discussed in this chapter.

3.2 Association Between Oral Health and Pneumonia

The presence of plaque (organised biofilm) on dental or prosthetic surfaces and on the tongue causes infections in the mouth, but may, for instance, also increase the risk of respiratory tract infections. Obviously, dental plaque can be aspirated and might contain, in addition to the usual oral bacteria, exogenous pathogens responsible for lung infections. It has been suggested that the oral cavity is an important reservoir for these pathogens. In this context, a systematic review was published in 2013 on the impact of oral hygiene on the risk of aspiration pneumonia [1]. In this review, five publications were considered of which two showed that an improvement in oral healthcare significantly reduced the risk of aspiration pneumonia and the risk of death from aspiration pneumonia. The remaining three studies showed that adequate oral healthcare reduced the amount of potential respiratory pathogens and also reduced the risk of aspiration pneumonia by exerting a favourable influence on the sensitivity of the swallow and cough reflex. The authors of this review conclude that proper oral care, consisting of brushing the teeth after every meal, daily brushing of dental prostheses, and weekly professional oral care, are the most effective interventions to reduce the incidence of aspiration pneumonia. As respiratory infections are a major cause of death in frail older people especially in nursing home residents and individuals with dysphagia; it is therefore extremely important to keep the mouth clean. Denture wearing during the night doubles the risk of aspiration

pneumonia [2]. So, it is recommended that dentures are removed and cleaned adequately overnight. To identify which individuals are at risk for aspiration pneumonia, the revised oral assessment guide (ROAG) seems to be a sensitive and specific tool which can be used [3]. In the past, there were several oral care intervention studies conducted in long-term care facilities with the aim to improve oral health in (frail) older people [4]. To date, it is still unclear which oral care program or which interventions are the most effective and efficient in reducing (aspiration) pneumonia of older people in long-term care facilities [5].

3.3 Oral Health and Cardiovascular Disorders

Chronic periodontal disease is associated with multiple potential bacteraemia events that may allow periodontal pathogens to migrate to non-oral tissues, including atheromatous plaques. Cardiovascular disease is understood here to mean ischemic disorders of the heart and blood vessels as a result of atherosclerotic changes. Clearly clinically recognisable and acute incidents of cardiovascular disease are heart attacks, cerebrovascular accidents, peripheral vascular disease, and sudden death. The most common clinical consequence of atherosclerosis is high blood pressure. Atherosclerosis is exacerbated by smoking, diabetes, and dyslipidaemia. In addition, genetic predisposition plays an important role. In the last 20 years, various chronic infections elsewhere in the body have also been mentioned as causal factors of cardiovascular disease [6]. For example, bacteria in the bloodstream could exacerbate or even initiate atherosclerosis.

In periodontitis, there are daily short-lived bacteria, which may explain the associative link with cardiovascular disease [7–9]. In addition, systemic consequences of periodontitis have been mentioned that can contribute to atherogenesis or to acute cardiovascular incidents, such as a pro-inflammatory and procoagulant status [9].

Nevertheless, there is still no certainty about a causal correlation between periodontitis and cardiovascular disease. There are ample indications that suggest a common genetic predisposition [10, 11]. The estimates of the relative risk of developing cardiovascular disease in persons with periodontitis vary between 1.2 and 1.3 [12]. In individuals with severe periodontitis, there is an increased risk and in individuals with an age <65 years the relative risk is 1.4. When only cerebrovascular accidents are considered, the relative risk for cerebral infarction in people with periodontitis appears to be 2.8. In a prospective study of 39,863 middle-aged women, periodontal disease patients were found to have a significantly increased risk for future cardiovascular disease [13].

Epidemiological studies also show strong associations of oral infections and cardiovascular disorders although these associations differ greatly between different populations and age groups. These associations can be explained by the development of a bacterial infection (bacteria in the bloodstream) as a result of an oral infection that allows bacteria to colonise and destabilise any atherosclerotic plaques with an increased cardiovascular risk as a result.

In addition, a bacteraemia also increases the systemic inflammatory burden that is partially responsible for atherosclerosis. Several intervention studies showed an improvement of the biomarkers for cardiovascular diseases as a result of good oral care. However, a direct effect of oral care on clinical signs and symptoms of cardiovascular disease has not yet been scientifically demonstrated. Although there are strong indications for a link between oral health and cardiovascular disease, there is insufficient evidence to believe that oral infections are a direct cause for the development or worsening of cardiovascular disease. Holm-Pedersen et al. investigated the oral and general health of the oldest group of older people (over 80 years of age) [14]. They found an association between root caries and cardiac arrhythmias. They conclude from this that older people with root caries should also be examined for cardiac arrhythmias [14]. Ide et al. investigated the relationship between oral health and mortality due to cardiovascular disease. They found that people who reported having sensitive teeth were less likely to die from cardiovascular disease than people without sensitive teeth. No significant relationship was demonstrated between cardiovascular death and difficulty in chewing, bleeding gums, and stickiness of the mouth [15].

Regular dental visits (once a year or more) for professional cleaning were shown to reduce cardiovascular risk by 14% [16]. Improved oral hygiene behaviours has shown to attenuate the cardiovascular risk originating from periodontal disease, dental caries, and tooth loss. Oral hygiene care such as frequent tooth brushing and regular dental visits for professional cleaning reduce the risk of future cardiovascular events in healthy adults [16]. Healthcare professionals should therefore alert patients with heart disease to the importance of good oral health and regular monitoring [17–19]. In addition, it is important that dental professionals are part of the multidisciplinary treatment team [20, 21]. Patients with CVD requires information about the association between oral health and CVD [19]. An Australian study indicated a lack of awareness or misinformation regarding oral health and CVD in patients with CVD [22]. Even though some patients had some idea of a possible connection between poor oral health and CVD they were unaware of the relevance of this association. The question is who should give this information? In an acute hospital setting, nurses have a close relationship with cardiac patients for several days, and they require assessment by the cardiac nurse prior to discharge. In the outpatient settings, patients who attend cardiac rehabilitation work closely with the nurse(s), physiotherapist(s) or exercise physiologist(s). Therefore, it is not surprising that patients would feel comfortable with cardiac care clinicians when they give the (first) information about the importance of a good oral health as specially in patients with CVD [22]. However, also dentists, dental hygienists, cardiologists, and other physicians should repeat this information.

Most patients with cardiovascular diseases receive multiple medications in accordance with the applicable guidelines, including anticoagulants, thiazide-type diuretics, loop-diuretics, angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, direct renin inhibitors, b-blockers, calcium channel blockers, and

cholesterol-lowering drugs [19]. Many of these medications have a negative impact on oral health. The most common complaint is xerostomia due to reduced saliva secretion rates (see also Chaps. 2 and 4). If whole saliva secretion rate falls below a certain value (0.1 mL/min for unstimulated saliva), it is called hyposalivation. Saliva plays a crucial role in oral homeostasis by modulating the ecosystem within the oral cavity. A specific function of saliva is protecting the teeth from caries by buffering actions. The main buffer systems contributing to the total buffer capacity of saliva are the bicarbonate, phosphate, and protein systems. The concentration of bicarbonate in saliva is related to the saliva secretion rate and with increasing saliva secretion rate more bicarbonate is produced. Inadequate saliva buffer capacity may, besides inadequate oral hygiene care, contribute to the development of caries in older people particular root caries [23].

In order to anticipate this problem, a good recommendation is drinking water regularly and eating highly fluid-containing food. Hyposalivation due to medication may be treated by altering the dosage of the medication or by replacing the medication by an equally effective, but not or less hyposalivation-inducing medication. Also, gustatory and mechanical salivary stimulating techniques may be helpful to relieve the feelings of xerostomia, such as consuming sugar-free chewing gum, candies, and mints. Systemic medication of pilocarpine or cevimeline or application of physostigmine to the oral mucosal surface may improve saliva secretion, but the possible side effects should be determined and, if possible, anticipated or controlled. When stimulating salivary secretion is not possible or not adequate, symptomatic relief of the oral complaints becomes the primary management strategy. Saliva substitutes, lubricating oral gel and intra-oral reservoirs of saliva substitutes may be used [23, 24]. Frequent oral evaluations and oral hygiene instructions are essential to prevent (root)caries and other oral infections in hyposalivation-related medications. Daily topical fluoride use and antimicrobial mouth rinses and/or two-daily brushing teeth with 5,000 ppm fluoride toothpaste may help preventing (root)caries.

If it is necessary to extract one or more teeth and a patient uses one or more anticoagulants, a dentist may ask the physician (cardiologist, neurologist, or general physician) if an anticoagulant can be temporarily discontinued. The following recommendations apply to planning and implementing simple invasive dental procedures (extraction of 1–3 teeth or molars, surgical wisdom tooth removal, periodontal treatments, operative root canal treatments, abscess incision, sites of max. three oral implants) [25]:

1. The use of one or combinations of platelet aggregation inhibitors, such as acetylsalicylate does NOT have to be discontinued.
2. Do NOT interrupt treatment with Vitamin K antagonists (VKA) such as acenocoumarin when the INR is below 3.5.
3. Do NOT interrupt treatment with (new oral anticoagulants (NOAC) or direct thrombin inhibitors or factor Xa inhibitors, such as apixaban, dabigatran, and rivaroxaban (DOAC).

3.4 Oral Health and Diabetes Mellitus (DM)

Different types of DM are distinguished, the type being indicative of the underlying aetiology. By far the majority (±90%) of diabetes patients suffer from type 2 (DM2). With this type, the action of insulin, a crucial hormone that regulates blood sugar levels, is reduced due to insulin resistance. Due to the absence of complaints during the initial phase of DM2, it is regularly diagnosed years later. Because of this late diagnosis, vital processes are often irreparably damaged, with an increased risk of serious complications later in life. Diagnosing DM2 in the initial phase can prevent and/or reduce any serious complications in the longer term. That is why diabetes care pays a lot of attention to finding new indications that imply the presence of DM2 at an early stage. It was shown that periodontitis can be an early indication of the development of DM2 [26]. In type 1 DM, variability in the IL-1 gen cluster may be one of the factors implicated in the association with chronic periodontitis [27].

On the other hand, the presence of DM, especially with insufficient glycaemic control, increases the risk of periodontitis, tooth loss, xerostomia, and burning mouth syndrome. Periodontitis in diabetic patients can in turn complicate glycaemic control and increase the risk of cardiovascular and renal disorders. The bidirectional associations between periodontitis and diabetes have to do with the increased systemic inflammation that both disorders cause. This systemic inflammation gives rise to insulin resistance, difficult glycaemic control, and greater damage to the periodontal tissues. Too high blood sugar levels disrupt various organs, as well as vital processes involved in the maintenance of the cardiovascular system, wound healing, and the defence against infections. In the longer term, complications mainly arise in the area of CVD. Due to the increased risk of infections and poor wound healing, periodontitis is diagnosed two to three times more often in diabetic patients. That is why periodontitis has been mentioned as a complication of this disease since the 1990s.

The physician, mostly a General Practioner (GP), plays an important role in the treatment of diabetes. The purpose of the treatment is to prevent and treat complaints and complications, such as (increase in) cardiovascular diseases, chronic kidney damage, retino- and neuropathy. Because of the increased risk for developing periodontitis in patients with diabetes and the negative impact of periodontitis on diabetes control and complications, physicians should also focus on the oral cavity. The following recommendations are therefore made by the International Diabetes Federation and the European Federation of Periodontology [28]:

Oral health education should be provided to all patients with diabetes as part of their overall educational programme.

- Patients with all forms of diabetes mellitus should be told that periodontal disease risk is increased, and if untreated, the periodontitis has a negative impact on metabolic control and may also increase the risk of complications of their diabetes such as cardiovascular and kidney disease.
- Patients should be advised that successful periodontal therapy may have a positive impact upon their metabolic control and diabetes complications.

- For people with diabetes, physicians should ask about a prior diagnosis of periodontal disease. If a positive diagnosis has been made, the physician should seek to ascertain that periodontal care and maintenance are being provided.
- Investigating the presence of periodontal disease should be an integral part of a diabetes care visit. People with diabetes should be asked about any signs and symptoms of periodontitis, including bleeding gums during brushing or eating, loose teeth, spacing or spreading of the teeth, oral malodour, and/or abscesses in the gums or gingival suppuration.
  - If a positive history is elicited, then a prompt periodontal evaluation should be recommended before their scheduled annual check-up.
  - In the case of a negative history, people with diabetes should be advised to check for the above symptoms, and if a positive sign appears, they should visit their dentist.
- For all people with newly diagnosed diabetes mellitus, referral for a periodontal examination should occur as part of their ongoing management of diabetes. Even if no periodontitis is diagnosed initially, annual periodontal review is recommended.
- In patients diagnosed with diabetes, annual oral screening is recommended through referral to a dental professional.
- Patients with diabetes who have extensive tooth loss should be encouraged to pursue dental rehabilitation to restore adequate mastication for proper nutrition.
- Patients with diabetes should be advised that other oral conditions such as dry mouth and burning mouth may occur, and if so, they should seek advice from their dental practitioner. Also, patients with diabetes are at increased risk of oral fungal infections and experience poorer wound healing than those who do not have diabetes.
- The physician should liaise with the dentist over diabetes management prior to the oral intervention and/or surgery to avoid hypoglycaemia and to consider its potential impact on the patient's ability to eat.

3.5 Oral Health and Dementia

The most common cause of dementia is Alzheimer's disease. Vascular dementia comes in second place. The relative distribution of causes varies with age. "Pure" Alzheimer's disease and "pure" vascular dementia are found primarily in relatively young patients. Patients older than 75 years usually have a "mixed form". The cause of Alzheimer's disease is unclear. In less than 5%, Alzheimer's disease is caused by a hereditary disorder. The most important risk factors for dementia include age, ethnic origin, lack of exercise, smoking, medication use, education level, alcohol consumption, BMI, comorbidity (diabetes, cardiovascular disease), and environmental factors [29, 30]. Alzheimer's dementia is, according to the most commonly accepted hypothesis, caused by an excessive amount of a certain protein (beta-amyloid) that plaques form outside the brain cells. Too high such an amount can be due to too much production or reduced drainage, for example, due to hereditary

defects in the amyloid precursor protein (APP) and is especially seen in younger people with Alzheimer's disease. There is also an intracellular characteristic of the disease, namely clusters (entanglements) of the Tau protein. Intertwining of the Tau protein, a protein that plays a role in the transport of nutrients through the cell, causes brain cells to die. In post-mortem examinations, a sharply shrunk cerebral cortex (atrophy) is found, with amyloid deposits (senile plaques) located outside the nerve cell, which also occur around the blood vessels in the brain. In addition, entanglements of the Tau protein (neurofibrillary tangles) are found in the cell.

In recent years, increasingly frequent publications have appeared suggesting an association between poor oral health and cognitive decline. Various pathophysiological mechanisms form the basis for this hypothesis (Fig. 3.1) [31]. It has been suggested that a common bacterium *Porphyromonas gingivalis* is partially responsible for the development of Alzheimer's disease [32]. However, this study was conducted on mice, and it has not (yet) been demonstrated whether this association also applies to humans [32]. Kamer et al. published an article that periodontitis is associated with a higher amyloid load in the brain in healthy older people [33]. However, the amount of amyloid in the brain is not correlated with the clinical symptoms of the disease. Some individuals have relatively little amyloid in the brain with fairly serious clinical symptoms of dementia, yet other individuals with ample amyloid in the brain show few or no clinical symptoms [34]. If there are serious clinical signs of dementia present without much amyloid in the brain, other forms

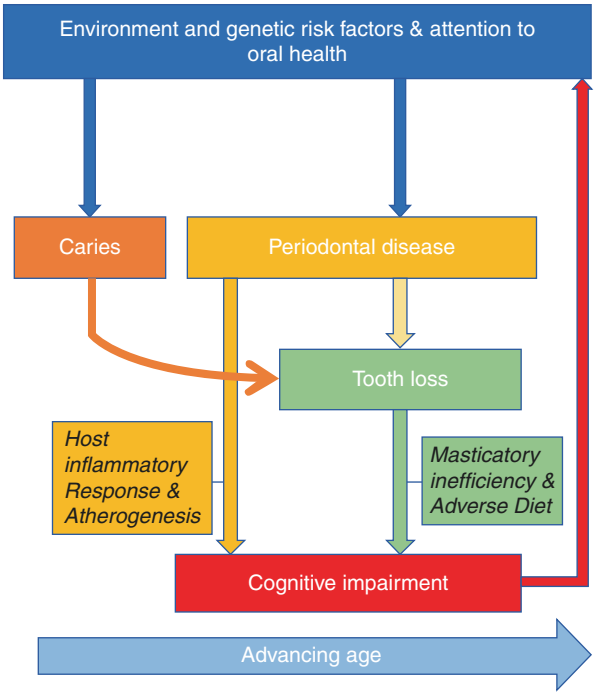

Fig. 3.1 Oral health-related factors that may be the cause of cognitive decline [31]

of dementia should also be considered. A systematic literature study published in 2016 showed that it is not yet possible to make a statement about whether there is an association between oral health and cognitive decline [35]. More research is needed to confirm such an association.

Older people with dementia has worse overall oral health than older people without dementia, including gingival bleeding, periodontal pockets, mucosal lesions, reduced salivary secretion rates, coronal caries, root caries, and retained roots [36, 37]. In contrast to these findings, the swallowing ability and chewing ability are mostly perceived as good by older people with dementia and their care givers [38]. The worse overall oral health in people with dementia can be explained due to by cognitive, medical, and functional changes. For example, agitated behaviour, characteristic for dementia, may complicate oral hygiene, resulting in increases plaque accumulation and higher risk of caries. In addition, reduced cooperation with dental treatment may constrain the possibilities for dental treatment. The risk of caries increases even further as a result of decreased submandibular saliva secretion rates in people with Alzheimer's disease and changes in food composition (e.g. more sticky, grinded, and cariogenic food), which are often seen in people with dementia. Furthermore, functional changes in dementia, like declined handgrip and motor skills, play a role in the caries risk. More specifically, the decline in motor coordination might result in more difficulty performing oral hygiene and lower chewing and swallowing efficiency [38]. That root caries is more present in older people with dementia than older people without dementia may be a result of the higher caries prevalence, fewer dental checks, resistance-to-care behaviour, altered diet, and decreased verbal communication skills. Furthermore, an article about the barriers to good oral hygiene to good oral hygiene in nursing homes pointed out that resistance-to-care behaviour is a major threshold in providing good oral care, which can be overcome be education of healthcare workers and more time to provide oral care [39]. Additionally, verbal communication about dental problems and pain can be complicated in people with dementia, because of the short-term memory loss and language disturbances, like aphasia [40]. The number of teeth and the percentage of older people with dementia wearing dentures is comparable to older people without dementia [36]. However, lower percentages of denture use are found in people with severe dementia [36]. A decrease of denture use with the progress of dementia can be explained by the lower tolerance of denture, decreased control of oral musculature, decreased quality and quantity of saliva, and/or higher risk of denture loss. Additionally, when people are edentulous for a long time, the alveolar process usually resorbs to a great extent, resulting in a decrease of denture retention, especially in the lower jaw. This increases the risk of aspiration of the lower dentures, particularly in older people with dementia, who are at increased risk of aspiration of foreign material [41]. Oral facial pain in older people is rarely studied. However, a few studies indicated that oral facial pain is frequently present in people with dementia, with prevalence rates up to 25% [42, 43]. Therefore, a regular oral examination by physicians and other healthcare providers in people with dementia is imperative, even if no pain is reported. The Oral Health Assessment Tool (OHAT), is a reliable

and valid screenings assessment tool what can be used, including those with dementia [44]. The OHAT has been translated and validated in multiple languages.

3.6 Oral Health and Nutrition

The oral cavity is the first part of the digestive tract, responsible for biting the food, chewing, adding saliva for bolus formation, and transporting it into the stomach. Nutrition and oral health are inseparably associated to each other. Poor nutritional status can impair oral health while poor oral health can influence the individual's dietary intake resulting in malnutrition [45]. A detailed discussion on oral health and nutrition in older adults is provided in Chap. 5.

Partial or complete teeth loss has been associated with poor dietary intake and linked to coronary heart disease and chronic kidney disease [46]. Individuals with teeth loss experience chewing difficulty due to reduced masticatory abilities which can affect food choice and nutritional status. Such individuals often experience difficulty in eating harder foods like fruits, raw vegetables, and meat and may prefer cooked foods with softer textures which they can chew without any discomfort [47, 48]. There is also the possibility that edentulous people ingest foods with soft texture, but calorie-rich and high-fat contents. Ritchie et al. reported higher consumption of refined carbohydrates, sugar, and dietary cholesterol in denture wearing individuals than dentate peoples. Individuals with these dietary foods are more prone for variety of systemic diseases [49]. In nursing-home residents, poor oral health, mostly problems with eating due to (artificial) teeth problems, was associated with an almost twofold risk for malnutrition [50]. Other oral symptoms which can also alter dietary intake and leading to malnutrition include hyposalivation, dysphagia, oral pain, periodontitis, mucosal lesions, or (ill-fitting) dentures [46, 51]. Although most studies agree that there is some evidence of an association between oral health and malnutrition in nursing home residents, this strength is weaker than in community-dwelling adults, but causality is very difficult to identify due to various confounders. Moreover, various methodological issues were raised, such as cross-sectional design, multiple definitions of malnutrition, and lack of multivariate analyses [51]. Oral health can play a crucial role in maintaining adequate nutrition. There is an increasing evidence that dental treatment when offered with tailored nutritional advice may improve the nutritional status of older people [51]. Multidisciplinary teams of physicians, dental professionals, nurses, and dieticians working together can help assure that older people maintain or achieve adequate oral health status and nutrition.

All patients with systemic diseases should receive advices how to achieve a healthy lifestyle, such as to assess more physical exercises, limiting tobacco and alcohol use, and healthy dietary habits [52]. It is important to limit carbohydrates, sweetened liquids, sticky foods, slowly dissolving candies, refined and processed foods, between-meal cariogenic snacks, acidic foods, and drinks including carbonated beverages, as they may cause caries and tooth erosion. Very hot food and drinks should also be avoided as they are potentially involved in oral cancer promotion.

After consuming acidic foods, the mouth should be rinsed with plenty of water to avoid tooth erosion. Encouraging older patients to eat more of fresh fruit and vegetables, cheese, and milk may help to keep oral tissues healthy [52].

Older people with dentures often face chewing difficulties. Therefore, patients and caregivers should be advised on appropriate food selection and preparation, including cutting it into small portions, chopping, mashing, or moistening before chewing. Medications containing sugar should be either replaced with sugar-free alternatives or given at mealtimes [52].

3.7 Oral Health and Other Disorders

There are additional conditions (e.g. rheumatoid arthritis, chronic kidney disease, osteoporosis, and certain forms of cancer) which suggest a link with oral health but for which the scientific evidence is too limited to confirm this [53–60]. The link between oral and systemic inflammatory processes is generally related to tissue response to a—mostly microbial—challenge and to inflammation. The course of this process is determined by the balance between mediators and sensors that amplify the inflammatory process and those that dampen the inflammatory process. Therefore, treating oral infections—either by checking the biofilm present or by checking the local inflammation—is recommended to mitigate the systemic inflammation associated with chronic systemic conditions.

Falls are major problem for a growing number of older people. The incidence of falls increases strongly with age. Thirty percent of community-dwelling persons age 65 or more have at least one fall a year, and about 15% have two or more falls a year. The fall rate is even higher for frail older people residing in long-term care facilities: 30–70% fall at least once a year and 15–40% fall two or more times a year [61]. Falls may have serious consequences, such as fractures, or other major injuries which may lead to hospital admission or even death. Fall-related injuries are the third leading cause of years lived with disability according to the WHO. A large Japanese study suggests that tooth loss is slightly associated with an increased risk of hip-fracture, and the number of teeth lost might be informative in predicting this risk [62]. Brand et al. investigated the effects of tooth loss on gait stability in a healthy older population. Dentated and fixed restored participants had a significantly higher gait velocity compared with denture wearers under both normal walking and dual-task performance conditions. In each test condition, among edentulous participants, gait velocity did not significantly differ according to whether the participant wore their dentures. The authors suggested that tooth loss in healthy seniors was associated with lower gait velocity and therefore may have a negative impact on gait stability [63]. Yoshida et al. reported better body balance in dentate compared with edentulous participants while standing on one foot with open and closed eyes [64]. They further reported that wearing or not wearing dentures does not influence body balance in edentulous healthy older people. It was hypothesised that the proprioceptive sensation of the periodontal ligament plays an important role in body balance control. The absence of periodontal ligament and thus a lack of important

proprioceptive feedback in an edentulous individual would not be reversed when the participant wore dentures. However, there is currently no evidence for a causal correlation between impaired oral proprioception due to loss of the periodontal ligament caused by tooth loss and gait instability of older people. However, different studies have demonstrated that the trigeminal sensorial afferent nerves and dental occlusion play roles in balance control [65]. Also, on this topic more research is needed to confirm this.

3.8 Oral Health and Frailty

Frailty is one of the risks associated with ageing that might threaten the need and wish of older people to live at home for as long as possible. Frailty has shown a rapid increase in the number of publications in the last years. Nonetheless, consensus about the definition of frailty is still lacking. In general, two approaches can be distinguished. In the first approach, frailty is conceptualised as a unidimensional approach including merely physical aspects of functioning. For example, the widely acknowledged frailty phenotype, as defined by Fried et al., examines unintentional weight loss, self-reported exhaustion, physical activity, grip strength, and walking speed [66]. In the second approach, frailty is operationalised as a multidimensional construct that takes other domains of functioning into account as well. A well-known example of an instrument measure multidimensional frailty is the frailty index, as developed by Rockwood and colleagues [67]. They theorise frailty as an accumulation of deficits and take a non-fixed set of clinical deficits into account, including, among others, physical status, memory, and mood. In accordance with the different definitions, prevalence rates on frailty vary between 4 and 60% with higher prevalence rates for the multidimensional approaches compared to the unidimensional approaches [68]. Nonetheless, both approaches have some common features. First, frailty is associated with an increased risk of adverse outcomes such as disability in activities of daily living, hospitalisation, early institutionalisation, and death. Second, frailty is associated with a loss of reserve capacities or resources, for example, in physiological systems, mobility or psychological functioning. Third, frailty is a dynamic state, and it is potentially reversible of modifiable by interventions. Fourth, the risk of frailty increases with increasing age although there are numerous other risks factors as well.

Given the high prevalence of multidimensional frailty, the increased risk of adverse outcomes and the potential for treatment interventions, early detection is important. It is hypothesised that the first signs of frailty can be noticed in the mouth. Studies determining the association between oral health and frailty are slightly increasing but they are still scarce. In 2019, a systematic review was published on the associations between oral health and frailty [69]. All the five included longitudinal studies used the Fried's frailty phenotype and showed a significant association between number of teeth, oral functions, accumulation of oral health problems, and number of dry mouth symptoms with frailty incidence. The association between periodontal disease and frailty incidence was inconsistent [69]. A

cross-sectional conducted study showed an association between self-reported oral pain, perceived chewing impairment, and components of the Fried's frailty phenotype in older people [70]. While lack of endurance was associated with both types of oral problems, weight loss and low handgrip strength were associated with oral pain. Whereas low physical activity and low gait speed were associated with chewing problems [70]. Another study showed that older people with a need for dental prostheses were significantly more likely to be prefrail and frail. Older people with 20 or more teeth had a lower chance of being frail compared to edentulous individuals [71]. Oral health might be one of the predictors and markers of frailty. However, further research is needed to explore whether oral health indicators could be used among the assessment tools of frailty. In addition, the role of oral health as a modifiable risk factor for frailty should be investigated to include oral health promotion in interventions aiming at prevention of frailty.

3.9 Conclusion

Poor oral health has been associated with general medical conditions like diabetes, aspiration pneumonia, cognitive decline, and cardiovascular diseases. However, for many of these associations there is too little scientific evidence for a causal link. An explanation is that most of the studies have a cross-sectional design and have too many confounding factors. Common risk factors for dental and chronic systemic conditions include smoking, age, sex, and BMI/overweight. A study by Sheiham and Watt also included diet, hygiene, alcohol use, stress, and trauma [72]. Future research should be directed towards studies with long-term follow-up and better control of confounders, and clinical trials that test underlining mechanisms of the associations between oral health and general health. Given the fact that oral health is an integral part of general health and well-being, and that major chronic systemic and oral diseases share common risk factors, oral health prevention, and promotion should be embedded within routine medical assessment and care provision. Early diagnosis of oral pathology and oro-functional impairment must be undertaken by a physician, who should refer appropriately selected patients to a dentist for a detailed oral examination.

References

1. van der Maarel-Wierink CD, Vanobbergen JN, Bronkhorst EM, Schols JM, de Baat C. Risk factors for aspiration pneumonia in frail older people: a systematic literature review. J Am Med Dir Assoc. 2011;12(5):344–54.
2. Iinuma T, Arai Y, Abe Y, Takayama M, Fukumoto M, Fukui Y, et al. Denture wearing during sleep doubles the risk of pneumonia in the very elderly. J Dent Res. 2015;94(3 Suppl):28S–36S.
3. Noguchi S, Yatera K, Kato T, Chojin Y, Furuta N, Akata K, et al. Using oral health assessment to predict aspiration pneumonia in older adults. Gerodontology. 2018;35(2):110–6.
4. Weening-Verbree L, Huisman-de Waal G, van Dusseldorp L, van Achterberg T, Schoonhoven L. Oral health care in older people in long term care facilities: a systematic review of implementation strategies. Int J Nurs Stud. 2013;50(4):569–82.

5. van der Maarel-Wierink CD, Vanobbergen JN, Bronkhorst EM, Schols JM, de Baat C. Oral health care and aspiration pneumonia in frail older people: a systematic literature review. Gerodontology. 2013;30(1):3–9.
6. Libby P, Ridker PM, Hansson GK, Leducq Transatlantic Network on Atherothrombosis. Inflammation in atherosclerosis: from pathophysiology to practice. J Am Coll Cardiol. 2009;54(23):2129–38.
7. Tonetti MS, Van Dyke TE, Working Group 1 of the Joint EFP/AAP Workshop. Periodontitis and atherosclerotic cardiovascular disease: consensus report of the joint EFP/AAP workshop on periodontitis and systemic diseases. J Periodontol. 2013;84(4 Suppl):S24–9.
8. Reyes L, Herrera D, Kozarov E, Rolda S, Progulske-Fox A. Periodontal bacterial invasion and infection: contribution to atherosclerotic pathology. J Periodontol. 2013;84(4 Suppl):S30–50.
9. Schenkein HA, Loos BG. Inflammatory mechanisms linking periodontal diseases to cardiovascular diseases. J Periodontol. 2013;84(4 Suppl):S51–69.
10. Khumaedi AI, Purnamasari D, Wijaya IP, Soeroso Y. The relationship of diabetes, periodontitis and cardiovascular disease. Diabetes Metab Syndr. 2019;13(2):1675–8.
11. Yagnik K, Mahendra J, Kurian VM. The periodontal-cardiovascular alliance: evaluation of miRNA-146a in subgingival plaque samples of chronic periodontitis patients with and without coronary heart disease. J Investig Clin Dent. 2019;10:e12442.
12. Dietrich T, Sharma P, Walter C, Weston P, Beck J. The epidemiological evidence behind the association between periodontitis and incident atherosclerotic cardiovascular disease. J Periodontol. 2013;84(4 Suppl):S70–84.
13. Yu YH, Chasman DI, Buring JE, Rose L, Ridker PM. Cardiovascular risks associated with incident and prevalent periodontal disease. J Clin Periodontol. 2015;42(1):21–8.
14. Holm-Pedersen P, Avlund K, Morse DE, Stoltze K, Katz RV, Viitanen M, et al. Dental caries, periodontal disease, and cardiac arrhythmias in community-dwelling older persons aged 80 and older: is there a link? J Am Geriatr Soc. 2005;53(3):430–7.
15. Ide R, Mizoue T, Fujino Y, Kubo T, Pham TM, Shirane K, et al. Oral symptoms predict mortality: a prospective study in Japan. J Dent Res. 2008;87(5):485–9.
16. Park SY, Kim SH, Kang SH, Yoon CH, Lee HJ, Yun PY, et al. Improved oral hygiene care attenuates the cardiovascular risk of oral health disease: a population-based study from Korea. Eur Heart J. 2019;40(14):1138–45.
17. Meurman JH, Janket SJ, Qvarnstrom M, Nuutinen P. Dental infections and serum inflammatory markers in patients with and without severe heart disease. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2003;96(6):695–700.
18. Okoro CA, Balluz LS, Eke PI, Ajani UA, Strine TW, Town M, et al. Tooth loss and heart disease: findings from the behavioral risk factor surveillance system. Am J Prev Med. 2005;29(5 Suppl 1):50–6.
19. Friedewald VE, Kornman KS, Beck JD, Genco R, Goldfine A, Libby P, et al. The American Journal of Cardiology and Journal of Periodontology editors' consensus: periodontitis and atherosclerotic cardiovascular disease. Am J Cardiol. 2009;104(1):59–68.
20. Lessard E, Glick M, Ahmed S, Saric M. The patient with a heart murmur: evaluation, assessment and dental considerations. J Am Dent Assoc. 2005;136(3):347–56; quiz 80-1.
21. Findler M, Findler M, Rudis E. Dental treatment of a patient with an implanted left ventricular assist device: expanding the frontiers. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2011;111(5):e1–4.
22. Sanchez P, Everett B, Salamonson Y, Ajwani S, Bhole S, Bishop J, et al. Oral health and cardiovascular care: perceptions of people with cardiovascular disease. PLoS One. 2017;12(7):e0181189.
23. van der Putten GJ, Brand HS, De Visschere LM, Schols JM, de Baat C. Saliva secretion rate and acidity in a group of physically disabled older care home residents. Odontology. 2013;101(1):108–15.
24. van der Putten GJ, Brand HS, Schols JM, de Baat C. The diagnostic suitability of a xerostomia questionnaire and the association between xerostomia, hyposalivation and medication use in a group of nursing home residents. Clin Oral Investig. 2011;15(2):185–92.

25. van Diermen DE, van der Waal I, Hoogstraten J. Management recommendations for invasive dental treatment in patients using oral antithrombotic medication, including novel oral anticoagulants. Oral Surg Oral Med Oral Pathol Oral Radiol. 2013;116(6):709–16.
26. Teeuw WJ, Kosho MX, Poland DC, Gerdes VE, Loos BG. Periodontitis as a possible early sign of diabetes mellitus. BMJ Open Diabetes Res Care. 2017;5(1):e000326.
27. Sabbah W, Folayan MO, El Tantawi M. The link between oral and general health. Int J Dent. 2019;2019:7862923.
28. Sanz M, Ceriello A, Buysschaert M, Chapple I, Demmer RT, Graziani F, et al. Scientific evidence on the links between periodontal diseases and diabetes: consensus report and guidelines of the joint workshop on periodontal diseases and diabetes by the International Diabetes Federation and the European Federation of Periodontology. J Clin Periodontol. 2018;45(2):138–49.
29. Chen JH, Lin KP, Chen YC. Risk factors for dementia. J Formos Med Assoc. 2009;108(10):754–64.
30. Chen LW. Age, neuropathology, and dementia. N Engl J Med. 2009;361(11):1118.
31. Noble JM, Scarmeas N, Papapanou PN. Poor oral health as a chronic, potentially modifiable dementia risk factor: review of the literature. Curr Neurol Neurosci Rep. 2013;13(10):384.
32. Dominy SS, Lynch C, Ermini F, Benedyk M, Marczyk A, Konradi A, et al. Porphyromonas gingivalis in Alzheimer's disease brains: evidence for disease causation and treatment with small-molecule inhibitors. Sci Adv. 2019;5(1):eaau3333.
33. Kamer AR, Pirraglia E, Tsui W, Rusinek H, Vallabhajosula S, Mosconi L, et al. Periodontal disease associates with higher brain amyloid load in normal elderly. Neurobiol Aging. 2015;36(2):627–33.
34. Visser PJ, Tijms B. Brain amyloid pathology and cognitive function: Alzheimer disease without dementia? JAMA. 2017;317(22):2285–7.
35. Wu B, Fillenbaum GG, Plassman BL, Guo L. Association between oral health and cognitive status: a systematic review. J Am Geriatr Soc. 2016;64(8):1752.
36. Delwel S, Binnekade TT, Perez RS, Hertogh CM, Scherder EJ, Lobbezoo F. Oral health and orofacial pain in older people with dementia: a systematic review with focus on dental hard tissues. Clin Oral Investig. 2017;21(1):17–32.
37. Delwel S, Binnekade TT, Perez R, Hertogh C, Scherder EJA, Lobbezoo F. Oral hygiene and oral health in older people with dementia: a comprehensive review with focus on oral soft tissues. Clin Oral Investig. 2018;22(1):93–108.
38. Delwel S, Scherder EJA, Perez R, Hertogh C, Maier AB, Lobbezoo F. Oral function of older people with mild cognitive impairment or dementia. J Oral Rehabil. 2018;45(12):990–7.
39. Willumsen T, Karlsen L, Naess R, Bjorntvedt S. Are the barriers to good oral hygiene in nursing homes within the nurses or the patients? Gerodontology. 2012;29(2):e748–55.
40. Hsu KT, Shuman SK, Hamamoto DT, Hodges JS, Feldt KS. The application of facial expressions to the assessment of orofacial pain in cognitively impaired older adults. J Am Dent Assoc. 2007;138(7):963–9; quiz 1021–2.
41. Langlois NE, Byard RW. Dentures in dementia: a two-edged sword. Forensic Sci Med Pathol. 2015;11(4):606–8.
42. Delwel S, Scherder EJA, de Baat C, Binnekade TT, van der Wouden JC, Hertogh C, et al. Orofacial pain and its potential oral causes in older people with mild cognitive impairment or dementia. J Oral Rehabil. 2019;46(1):23–32.
43. Delwel S, Perez R, Maier AB, Hertogh C, de Vet HCW, Lobbezoo F, et al. Psychometric evaluation of the orofacial pain scale for non-verbal individuals as a screening tool for orofacial pain in people with dementia. Gerodontology. 2018.
44. Chalmers JM, King PL, Spencer AJ, Wright FA, Carter KD. The oral health assessment tool—validity and reliability. Aust Dent J. 2005;50(3):191–9.
45. Kossioni AE, Hajto-Bryk J, Maggi S, McKenna G, Petrovic M, Roller-Wirnsberger RE, et al. An expert opinion from the European College of Gerodontology and the European Geriatric Medicine Society: European policy recommendations on oral health in older adults. J Am Geriatr Soc. 2018;66(3):609–13.

46. Gondivkar SM, Gadbail AR, Gondivkar RS, Sarode SC, Sarode GS, Patil S, et al. Nutrition and oral health. Dis Mon. 2019;65(6):147–54.
47. Sahyoun NR, Lin CL, Krall E. Nutritional status of the older adult is associated with dentition status. J Am Diet Assoc. 2003;103(1):61–6.
48. Nowjack-Raymer RE, Sheiham A. Numbers of natural teeth, diet, and nutritional status in US adults. J Dent Res. 2007;86(12):1171–5.
49. Ritchie CS, Joshipura K, Hung HC, Douglass CW. Nutrition as a mediator in the relation between oral and systemic disease: associations between specific measures of adult oral health and nutrition outcomes. Crit Rev Oral Biol Med. 2002;13(3):291–300.
50. Huppertz VAL, van der Putten GJ, Halfens RJG, Schols J, de Groot L. Association between malnutrition and oral health in Dutch nursing home residents: results of the LPZ study. J Am Med Dir Assoc. 2017;18(11):948–54.
51. Kossioni AE. The association of poor oral health parameters with malnutrition in older adults: a review considering the potential implications for cognitive impairment. Nutrients. 2018;10(11).
52. Kossioni AE, Hajto-Bryk J, Janssens B, Maggi S, Marchini L, McKenna G, et al. Practical guidelines for physicians in promoting oral health in frail older adults. J Am Med Dir Assoc. 2018;19(12):1039–46.
53. Correa MG, Sacchetti SB, Ribeiro FV, Pimentel SP, Casarin RC, Cirano FR, et al. Periodontitis increases rheumatic factor serum levels and citrullinated proteins in gingival tissues and alter cytokine balance in arthritic rats. PLoS One. 2017;12(3):e0174442.
54. Rabbo MA, Mitov G, Gebhart F, Pospiech P. Dental care and treatment needs of elderly in nursing homes in Saarland: perceptions of the homes managers. Gerodontology. 2012;29(2):e57–62.
55. Ruokonen H, Nylund K, Meurman JH, Heikkinen AM, Furuholm J, Sorsa T, et al. Oral symptoms and oral health-related quality of life in patients with chronic kidney disease from predialysis to posttransplantation. Clin Oral Investig. 2019;23(5):2207–13.
56. Krane V, Wanner C. Should we aim for oral health to improve outcomes in chronic kidney disease? Nephrol Dial Transplant. 2016;31(10):1551–4.
57. Akar H, Akar GC, Carrero JJ, Stenvinkel P, Lindholm B. Systemic consequences of poor oral health in chronic kidney disease patients. Clin J Am Soc Nephrol. 2011;6(1):218–26.
58. Corbella S, Veronesi P, Galimberti V, Weinstein R, Del Fabbro M, Francetti L. Is periodontitis a risk indicator for cancer? A meta-analysis. PLoS One. 2018;13(4):e0195683.
59. Heikkila P, But A, Sorsa T, Haukka J. Periodontitis and cancer mortality: register-based cohort study of 68,273 adults in 10-year follow-up. Int J Cancer. 2018;142(11):2244–53.
60. Choi JK, Kim YT, Kweon HI, Park EC, Choi SH, Lee JH. Effect of periodontitis on the development of osteoporosis: results from a nationwide population-based cohort study (2003-2013). BMC Womens Health. 2017;17(1):77.
61. Neyens JC, van Haastregt JC, Dijcks BP, Martens M, van den Heuvel WJ, de Witte LP, et al. Effectiveness and implementation aspects of interventions for preventing falls in elderly people in long-term care facilities: a systematic review of RCTs. J Am Med Dir Assoc. 2011;12(6):410–25.
62. Wakai K, Naito M, Naito T, Kojima M, Nakagaki H, Umemura O, et al. Tooth loss and risk of hip fracture: a prospective study of male Japanese dentists. Community Dent Oral Epidemiol. 2013;41(1):48–54.
63. Brand C, Bridenbaugh SA, Perkovac M, Glenz F, Besimo CE, Sendi P, et al. The effect of tooth loss on gait stability of community-dwelling older adults. Gerodontology. 2015;32(4):296–301.
64. Yoshida M, Kikutani T, Okada G, Kawamura T, Kimura M, Akagawa Y. The effect of tooth loss on body balance control among community-dwelling elderly persons. Int J Prosthodont. 2009;22(2):136–9.
65. Gangloff P, Perrin PP. Unilateral trigeminal anaesthesia modifies postural control in human subjects. Neurosci Lett. 2002;330(2):179–82.
66. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci. 2001;56(3):M146–56.

67. Rockwood K, Mitnitski A. Frailty in relation to the accumulation of deficits. J Gerontol A Biol Sci Med Sci. 2007;62(7):722–7.
68. Collard RM, Boter H, Schoevers RA, Oude Voshaar RC. Prevalence of frailty in community-dwelling older persons: a systematic review. J Am Geriatr Soc. 2012;60(8):1487–92.
69. Hakeem FF, Bernabe E, Sabbah W. Association between oral health and frailty: a systematic review of longitudinal studies. Gerodontology. 2019;36:205.
70. Kamdem B, Seematter-Bagnoud L, Botrugno F, Santos-Eggimann B. Relationship between oral health and Fried's frailty criteria in community-dwelling older persons. BMC Geriatr. 2017;17(1):174.
71. de Andrade FB, Lebrao ML, Santos JL, Duarte YA. Relationship between oral health and frailty in community-dwelling elderly individuals in Brazil. J Am Geriatr Soc. 2013;61(5):809–14.
72. Sheiham A, Watt RG. The common risk factor approach: a rational basis for promoting oral health. Community Dent Oral Epidemiol. 2000;28(6):399–406.

Medications and Oral Health: Points to Consider in Older People

4

Mirko Petrovic and Barbara Janssens

Abstract

This chapter describes the increase of chronic illness, multimorbidity, care dependency, and related polypharmacy as a consequence of ageing. Moreover, a focus has been put on drug-related oral health problems since clear associations have been found between the medication intake and the oral status of older people. Prescribing physicians must be aware of the potential oral complications caused by medications in order to be able to develop an appropriate and tailored treatment plan that also considers oral health-related complications. Approaches to identify potential drug-related problems and to optimize medication use comprise medication reconciliation followed by medication review and criteria to assess quality of prescribing, preferably incorporated in computer-based prescribing systems and as a part of comprehensive geriatric assessment (CGA) and management.

Taking into consideration the differences in life expectancy, and in order to provide an integrated plan for treatment, rehabilitation, support and long-term care, CGA and assessment of multimorbidity are assumed to distinguish between three groups of older patients, i.e. fit, vulnerable, and frail.

M. Petrovic (✉)
Department of Internal Medicine and Paediatrics, Section of Geriatrics, Faculty of Medicine and Health Sciences, Ghent University, Ghent, Belgium
e-mail: mirko.petrovic@ugent.be

B. Janssens
Department of Oral Health Sciences, Special Needs in Oral Health, Gerodontology, Faculty of Medicine and Health Sciences, Ghent University, Ghent, Belgium
e-mail: barbarae.janssens@ugent.be

A. Kossioni (ed.), *Gerodontology Essentials for Health Care Professionals*, Practical Issues in Geriatrics, https://doi.org/10.1007/978-3-030-41468-9_4

Learning Objectives
After reading this chapter, readers should be able to:

- Be aware of the potential oral complications caused by medications.
- Assess pharmacotherapy in older patients.
- Derive the optimal solutions for the detected problems.
- Tailor pharmacotherapy for the individual older patients.

4.1 Polypharmacy and Medication-Related Problems in Older People

The global population is ageing and an important consequence of this demographic change is the increase of chronic illness, multimorbidity, care dependency, and related polypharmacy. It has been reported in the literature that the mean number of medications taken among older patients is up to six prescribed medications combined with up to three non-prescribed medications [1].

Polypharmacy often leads to potentially inappropriate prescribing and drug-related problems (DRPs). Various factors can explain the high incidence of DRPs among older people in comparison with their younger counterparts [2–8].

First, older people often suffer from multiple chronic diseases and are therefore treated with many medications. It has been demonstrated that polypharmacy positively correlates with an increased risk for both drug–drug interactions (DDIs) and drug–disease interactions (DDisI) [9]. For example, patients taking two medications have a 13% risk of adverse drug–drug interactions, which rises to 38% for four medications, and even to 82% if seven or more medications are taken at the same time [10]. In addition, polypharmacy can increase the risk for medication non-adherence, which on its turn can result in suboptimal therapeutic effectiveness and poor clinical response. Unrecognized non-adherence can cause a dose increase of the initial medication or the addition of a second medication, thereby increasing the risk for an adverse drug reaction (ADR) [11]. However, when addressing polypharmacy, we should take into consideration that several chronic conditions often require more than one medication in order to be adequately treated (i.e. ‘rational polypharmacy’ resulting from treatment via different mechanisms).

Second, age-related changes in pharmacokinetics and pharmacodynamics predispose older people, and particularly those with frailty, to DRPs [12].

As to pharmacokinetic changes, age-related alterations in renal structure may cause altered medication excretion. Consequently, the dosage of a medication eliminated through the kidneys should be adjusted for decreased renal function [13].

In addition, the possibility of reduced hepatic metabolism in older age should be anticipated as well. Moreover, medications that normally show significant, hepatic, first-pass metabolism may instead have a higher bioavailability and faster onset, which will require initiation at lower doses with possible

extended administration intervals. Cytochrome P450 oxidation declines as well, increasing the risk for toxicity and possible drug–drug interactions for medications that are substrates of these enzymes [14, 15]. A rapid decline in serum albumin during acute illness may additionally lead to altered free-drug kinetics.

Cardiac output is another system function that can decline substantially with age, the main consequences being lowered blood flow to the kidneys and liver. For high extraction medications, this could change the overall elimination of the drug because the elimination of such compounds depends upon blood flow. In addition, the decreased clearance of such compounds will cause an increase in half-life as a consequence of decreased blood flow [16].

In older people, lean body mass and total body water decrease, with a relative increase in total body fat. These alterations lead to a decreased volume of distribution for hydrophilic medications. The opposite situation occurs with lipid-soluble medications, which exhibit an increased volume of distribution that can cause a changed elimination half-life although not necessarily an altered rate of clearance [17].

Pharmacodynamic changes in the end-organ reaction to medications at receptor or post-receptor levels result in changed, usually increased, sensitivity to several classes of medications, such as anticoagulants, cardiovascular and psychotropic medications. Furthermore, decreased homeostatic mechanisms make older people more vulnerable to adverse effects (e.g. orthostatic hypotension is more likely to happen at a 'normal dose' of a vasodilator medication in an older person, based on slow baroreceptor response) [18].

The role of age as a cause of increased risk of ADRs should be rather seen in the context of accumulated, patient-specific physiological and functional alterations, which are probably more important than chronological age as such in predicting ADRs [19]. In addition, living alone, receiving medications from different prescribers, and having cognitive problems and/or poor knowledge of the medications prescribed have all been suggested to contribute to a higher risk of non-adherence and consecutive ADRs [20].

The use of potentially inappropriate medications in older people has also been described as one of the causes of ADRs [21]. Inappropriate prescribing, a potentially preventable risk factor for ADRs, happens frequently and deserves currently more attention than in the past because of the outburst in the number of medications available, less overall knowledge in their use by providers, and most importantly, less time for consideration in regard to the patient.

In the following paragraphs, a particular focus is put on drug-related oral health problems since clear associations have been found between the medication intake and the oral status of older people ([22]; Table 4.1). DRPs in the oral cavity are frequent and might show various clinical presentations. Prescribing physicians must be aware of the potential oral cavity complications caused by medications in order to be able to develop an appropriate and tailored treatment plan that also considers the oral health impact of the prescribed medications.

Table 4.1 Common medication-related oral health problems and potential culprit medications

Oral health problem	Potential culprit medications
Dry mouth	Psycho-analeptics, benzodiazepine-related agents, cardiac agents (e.g. beta-blockers, calcium channel blockers, ACE inhibitors, and angiotensin II receptor blockers), thiazide diuretics, statins, respiratory agents, glucocorticoids, antithrombotics, laxatives containing magnesium compounds, proton pump inhibitors, insulin and oral anti-diabetics, urologic medication
Mucosal lesions	Non-steroidal anti-inflammatory drugs (e.g. ibuprofen, piroxicam, naproxen), antibacterials (e.g. clindamycin, trimethoprim-sulfamethoxazole), antiepileptics (e.g. carbamazepine, phenytoin, anti-diabetics (e.g. chlorpropamide), diuretics (e.g. furosemide), antihypertensives (e.g. angiotensin receptor blockers—losartan, candesartan, irbesartan, angiotensin-converting enzyme inhibitors—captopril, beta-blockers—labetalol, calcium channel blockers—nifedipine, verapamil, diltiazem), chemotherapy agents (5-flourouracil, cisplatin, methotrexate, hydroxyurea)
Oral lichen planus	NSAIDs, antihypertensives (beta-blockers, angiotensin-converting enzyme inhibitors, diuretics, and calcium channel blockers), antiarrhythmics (quinidine), anti-diabetics (e.g. tolbutamide, glipizide), antiepileptics, (carbamazepine), sulfasalazine, allopurinol, gold salts, penicillamine, biologic agents (e.g. obinutuzumab, infliximab, adalimumab, etanercept, abatacept)
Taste alteration	Beta-blockers (e.g. atenolol, metoprolol); calcium channel blockers (e.g. diltiazem); carbonic anhydrase inhibitor (acetazolamide); nicotine patches; NSAIDs (e.g. phenylbutazone); anti-infectives (e.g. metronidazole, chlorhexidine); muscle relaxants (e.g. baclofen)
Angioedema	angiotensin-converting enzyme inhibitors—captopril, lisinopril, enalapril; angiotensin receptor blockers—losartan, telmisartan, candesartan, valsartan; renin inhibitor—aliskiren; beta-blockers—metoprolol, propranolol; calcium channel blockers—amlodipine, nicardipine; diuretics—hydrochlorothiazide; statins—simvastatin, atorvastatin, rosuvastatin; non-steroidal anti-inflammatory drugs
Gingival enlargement	Phenytoin and various calcium channel blockers including nifedipine, amlodipine, felodipine, nicardipine, nitrendipine, isradipine, verapamil, and diltiazem
Altered haemostasis	Anticoagulants; antiplatelets; concomitant use of NSAIDs, SSRIs, and herbal supplements (e.g. ginkgo biloba, garlic)
Altered alveolar bone	Corticosteroids; enzyme-inducing antiepileptic medications (i.e. phenytoin, carbamazepine, primidone)
Medication-related osteonecrosis of the jaw	Bisphosphonates; denosumab; concomitant chemotherapy and corticosteroids

4.2 Medication-Related Oral Health Problems

Medication-related oral health problems are among important potential side-effects of polypharmacy in older people, in particular medications with anticholinergic properties.

4.2.1 Dry Mouth

Saliva is extremely important for the health of oral tissues and oral function (see details in Chap. 2). The lubricating and anti-microbial properties are contributing to maintaining the oral mucosal and gingival health [23]. A decreased salivary flow contributes to the increased ionic concentration of saliva, insufficient amount of fluid necessary to cover the oral cavity and decreased capacity of salivary pellicle restoration. In addition, reduced salivary mucins and calcium might contribute to a decreased hydrophilicity of the oral cavity which consequently might lead to xerostomia, related oral symptoms and potential abnormalities in sensorial or textual awareness [24].

Dry mouth may occur mainly due systemic disease, radiotherapy in head and neck, and medication intake. The main symptom is xerostomia, the subjective feeling of a dry mouth. Oral dryness can be assessed by Clinical Oral Dryness Score (CODS) which consists of a 10-point scale, each point representing a feature of dryness in the mouth. An additive score 1–3 represents mild, 4–6 moderate, and 7–10 severe oral dryness [25].

The ageing process is associated with reduced number of acinar cells (responsible for secretion of the primary saliva fluid) which are replaced by fibrous and fatty tissue, but the composition remains the same in non-medicated older people. A recent meta-analysis of 47 studies concluded that unstimulated and stimulated whole and submandibular and sublingual (SMSL) salivary flow rates appear to be lower in older people compared to their younger counterparts. On the other hand, parotid gland who is responsible for the largest volume of saliva when eating, and minor gland salivary flow rates do not differ significantly between older and younger adults. Accordingly, the age-related decrease in SMSL and unstimulated total salivary flow rates does not seem to be fully explained by medications effects only [26].

The anticholinergic load of medications significantly contributes to the severity of the decrease of salivary production [27–29]. Many drug classes, according to Anatomical Therapeutic Chemical (ATC) classification, have been associated with dry mouth. It has been shown that dry mouth is more likely to happen in older people who take psycho-analeptics (N06), specially selective serotonin reuptake inhibitors, benzodiazepine-related agents (N05CF), cardiac agents (C01), including beta-blockers, calcium channel blockers (mainly verapamil), ACE inhibitors and angiotensin II receptor blockers, thiazide diuretics (C03AA), statins (C10A), respiratory agents (R03), mainly glucocorticoids, antithrombotics (B01), laxatives containing magnesium compounds (A02AA), proton pump inhibitors (A02BC), insulin and oral anti-diabetics (A10), and urologic medication (G04) [30, 31].

The xerogenic effect might increase with polypharmacy. However, when evaluating patients with dry mouth, clinicians should always differentiate between the iatrogenic, i.e. medication-induced dry mouth, and dry mouth as the result of an underlying health condition. For example, dry mouth is also observed in patients with Sjögren's syndrome, endocrine disorders, nutritional deficiencies, depression as well as in patients who were treated with radiation therapy or chemotherapy.

In case of presumed iatrogenic dry mouth, a clinician needs to evaluate which medications from the patient's medication list have potential salivary effects.

Therapeutic strategies in medication-induced xerostomia consist in first instance of a possible reduction in the number or dosage of the medications taken by the patient or substitution with medications or formulations with less xerogenic effects, in addition to optimal hydration, avoidance of irritating toothpastes and crispy/hard foods and use of saliva stimulants such as sugar-free chewing gums and saliva substitutes/mucosal lubricants [23, 32] (see more details in Chap. 8).

4.2.2 Mucosal Lesions

Mucosal lesions might occur as aphthous or non-aphthous ulcers presenting as multiple small round ulcers with demarcated margins and erythematous haloes [33].

An association between mucosal lesions and different drug classes and has been described. The medications most commonly associated with mucosal lesions include non-steroidal anti-inflammatory drugs (e.g. ibuprofen, piroxicam, naproxen), antibacterials (e.g. clindamycin, trimethoprim-sulfamethoxazole) [33–37], antiepileptics (e.g. carbamazepine, phenytoin), anti-diabetics (e.g. chlorpropamide), diuretics (e.g. furosemide), several antihypertensives (e.g. angiotensin receptor blockers—losartan, candesartan, irbesartan; angiotensin-converting enzyme inhibitors—captopril; beta-blockers—labetalol; calcium channel blockers—nifedipine, verapamil, diltiazem), and chemotherapy agents (5-flourouracil, cisplatin, methotrexate, hydroxyurea) [33, 34, 38–43].

When medication-associated, mucosal lesions usually have an onset from days to weeks after the patient starts taking the culprit medication, and they resolve when the patient stops using the medication. In cases when the mucosal lesion cause swelling or ulceration, topical corticosteroids are recommended. Topical anaesthetic ointments can also be used to treat pain [42].

4.2.3 Oral Lichen Planus

Lichen planus is an immune-mediated process, where T-cells are involved in the destruction of the basal cells of the epithelium. It affects the skin and oral mucosa. The two main types have been described, i.e. reticular and erosive oral lichen planus. The reticular form, which the most common, usually presents as interlacing white keratotic lines (known as Wickham's striae) with an erythematous border, located bilaterally on the buccal mucosa, mucobuccal fold, gingiva and, less often, the tongue, palate, and lips (Fig. 4.1). A variant of reticular OLP is the plaque-like form, which clinically resembles leucoplakia but which has a multifocal distribution. The erosive form presents as a mix of erythematous and ulcerated areas surrounded by finely radiating keratotic striae. In case when erosive OLP involves the attached gingival tissue, it is called desquamative gingivitis. Two additional

Fig. 4.1 Reticular form of oral lichen planus (©Zervou-Valvi F. Oral pathology in older adults. In: AE. Kossioni. Gerodontology. First Edition. Athens, 2018, p.155)

presentations are the atrophic and bullous forms, which are considered variants of the erosive type [43].

Association of oral lichenoid adverse drug-effects has been reported with NSAIDs, antihypertensives (beta-blockers, angiotensin-converting enzyme inhibitors, diuretics and calcium channel blockers), antiarrhythmics (quinidine), antidiabetics (e.g. tolbutamide, glipizide), antiepileptics (carbamazepine), sulfasalazine, allopurinol, gold salts, penicillamine, and more recently biologic agents (e.g. obinutuzumab, infliximab, adalimumab, etanercept, abatacept) as well [33, 34].

In addition to cessation of the culprit drug, relief can often be achieved by topical application of corticosteroids, with or without the combination of other immunomodulators [44].

4.2.4 Taste Alteration—Dysgeusia

Taste alteration (dysgeusia) is accompanied by discomfort during food intake and consequently might affect appetite, body weight, and the quality of life. Dysgeusia has been associated with some medications, with taste changes mostly varying from bitter to metallic. There is a hypothesis that medications might alter taste by affecting trace metal ions, which interact with cell membrane pores. An association between dysgeusia and different drug classes has been described, including angiotensin-converting enzyme inhibitors (e.g. captopril), angiotensin receptor blockers (e.g. losartan, valsartan, candesartan) [45–48], beta-blockers (e.g. atenolol, metoprolol), calcium channel blockers (e.g. diltiazem, nifedipine, amlodipine), nicotine patches, non-steroidal anti-inflammatory drugs (e.g. phenylbutazone),

antiplatelet medication (clopidogrel), anti-infectives (e.g. metronidazole, chlorhexidine), and muscle relaxants (e.g. baclofen) [49, 50].

In case of severe discomfort, discontinuation of drug administration should be considered.

4.2.5 Angioedema

Angioedema is an acute non-pitting swelling involving skin, subcutaneous tissue and mucous membranes of the face and upper respiratory tract. It is possibly the result of bradykinin-induced vasodilatation which leads to an increased vascular permeability. It can even be life-threatening when the mucosal and submucosal tissues of the upper respiratory tract are involved. Angioedema may be caused by drug-induced hypersensitivity reactions. An association with use of different drug classes has been reported including angiotensin-converting enzyme inhibitors (e.g. captopril, lisinopril, enalapril) [51–54], angiotensin receptor blockers (e.g. losartan, olmesartan, telmisartan, candesartan, valsartan) [55–59], renin inhibitor (e.g. aliskiren) [60], beta-blockers (e.g. metoprolol, propranolol), calcium channel blockers (e.g. amlodipine, nicardipine), diuretics (e.g. hydrochlorothiazide), statins (e.g. simvastatin, atorvastatin, rosuvastatin), and non-steroidal anti-inflammatory drugs [61–66]. Angioedema develops soon after the medication is initiated, but can also occur in case of prolonged use of the medication.

Discontinuing use of the culprit medication results in reversal of the angioedema within hours (depending on the half-life of the drug).

4.2.6 Gingival Enlargement

Gingival enlargement is an increase in the size of the gingiva. Proposed mechanisms of action of gingival enlargement or gingival overgrowth involve inflammatory factors within the gingival tissue. It has been shown that the tissue of a patient treated with a culprit medication resembles tissue with an inflammatory-type hyperplasia in which inflammatory cells replace collagen in connective tissue. An association between gingival enlargement and several medications has been described, mainly with phenytoin and various calcium channel blockers including nifedipine, amlodipine, felodipine, nicardipine, nitrendipine, isradipine, verapamil, and diltiazem [67–78].

It has been shown that if patients are placed on a strict programme of oral hygiene within 10 days of initiation therapy with culprit medication inducing gingival enlargement, the occurrence can be minimized. Therefore, in patients showing gingival enlargement, strict plaque control as preventive procedure should be recommended [42].

Anticipating and timely switch from calcium channel blockers to other class of antihypertensives might be necessary in order to avoid further gingival enlargement.

4.2.7 Altered Haemostasis

Altered haemostasis has been reported with medications that interfere with platelet function or affect prothrombin synthesis in the lever. Abnormal haemostasis is seen in patients taking anticoagulants and antiplatelet medication. Concomitant use of NSAIDs, SSRIs and herbal supplements (e.g. ginkgo biloba, garlic) can interfere with anticoagulants and antiplatelets and consequently increase the risk of bleeding. It is also known that clinically relevant interactions between coumarin derivatives and strong CYP2C9 inhibitors such as miconazole may occur. Therefore, one should also be aware of this possibility with cutaneous use of miconazole and other strong CYP2C9 inhibitors [79].

A plan for the assessment of patients taking anticoagulation therapy should include: identification of the indication for anticoagulation therapy, considering the potential risk versus the benefit of altering the medication regimen, knowing the laboratory tests used to assess anticoagulation levels (i.e. in case of warfarin and acenocoumarin) and knowing the methods of obtaining local haemostasis in case of bleeding or oral surgery [80].

4.2.8 Altered Alveolar Bone

Chronic use of corticosteroids may lead to osteoporosis which also can affect the alveolar bone. Likewise, enzyme-inducing antiepileptic medications (i.e. phenytoin, carbamazepine, primidone) have been associated with a higher risk of having lower bone mineral density in comparison with non-enzyme-inducing antiepileptics (such as valproic acid, clonazepam, lamotrigine, gabapentin, topiramate, and ethosuximide) [42, 81].

4.2.9 Medication-Related Osteonecrosis of the Jaw

Current or previous treatment with antiresorptive (bisphosphonates or denosumab) or antiangiogenic agents in patients at risk for developing skeletal complications due to osteoporosis or cancer with metastasis in the bone can lead to medication-related osteonecrosis of the jaw (MRONJ) as an adverse side effect (Figs. 4.2 and 4.3). MRONJ is defined as an area of exposed bone or bone that can be probed through an intra- or extraoral fistula in the maxillofacial region, persisting for over 8 weeks in patients receiving or who have received the above-mentioned medication, and who have not undergone radiotherapy or present evidence of metastatic disease in the mentioned anatomical region [82]. The most important risk factor for MRONJ is dentoalveolar surgery, with tooth extractions being the most common predisposing event. Other risk factors are poor oral hygiene, having a removable denture, smoking, systemic factors (e.g. diabetes), medication (chemotherapy and corticosteroids), and oral inflammatory infections (e.g. periodontitis). The occurrence of MRONJ depends on the duration of

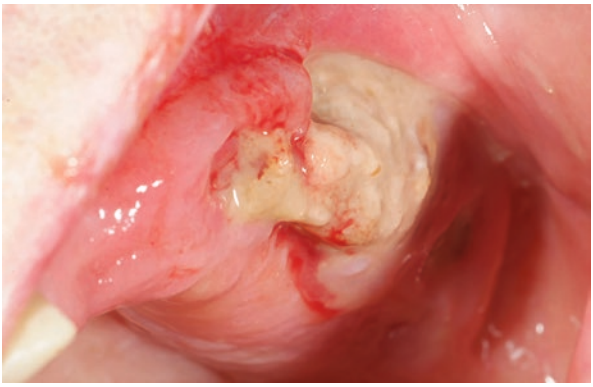

Fig. 4.2 Clinical picture of a medication-related osteonecrosis of the jaw (MRONJ) in the upper jaw in a nursing home resident. (Community Dentistry and Oral Public Health, Dental School, Ghent University, Belgium ©)

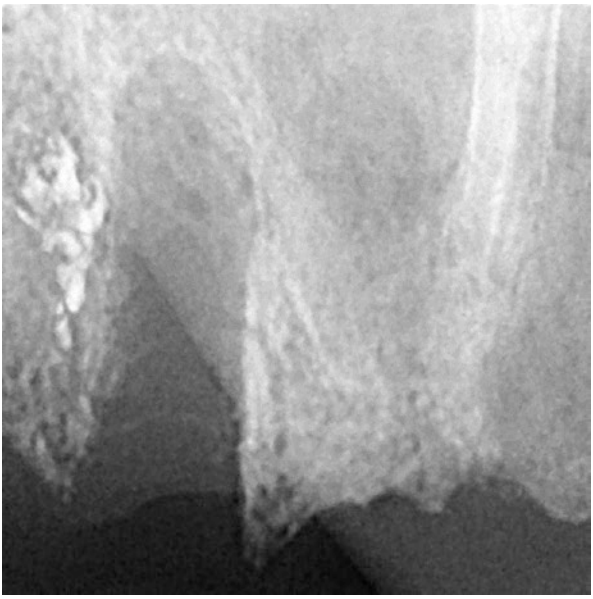

Fig. 4.3 The radiograph related to the clinical image clearly shows that the medication-related osteonecrosis of the jaw (MRONJ) is related to the previous extraction of a tooth. (Community Dentistry and Oral Public Health, Dental School, Ghent University, Belgium ©)

the treatment and the potency, IV treatment and long treatments being associated with higher risks compared to oral treatment or treatments of short duration. The incidence of MRONJ after a dental extraction under ideal circumstances (good oral hygiene, atraumatic procedure) in patients treated IV for oncological reasons is 3.2%, whereas it is only 0.5% in patients treated *per os* for osteoporosis [83]. MRONJ is difficult to manage and the course is difficult to predict. Therefore, prevention and control of the risk factors are very important [83]. When a treatment with antiresorptive or antiangiogenic medication is started, the patient should be seen as soon as possible by a dentist (preferably before the first intake) to eliminate teeth that might cause future problems and after that the

patients should be seen by a dentist at least every 6 months, even if they wear a removable denture. Of course, it is also very important to maintain optimal oral hygiene to avoid future extractions of infections [82–84].

4.2.10 Oral Pigmentation

Oral pigmentation can be produced by different medications such as chemotherapeutic agents like cyclophosphamide, busulfan, bleomycin and fluorouracil, tranquilizers, antimalarials like clofazamine, chloroquine, amodiaquine, anti-microbial agents as minocycline, anti-retroviral agents like zidovudine, and antifungals such as ketoconazole. Palate and gingiva are usually affected. In addition to mucosal changes, teeth may be bluish grey due to minocycline/tetracycline use. The pathogenesis underlying medication-related pigmentation can be considered as a consequence of medication or medication metabolite deposition in dermis and epidermis, enhanced melanin deposition with or without increase in melanocytes, medication-induced post-inflammatory changes to the mucosa particularly if the medications cause an oral lichenoid reaction and bacterial metabolism, alone or in combination, which may result in oral pigmentations [85, 86].

4.2.11 Points to Consider when Prescribing Medications in Older People

When prescribing a medication, there are several important points to consider, i.e. prescribe only where necessary, and take into account both benefits and risks in order to assure efficacy, safety, and access to best care avoiding the risk of iatrogenicity. Involve the patient in decisions about their care and respect the patient's autonomy. Notice the patient's age, medical history, and any concurrent medication. Think about dosage judiciously; manufacturers' recommended doses are based on population studies and assume 'one dose fits all'. Check always for indication, right choice, dosage, directions, drug–drug interactions, drug–disease interactions, duration of treatment, and adverse drug reactions. Medication history, potential medication-related problems, and their impact on oral health should be considered while assessing oral symptoms and findings.

4.2.12 Approaches to Optimize Medication Use

Approaches to identify potential DRPs, including oral health conditions, and to optimize medication use in older people comprise medication reconciliation followed by medication review and criteria to assess quality of prescribing, preferably incorporated in computer-based prescribing systems and as a part of comprehensive geriatric assessment and management (Table 4.2).

Table 4.2 Approaches to optimize medication use

Medication reconciliation
Medication review
Criteria to assess quality of prescribing
Comprehensive geriatric assessment and management

Importantly, when these approaches are combined, for instance, in studies assessing the efficacy of an intervention based on clinical pharmacists performing medication review in the context of a multidisciplinary team, positive effects on patient's health-related outcomes are found. Integration of skills from different healthcare professionals is therefore necessary to address medical complexity of older people. The challenge for future research is to integrate valuable information obtained by existing methods in a complete and global approach targeting all potential factors involved in the onset of DRPs [87].

4.2.13 Medication Reconciliation and Medication Review

Medication reconciliation is defined as 'a process of verifying a complete list of all patient's current medications—including the name, dosage, frequency, and administration route' [88]. Medication reconciliation is usually followed by a medication review. Medication review, on its turn, is defined as 'a structured, critical examination of a patient's medications with the objective of reaching an agreement with the patient about treatment, optimizing the impact of medications, minimizing the number of medication related problems and reducing waste' [89]. Medication review consists of the following three steps: (1) Identification of all the medications that the patient is taking; (2) Screening of medication list for potential DRPs; (3) Discussing possible solutions to the DRPs with the treating team and, if possible, with the patient him/herself.

4.2.14 Criteria to Assess Quality of Prescribing

Several tools and criteria have been developed for the purpose of medication appropriateness assessment and are categorized as implicit (judgement-based) or explicit (criteria-based) approaches or use a combination of both.

Using an implicit tool indicates that clinical information of the individual patient is considered to judge appropriateness. In contrast, explicit criteria tend to be based on lists of medications to avoid, or indicators for appropriate prescribing for several medications or diseases. Explicit criteria used with prescription data alone or with clinical data are commonly used to detect inappropriate prescribing.

A systematic review by Kaufmann et al. identified 46 tools to assess appropriateness of prescribing which were published between 1991 and 2013 [90]. Since the publication of that review in 2014 until now, the updates of some of these tools have been published in addition to several new tools [91–94]. These tools are classified as explicit (criterion-based) or implicit (judgement-based) tools.

4.2.14.1 Explicit Tools

Explicit tools or criteria used with prescribing data only, or with clinical data, are often used to identify inappropriate prescribing. The medication-to-avoid criteria have been the most often used. They are based on lists of potentially inappropriate medications (PIMs), i.e. medications that should be avoided in older people because the risks outweigh the benefits [95]. Several explicit tools are available although only the Beers Criteria and the STOPP/START criteria have been evaluated for predictive validity. Beers Criteria, last updated in 2015, identify a list of 53 PIMs or medication classes divided into three categories: PIMs to avoid independent of comorbidities, PIMs to avoid in older people with certain diseases and syndromes, and medications to be used with caution [96, 97].

The STOPP criteria for screening PIMs, as well as the START criteria for the detection of potential prescribing omissions of indicated, potentially beneficial drugs medications, updated in 2015, are ordered according to physiological systems and include both PIMs (80 criteria) and omission of potentially beneficial pharmacotherapy (34 criteria) [92, 98]. Explicit criteria can be applied with little or no clinical judgement but do not address individual differences between patients.

As to their relevance in everyday practice, these criteria generally neither address comorbidities often found in older patients, nor do they consider patient's predilections or previous treatments.

Explicit criteria have limited transferability between countries due to variations in national prescribing patterns and drug availability. Also, they must be repeatedly updated in accordance with growing clinical evidence [95].

4.2.14.2 Implicit Tools

Implicit tools take into consideration clinical information of the individual patient to adjudicate appropriateness of prescribing. The Medication Appropriateness Index (MAI) is a comprehensive and validated implicit tool [99]. It is a judgement-based process measure of prescribing appropriateness that assesses ten elements of prescribing: indication, effectiveness, dose, correct directions, practical directions, DDI, DDisI, duplication, duration, and cost. These elements are assessed based on clinical adjudicate rather than on objective measures, and the ratings result in a weighted score that serves as a summary measure of prescribing appropriateness. Recently, an adapted version has been published in which the original MAI was

amended to cover more aspects of pharmacotherapy and to reduce the number of questions by grouping certain aspects [100]. Implicit criteria are time-consuming and more dependent on the user.

No single ideal tool exists so far. The choice of a tool may depend on the purpose of use and availability of data. Implementation of such a tool necessitates that the tool should not only be well designed and comprehensive but at the same time applicable in daily practice. Incorporation of assessment tools in electronic decision support systems could be a promising approach. These tools are useful for identifying potentially inappropriate prescribing although they cannot substitute good clinical decision when treating older patients.

4.2.15 Comprehensive Geriatric Assessment (CGA) and Tailored Care

One of the key challenges concerning therapeutic goals setting in older patients is to evaluate whether the expected benefits of treatment outweigh the risks in a population with decreased life expectancy and reduced tolerance to stress [101]. Taking into consideration the differences in life expectancy and in order to provide an integrated plan for treatment, rehabilitation, support and long-term care, CGA and assessment of multimorbidity is assumed to distinguish between three groups of patients, i.e. fit, vulnerable, and frail [102, 103].

Fit patients are functionally independent patients without medically relevant comorbidity in whom full therapy in order to achieve outcomes similar to those in their younger counterparts should be considered.

Vulnerable patients stand for the group with minor dependencies in instrumental activities of daily living (IADL) and/or one or two comorbidities but without a geriatric syndrome or dependence in activities of daily living (ADL) in whom adapted/tailored approach with reconsidering of pharmacotherapy should deserve the priority.

Frail patients are identified by at least one of the following elements: the presence of one or more geriatric syndromes, multiple comorbidities, or dependence in ADL. Most patients aged ≥85 years belong to this group in whom symptom palliation including judicious medication withdrawal seems the most appropriate approach.A practical example of a straightforward algorithm for the classification of older patients according to their functional status, which is both fast and can easily be performed by most health professionals is the Clinical Frailty Scale of the Canadian Study of Health and Aging (CSHA) (Fig. 4.4). This scale represents a practical decision-making tool to adapt therapeutic strategies. This scale discriminates between three profiles of patients, i.e. those with preserved functional status (fit, 1–3), those with loss of function but preserved autonomy for the ADL (vulnerable, 4–6), and those with severe loss of functional impairment and loss of autonomy for the ADL (frail, 7–9) [104, 105].

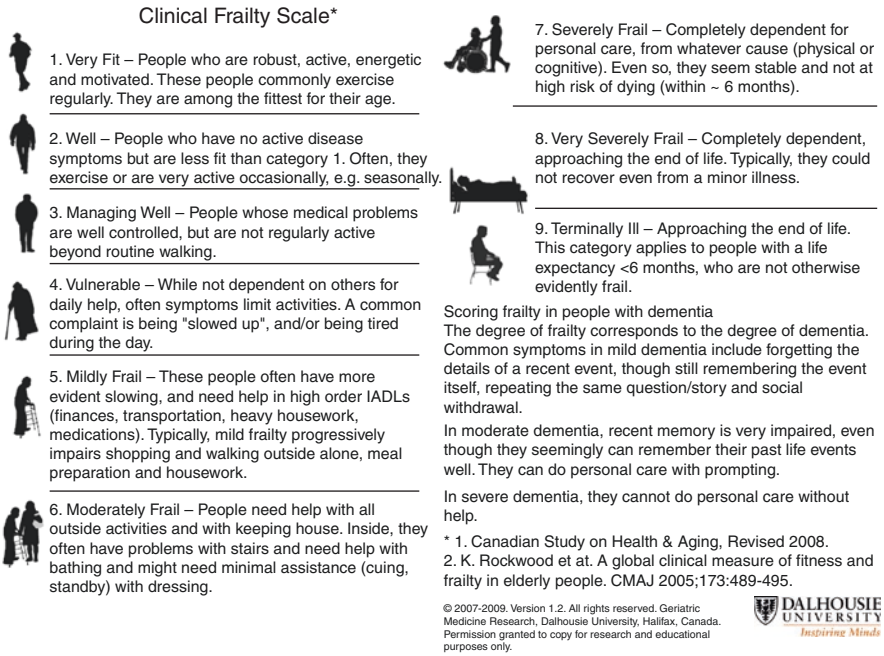

Fig. 4.4 Profiles according to frailty and functional status in older patients (source: Geriatric Medicine Research, Dalhousie University, Halifax, Canada: https://www.dal.ca/sites/gmr/our-tools/clinical-frailty-scale.html [104])

4.3 Conclusion

The global population is ageing and an important consequence of this demographic change is the increase of chronic illness, multimorbidity, care dependency, and related polypharmacy. Medication-related oral health problems are among important potential side-effects of polypharmacy in older people, in particular medications with anticholinergic properties. Pharmacotherapy in older people should therefore be judicious and always adapted to their functional reserve and frailty levels.

References

1. Stewart R, Cooper J. Polypharmacy in the aged. Practical solutions. Drugs Aging. 1994;4:449–61.
2. van den Bemt P, Egberts A, Lenderink A, Verzijl J, Simons K, van der Pol W, et al. Risk factors for the development of adverse drug events in hospitalized patients. Pharm World Sci. 2000;22:62–6.

3. Hajjar E, Hanlon J, Artz M, Lindblad C, Pieper C, Sloane R, et al. Adverse drug reaction risk factors in older outpatients. Am J Geriatr Pharmacother. 2003;1:82–9.
4. Field T, Gurwitz J, Avorn J, McCormick D, Jain S, Eckler M, et al. Risk factors for adverse drug events among nursing home residents. Arch Intern Med. 2001;161:1629–34.
5. Field T, Gurwitz J, Harrold L, Rothschild J, Debellis K, Seger A, et al. Risk factors for adverse drug events among older adults in the ambulatory setting. J Am Geriatr Soc. 2004;52:1349–54.
6. Lund B, Carnahan R, Egge J, Chrischilles E, Kaboli P. Inappropriate prescribing predicts adverse drug events in older adults. Ann Pharmacother. 2010;44:957–63.
7. Steinman M, Landefeld C, Rosenthal G, Berthenthal D, Sen S, Kaboli P. Polypharmacy and prescribing quality in older people. J Am Geriatr Soc. 2006;54:1516–23.
8. Page R, Linnebur S, Bryant L, Ruscin M. Inappropriate prescribing in the hospitalized elderly patient: defining the problem, evaluation tools, and possible solutions. Clin Interv Aging. 2010;5:75–87.
9. Hajjar E, Cafiero A, Hanlon J. Polypharmacy in elderly patients. Am J Geriatr Pharmacother. 2007;5:314–6.
10. Goldberg R, Mabee J, Chan L, Wong S. Drug-drug and drug disease interactions in the ED: analysis of a high-risk population. Am J Emerg Med. 1996;14:447–50.
11. Col N, Fanale JE, Kronholm P. The role of medication noncompliance and adverse drug reactions in hospitalizations of the elderly. Arch Intern Med. 1990;150:841–5.
12. Petrovic M, Gnjidic D, Tommelein E, Boussery K. Pharmacotherapy. In: Roller-Wirnsberger R, Singler K, Polidori MC, editors. Learning geriatric medicine: a study guide for medical students. Cham: Springer International Publishing AG; 2018. p. 219–35.
13. Laroche ML, Charmes JP, Marcheix A, Bouthier F, Merle L. Estimation of glomerular filtration rate in the elderly: Cockcroft-Gault formula versus modification of diet in renal disease formula. Pharmacotherapy. 2006;26:1041–6.
14. Page R, Linnebur S, Bryant L, et al. Inappropriate prescribing in the hospitalized elderly patient: defining the problem, evaluation tools, and possible solutions. Clin Interv Aging. 2010;5:75–87.
15. Kinirons MT, Crome P. Clinical pharmacokinetic considerations in the elderly: an update. Clin Pharmacokinet. 1997;33:302–12.
16. Mayersohn M. Pharmacokinetics in the elderly. Environ Health Perspect. 1994;102(Suppl. 11):119–24.
17. Klotz U, Avant G, Hoyumpa A, Schenker S, Wilkinson G. The effects of age and liver disease on the disposition and elimination of diazepam in adult man. J Clin Invest. 1975;55:347–59.
18. Swift C. Pharmacodynamics: changes in homeostatic mechanisms, receptor and target organ sensitivity in the elderly. Br Med Bull. 1990;40:36–52.
19. Gurwitz JH, Avorn J. The ambiguous relation between aging and adverse drug reactions. Ann Intern Med. 1991;114:956–66.
20. Barat I, Andreasen F, Damsgaard EM. Drug therapy in the elderly: what doctors believe and patients actually do. Br J Clin Pharmacol. 2001;51:615–22.
21. Lindley C, Tully M, Paramsothy V, Tallis R. Inappropriate medication is a major cause of adverse drug reactions in elderly patients. Age Ageing. 1992;21:294–300.
22. Janssens B, Petrovic M, Jacquet W, Schols J, Vanobbergen J, De Visschere L. Medication use and its potential impact on the oral health status of nursing home residents in Flanders (Belgium). J Am Med Dir Assoc. 2017;18:809.e1–8.
23. Singh M, Papas A. Oral implications of polypharmacy in the elderly. Dent Clin N Am. 2014;58:783–96.
24. Xu F, Laguna L, Anwesha S. Aging-related changes in quantity and quality of saliva: where do we stand in our understanding? J Texture Stud. 2019;50:27–35.
25. Das P, Challacombe S. Dry mouth and clinical oral dryness scoring systems. Prim Dent J. 2016;5:77–9.
26. Affo R, Foley N, Garrick R, Siqueira W, Martin R. Meta-analysis of salivary flow rates in young and older adults. J Am Geriatr Soc. 2015;63:2142–51.

27. Navazesh M, Christensen C, Brightman V. Clinical criteria for the diagnosis of salivary gland hypofunction. J Dent Res. 1992;71:1363–9.
28. Amerongen AV, Veerman EC. Saliva—the defender of the oral cavity. Oral Dis. 2002;8: 12–22.
29. Vissink A, Spijkervet FK, Van Nieuw Amerongen A. Aging and saliva: a review of the literature. Spec Care Dentist. 1996;16:95–103.
30. Smidt D, Torpet L, Nauntofte B, Heegaard K, Pedersen A. Associations between oral and ocular dryness, labial and whole salivary flow rates, systemic diseases and medications in a sample of older people. Community Dent Oral Epidemiol. 2011;39:276–88.
31. Smidt D, Torpet L, Nauntofte B, Heegaard K, Pedersen A. Associations between labial and whole salivary flow rates, systemic diseases and medications in a sample of older people. Community Dent Oral Epidemiol. 2010;38:422–35.
32. Turner M, Ship J. Dry mouth and its effects on the oral health of elderly people. J Am Dent Assoc. 2007;138(Suppl):15S–20S.
33. Balakumar P, Kavitha M, Nanditha S. Cardiovascular drugs-induced Oral toxicities: a murky area to be revisited and illuminated. Pharmacol Res. 2015;102:81–9.
34. Yuan A, Woo S. Adverse drug events in the oral cavity. Oral Surg Oral Med Oral Pathol Oral Radiol. 2015;119:35–47.
35. Boulinguez S, Reix S, Bedane C, Debrock C, Bouyssou-Gauthier ML, Sparsa A, Le Brun V, De Vencay P, Bernard P, Bonnetblanc J. Role of drug exposure in aphthous ulcers: a case-control study. Br J Dermatol. 2000;143:1261–5.
36. Siegel M, Balciunas B. Medication can induce severe ulcerations. J Am Dent Assoc. 1991;122:75–7.
37. Healy C, Thornhill M. An association between recurrent oro-genital ulceration and non-steroidal anti-inflammatory drugs. J Oral Pathol Med. 1995;24:46–8.
38. Goffin E, Pochet J, Lejuste P, De Plaen J. Aphtous ulcers of the mouth associated with losartan. Clin Nephrol. 1998;50:197.
39. Susser W, Whitaker-Worth D, Grant-Kels J. Mucocutaneous reactions to chemotherapy. J Am Acad Dermatol. 1999;40:367–98.
40. Logan R, Stringer A, Bowen J, Gibson R, Sonis S, Keefe D. Is the pathobiology of chemotherapy-induced alimentary tract mucositis influenced by the type of mucotoxic drug administered? Cancer Chemother Pharmacol. 2009;63:239–51.
41. Sonis S. Regimen-related gastrointestinal toxicities in cancer patients. Curr Opin Support Palliat Care. 2010;4:26–30.
42. Ciancio S. Medications' impact on oral health. J Am Dent Assoc. 2004;135:1440–8.
43. Edwards PC, Kelsch R. Oral lichen planus: clinical presentation and management. J Can Dent Assoc. 2002;68:494–9.
44. Lavanya N, Jayanthi P, Rao U, Ranganathan K. Oral lichen planus: an update on pathogenesis and treatment. J Oral Maxillofac Pathol. 2011;15:127–32.
45. Coulter D. Eye pain with nifedipine and disturbance of taste with captopril: a mutually controlled study showing a method of postmarketing surveillance. Br Med J (Clin Res Ed). 1988;296:1086–8.
46. Boyd I. Captopril-induced taste disturbance. Lancet. 1993;342:304.
47. Heeringa M, van Puijenbroek E. Reversible dysgeusia attributed to losartan. Ann Intern Med. 1998;129:72.
48. Tsuruoka S, Wakaumi M, Ioka T, Yamamoto H, Ando H, Sugimoto K, Fujimura A. Angiotensin II receptor blocker-induces blunted taste sensitivity: comparison of candesartan and valsartan. Br J Clin Pharmacol. 2005;60:204–7.
49. Sadasivam B, Jhaj R. Dysgeusia with amlodipine—a case report. Br J Clin Pharmacol. 2007;63:253.
50. Ackerman B, Kasbekar N. Disturbances of taste and smell induced by drugs. Pharmacotherapy. 1997;17:482–96.
51. Maier C. Life-threatening postoperative angioedema following treatment with an angiotensin converting enzyme inhibitor. Anaesthesist. 1995;44:875–9.

52. Hall R. Angioedema and ACE inhibitors. Periodont Insights. 1998;5:6–7.
53. Israili Z, Hall W. Cough and angioneurotic edema associated with angiotensin-converting enzyme inhibitor therapy. A review of the literature and pathophysiology. Ann Intern Med. 1992;117:234–42.
54. Chin H, Buchan D. Severe angioedema after long-term use of an angiotensin-converting enzyme inhibitor. Ann Intern Med. 1990;112:312–3.
55. Campbell D, Krum H, Esler M. Losartan increases bradykinin levels in hypertensive humans. Circulation. 2005;111:315–20.
56. Lo K. Angioedema associated with candesartan. Pharmacotherapy. 2002;22:1176–9.
57. Irons B, Kumar A. Valsartan-induced angioedema. Ann Pharmacother. 2003;37:1024–7.
58. Nykamp D, Winter E. Olmesartan medoxomil-induced angioedema. Ann Pharmacother. 2007;41:518–20.
59. ONTARGET Investigators, Yusuf S, Teo K, Pogue J, Dyal L, Copland I, Schumacher H, Dagenais G, Sleight P, Anderson C. Telmisartan, ramipril, or both in patients at high risk for vascular events. N Engl J Med. 2008;358:1547–59.
60. Jagadeesh G, Balakumar P, Stockbridge N. How well do aliskiren's purported mechanisms track its effects on cardiovascular and renal disorders? Cell Signal. 2012;24:1583–91.
61. Southward J, Irvine E, Rabinovich M. Probable amlodipine-induced angioedema. Ann Pharmacother. 2009;43:772–6.
62. Pierce W, Hederman A, Gordon C, Ostrenga A, Herrington B. Angioedema associated with dihydropyridine calcium-channel blockers in a child with Burkitt lymphoma. Am J Health Syst Pharm. 2011;68:402–6.
63. Ruscin J, Page R 2nd, Scott J. Hydrochlorothiazide-induced angioedema in a patient allergic to sulphonamide antibiotics: evidence from a case report and a review of the literature. Am J Geriatr Pharmacother. 2006;4:325–9.
64. Nisly S, Kara A, Knight T. Simvastatin: a risk factor for angioedema? J Pharm Technol. 2013;29:149–52.
65. Hampson J, Smith D, Cowell R, Baker A. Hypotension and eosinophilia with atorvastatin. Pharm World Sci. 2005;27:279–80.
66. Rees S, Gibson J. Angioedema and swellings of the orofacial region. Oral Dis. 1997;3:39–42.
67. Dongari-Bagtzoglou A, Research, Science and Therapy Committee, American Academy of Periodontology. Drug-associated gingival enlargement. J Periodontol. 2004;75:1424–31.
68. Sam G, Sebastian S. Nonsurgical management of nifedipine induced gingival overgrowth. Case Rep Dent. 2014;2014:741402.
69. Bhatia V, Mittal A, Parida A, Talwar R, Kaul U. Amlodipine induced gingival hyperplasia: a rare entity. Int J Cardiol. 2007;122:e23–4.
70. Young P, Turiansky G, Sau P, Liebman M, Benson P. Felodipine-induced gingival hyperplasia. Cutis. 1998;62:41–3.
71. Maguin B, Yachouh J, Goudot P. Nicardipine-induced gingival hyperplasia: case report. Rev Stomatol Chir Maxillofac. 2004;105:219–21.
72. Brown R, Sein P, Corio R, Bottomley W. Nitrendipine-induced gingival hyperplasia. First case report. Oral Surg Oral Med Oral Pathol. 1990;70:593–6.
73. Hall W. Dilantin hyperplasia: a preventable lesion? Compend Suppl. 1990;14:S502–5.
74. Ciancio S, Yaffe S, Catz C. Gingival hyperplasia and diphenylhydantoin. J Periodontol. 1972;43:411–4.
75. Nakade O, Baylink D, Lau K. Phenytoin at micromolar concentrations is an osteogenic agent for human-mandible-derived bone cells in vitro. J Dent Res. 1995;74:331–7.
76. Ellis J, Seymour R, Steele J, Robertson P, Butler T, Thomason J. Prevalence of gingival overgrowth induced by calcium channel blockers: a community-based study. J Periodontol. 1999;70:63–7.
77. Nishikawa S, Tada H, Hamasaki A, Kasahara S, Kido J, Nagata T, Ishida H, Wakano Y. Nifedipine-induced gingival hyperplasia: a clinical and in vitro study. J Periodontol. 1991;62:30–5.

78. Seymour R, Smith D. The effect of a plaque control programme on the incidence and severity of cyclosporin-induced gingival changes. J Clin Periodontol. 1991;18:107–10.
79. Ortín M, Olalla JI, Muruzábal MJ, Peralta FG, Gutiérrez MA. Miconazole oral gel enhances acenocoumarol anticoagulant activity: a report of three cases. Ann Pharmacother. 1999;33:175–7.
80. Sindet-Pedersen S, Ramström G, Bernvil S, Blombäck M. Hemostatic effect of tranexamic acid mouthwash in anticoagulant-treated patients undergoing oral surgery. N Engl J Med. 1989;320:840–3.
81. Farhat G, Yamout B, Mikati M, Demirjian S, Sawaya R, El-Hajj Fuleihan G. Effect of anti-epileptic drugs on bone density in ambulatory patients. Neurology. 2002;58:1348–53.
82. Salvatore R, Dodson T, Fantasia J, Goodday R, Aghaloo T, Mehrotra B, O'Ryan F. American Association of Oral and Maxillofacial Surgeons position paper on medication-related osteonecrosis of the jaw—2014 update. J Oral Maxillofac Surg. 2014;72:1938–56.
83. Gaudin E, Seidel L, Bacevic M, Rompen E, Lambert F. Occurrence and risk indicators of medication-related osteonecrosis of the jaw after dental extraction: a systematic review and meta-analysis. J Clin Periodontol. 2012;42:922–32.
84. Diniz-Freitas M, Limeres J. Prevention of medication-related osteonecrosis of the jaws secondary to tooth extractions. A systematic review. Med Oral Patol Oral Cir Bucal. 2016;21:e250–9.
85. Sreeja C, Ramakrishnan K, Vijayalakshmi D, Devi M, Aesha I, Vijayabanu B. Oral pigmentation: a review. J Pharm Bioallied Sci. 2015;7(Suppl 2):S403–8.
86. Anil Kumar N, Divya P. Adverse drug effects in mouth. Int J Med Appl Sci. 2015;4:82–91.
87. Onder G, van der Cammen T, Petrovic M, Somers A, Rajkumar C. Strategies to reduce the risk of iatrogenic illness in complex older adults. Age Ageing. 2013;42:284–91.
88. Agency for Healthcare Research and Quality U.S. Department of Health and Human Services; 2012. https://www.ahrq.gov/sites/default/files/publications/files/match.pdf. Accessed 8 Dec 2019.
89. NHS Cumbria Medicines Management Team. 2013. http://www.cumbria.nhs.uk/ProfessionalZone/MedicinesManagement/Guidelines/MedicationReview-PracticeGuide2011.pdf. Accessed 8 Dec 2019.
90. Kaufmann C, Tremp R, Hersberger K, Lampert M. Inappropriate prescribing: a systematic overview of published assessment tools. Eur J Clin Pharmacol. 2014;70:1–11.
91. Tommelein E, Petrovic M, Somers A, Mehuys E, van der Cammen T, Boussery K. Older patients' prescriptions screening in the community pharmacy: development of the Ghent older People's prescriptions community pharmacy screening (GheOP^{3}S) tool. J Public Health (Oxf). 2016;38:e158–70.
92. O'Mahony D, O'Sullivan D, Byrne S, O'Connor M, Ryan C, Gallagher P. STOPP/START criteria for potentially inappropriate prescribing in older people: version 2. Age Ageing. 2015;44:213–8.
93. American Geriatrics Society 2015 Beers Criteria Update Expert Panel. American Geriatrics Society 2015 updated beers criteria for potentially inappropriate medication use in older adults. J Am Geriatr Soc. 2015;63:2227–46.
94. Renom Guiteras A, Meyer G, Thürmann PA. The EU(7)-PIM list: a list of potentially inappropriate medications for older people consented by experts from seven European countries. Eur J Clin Pharmacol. 2015;71:861–75.
95. Spinewine A, Schmader KE, Barber N, Hughes C, Lapane K, Swine C, et al. Appropriate prescribing in elderly people: how well can it be measured and optimised? Lancet. 2007;370:173–84.
96. Beers M, Ouslander J, Rollingher I, Reuben D, Brooks J, Beck J. Explicit criteria for determining inappropriate medication use in nursing home residents. Arch Intern Med. 1991;151:1825–32.
97. American Geriatrics Society 2012 Beers Criteria Update Expert Panel. American Geriatrics Society updated beers criteria for potentially inappropriate medication use in older adults. J Am Geriatr Soc. 2012;60:616–31.

98. Gallagher P, Ryan C, Byrne S, Kennedy J, O'Mahony D. STOPP (screening tool of older person's prescriptions) and START (screening tool to alert doctors to right treatment). Consensus validation. Int J Clin Pharmacol Ther. 2008;46:72–83.
99. Hanlon J, Schmader K, Samsa G, Weinberger M, Uttech K, Lewis I, et al. A method for assessing drug therapy appropriateness. J Clin Epidemiol. 1992;45:1045–51.
100. Somers A, Mallet L, van der Cammen T, Robays H, Petrovic M. Applicability of an adapted medication appropriateness index for detection of drug-related problems in geriatric inpatients. Am J Geriatr Pharmacother. 2012;10:101–9.
101. Vander Walde N, Jagsi R, Dotan E, Baumgartner J, Browner I, Burhenn P, et al. NCCN guidelines insights: older adult oncology, version 2.2013. J Natl Cancer Netw. 2016;14:1357–70.
102. Stauder R. The challenge of individualised risk assessment and therapy planning in elderly high-risk myelodysplastic syndromes (MDS) patients. Ann Hematol. 2012;91:1333–43.
103. Balducci L, Extermann M. Management of cancer in the older person: a practical approach. Oncologist. 2000;5:224–37.
104. Geriatric Medicine Research, Dalhousie University, Halifax. https://www.dal.ca/sites/gmr/our-tools/clinical-frailty-scale.html. Accessed 8 Dec 2019.
105. Rockwood K, Song X, MacKnight C, Bergman H, Hogan DB, McDowell I, Mitnitski A. A global clinical measure of fitness and frailty in elderly people. Can Med Assoc J. 2005;173:489–95.

Dietary Habits, Nutrition and Oral Health

5

Vassiliki Anastassiadou

Abstract

The perception of sensory and internal texture qualities of food, released during chewing and swallowing contribute to food choices and variety of diet. The older adults are vulnerable in food intake quality due to reduced hedonic perception, lower food appeal and appetite that limit food choices. Teeth are vital for chewing and oral health, but also for maintaining general health. A significant number of elders suffer from tooth loss and edentulism. The result is impaired chewing ability leading to food choice restriction and reduced intake of essential macronutrients and micronutrients, increasing the risk for malnutrition and health burden. The number, distribution and functional occluding tooth units of remaining teeth are of essential clinical significance regarding chewing performance and efficiency. Oral indicators for assessing chewing difficulties are critical for dietary interventions and dietary advice for increasing food awareness, variety in texture, cooking methods and food preparation especially to those with compromised dentitions, tooth loss and denture wearing. By applying meaningful interventions, such as providing regular oral screenings, individualised dietary and oral hygiene advise, skills are developing for health professionals with regard to oral health and its links to nutritional evaluation. Establishing practical guidelines and identifying roles in promoting oral health in an interdisciplinary environment contribute to the maintenance of older persons' oral health in terms of chewing ability and secure balanced diet, optimal nutritional status, systemic health and overall well-being.

V. Anastassiadou (✉)
Department of Prosthodontics, School of Dentistry, Faculty of Health Sciences, Aristotle University of Thessaloniki, Thessaloniki, Greece
e-mail: vanasta@dent.auth.gr

A. Kossioni (ed.), *Gerodontology Essentials for Health Care Professionals*, Practical Issues in Geriatrics, https://doi.org/10.1007/978-3-030-41468-9_5

Learning Objectives
After reading this chapter, readers should be able to:

- Explain why teeth and individualised masticatory function affect food perception.
- Describe how oral clinical indicators act as risk factors for impaired chewing ability that impact on dietary intake and nutritional status.
- Integrate in the daily practice interviews regarding the eating behaviour of older persons and provide tailored dietary counselling taking into consideration the existing oral health status.

5.1 Current View on the Ageing Process

Given the demographic shift to an older population, modern societies have to deal with the challenge of massive ageing and a vulnerable community structure. In the twenty-first century second decade, the continuing increase of life expectancy (3 months per year) and lifespan stimulate vital questions such as whether the added years will be of good quality, in terms of good health and well-being.

The heterogeneity of the older adult population regarding their culture, living conditions, education and socioeconomic level directly affects lifestyle, nutrition and the progression of ageing. Consequently, health behaviour is influenced, throughout the lifespan, by individual profile characteristics such as gender, family, residency and ethnicity.

Conventionally, ageing has been viewed as a physiological condition, which favours the onset of a variety of chronic diseases, complex conditions, and syndromes that promote weakness, wear and limited lifespan.

Recently, Franceshi et al. (2018) described biological ageing as a complex and multifactorial phenomenon, often characterised by inflammatory conditions, such as stress maladaptation, proteostasis loss, stem-cell depletion, metabolism imbalance, macromolecular impairment and epigenetic alterations. Therefore, ageing can be defined as the period of life that is evolutionarily unpredictable [1–3].

The genetic and environmental background, along with individual characteristics, defines health behaviour status and affects healthcare accordingly. There is evidence that behaviours such as proper nutrition and maintenance of body mass can contribute in cognitive function and functional capacity preservation of the older adults, thus promoting their independence.

For the elderly patients to receive a standardised level of care, which will provide consistent outcomes, healthcare professionals should consider the *limit of vulnerability line*. The latter is conceived as the threshold for a non-symptomatic vulnerability period or a period with clinical uncertainties that could progressively lead to frailty. The duration of the vulnerability period depends on health status and presence of chronic diseases, Activity Daily Living (ADL) performance, medication use and eating behaviour. Moreover, it is related to other factors as well, such as deprivation and isolation, access to services, family support, social interaction and luck [4].

5.2 Diet–Dietary Habits–Eating Behaviour

Food is an integral factor for human well-being and quality of life. It ensures both saturation of hunger and nourishment. Some foods are of symbolic importance and shape eating habits. These habits are guided, either consciously or subconsciously, by religious, cultural, social and emotional experiences [5].

Dietary habits are habitual food choices in daily life and are made based on both internal, such as values and external, such as policy-making factors. These habits are subjected to changes during the lifespan. Furthermore, they are driven by personal/individual preferences developed over time and are influenced not only by profile characteristics, such as gender and age (Table 5.1), but also by personal experiences, such as family customs and rituals, advertising, personal values and motivation [6].

Culture-driven standards form food preferences, create eating patterns, shape eating behaviours and thus contribute to the individual's identity and sense of belonging. Cost is a factor that complicates food demand and hence its availability and integration into diet. Technology and transportation contribute to the long-term availability of foods that are accessible everywhere and at all times. Food labelling laws, trade agreements, advertising tactics and prices are considered policy-making and legislative influences on the food market [7].

Recent studies have provided valuable insights into daily practices related to food intake at older ages. In particular, older persons tend to cook less frequently and prepare simple meals although they are aware of consequent imbalance on dietary intake and the resulting nutritional risk. Moreover, as a more convenient alternative to cooking, they often turn to pre-cooked, frozen foods that contain high levels of sugar and/or salt as preservatives. A key reason for the reduction in food intake quality has been attributed to limited functional capacity and impaired dexterity, thus highlighting food convenience as a fundamental factor in food choice,

Table 5.1 Age and gender profile characteristics related to food intake

Gender:
(a) Health beliefs and weight control motivation may explain up to 50% of gender-based differences in food choice
(b) The healthier food choice profile in women than in men is attributed to a more in-depth nutritional knowledge and stronger motivation of weight control
Age: Older people suffer from:
(a) Slower gastric emptying
(b) Altered hormonal responses
(c) Decreased basal metabolic rate
(d) Altered taste and smell. Gustatory and more pronounced olfactory function decline lead to a decrease in the pleasantness of food; thus resulting in loss of appetite
(e) Diminished specific sensory satiety, which leads to a limited variety of diet
(f) Sarcopenia of masticatory muscles
(g) Reduced bite force due to tooth loss
(h) Tooth mobility due to advanced periodontal disease
(i) Xerostomia mainly due to medications

Table 5.2 Hedonic perception and food preference

(a)	Taste perception and taste preferences, but not taste acuity affect food preferences and food intake
(b)	Diminished perception of saltiness may lead to increased preference for salt
(c)	Sucrose taste sensitivity is also decreased. Research evidence indicated that older adults prefer higher levels of sugar because of taste impairment, but this was not accompanied by food intake increase, nor increased overall pleasantness

especially of homebound older adults. The household diet is reported profoundly altered following bereavement, illness and loss of mobility [8].

Furthermore, older individuals often experience higher levels of social isolation and that eating with others motivates them to have better dietary quality. Consequently, social engagement appears to have a significant influence on nutritional intake [9, 10].

Older adults frequently report alterations in their routine diet, such as reduced meat consumption, an increasing preference for fish and chicken and avoidance of dense foods. In the low-income older population, dietary changes were associated with reduced diet quality. Food choices were based primarily on hedonic attributes (Table 5.2) with a preference for high-energy foods, such as sweet baked products. Therefore, it was revealed that health aspects were not a critical factor in food-based decisions. However, health aspects were a significant concern for older people belonging to higher socioeconomic levels; thus, the motivation for adopting a healthier diet was prevalent [11].

5.3 Trends in Nutrition: Patterns of Food Intake in Older Adults

Nutrition is an essential determinant of human health because it provides the indispensable building blocks for the development of the body and maintenance of a healthy status throughout the lifespan. During the ageing process, lean body mass and basal metabolic rate decline. The energy requirement, expressed as per kilogramme of body weight, is also reduced. Additionally, several changes occur, such as increased medication use due to non-communicable diseases (NCDs) prevalent to older people, reduced food intake due to lower food appeal and compromised nutrient absorption (Fig. 5.1).

These complex and multifaceted changes make it difficult for the older adults to meet their nutritional requirements, as requirements may be reduced for some nutrients and increased for others [12].

Appropriate dietary management recommendations are required because nutrient surveys indicate that the ageing population is at particular risk for inadequate nutrient intake and nutritional status, which may result in increased risk for chronic fatigue and cardiovascular, cognitive and neuromuscular disorders.

Dietary approaches as to which food items should be encouraged and which limited, are of paramount importance in promoting a balanced diet and contributing to the management of NCDs [12, 13]. Mozzaffarian et al. (2018) supported that inappropriate dietary patterns and a lack of variety in food intake were the critical factors for NCDs prevalence rather than single nutrient deficiency [14].

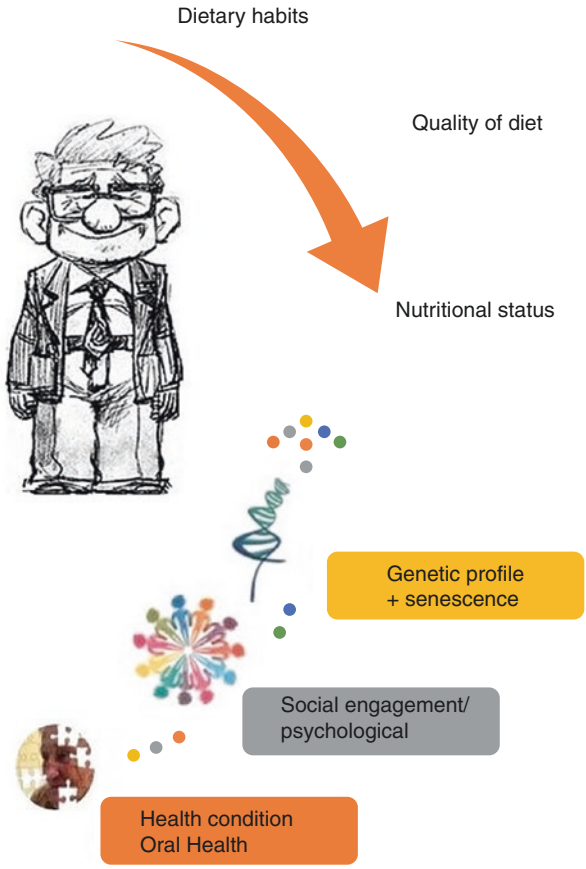

Fig. 5.1 Paths relating dietary habits, quality of diet and nutritional status to critical features of ageing

Dietary interventions and dietary advice for increasing fruit and vegetable intake and adequate amounts of particular food groups such as cereal, meat and dairy products can improve dietary intake. Additionally, advice of adopting new cooking methods, especially to those suffering from total tooth loss contribute to maintaining a healthy and high-quality social life. Individualised interventions to minimise unhealthy dietary patterns and physical inactivity were both adversely correlated to the energy intake/energy expenditure ratio [9].

5.4 Teeth/Masticatory Function and Food Perception

The oral cavity being the portal of the digestive system is in constant contact with the outside world. Foods from different sources are prepared for further digestion by chewing, a complex process involving grinding of food into smaller pieces mechanically by the teeth and mix it with saliva until swallowing [15, 16].

Therefore, mastication is closely related to food and nutrient intake; thus, chewing behaviour affects nutritional status [17]. This effect is related to the perception of sensory and internal texture qualities of food, released during chewing and swallowing. This perception offers satisfaction and pleasure of eating.

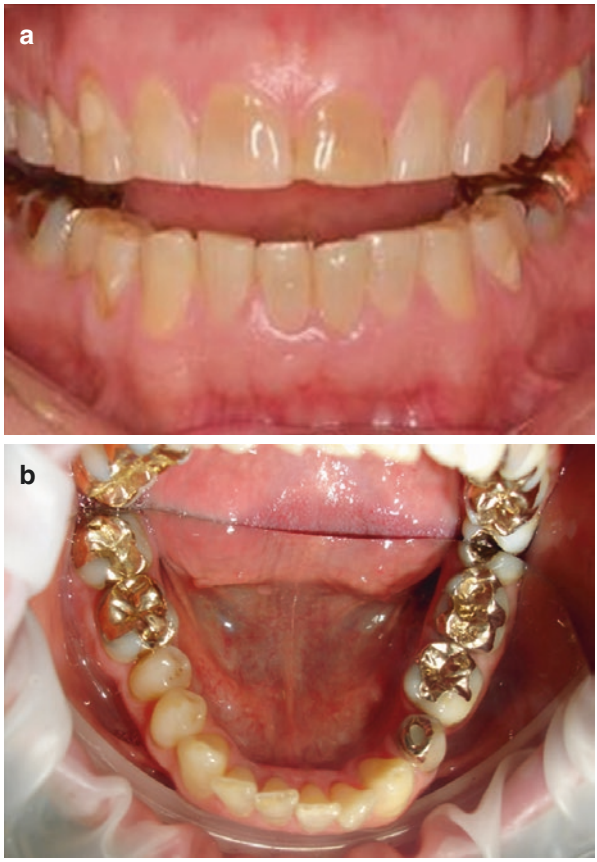

Fig. 5.2 (**a**) A man, 65 years old, maintaining all-natural teeth but presenting tooth wear. (**b**) Restorations are aiming to prevent further deterioration of tooth surface such as onlays on molars

Teeth are vital, for not only chewing and oral health, but also for maintaining the nutritional status and general health, including cognitive function [18]. A more inferior chewing function has been associated with cognitive decline and an increased incidence of dementia [17]. Thus, insight in paths and underlying mechanisms highlighting the association between chewing performance and neurodegeneration is vital for dental professionals in decision-making related to dental treatment [19–21], and also for other health providers to make appropriate dental referrals.

Older people maintain their chewing behaviour with regard to the texture of foods as long as they retain their natural teeth [22]. Due to ageing, changes in the position and shape of natural teeth may affect the mechanical performance of teeth with regard to the fragmenting the food. The loss of tooth surface texture, namely enamel, known as "tooth wear" is a physiological process occurring throughout life (Fig. 5.2*)*. However, accelerated tooth wear affecting dentin and even pulp vitality can become a dental condition demanding restorative or prosthodontic treatment. Tooth wear is aggravated by the abrasive qualities of foods.

Adults present with a wide variation in dental status from the age of 50+, mainly because of tooth loss due to tooth decay (caries) and gum (periodontal) disease.

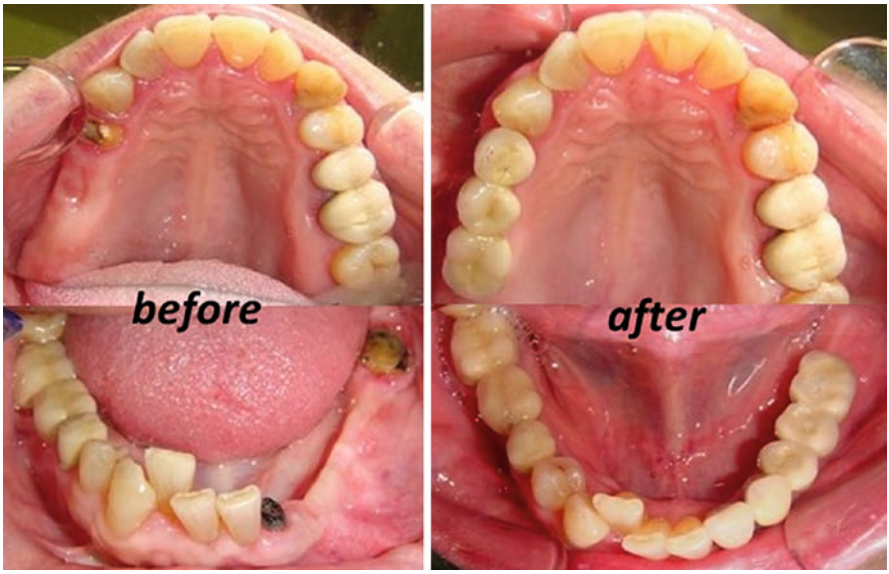

Fig. 5.3 Fixed implant prostheses to extensive tooth loss in a woman 75 years old

They were linked with unhealthy diets, such as increased consumption of sugar and insufficient oral hygiene leading to tooth loss [23].

Maintaining natural teeth in the oral cavity becomes more difficult with increasing age. As a result, a significant number of older adults suffer from extensive tooth loss and edentulism. The number, distribution and functional tooth units of occluding remaining teeth are of essential clinical significance regarding chewing performance and efficiency (Fig. 5.3).

Moreover, tooth loss may be associated with nutritional deficits as it influences diet in terms of food selection, style of cooking and preparation of food. Functional dentitions of more than 20 well-distributed teeth with six occluding teeth by intact premolars and at least one pair of occluding molars promote satisfactory eating ability in older adults, improve dietary habits and increase food awareness attained by tailored dietary intervention (Fig. 5.4). The presence of occlusal teeth contacts is also crucial for swallowing [9, 24–28].

People with dentures reported specific difficulties eating hard consistency food (meat, apples and carrots), food with seeds, which are trapped under the denture base, causing discomfort and pain (tomatoes and grapes) and sticky foods (chocolate and gums) attached to the acrylic dentures' teeth displacing the dentures. These findings were obtained by subjectively perceived masticatory function via validated questionnaires such as Oral Health Impact Profile Index (OHIP), Geriatric Oral Health Assessment Index (GOHAI), food items and frequency questionnaires and diet history recordings. Denture problems also lead to social isolation, to avoid embarrassment from denture displacement, pain and discomfort during meals [29–32].

Routes that reduce masticatory performance in edentate older adults and complete denture wearers are: atrophy of masticatory muscles, reduced ability to chew

Fig. 5.4 Replacement of defective old prostheses with removable partial dentures (upper jaw) and fixed small prostheses (lower jaw) in a woman 85 years old

Fig. 5.5 New complete dentures (replacement dentures) in man 87 years old

foods, altered sensory feedback via gingival tissues in the absence of periodontal receptors and lower associated force production. Additionally, trigeminal nerve stimulus is considered decreased; sensory information sent through mastication to the brain can maintain learning and memory function [21]. Evidence indicated that there is better masticatory ability and mucous membrane stimulus with good quality dentures (Fig. 5.5) [21, 31].

However, objectively measured improvement of masticatory performance via sieving methods and maximal biting force devices still appears significantly different from subjective evaluation of chewing ability [9, 28, 32, 33].

Tailored dietary intervention incorporated into appropriate behaviour change strategies and monitored for extended periods is very promising to achieve effective dietary change in older adults or those at risk of malnutrition, before progressive nutritional declines. Trials should be implemented using this type of dietary counselling in different settings, including routine dental practice and care home settings to maximise the public health impact [34].

Research data showed that no differences in food processing were observed in individuals with similar dental condition. Each person has its individualised way of cutting and preparing food for swallowing, but the food properties did not alter during crushing and preparation for swallowing among individuals [35].

In older edentate individuals, wearing complete dentures was found that chewing performance is one-sixth than that is seen in younger patients [22]. Besides, older complete denture wearers use lower intensity forces than those retaining natural teeth therefore, the processing of food is smaller and slower [36]. The prevalence of the reduction in chewing performance reached 44% in the over 85-year-old adults; being attributable to normal deterioration and reduced physical exercise [37–39]. It partially may explain the compromised food intake in terms of lower intake of fruits, vegetables, fibres and proteins in older persons, who suffer from total tooth loss and wear dentures [28, 33, 40].

5.5 Oral Health and Nutritional Challenges

The conventional/classical dental education fosters effective prevention, identification/location and cure/treatment of specific oral disease. All these in conjunction with older patients' desires, expectations and abilities to maintain oral health form positive outcomes from health interventions and quality of life impact. Therefore, dental health needs are addressed on a life course approach with vulnerability integrated within the assessment and management of need [4, 41].

The oral cavity health reflects the resilience and hence recovery from constant environmental challenges. As a result, the oral cavity is a dynamic ecosystem that pools a reasonably stable, but varied microbial composition balanced by host immunological, epithelial cells and saliva. It can mitigate the severe health challenges/problems of the mouth, such as a high intake of sugar and pathogens that challenge the oral disease burden. Moreover, it positively affects systemic health. This process is of profound importance in older adults [23, 42, 43] (Fig. 5.6).

Specifically, poor oral hygiene promotes the presence of unbalanced biofilm (dysbiotic microbiome), the development of caries and inflammation of periodontal tissues. Consequently, attachment loss, tooth mobility, root exposure and root caries occur, leading to tooth loss (Fig. 5.7).

The resulting clinical condition is the loss of functional dentition, food choice restriction and reduced intake of essential macronutrients and micronutrients; thus, increasing the risk for malnutrition and health burden [44].

Due to dietary changes, such as lower intake of fruits, vegetables and fibres the periodontal pathogens become "radicalised" or dysbiotic [16, 24, 45]. Furthermore,

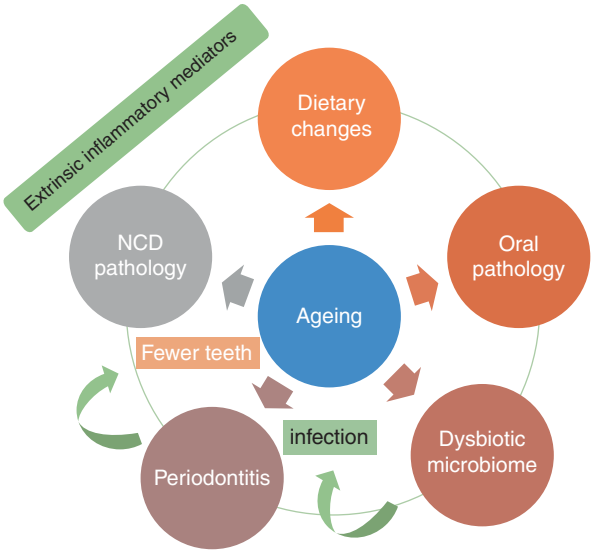

Fig. 5.6 Oral vs. comorbid systemic conditions

Fig. 5.7 Poor oral hygiene leading to tooth loss in a man 72 years old

inflammation mediators from the oral cavity, such as lipopolysaccharides and cytokines, may spread systematically promoting systematic disorders [46, 47]. Tooth loss ensued from periodontal disease and resulting in deterioration of chewing function is considered a disability in late-life [16]. Thus, poor oral health harms nutrition, well-being and overall quality of life [48, 49].

Current evidence links malnutrition in older people with immune deficiencies due to reduced calorie-protein nutrient intake and zinc deficiency because they

appear to be associated with immune cell functions [50]. Additionally, immune senescence in the elders can contribute to the proliferation of bacteria not only from direct bacterial actions but also by indirect immune cell pathology [51].

Missing teeth is an indication of cumulative stresses in the human body and is considered as a predictor of shortened longevity. Extensive tooth loss has been indicated as a mediator of reduced muscle strength with a subsequent decline in body function and impact on overall physical activity and well-being [16, 45, 52]. So far, research findings are confounding as to whether malnourished older adults or those at risk for malnutrition retain less number of teeth.

The use of dentures or being edentulous harbours an association with nutritional status [53]. Research findings revealed that edentulous individuals who used a pair of complete dentures were able to eat a higher number of foods, than those who used only one denture, implying a better nutritional status and less risk for malnutrition [54].

5.6 Conclusion

The oral tissues and functions play a crucial role in the chewing and swallowing processes and may affect the quality of nutrition in older individuals. Poor oral health due to tooth loss, caries, tooth mobility, xerostomia and defective or poorly fitted dentures can deteriorate chewing function, leading to food restriction and dietary changes towards easier manageable foods. The existing evidence indicates that older individuals who retain their natural teeth and supporting soft tissues healthy into old age or have a functional dentition with a minimum of 20 teeth with antagonist contact can maintain their chewing efficiency and chew a large variety of foods. Therefore, when good oral health is recorded, nutritional status is stereotypically affected by other factors than dental status. The number and distribution of teeth, the pairs of opposing teeth and the presence of dentures are considered a reliable indicator of an individualised chewing pattern and may determine chewing ability. The replacement of missing teeth through prosthodontic treatment, although it improves chewing ability and efficiency and enables food awareness, does not necessarily contribute to nutritional status improvement. Simple dietary advice accompanying dental treatment can enhance food awareness. Regardless, a long-term improvement in nutritional status has not been established due to the absence of a long-term tailored dietary counselling data.

The non-dental healthcare provider should promote oral health of older adults in order to maintain their chewing efficiency, providing oral cavity screenings for identifying clinical indicators (i.e. number and occluding pairs of teeth, gum bleeding, tooth mobility, level of oral hygiene, mucosal inflammation, quality of dentures and xerostomia) and referring to the dentist when indicated. Moreover, he/she should interview the patient regarding their dietary habits and provide advice on a healthy non-cariogenic diet and instructions for maintaining oral and denture hygiene.

References

1. Ferruci L, Fabbri E. Inflammageing: chronic inflammation in ageing, cardiovascular disease, and frailty. Nat Rev Cardiol [Internet]. 2018;15(9):505–22. http://www.embase.com/search/results?subaction=viewrecord&from=export&id=L623396519%0A, https://doi.org/10.1038/s41569-018-0064-2.
2. Franceschi C, Garagnani P, Morsiani C, Conte M, Santoro A, Grignolio A, et al. The continuum of aging and age-related diseases: common mechanisms but different rates. Front Med. 2018;5:61.
3. Kennedy BK, Berger SL, Brunet A, Campisi J, Cuervo AM, Epel ES, et al. Geroscience: linking aging to chronic disease. Cell [Internet]. 2014;159(4):709–13. https://doi.org/10.1016/j.cell.2014.10.039.
4. Pretty IA. The life course, care pathways and elements of vulnerability. A picture of health needs in a vulnerable population. Gerodontology. 2014;31:1–8.
5. Donini LM, Savina C, di Roma U, Sapienza L, Roma IL, di Scienza dell L, et al. Eating habits and appetite control in the elderly: the anorexia of aging. Int Psychogeriatrics [Internet]. 2003;IS(1):73–87. https://journals.scholarsportal.info/pdf/10416102/v15i0001/73_ehaacitetaoa.xml.
6. Elsner RJF. Changes in eating behavior during the aging process. Eat Behav. 2002;3(1):15–43.
7. Palacios C, Joshipura KJ, Willett W. Nutrition and health: guidelines for dental practitioners. Oral Dis [Internet]. 2009;15(6):369–81. http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=emed9&NEWS=N&AN=2009442641.
8. Bloom I, Lawrence W, Barker M, Baird J, Dennison E, Sayer AA, et al. What influences diet quality in older people? A qualitative study among community-dwelling older adults from the Hertfordshire cohort study. UK Public Health Nutr. 2017;20(15):2685–93.
9. Nabeshima G, Fueki K, Inamochi Y, Wakabayashi N. Effect of dietary counselling with prosthetic restoration on fruit and vegetable intake in partially dentate patients: a prospective study. J Oral Rehabil. 2018;45(8):618–26.
10. Reyes Fernández B, Warner LM, Knoll N, Montenegro Montenegro E, Schwarzer R. Synergistic effects of social support and self-efficacy on dietary motivation predicting fruit and vegetable intake. Appetite [Internet]. 2015;87:330–5. https://doi.org/10.1016/j.appet.2014.12.223.
11. Whitelock E, Ensaff H. On your own: older adults' food choice and dietary habits. Nutrients. 2018;10(4).
12. Bruins MJ, Van Dael P, Eggersdorfer M. The role of nutrients in reducing the risk for noncommunicable diseases during aging. Nutrients. 2019;11(1).
13. Mertens E, Kuijsten A, Dofková M, Mistura L, D'Addezio L, Turrini A, et al. Geographic and socioeconomic diversity of food and nutrient intakes: a comparison of four European countries. Eur J Nutr. 2019;58(4):1475–93.
14. Mozaffarian D, Rosenberg I, Uauy R. History of modern nutrition science-implications for current research, dietary guidelines, and food policy. BMJ. 2018;361:1–6.
15. Yoshida M, Suzuki R, Kikutani T. Nutrition and oral status in elderly people. Jpn Dent Sci Rev [Internet]. 2014;50(1):9–14. https://doi.org/10.1016/j.jdsr.2013.09.001.
16. Friedman PK, Lamster IB. Tooth loss as a predictor of shortened longevity: exploring the hypothesis. Periodontol 2000. 2016;72(1):142–52.
17. Tada A, Miura H. Association between mastication and cognitive status: a systematic review. Arch Gerontol Geriatr. 2017;70:44–53.
18. Kondo H, Kurahashi M, Mori D, Iinuma M, Tamura Y, Mizutani K, et al. Hippocampus-dependent spatial memory impairment due to molar tooth loss is ameliorated by an enriched environment. Arch Oral Biol. 2016;61:1–7.
19. Campos CH, Ribeiro GR, Costa JLR, Rodrigues Garcia RCM. Correlation of cognitive and masticatory function in Alzheimer's disease. Clin Oral Investig. 2017;21(2):573–8.
20. Wu B, Fillenbaum GG, Plassman BL, Guo L. Association between oral health and cognitive status: a systematic review. J Am Geriatr Soc. 2016;64(4):739–51.

21. Cerutti-Kopplin D, Emami E, Hilgert JB, Hugo FN, Padilha DMP. Cognitive status of edentate elders wearing complete denture: does quality of denture matter? J Dent. 2015;43(9):1071–5.
22. Heath MR. The oral management of food: the bases of oral success and for understanding the sensations that drive us to eat. Food Qual Prefer. 2002;13:453–61.
23. Peres MA, Macpherson LMD, Weyant RJ, Daly B, Venturelli R, Mathur MR, et al. Oral diseases: a global public health challenge. Lancet [Internet]. 2019;394(10194):249–60. https://linkinghub.elsevier.com/retrieve/pii/S0140673619311468.
24. Harding A, Gonder U, Robinson SJ, Crean SJ, Singhrao SK. Exploring the association between Alzheimer's disease, oral health, microbial endocrinology and nutrition. Front Aging Neurosci. 2017;9:398.
25. Petersen P, Yamamoto T. Improving the oral health of older people: the approach of the WHO global oral health programme. Commun Dent Oral Epidemiol [Internet]. 2005;33(2):81–92. http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=emed7&NEWS=N&AN=15725170.
26. Naka O, Anastassiadou V, Pissiotis A. Association between functional tooth units and chewing ability in older adults: a systematic review. Gerodontology. 2014;31(3):166–77.
27. Kossioni AE, Dontas A. The stomatognathic system in the elderly. Useful information for the medical practitioner. Clin Interv Aging. 2008;2(4):591–7.
28. Wöstmann B, Simon T, Neuhäuser-Berthold M, Rehmann P. Pilot study on the influence of nutritional counselling and implant therapy on the nutritional status in dentally compromised patients. PLoS One [Internet]. 2016;11(1):1–11. https://doi.org/10.1371/journal.pone.0147193.
29. Kossioni A, Bellou O. Eating habits in older people in Greece: the role of age, dental status and chewing difficulties. Arch Gerontol Geriatr. 2011;52:197–201.
30. Kossioni AE, Hajto-Bryk J, Janssens B, Maggi S, Marchini L, McKenna G, et al. Practical guidelines for physicians in promoting oral health in frail older adults. J Am Med Dir Assoc. 2018;19(12):1039–46.
31. Anastassiadou V, Naka O, Heath MR, Kapari D. Validation of indices for functional assessment of dentures. Gerodontology. 2002;19(1).
32. Anastassiadou V, Robin Heath M. The effect of denture quality attributes on satisfaction and eating difficulties. Gerodontology. 2006;23(1).
33. Komagamine Y, Kanazawa M, Iwaki M, Jo A, Suzuki H, Amagai N, et al. Combined effect of new complete dentures and simple dietary advice on nutritional status in edentulous patients: study protocol for a randomized controlled trial. Trials [Internet]. 2016;17(1):1–7. https://doi.org/10.1186/s13063-016-1664-y.
34. Mcgowan L, Mccrum L-A, Watson S, Cardwell C, McGuinness B, Rutherford H, et al. The impact of oral rehabilitation coupled with healthy dietary advice on the nutritional status of adults: a systematic review and meta-analysis. Crit Rev Food Sci Nutr [Internet]. 2019:1–21. https://www.tandfonline.com/doi/full/10.1080/10408398.2019.1630600.
35. Mioche L, Bourdiol P, Monier S. Chewing behaviour and bolus formation during mastication of meat with different textures. Arch Oral Biol. 2003;48(3):193–200.
36. Mishellany-Dutour A, Renaud J, Peyron M-A, Rimek F, Woda A. Is the goal of mastication reached in young dentates, aged dentates and aged denture wearers? Br J Nutr. 2008;99(1):121–8.
37. Hildebrandt G, Dominguez L, Schork M, Loesche WJ. Functional units, chewing, swallowing, and food avoidance among the elderly. J Prosthet Dent [Internet]. 1997;77(6):588–95. http://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,shib&db=jlh&AN=107346669&site=ehost-live&scope=site.
38. Miura H, Araki Y, Hirai T, Isogai E, Hirose K, Umenai T. Evaluation of chewing activity in elderly person. J Oral Rehabil. 1998;25(3):190–3.
39. Ostenberg T, Tsuga K, Rothenberg E, Carlsson G, Steen B. Masticatory ability in 80-year-old subjects and its relation to intake of energy, nutrients and food items. Gerodontology. 2002;19(2):95–101.

40. Bomfim RA, de Souza LB, Corrente JE. Tooth loss and its relationship with protein intake by elderly Brazilians—a structural equation modelling approach. Gerodontology. 2018;35(1):51–8.
41. van der Putten GJ, de Baat C, De Visschere L, Schols J. Poor oral health, a potential new geriatric syndrome. Gerodontology. 2014;31:17–24.
42. Callif K, Schwarzberg-Lipson K, Garg N, Gibbons S, Caporaso J, Slots J, et al. crossm. mSystems [Internet]. 2017;2(3):1–14. https://msystems.asm.org/content/2/3/e00016-17.
43. Zaura E, Brandt BW, Prodan A, Teixeira De Mattos MJ, Imangaliyev S, Kool J, et al. On the ecosystemic network of saliva in healthy young adults. ISME J [Internet]. 2017;11(5):1218–31. https://doi.org/10.1038/ismej.2016.199.
44. Leslie W, Hankey C. Aging, nutritional status and health. Healthcare. 2015;3(3):648–58.
45. Liljestrand JM, Havulinna AS, Paju S, Männistö S, Salomaa V, Pussinen PJ. Missing teeth predict incident cardiovascular events, diabetes, and death. J Dent Res. 2015;94(8):1055–62.
46. Chrysohoou C, Pitsavos C, Panagiotakos DB, Skoumas J, Stefanadis C. Association between prehypertension status and inflammatory markers related to atherosclerotic disease: the ATTICA study. Am J Hypertens. 2004;17(7):568–73.
47. Scannapieco FA, Cantos A. Oral inflammation and infection, and chronic medical diseases: implications for the elderly. Periodontol 2000. 2016;72:153–75.
48. Barnes VM, Kennedy AD, Panagakos F, Devizio W, Trivedi HM, Jönsson T, et al. Global metabolomic analysis of human saliva and plasma from healthy and diabetic subjects, with and without periodontal disease. PLoS One. 2014;9(8):1–8.
49. Panagiotakos DB, Milias GA, Pitsavos C, Stefanadis C. MedDietScore: a computer program that evaluates the adherence to the Mediterranean dietary pattern and its relation to cardiovascular disease risk. Comput Methods Prog Biomed. 2006;83(1):73–7.
50. Hughes S, Kelly P. Interactions of malnutrition and immune impairment, with specific reference to immunity against parasites. Parasite Immunol. 2006;28(11):577–88.
51. Loesche WJ, Lopatin DE. Interactions between periodontal disease, medical diseases and immunity in the older individual. Periodontol 2000. 1998;16(1):80–105.
52. Kanasi E, Ayilavarapu S, Jones J. The aging population: demographics and the biology of aging. Periodontol 2000. 2016;72(1):13–8.
53. Toniazzo MP, de Amorim PSA, Muniz FWMG, Weidlich P. relationship of nutritional status and oral health in elderly: systematic review with meta-analysis. Clin Nutr [Internet]. 2018;37(3):824–30. https://doi.org/10.1016/j.clnu.2017.03.014.
54. El Osta N, Hennequin M, Tubert-Jeannin S, Abboud Naaman NB, El Osta L, Geahchan N. The pertinence of oral health indicators in nutritional studies in the elderly. Clin Nutr [Internet]. 2014;33(2):316–21. https://doi.org/10.1016/j.clnu.2013.05.012.

Quality of Life and Oral Health in Older People

6

Dominique Niesten and Gerry McKenna

Abstract

The concept of oral health-related quality of life (OHRQoL) delineates how oral outcomes impact on an individual's physical, psychological, and social functioning and hence overall quality of life. It explains how compromised oral health can negatively impact on quality of life through impairing daily activities, social interactions, and self-esteem. Factors that contribute to OHRQoL are in the areas of: oral health (mostly tooth loss, periodontal disease, and pain), general health (especially chronic conditions and cognitive impairments causing deficient oral health behaviour), personal traits (including the ability to cope and adapt), demographic factors (age, gender, socioeconomic status, ethnicity, culture), social (support, integration), and environmental factors (lifestyle, place of residence). In order to assess OHRQoL outcomes, a number of specific instruments, mostly questionnaires, have been developed.

Medical practitioners can make a major contribution towards improvement of OHRQoL and thereby the overall quality of life of their patients, and the public at large, through including oral health-related questions in holistic medical assessments, promotion of good oral hygiene practices, and increasing the awareness of the importance of good oral health to maintaining overall quality of life.

D. Niesten (✉)
College of Dental Sciences, Radboud University Nijmegen Medical Center, Nijmegen, The Netherlands
e-mail: Dominique.niesten@radboudumc.nl

G. McKenna
Centre for Public Health, School of Medicine, Dentistry and Biomedical Sciences, Queen's University Belfast, Belfast, UK
e-mail: G.McKenna@qub.ac.uk

A. Kossioni (ed.), *Gerodontology Essentials for Health Care Professionals*, Practical Issues in Geriatrics, https://doi.org/10.1007/978-3-030-41468-9_6

Learning Objectives
After reading this chapter, readers should be able to:

- Understand the concept of oral health-related quality of life.
- State the dimensions measured in different methods of measuring oral health-related quality of life.
- Argue on the importance of good oral health in maintaining overall quality of life.

6.1 OHRQoL: The Concept, Its Relation to General Health, Assessment

Quality of life (QoL) is defined as 'an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns' [1]. As such, QoL is closely related to well-being [2], and is both multidisciplinary and subjective in nature. QoL is affected through complex interactions between an individual's physical and psychological health, personal beliefs, social relationships, and their environment, and can only be understood from a personal perspective. This can help to explain why persons with similar health status can have different QoL perspectives based on differing experiences, expectations, and perceptions.

Oral health is understood to be integral to both general health and quality of life [3]. As such, the concept of oral health-related QoL (OHRQoL) delineates how oral outcomes impact on an individual's overall QoL. Many definitions of OHRQoL have been suggested since Locker first described the concept and illustrated the pathways involved [4, 5]. This description captured all of the important aspects of oral health which contribute to QoL including function (chewing, biting, speaking, swallowing), psychological factors (aesthetics, self-esteem, appearance), social factors (relating to interactions with others), and the experience of pain and discomfort. A recent definition by the FDI World Dental Federation closely reflects the dynamic, multidimensional, and subjective nature of the concept: *'OHRQoL is a multidimensional construct that reflects (among other things) people's comfort when eating, sleeping and engaging in social interaction; their self-esteem; and their satisfaction, with respect to their oral health'* [6].

In the last two decades, the concept of OHRQoL has helped to shift the emphasis of clinicians and researchers from purely focusing on objective measures of oral health to adopting a more holistic and patient-centred approach. It acknowledges that the ultimate goal of dental care, good oral health, is not the mere absence of oral disease or disorders. Although these clinical oral outcomes remain relevant, the experienced functional, psychological, and social impacts of oral outcomes on a person's QoL are arguably more important. This is especially true in an era where a patient's values, preferences, and context play a central role in clinical decision-making and where personalized healthcare is the dominant healthcare paradigm [7, 8]. Thus, OHRQoL outcomes are vital not only to the delivery of oral healthcare,

but also to shape oral health promotion and prevention programmes, allocate resources, develop oral health policies, and organize oral healthcare. Documented uses of OHRQoL outcomes are listed in Table 6.1.

In aspects of healthcare, a series of Patient Reported Outcome Measures (PROMs) have been developed to measure outcomes which matter to patients. In order to assess OHRQoL outcomes, a number of specific instruments have also been developed. These instruments utilize a variety of methodologies, of which the self-administered individual questionnaire is the most popular [10]. Table 6.2 lists the most often used questionnaires and their characteristics. Although such questionnaires differ in underlying theory, focus, and length they all attempt to capture the constituent elements of OHRQoL (functional, psychological, social, pain/discomfort). It is important to note that the way in which these factors contribute to an individual's OHRQoL depends on the person, the situation, and the interaction between that person and the situation. These relationships are dynamic and can change significantly over time, in particular when patients become frail or care dependent [12], as demonstrated through the case of 'Mrs. Brown'.

Table 6.1 Uses of measures of health-related quality of life

- Screening and monitoring for psychosocial problems in individual patient care
- Population surveys of perceived health problems
- Medical audit
- Outcome measures in health services or evaluation research
- Clinical trials
- Cost-utility analysis

Source: Fitzpatrick et al. [9]

Table 6.2 Characteristics of the most used OHRQoL assessment instruments

Instrument	Abbreviation	Dimensions measured	No. of questions
Oral health impact profile	OHIP, OHIP-14	Function, pain, physical disability, social disability, handicap	49 (14)
Dental impact profile	DIP	Appearance, eating, speech, confidence, happiness, social life, relationships	25
General/geriatric oral health assessment index	GOHAI	Pain/discomfort, psychosocial, functional	12
Oral health quality of life inventory	OHQoL inventory	Oral health, nutrition, self-rated oral health, overall QoL	56
Dental impact of daily living	DIDL	Comfort, appearance, pain, daily activities, eating	36
Oral health-related quality of life	OHQoL	Daily activities, social activities, conversation	3
Oral impacts on daily performances	OIDL	Eating, speaking, oral hygiene, sleeping, appearance	9

Source: Adapted from Bennadi 2013 [11]

Case. Mrs. Brown

Mrs. Brown has always cared a lot about her appearance, as shown through her immaculate clothing, well-manicured fingers, well-groomed hairstyle, and neat facial make-up. She has always visited the dentist twice a year and her oral self-care has always been perfect. At the age of 82, she still has all of her natural teeth. However, she has progressive Parkinson's disease. Her joints are increasingly painful and have started to impede her dexterity. Handling a toothbrush is increasingly difficult for her. Since she is aware that her toothbrushing efforts are not effective, she has decided—also because she feels tired almost throughout the day—to give up brushing. As a result, she develops a number of carious lesions and ends up losing five teeth in 6 months' time. Now, several scenarios are possible, e.g.:

(a) *She cannot bite hard food anymore and she minds—her OHRQoL is negatively affected in the oral function domain.*
(b) *She does not mind her oral functions, but cares a lot about her mutilated dentition, she hates the ways she looks now and does not dare to go out anymore (her OHRQoL is negatively affected in the psychological and social domain)*
(c) *She adapts to the new situation by eating only soft foods and not looking in the mirror anymore—impacts on her OHRQoL are nil.*
(d) *She decides to have her teeth replaced by full dental prostheses and adapts to wearing these; she likes the look of her new teeth even more than her natural teeth and is satisfied with the oral functions—impacts on her OHRQoL are positive.*

Reported OHRQoL outcomes of older people almost exclusively result from quantitative surveys which utilize the questionnaires in Table 6.2. One major drawback of these OHRQoL questionnaires is that they generally only measure negative oral health impacts without considering the potentially positive or neutral experiences of such negative oral impacts. For instance, not all patients are concerned that they cannot bite an apple because of loose teeth. Such a response could be a result of coping and adaptation [13, 14] and altered health expectations in old age [15]. These neutral or positive responses to negative QoL impacts could help to clarify the discrepancy between self-rated oral health status and related OHRQoL found in older people [15–17]. In this light, it is important to notice that existing evidence on the associations between OHRQoL and oral health of older people is controversial, with several studies indicating that the OHRQoL remains stable or even improves despite decreasing oral health [15–19], while others show a negative effect of decreasing OH on OHRQoL [20–23].

Since OHRQoL is highly dependent on a context that is rapidly changing in old age, this context should be queried by care providers and researchers, ideally through open questions (e.g. What is important to you in life? What activities do

contribute to your well-being? How does your oral health support or impede engagement in such activities?), and possibly in addition to OHRQoL self-administered questionnaires. Such questioning can also help to identify older people who do not prioritize oral health, thus enabling appropriate preventative and educational regimes to be implemented.

6.2 Factors Contributing to OHRQoL

Since the development of the first OHRQoL instruments, hundreds of studies have assessed the factors that contribute to OHRQoL. These factors can be divided into several categories: oral health, general health, personal traits, demographic factors, and social and environmental factors. Which factors have the strongest predictive value depends primarily on characteristics of the target population and, to a lesser extent, to the used instruments. In older populations, oral health factors often appear to have relatively less predictive value than, for instance, social factors and personal traits. Moreover, none of the factors associated with OHRQoL are evidenced consistently in scientific studies, nor are their effects consistent across similar populations and, at individual and population level, over time.

Oral health: A systematic review and meta-analysis has indicated that loss of natural teeth is directly and negatively associated with OHRQoL [24]. Analysed evidence was derived from all parts of the world, including Europe, North and Southern America, Southeast Asia (China, Japan, South Korea, Sri Lanka), and Africa (Tanzania). This review included a study from Finland which used nationally representative population datasets to explore the relationship between age, tooth loss, and OHRQoL. The authors reported that age and tooth loss are closely associated, but have independent effects on OHRQoL [25]. Tooth loss (which is associated with increasing age) is associated with more negative impacts, while increasing age independently results in fewer. In all of the populations and sub-populations studied, a complete or almost complete natural dentition was associated with the best OHRQoL.

Tooth loss not only impairs chewing functions, speech, and appearance, it also negatively affects people's self-worth, e.g. by hampering a person's sense of intactness and pride, as well as interpersonal relationships [26]. Prosthodontic replacement of missing teeth can also impact on OHRQoL, with a generally positive impact reported for fixed prostheses [27] compared with mixed impacts for removable prostheses (Figs. 6.1, 6.2, 6.3, and 6.4). In older people ill- or loose fitting removable prostheses are often a source of pain and discomfort [28] and can severely impact OHRQoL. This point has been illustrated in work carried out by McKenna et al. who demonstrated significantly improved OHRQoL outcomes for partially dentate older patients restored to shortened dental arches (a specific type of a dentition with a reduced number of posterior teeth, often called functional dentition) with fixed prostheses compared to removable partial dentures (Figs. 6.3 and 6.4) [29]. A decreased number of teeth, as well as ill-fitting tooth replacements, lead to reduced chewing ability which in turn can result in a preference for foods that are softer and

Fig. 6.1 Edentate older patient prior to prosthodontic rehabilitation with complete dentures

Fig. 6.2 Edentate older patient rehabilitated with complete dentures

Fig. 6.3 Patient rehabilitated to a shortened dental arch using fixed adhesive prostheses (a specific type of a dentition with a reduced number of posterior teeth, often called functional dentition)

Fig. 6.4 Partially dentate patient rehabilitated using a removable partial denture

easier to chew. Typically, such foods are relatively low in nutrients and high in calories and complex carbohydrates [30], and hence induce poor nutritional status and subsequent health. It should thereby be noted that adequate masticatory function is a prerequisite but not sufficient condition for good nutrient intake [31]. Poor eating behaviour of the elderly people is also influenced by personal and contextual factors, such as depression, physical illness, tastiness of served meals, and social context (detailed discussion in Chap. 5).

A recent systematic review showed that periodontal diseases also seem to be associated with worse OHRQoL, with severe periodontitis exerting the most significant impact by compromising aspects related to oral function and aesthetics [32]. Evidence was derived from over 20 countries worldwide, including Brazil, the UK, the USA, Australia, India, China, Jordan, and Nigeria. The same review showed that gingivitis (inflammation of the gums) was associated with pain, discomfort, and with difficulties performing oral hygiene and wearing dentures.

Other oral health factors that are associated with OHRQoL, mostly through pain and discomfort or affecting appearance, are toothache, fractured or damaged teeth, oral cancer, mucositis, and xerostomia [33]. Caries, which is the most prevalent oral disease, eventually leading to tooth destruction, and tooth loss, is often unnoticed by the patient, and has therefore no or little impact on OHRQoL until it becomes severe and causes pain or discomfort. This illustrates why regular and systematic oral health assessments by care providers (dental and non-dental staff) are vitally important to detect carious lesions before they become symptomatic and potentially difficult to manage.

General health: Despite considerable evidence for significant associations between oral and systemic health conditions, evidence on associations between impaired general health and oral health-related quality of life (OHRQoL) offer contradicting results. For instance, Jensen et al. [34] found no association between OHRQoL and performance in activities of daily living (ADL), while Miura et al. [35] found a significant positive association between OHRQoL and ADL, especially communication. Ostberg et al. [36] showed that OHRQoL was significantly associated with self-rated general health and self-rated mental health, but not with

self-rated physical health, whereas Hassel et al. [37] found a significant inverse association between physical pain and OHRQoL. Similar inconsistent findings have resulted from research on the associations between general health and quality of life. Clearly, the associations between impaired health, OH and OHRQoL are complex. Yet, evidence on links between impaired general health and disadvantageous oral health behaviour (oral self-care (e.g. toothbrushing) and dental service use) is less controversial: people with chronic conditions, pain, impaired dexterity or mobility, low energy, depression, and especially with impaired cognitive functions, show worse oral healthcare behaviour than healthy persons [38–42], with a proven negative effect on their oral health (e.g. [42]).

Personal, demographic, social, and environmental factors: As populations age and lose teeth, their quality of life may be expected to change, particularly with respect to the way that their oral condition impacts on day-to-day activities. This may happen as a direct result of altered function due to tooth loss, but possibly also as a result of changes in perceptions and values that occur with increasing age. Evidence has shown that experience of oral diseases has a more significant impact on subjective oral health when it occurs early in adulthood rather than in old age [16]. Other factors which may mediate the relationship between OH and QoL are personal traits, health beliefs, demographic factors, social and environmental factors. Personal traits include coping and adaptation ability, locus of control (the degree to which people believe that they have control over the outcome of events in their lives), self-efficacy (the degree to which people believe they can succeed in a specific situation or accomplish a task), neuroticism, extraversion, and optimism [43–48]. The fact that the above factors mitigate OHRQoL is, for instance, explained by the need for older people to adapt as an integral part of successful ageing and a means of coping with the impact of oral disorders, and by balancing gains and losses, adjusting expectations, and seeking social support [49, 50].

Demographic factors that have been shown to positively impact OHRQoL include higher age, being male, ethnicity (e.g. not belonging to ethnic minorities and being of Caucasian origin), higher socioeconomic status, and residing in an urban environment (e.g. [12, 42]).

Social and environmental factors include social and lifestyle factors. More social support and a higher degree of social integration have been proven to increase OHRQoL [51, 52].

In general, social determinants of health (being ‘the conditions in which people are born, grow, work, live, and age, and the wider set of forces and systems shaping the conditions of daily life like economic policies and systems, development agendas, social norms, social policies and political systems’ (www.who.int/social_determinants/en/)), influence both oral health and OHRQoL throughout the life-course [53]. Improving OHRQoL therefore would ideally involve multifactorial life-course interventions. In any case, interventions aiming at (general) health promotion, development of positive health beliefs, and better access to healthcare from early childhood onwards, will also benefit OHRQoL. Therefore, oral health prevention and promotion should be a priority for all members of the care team (dental and non-dental members of staff).

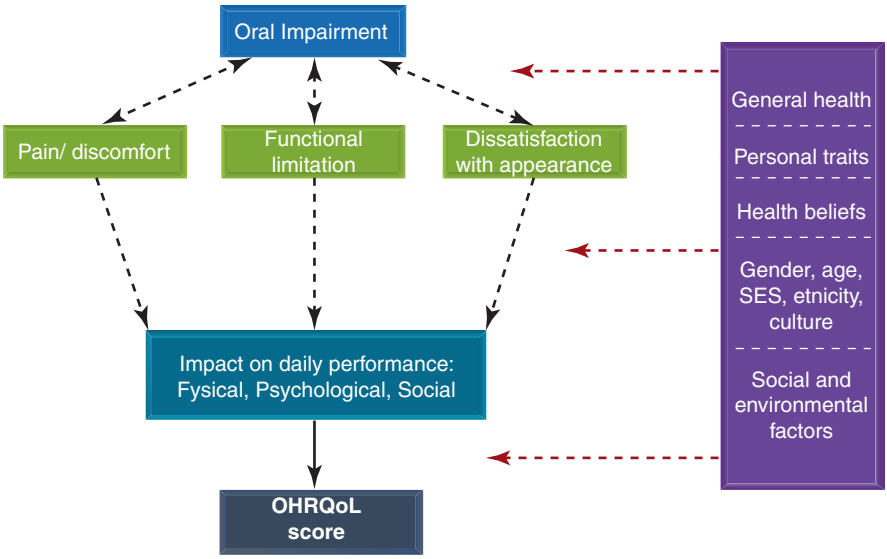

Fig. 6.5 Theorized pathways affecting OHRQoL. Dotted lines symbolize an evidenced possible effect. The model left from the purple rectangle is a modified version of the model from the WHO International Classification of Impairments, Disabilities, and Handicaps amended for dentistry [54]

Figure 6.5 delineates the associations between evidenced factors and OHRQoL, and the mediating role of non-oral health factors (in the purple rectangle) on the links between oral impairments, experienced oral effects, and impacts on daily performance. To illustrate the tentative nature of associations and controversies about direction of found relations between the above factors, lines are dotted, and some lines double-arrowed.

6.3 Implications for Healthcare Practice

As demonstrated in this chapter, there are numerous ways that oral health can have significant impacts on quality of life. Moreover, poor oral health may be underreported by the older patients for the reasons previously explained. All members of the healthcare team should be aware of these threats and implications and strive to promote and deliver care which preserves and improves oral health-related quality of life.

Given that poor oral health has negative impacts on quality of life, it is essential that every effort is made to regularly evaluate oral health status and prevent chronic dental diseases and ultimately natural tooth loss. Dental care for older patients should have a preventative focus with attention given to clear and achievable messages. Where patients are dependent, these messages should be shared with carers and family members. Preventative advice should be tailored to take into account individual patients' needs with adaptation of oral hygiene tools suggested for those

with physical limitations. This advice should be emphasized regularly and checked to ensure understanding and implementation.

6.4 Conclusion

Regardless of the definition of OHRQoL, it is clear that oral conditions can have varied impacts on daily living and that the patients' perceptions about their oral health and related QoL are significant in clinical practice and patient management. The extent of these impacts could be assessed by OHRQoL assessments, wherein standardized, validated instruments should ideally be complemented by open questions. Such assessments can be appropriately incorporated into oral healthcare practices, but also in general healthcare, e.g. through inclusion of such questions in comprehensive geriatric or medical assessments. As such, healthcare professionals play an important role in enhancing the OHRQoL, and thereby QoL of their patients and the public at large.

The importance of assessing both patients' perceptions of health and presence or absence of disease lies in the need to have accurate data to promote health, disease prevention programmes, and for allocation of health resources. Furthermore, as patients' assessment of their health-related quality of life is often markedly different to the opinion of healthcare professionals, patient assessment of healthcare interventions is warranted.

References

1. World Health Organization. WHOQOL: measuring quality of life. https://www.who.int/healthinfo/survey/whoqol-qualityoflife/en/.
2. Skevington SM, Bohnke JR. How is subjective well-being related to quality of life? Do we need two concepts and both measures? Soc Sci Med. 2018;206:22–30.
3. Baiju RM, Peter E, Varghese NO, Sivaram R. Oral health and quality of life: current concepts. J Clin Diagn Res. 2017;11(6):Ze21–ze26.
4. Locker D. Concepts of oral health, disease and the quality of life. In: Measuring oral health and quality of life. Chapel-Hill: Department of Dental Ecology, University of North Carolina; 1996.
5. Sischo L, Broder HL. Oral health-related quality of life: what, why, how, and future implications. J Dent Res. 2011;90(11):1264–70.
6. FDI World Dental Federation, Oral health and quality of life. https://www.fdiworlddental.org/resources/policy-statements-and-resolutions/oral-health-and-quality-of-life.
7. Blobel B, Ruotsalainen P. Healthcare transformation towards personalized medicine—chances and challenges. Stud Health Technol Inform. 2019;261:3–21.
8. Annadurai K, Danasekaran R, Mani G. Personalized medicine: a paradigm shift towards promising health care. J Pharm Bioallied Sci. 2016;8(1):77–8.
9. Fitzpatrick R, Fletcher A, Gore D, Spiegelhalter D, Cox D. Quality of life measures in health care. I: application and issues in assessment. Br Med J. 1992;305:1074–7.
10. Abreu LG. An overview of oral health related quality of life. Oral Health Case Rep. 2015;1:e105.

11. Bennadi D, Reddy CV. Oral health related quality of life. J Int Soc Prev Community Dent. 2013;3(1):1–6.
12. Niesten D. Oral health care and oral health-related quality of life of frail and care-dependent older people, in medicine. Radboud University Nijmegen: Nijmegen; 2017.
13. Allison PJ, Locker D, Feine JS. Quality of life: a dynamic construct. Soc Sci Med. 1997;45(2):221–30.
14. von Faber M, Bootsma-van der Wiel A, van Exel E, Gussekloo J, Lagaay AM, van Dongen E, et al. Successful aging in the oldest old: who can be characterized as successfully aged? Arch Intern Med. 2001;161(22):2694–700.
15. Locker D, Gibson B. Discrepancies between self-ratings of and satisfaction with oral health in two older adult populations. Community Dent Oral Epidemiol. 2005;33(4):280–8.
16. Slade GD, Sanders AE. The paradox of better subjective oral health in older age. J Dent Res. 2011;90(11):1279–85.
17. Steele JG, Sanders AE, Slade GD, Allen PF, Lahti S, Nuttall N, et al. How do age and tooth loss affect oral health impacts and quality of life? A study comparing two national samples. Community Dent Oral Epidemiol. 2004;32(2):107–14.
18. Sanders AE, Slade GD, Lim S, Reisine ST. Impact of oral disease on quality of life in the US and Australian populations. Community Dent Oral Epidemiol. 2009;37(2):171–81.
19. Dahl KE, Wang NJ, Skau I, Ohrn K. Oral health-related quality of life and associated factors in Norwegian adults. Acta Odontol Scand. 2011;69(4):208–14.
20. Petersen PE, Kandelman D, Arpin S, Ogawa H. Global oral health of older people—call for public health action. Community Dent Health. 2010;27(4 Suppl 2):257–67.
21. Ettinger RL. Oral health and the aging population. J Am Dent Assoc. 2007;138(Suppl):5S–6S.
22. Locker D, Clarke M, Payne B. Self-perceived oral health status, psychological well-being, and life satisfaction in an older adult population. J Dent Res. 2000;79(4):970–5.
23. MacEntee MI. Missing links in oral health care for frail elderly people. J Can Dent Assoc. 2006;72(5):421–5.
24. Gerritsen AE, Allen PF, Witter DJ, Bronkhorst EM, Creugers NH. Tooth loss and oral health-related quality of life: a systematic review and meta-analysis. Health Qual Life Outcomes. 2010;8:126.
25. Lahti S, Suominen-Taipale L, Hausen H. Oral health impacts among adults in Finland: competing effects of age, number of teeth, and removable dentures. Eur J Oral Sci. 2008;116(3):260–6.
26. Niesten D, van Mourik K, van der Sanden W. The impact of having natural teeth on the QoL of frail dentulous older people. A qualitative study. BMC Public Health. 2012;12:839.
27. Ali Z, Baker SR, Shahrbaf S, Martin N, Vettore MV. Oral health-related quality of life after prosthodontic treatment for patients with partial edentulism: a systematic review and meta-analysis. J Prosthet Dent. 2019;121(1):59–68.e3.
28. MacEntee MI, Hole R, Stolar E. The significance of the mouth in old age. Soc Sci Med. 1997;45(9):1449–58.
29. McKenna G, Allen PF, Hayes M, DaMata C, Moore C, Cronin M. Impact of oral rehabilitation on the quality of life of partially dentate elders in a randomised controlled clinical trial: 2 year follow-up. PLoS One. 2018;13(10):e0203349.
30. Moynihan PJ. The relationship between nutrition and systemic and oral well-being in older people. J Am Dent Assoc. 2007;138(4):493–7.
31. Tada A, Miura H. Systematic review of the association of mastication with food and nutrient intake in the independent elderly. Arch Gerontol Geriatr. 2014;59(3):497–505.
32. Ferreira MC, Dias-Pereira AC, Branco-de-Almeida LS, Martins CC, Paiva SM. Impact of periodontal disease on quality of life: a systematic review. J Periodontal Res. 2017;52(4):651–65.
33. Skoskiewicz-Malinowska K, Malicka B, Zietek M, Kaczmarek U. Does oral dryness influence quality of life? Current perspectives in elderly dental care. Adv Clin Exp Med. 2019;28(9):1209–16.
34. Jensen PM, Saunders RL, Thierer T, Friedman B. Factors associated with oral health-related quality of life in community-dwelling elderly persons with disabilities. J Am Geriatr Soc. 2008;56(4):711–7.

35. Miura H, Yamasaki K, Morizaki N, Moriya S, Sumi Y. Factors influencing oral health-related quality of life (OHRQoL) among the frail elderly residing in the community with their family. Arch Gerontol Geriatr. 2010;51(3):e62–5.
36. Ostberg AL, Hall-Lord ML. Oral health-related quality of life in older Swedish people with pain problems. Scand J Caring Sci. 2011;25(3):510–6.
37. Hassel AJ, Koke U, Schmitter M, Rammelsberg P. Factors associated with oral health-related quality of life in institutionalized elderly. Acta Odontol Scand. 2006;64(1):9–15.
38. Dolan TA, Peek CW, Stuck AE, Beck JC. Functional health and dental service use among older adults. J Gerontol A Biol Sci Med Sci. 1998;53(6):M413–8.
39. Chalmers J, Pearson A. Oral hygiene care for residents with dementia: a literature review. J Adv Nurs. 2005;52(4):410–9.
40. Niesten D, Witter D, Bronkhorst E, Creugers N. Oral health-related quality of life and associated factors in a care-dependent and a care-independent older population. J Dent. 2016;55:33–9.
41. Niesten D, Witter DJ, Bronkhorst EM, Creugers NHJ. Oral health care behavior and frailty-related factors in a care-dependent older population. J Dent. 2017;61:39–47.
42. MacEntee MI, editor. Oral healthcare and the frail elder. Iowa: Wiley-Blackwell; 2011.
43. Ekback G, Persson C, Linden-Bostrom M. What factors can be protective for both self-rated oral health and general health? Swed Dent J. 2015;39(2):99–107.
44. Takeshita H, Ikebe K, Kagawa R, Okada T, Gondo Y, Nakagawa T, et al. Association of personality traits with oral health-related quality of life independently of objective oral health status: a study of community-dwelling elderly Japanese. J Dent. 2015;43(3):342–9.
45. Jamieson LM, Parker EJ, Roberts-Thomson KF, Lawrence HP, Broughton J. Self-efficacy and self-rated oral health among pregnant aboriginal Australian women. BMC Oral Health. 2014;14:29.
46. Schwartz CE, Bode R, Repucci N, Becker J, Sprangers MA, Fayers PM. The clinical significance of adaptation to changing health: a meta-analysis of response shift. Qual Life Res. 2006;15(9):1533–50.
47. Acharya S, Sangam DK. Oral health-related quality of life and its relationship with health locus of control among Indian dental university students. Eur J Dent Educ. 2008;12(4):208–12.
48. Miao L, Feng J, Wu L, Zhang S, Ge Z, Pan Y. The mediating role of general self-efficacy in the association between perceived social support and oral health-related quality of life after initial periodontal therapy. BMC Oral Health. 2016;16(1):68.
49. MacEntee MI. Quality of life as an indicator of oral health in older people. J Am Dent Assoc. 2007;138(Suppl):47S–52S.
50. Brondani M. The voice of the elderly in accepting alternative perspectives on oral health. Community Dent Health. 2010;27(3):139–44.
51. Maupome G, MacEntee MI. Prosthodontic profiles relating to economic status, social network, and social support in an elderly population living independently in Canada. J Prosthet Dent. 1998;80(5):598–604.
52. McGrath C, Bedi R. Influences of social support on the oral health of older people in Britain. J Oral Rehabil. 2002;29(10):918–22.
53. Watt RG. Emerging theories into the social determinants of health: implications for oral health promotion. Community Dent Oral Epidemiol. 2002;30(4):241–7.
54. Locker D. Measuring oral health: a conceptual framework. Community Dent Health. 1988;5:3–18.

Oral Health Assessment in Primary and Institutional Care

7

Frauke Müller and Leonardo Marchini

Abstract

Gradual improvement in the prevention and treatment of oral diseases lead to the current and future older adults being likely to keeping all, or at least most teeth for life. However, age-related risk factors render elder persons more susceptible for rapid oral health deterioration, and consequently they often present worse oral health compared to younger cohorts. Due to limited income, reduced mobility and a shift in priorities, many older adults have irregular access to oral healthcare and a lower uptake of dental services. Yet, preserving oral health and a functional dentition is important for the general well-being. Beyond just preventing local pain, maintaining appropriate oral health reduces the risk of infection and oral bacteria spreading to other organs, helps keeping adequate nutritional intake, and maintains the appearance, thus fostering social interaction. Frequent oral health examinations allow for prevention, and if necessary early intervention, especially for oral cancer. As older patients consult with primary care providers more often than with dentists, it is strategic for primary care providers to understand the importance of oral health for the well-being of older adults and systematically screen for oral health problems during patients interviews and physical examinations. This chapter describes how primary care providers can perform quick and efficient oral health screenings for their patients, leading to a decision about when a patient needs to be referred to a dentist.

F. Müller
Division of Gerodontology and Removable Prosthodontics, University Clinics of Dental Medicine, University of Geneva, Geneva, Switzerland
e-mail: frauke.mueller@unige.ch

L. Marchini (✉)
Department of Preventive and Community Dentistry, University of Iowa College of Dentistry and Dental Clinics, Iowa City, IA, USA
e-mail: leonardo-marchini@uiowa.edu

A. Kossioni (ed.), *Gerodontology Essentials for Health Care Professionals*, Practical Issues in Geriatrics, https://doi.org/10.1007/978-3-030-41468-9_7

Learning Objectives
After reading this chapter, readers should be able to:

- Explain the significance of oral health for the general well-being of older adults.
- List oral health-related questions that might be used during an initial interview with a patient.
- List oral-health examination tools that might be used for an initial oral-health screening.
- Understand and perform an oral-health screening examination.
- Decide when to refer a patient to the dentist.

7.1 Introduction

Today's older adults are keeping their teeth for longer, and edentulism has been reduced decade after decade [1]. This is largely due to the spread of preventive oral healthcare programs and advances in clinical dentistry [1, 2]. From the broad determinants of oral health extensively analysed in Chap. 8, many age-related risk factors render elder persons susceptible for rapid oral health deterioration (ROHD), [3] which may include (1) poor general health conditions, including but not limited to dementia, depression, diabetes and other chronic diseases, (2) functional impairment including decreased manual dexterity, vision and sensory impairments; (3) unfavorable socio-economic conditions, such as limited income, institutionalization, limited access to dental services, inadequate oral health literacy and finally (4) oral health conditions such as xerostomia, poor oral hygiene, gingival recession and periodontal disease, caries and/or heavily restored dentition, as well as the presence of removable dentures [3].

ROHD risk factors are the underlying cause for the poor oral health outcomes that are usually reported for older adults' cohorts as compared to their younger counterparts [4]. Oral health outcomes are even poorer among the most dependent and vulnerable groups of older adults, such as the institutionalized [5–8] and homebound [9]. Poor oral health conditions can have drastic consequences to the health and general well-being of these populations [10, 11].

Caries and periodontal disease are the most common oral diseases, which can provoke excruciating and incapacitating pain. For patients who are unable to reliably report on pain, like those with severe dementia, unrecognized pain of oral origin can be the cause of changes in eating habits and aggressive behaviour [12]. Another consequence of untreated caries and periodontal disease is tooth loss. Tooth loss can have negative repercussion on patients' dietary habits, as chewing efficiency is reduced, and food choices are restricted [13]. Furthermore, tooth loss can also impact dental appearance and affect self-esteem and social interaction [14]. It has also been associated to many systemic conditions, such as peripheral arterial disease [15], cognitive decline [16–18] and even overall mortality [19].

Periodontal disease has also been consistently associated with prevalent systemic conditions, such as type 2 diabetes mellitus, [11, 20] atherosclerosis, [21, 22] and

aspiration pneumonia [11, 23]. Poor glycaemic control has consistently been associated with poorer periodontal disease outcomes, and vice versa, as treating periodontal disease has proved to improve glycaemic control. This bi-directional relationship led to a recommendation for physicians to increase their awareness of periodontal disease and their implications to type 2 diabetes mellitus management [20]. Likewise, recommendations have been made to consider periodontal disease control for reducing the risk of atherosclerosis [22] and aspiration pneumonia [23].

Poor oral health has also shown to be associated with a decline in quality of life, having an impact on physical, psychological and social daily performance [24–28].

As explained above, older adults might present with poor oral health conditions and this deteriorated oral health has shown to be associated with undesirable consequences for systemic health and general well-being. Therefore, oral health screenings and treatment should be considered as an important component of multidisciplinary healthcare for older adults, as previously recommended [29].

Primary care providers, geriatricians and elderly care physicians, both in the communities or long-term care facilities, have more frequent interactions with older adults than dentists do. Consequently, these healthcare professionals play a critical role in assessing and promoting oral healthcare for older adults [28]. This chapter describes how primary care providers can render quick and efficient oral health screenings for their patients, essentially leading to a decision about when a patient needs to be referred to a dentist.

7.2 Patient Interview

It is widely known that obtaining a complete health history during medical interview is critical to deliver appropriate healthcare for older adults [27]. A usual medical interview can also reveal many important risk factors for rapid oral health deterioration, [3] and the most relevant risk factors can be outlined in "7 Ds": ***D**ementia, **D**epression, **D**exterity, **D**rugs, **D**iabetes, **D**emotivation and **D**iet* [28].

Dementia is frequently associated with age and can lead to impaired oral healthcare-related function [30]. Patients with dementia usually present with poor oral health as compared to patients that are cognitively intact [31]. In the severe stages, they may not be able to report oral pain and often develop combative behaviours to any attempt for oral hygiene and care provision. Depression is another common disorder among older adults that can have a negative impact on oral health as a result of self-neglect, change in diet and avoidance of necessary oral healthcare [32, 33]. Manual dexterity is often compromised as a result of diseases that are more prevalent among older adults, including, but not limited to arthritis, Parkinson's disease and stroke [34]. Compromised manual dexterity has been associated with poor oral hygiene and consequently poor oral health outcomes among older adults [35]. Polypharmacy is often observed among older adults, and the use of multiple medications has been associated with xerostomia, [36] which can have dramatic consequences for patients' oral health [37]. Consequences of dry mouth include higher risk of caries, problems with dentures and diminished oral health-related quality of life [37]. Often

medications contain sugar, which is another source of dental disease. Diabetes, another common condition among older adults, has shown to be an important risk factor for periodontal disease [20] and oral candidiasis [38]. Demotivation for performing daily oral hygiene and cariogenic, sugary diet have also been associated with poorer oral health outcomes among older adults [39].

Although the "7 Ds" provide a good mnemonic guide to help memorizing the most important risk factors for rapid oral health deterioration, it is worth noticing that other relevant risk factors can also be uncovered during the medical interview. For example, xerostomia caused by continuous positive airway pressure (CPAP) machines used for the treatment of chronic obstructive pulmonary disease or secondary to cancer treatment, but also reduced health literacy relying on caregivers for oral hygiene routines. Moreover, apart from unhealthy dietary habits, smoking habits and excessive alcohol intake are common risk factors for both general and oral health.

Therefore, it is important to provide physicians with tools designed for a first assessment of the risk of rapid oral health deterioration.

Considering that medical interview length increases significantly with age, a previous report [28] has suggested the inclusion of only six oral health-related questions to be applied during the medical interview for an initial oral health screening.

The first question is "***Is there anything bothering you in your mouth***?" If the patient answers "yes" to this question, it is an indication that there is some oral health-related problem, and the follow-up procedure is either doing an initial oral health assessment and/or directly referring the patient to a dentist. If the patient answers "no", then there may, or may not be additional concerns, as some oral diseases, even oral cancer, often remain subjectively unnoticed.

The second question is "***Do you feel your mouth dry***?" If the patient answers "yes" to this question, it is an indication that the risk of rapid oral health deterioration might be higher due to decreased salivary flow, although sometimes the feeling of a dry mouth is subjective, and not related to a measurable hyposalivation. Nevertheless, in case of an affirmation to this question, the recommendation includes reviewing the medical history for possible factors associated with xerostomia, checking the medication list for possible drugs reconciliation aiming to reduce the xerostomic effect, considering therapies aiming at xerostomia mitigation, and doing an initial oral health assessment and/or referring the patient to a dentist. It should also be kept in mind that even if the patient answers "no", hyposalivation may be present without subjective symptoms of dry mouth. More detailed and validated questionnaires like the Xerostomia Inventory may be used if the health practitioner suspects xerostomia based on the medical and medication history of the patient [40].

The third question is "***Do you have natural teeth, dentures or both?***" The answer to this question dictates how the next two questions should be formulated.

If the patient has some natural teeth, with or without partial dentures, the fourth question would then be: "***How often do you brush your teeth (and partial dentures)?***" If the answer is less than once a day, patient should receive counselling about appropriate daily oral hygiene, have an initial oral health assessment and/or

be referred to a dentist. If the answer is once a day or more frequently, then the provider should review oral care practices and tools and offer counselling. A detailed description of current oral health prevention and promotion techniques is provided in Chap. 8.

If the patient uses removable dentures, then the fourth question would be: "***How often do you brush your dentures and gums?***" If the answer is less than once a day, the patient should receive counselling about appropriate daily denture hygiene, and the provider should perform an initial oral health assessment and/or refer the patient to a dentist. If the answer is once a day or more frequently, then the provider should check the denture and offer counselling if the dentures are visibly soiled (Fig. 7.1). If the patient removes once a day the prosthesis for cleaning, but never scrubs the tongue and mucosa in the mouth, instructions to do so should be provided. A detailed description of denture hygiene and maintenance techniques is provided in Chap. 8.

The fifth question is only applicable to patients with remaining natural teeth: "***Do your gums bleed on brushing, when eating or even spontaneously***?" If the patient answers "yes" to this question, it is an indication that patient may present active periodontal disease, and the follow-up procedure is either doing an initial oral health assessment and/or immediately referring the patient to a dentist.

The last question is "***Did you have a dental visit in the past 12 months***?" If the patient answers "yes", and no other oral problem is reported or recorded during oral examination, no follow-up dental appointment needs to be scheduled. If the answer is "no", it is an indication that patients have not followed a regular scheme of dental visits, which increases the risk for rapid oral health deterioration, and the follow-up procedure is either doing an initial oral health assessment and/or referring the patient to a dentist.

These questions may provide useful guidance for an initial screening regarding oral health for older adults. However, many patients in this population are unable to report oral health problems in a reliable manner, especially dental caries, or even more important oral cancer. Hence, it is important to notice that this interview does not replace an initial oral health assessment, which is warranted for ALL frail older adults and particularly those with cognitive problems.

Fig. 7.1 Visibly soiled complete upper and lower dentures from an 81-year-old institutionalized patient with dementia

7.3 Oral Health Assessment

An initial oral health assessment should be a component of the overall physical examination of older adults and can be added as part of the head, ears, eyes, nose and throat (HEENT) examination, thus becoming a head, ears, eyes, nose, **oral** and throat (HEENOT) examination [41]. By performing an initial oral health examination, primary care providers, geriatricians, elderly care physicians and other healthcare providers can contribute to their patients' general well-being by allowing early identification of oral health disorders and dysfunction, by providing appropriate counselling, and also by seeking specialist advice for patients in need of oral healthcare through referral to a general dentist or specialist.

Many oral health screening tools have been developed to be used by non-dental healthcare providers.

The Brief Oral Health Status Examination (BOHSE) was first published in 1995. This tool was created to evaluate the oral health of nursing home residents by nursing home staff [42]. The BOHSE included an examination of the (1) lymph nodes, (2) lips, (3) tongue, (4) oral mucosa (including cheeks, palate and floor of the mouth), (5) gums between teeth and under dentures, (6) saliva, (7) teeth, (8) dentures, (9) pairs of teeth in chewing position and (10) oral cleanliness. Each of the ten items receive a score (0 for normal, 1 for mild changes, 2 for severe changes) and thus provide with a final score. In addition to the examination score, the BOHSE also includes three questions: "Is the upper denture labeled?"; "Is the lower denture labeled?" and "Is your mouth comfortable?"

The Holistic and Reliable Oral Assessment Tool (THROAT) dates from 2001. This tool was designed to be a reliable oral health assessment tool used by nurses in their daily routine care [43]. It includes the examination of the lips, teeth, dentures, gums, oral mucosa, palate, tongue, floor of the mouth, oral odour (smell) and saliva. All assessed items are categorized and scored as normal (score = 0), mild (score = 1), moderate (score = 2) or severe (score = 3). The THROAT proved reliable on individual items scores and total score and presented appropriate reliability both intra- and inter-examiners.

The Oral Health Assessment Tool (OHAT) was presented in 2008, [44] and is a simplified version of the BOHSE. The OHAT includes the examination of eight items: lips, tongue, gums and tissues, saliva, natural teeth, dentures, oral cleanliness and dental pain. Similarly to the other two assessment instruments, OHAT items are scored 0 if healthy, 1 if it presents changes, and 2 if it is deemed unhealthy. It is interesting to note that the OHAT will trigger an examination by a dentist if a score 1 or 2 is marked for any of the listed categories. It also includes two other important action items: completing a personalized oral hygiene care plan and scheduling an appointment for reviewing the patient's oral health again. Free online training for healthcare providers for using the OHAT is available at https://igec.uiowa.edu/gerialearning/geriatric-oral-health-training. New user only need to register free of charge to gain access to the website's content.

The oral health assessment instruments reported above are very useful tools to be used by non-dental health professionals and have been validated as such [42–44]. The instruments also provide a score, which helps identifying the severity of oral health conditions and need of referral for an in-depth examination.

When examining patients' oral cavities, primary care providers should be aware of the most common oral health diseases: caries and periodontal disease (details in Chap. 2). Both are chronic, infectious diseases and the latter affect the tooth attachment apparatus, whereas the former affect tooth hard tissues. Advanced carious lesions, are characterized by cavities in the tooth that are usually brown or black, as it can be seen in Figs. 7.2 and 7.3. Periodontal disease is usually characterized by red, inflamed, swollen gums that bleed easily (Fig. 7.4). In an advanced stage, periodontal disease leads to gingival recession (long clinical crowns) and tooth displacement, often visible by spaces in between teeth. Finally, the teeth become mobile, first horizontally, and later even vertically. If caries or periodontal disease are observed during an oral examination, a referral to a dentist is mandatory.

The oral tissues may also present various diseases, with the most common being the candidiasis, a fungal infection which presents with white patches on the mucosa, which may be wiped off with a gauze, exposing red mucosa without keratin layer. Present frequently during the intake of antibiotics, but also radiotherapy in the head and neck region, candidiasis may remain asymptomatic to the patient, but requires treatment nevertheless. A healthy patient with a good oral hygiene, practically never presents with a candidiasis in the mouth, and when dental biofilm or poorly cleaned

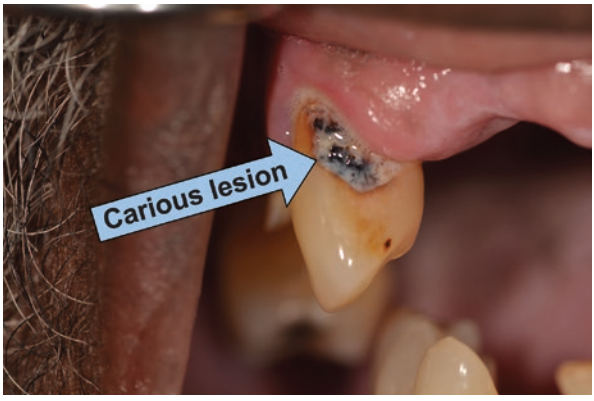

Fig. 7.2 Active caries lesion on the root surface of an anterior tooth (canine), covered by plaque, in a 65-year-old patient with severe depression and generalized anxiety disorder

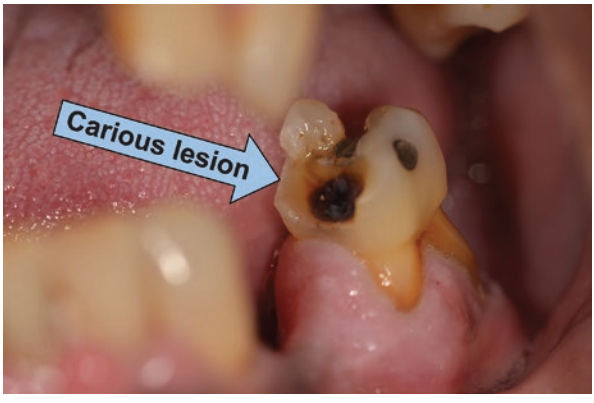

Fig. 7.3 Caries lesion on the coronal surface of a posterior tooth (molar) in a 65-year-old patient with severe depression and generalized anxiety disorder

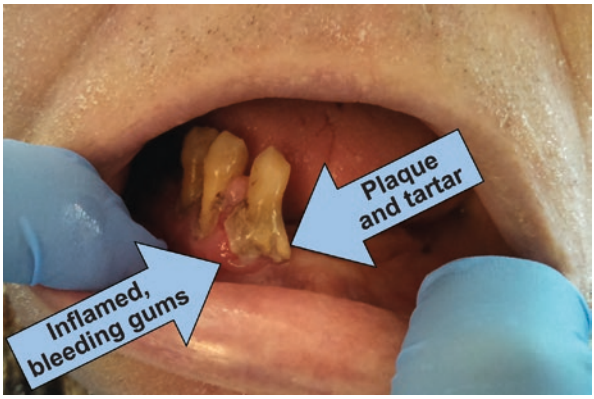

Fig. 7.4 Periodontal disease with swelling, bleeding gums in a 78-year-old, institutionalized patient with dementia

prostheses are excluded as potential causes, an in-depth examination by the physician is indicated. *Candida albicans*, the fungus causing this mycositis, is present in any oral cavity, but when its prevalence gets out of balance and presents clinical symptoms, it is a serious warning sign for a challenged immune system. Another inflammation often noticed in denture wearers is the so-called denture stomatitis, where the denture base is mirrored on the underlying mucosa in red and swollen tissues, with or without abundant biofilm present.

It is also important to be attentive to changes of the oral mucosa, as oral cancer is common and more frequent among older adults as compared to younger groups [45]. Oral cancer may be life-threatening and its therapies may have a negative impact on patients' quality of life, especially when radiotherapy is applied to the head and neck region. It is crucial to know that the earlier the diagnosis is done the better the prognosis is [46]. Important pre-malignant alterations of the oral mucosa include both white and red spots. Oral cancer usually present with the following signs and symptoms:

- Loss of surface integrity (ulceration/exophytic tissues)
- Loss of shiny tissue surface
- Induration (hard tissues on palpation)
- Atypic vascularization
- No pain

If an ulcer does not heal in a two-week period, it requires further examination and a dentist should be contacted as soon as possible (Fig. 7.5). Please bear in mind that patients subjectively often do not notice oral cancers, as they do not necessarily provoke pain. Some patients present only when the swelling becomes visible extra-orally, the denture does not fit anymore, or oral functions like eating, breathing or swallowing are impaired. Screening the oral cavity and the pharynx (have the patient say A) are hence a mandatory part of any oral screening examination. Please also bear in mind that more than half of the malignant tumors are located UNDER the tongue, so the tongue needs to be physically lifted with a spatula or a gauze for a thorough inspection.

A removable prosthesis also needs attention during an oral screening procedure. A well-functioning denture should be retentive while wide mouth opening and

Fig. 7.5 Oral cancer (Photo courtesy of Dr. Ana Lia Anbinder, ICT-UNESP, Brazil)

speech and does not displace when loaded with a finger in the molar area. It should sit firmly on the underlying tissues and be well adapted so that no food-stuff gets trapped underneath. The denture body should be pink and not discoloured or covered with calculus, biofilm or food debris. All borders should be smooth without cutting edges which may cause irritation fibromas or injury to the lips or cheeks. Missing parts or cracks and fissures could easily be repaired by the dentist. The atrophy of the alveolar ridges is continuous over the life-time, so dentures need from time to time a reline to fill the space that is appearing under the denture base and the underlying tissues. The need for a reline is indicated by food, being trapped under the dentures, a poor or decreasing denture retention or an instability during chewing. Sometimes, the incisor teeth "disappear" and are barely visible due to the ridge atrophy. Partial dentures, which rely on natural abutment teeth for retention via various mechanisms, mostly chrome clasps, should also be inspected for integrity and adaptation. Most common problems relate to broken or poorly adapted clasps, or metal connector parts cutting into the tissues. For partial dentures, repairs are often complex and a new denture may be the most straightforward solution.

Last but not least, an oral screening examination should be complemented by a simple chewing test. Various methods have been described in the literature, with the most simple being the two-colour mixing test [47, 48]. Here, two strips of differently coloured gum are chewed for 20 strokes, and the degree of colour mixture may be evaluated by simple visual assessment with reference to a scoring scale from 1 to 5, or, for further precision, an electronical analysis of the degree of colour mixture. This test allows a diagnosis beyond the presence of natural or prosthodontic teeth, analysing the oral chewing function as such. A poor chewing efficiency may not only indicate the need for a dental restoration, but also reveal neurological disorders like Parkinson's, Dementia or Stroke. Chewing is a beneficial activity at any age, training the chewing muscles [49] and oxygenizing the blood flow to the brain [50]. Hence, no elderly person should be prescribed mixed food when a simple dental treatment could restore the chewing function. Eating is often one of the last pleasures in old age, and an appetizingly presented un-mixed meal fosters the patient's appetite, caloric intake and the pleasures of eating in company of friends and family.

A summary of the oral health assessment procedures, including interview and oral examination, can be seen as flowchart in Figs. 7.6 and 7.7

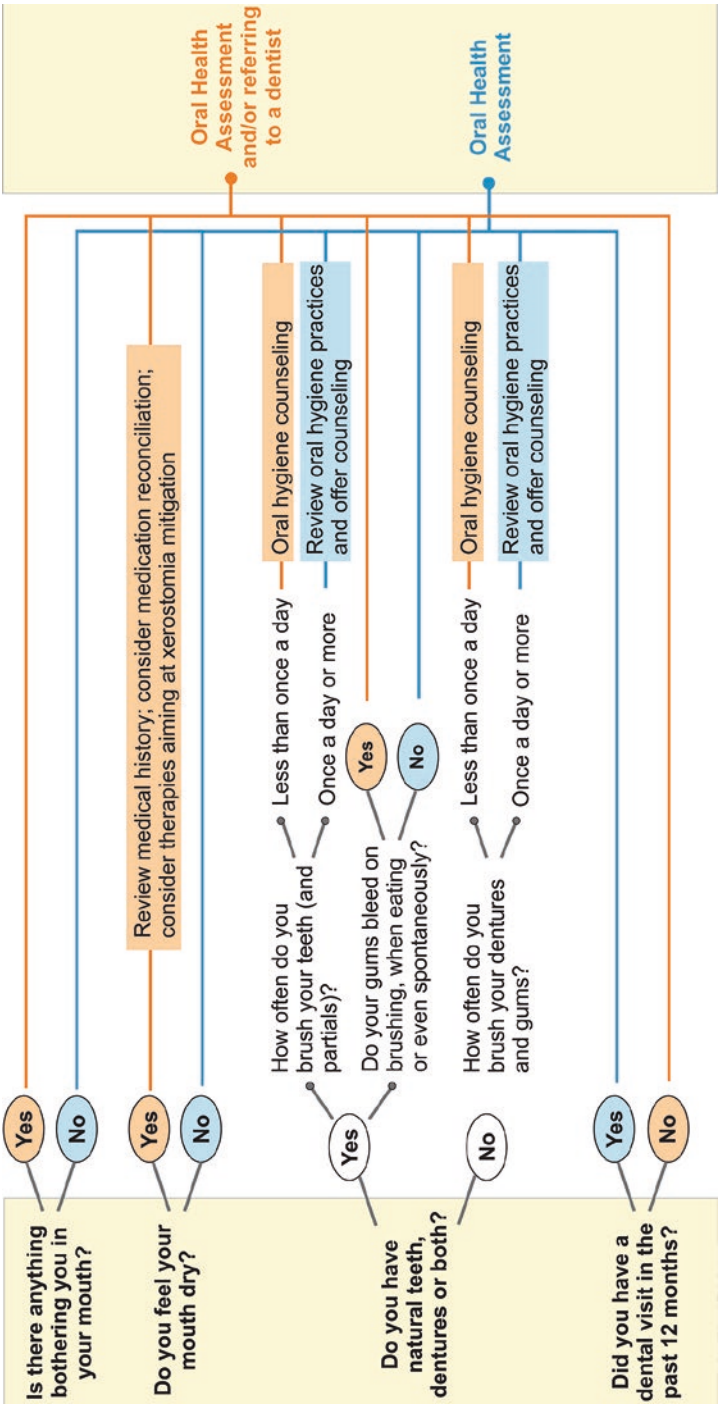

Fig. 7.6 Flowchart for the patient's interview regarding oral health

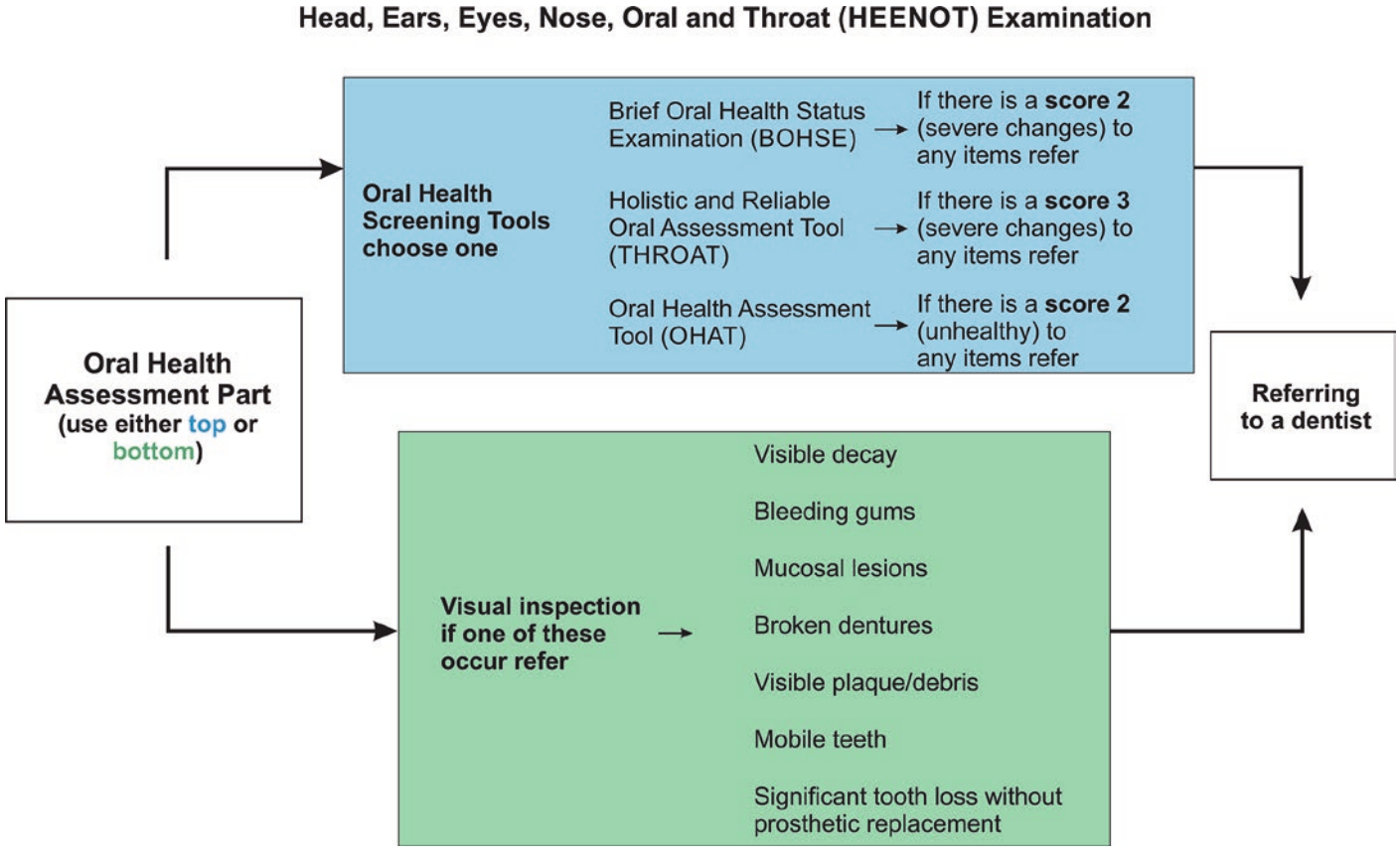

Fig. 7.7 Oral examination flowchart

Case 7.1

Case 7.1 reports on 77-year-old man presenting with early signs of dementia at the patient's initial appointment at the memory clinic.

This 77-year-old man with early signs of dementia came to his initial appointment in the memory clinic. The patient is a current smoker (10+ cigarettes a day), had a stroke 4 years ago, and has hypertension, sinusitis, obstructive sleep apnea (uses CPAP), benign prostate hypertrophy, seizures, bladder dysfunction and is allergic to penicillin, sulpha drugs and codeine. Patient current medication list includes albuterol, finasteride, fluticasone, gabapentin, hydrochlorothiazide, Lisinopril and vitamins.

When asked if there is anything bothering him in his mouth, he answered that "the gums hurt badly when I brush", he also said he feels his mouth dry at night due to CPAP use, and reported having his natural teeth and no dentures, as well as brushing his teeth less than once a day ("because it hurts"). He was not able to recall his last dental visit, but his wife said it was more than 2 years ago.

Considering his answers to the oral health part of the interview, the primary care provider decided performing an oral health assessment by visual inspection. Upon examination, there was visible plaque over the tooth (Fig. 7.8) and bleeding gums. Patient was referred to a dentist and diagnosed with severe, advanced periodontitis. As multiple teeth presented with high mobility and were at risk of being aspirated, extraction of all remaining teeth and fabrication of complete upper and lower dentures were the treatments of choice. Patient was instructed that dentures should be removed at night, which helps mitigating the dry mouth sensation caused by the CPAP machine use. Primary care provider assessment and referral was critical in this case, allowing the dentist to fabricate new dentures in an earlier stage of dementia, when patients are still able to go through the necessary dental treatment appointments and adapt to dentures.

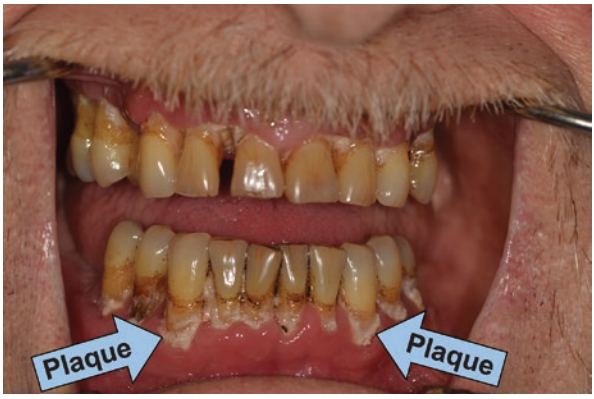

Fig. 7.8 Case 7.1

Case 7.2

Case 7.2 reports on a 79-year-old patient with moderate dry mouth and the consequences of dry mouth to his teeth.

This 79-year-old patient presented to an initial visit to a new primary care provider. Patient health history reveled that he was a former smoker, who have smoked for 20+ years, but have stopped 33 years ago. Patient drinks alcohol daily (1–2 drink/day) and has hypertension, urinary incontinence, multiple sclerosis, diabetes (last A1C was 7.5), hypothyroidism and depression. No known drug allergies. Patient's medication list includes hydrochlorothiazide, metformin, omeprazole, terazosin, warfarin, glipizide, levothyroxine, Lisinopril, oxybutynin, atorvastatin, finasteride, metoprolol and sertraline.

When asked if there is anything bothering him in his mouth, he answered that he feels his "mouth pretty dry". He also reported having his natural teeth and wearing partial dentures, and brushing both teeth and dentures twice a day. His last dental visit was "a while ago, but certainly much more than one year". Considering these answers, the primary care provider decided proceeding with using the Oral Health Assessment Tool (OHAT) for an oral health assessment. As the patient presented with fissured, dry tongue that is characteristic of a patient with dry mouth, and root tips and root caries were also present (Fig. 7.9), the OHAT scores were marked as 2 (unhealthy) for the saliva and natural teeth items. Therefore, the OHAT triggered an exam by a dentist and the patient was referred to an oral healthcare provider.

At the dentist, patient received the dental treatment he needed, and saliva substitutes and dietary orientation (like avoiding alcohol) to help alleviating his dry mouth symptoms. After discussing patient's medication list with the pharmacist and primary care provider, the medication list was reconciled and, among other changes, oxybutynin was replaced by tolterodine tartrate and dry mouth was greatly reduced, and the patient was then able to have a more diversified diet, contributing to his diabetes control.

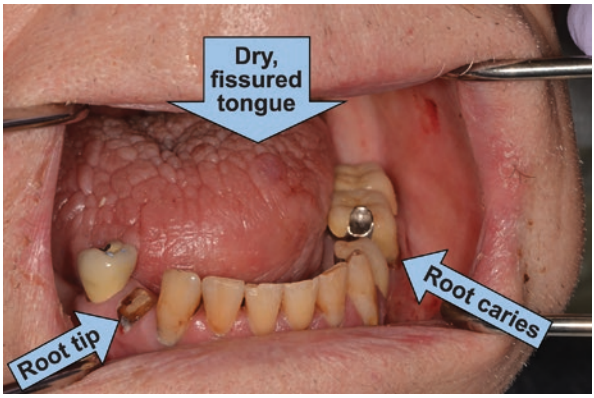

Fig. 7.9 Case 7.2

Case 7.3

Case 7.3 shows the consequence of constant sugar intake and inappropriate oral hygiene in a 70-year-old patient.

This 70-year-old patient presented to an initial appointment to a new primary care provider. Patient's health history included hypertension and arthritis with a total hip replacement 3 in the late 1950s and donated a kidney 17 years ago. Patient reported taking cefazolin, cyclobenzaprine, metoprolol, morphine, omeprazole, ondansetron, promethazine and hydromorphone.

When asked if there is anything bothering him in his mouth, he answered that he feels "some sharp edges on his top teeth that bother his tongue". He reported not feeling his mouth dry, having his own teeth and no dentures, brushing his teeth "once in a while, as there is not much left" and not seeing a dentist in the last 5 years. These answers triggered an oral health assessment, and the primary care provider decided using the Oral Health Assessment Tool (OHAT) for assessing patient's oral health. The OHAT score for natural teeth was marked as 2 (unhealthy) due to the presence of multiple root tips and decay (Fig. 7.10). The primary care provider was surprised with the absence of enough teeth to chew and asked how was the patient's diet, and the patient said it have not changed much, as he usually eats sugary snacks throughout the day.

Therefore, the patient was referred to a dentist and almost all remaining tooth structures presented with an osteolytic infection lesions around their root apexes. Patient had all remaining teeth extracted and complete upper and lower dentures fabricated. Patient also received dietary counselling and improved his dietary habits.

Fig. 7.10 Case 7.3

7.4 Conclusion

Oral health promotion can improve systemic health and well-being among frail older adults. As primary care providers have more frequent encounters with older adults, they can play an important role on increasing awareness of the importance of oral health among patients and caregivers, as well as help promoting appropriate oral healthcare routines and healthy habits. Primary care providers can provide a quick and efficient oral health screening for their older patients, and then decide about when a patient needs to be referred to a dentist.

References

1. Slade GD, Akinkugbe AA, Sanders AE. Projections of U.S. edentulism prevalence following 5 decades of decline. J Dent Res. 2014;93(10):959–65.
2. Felton DA. Complete edentulism and comorbid diseases: an update. J Prosthodont. 2016;25(1):5–20.
3. Marchini L, Hartshorn JE, Cowen H, Dawson DV, Johnsen DC. A teaching tool for establishing risk of oral health deterioration in elderly patients: development, implementation, and evaluation at a U.S. Dental School. J Dent Educ. 2017;81(11):1283–90.
4. Boscato N, Schuch HS, Grasel CE, Goettems ML. Differences of oral health conditions between adults and older adults: a census in a southern Brazilian city. Geriatr Gerontol Int. 2016;16(9):1014–20.
5. Marchini L, Recker E, Hartshorn J, Cowen H, Lynch D, Drake D, et al. Iowa nursing facility oral hygiene (INFOH) intervention: a clinical and microbiological pilot randomized trial. Spec Care Dentist. 2018;38:345.
6. De Visschere LM, Grooten L, Theuniers G, Vanobbergen JN. Oral hygiene of elderly people in long-term care institutions—a cross-sectional study. Gerodontology. 2006;23(4):195–204.
7. Katsoulis J, Schimmel M, Avrampou M, Stuck AE, Mericske-Stern R. Oral and general health status in patients treated in a dental consultation clinic of a geriatric ward in Bern, Switzerland. Gerodontology. 2012;29(2):e602–10.
8. Zuluaga DJ, Ferreira J, Montoya JA, Willumsen T. Oral health in institutionalised elderly people in Oslo, Norway and its relationship with dependence and cognitive impairment. Gerodontology. 2012;29(2):e420–6.
9. Ornstein KA, DeCherrie L, Gluzman R, Scott ES, Kansal J, Shah T, et al. Significant unmet oral health needs of homebound elderly adults. J Am Geriatr Soc. 2015;63(1):151–7.
10. Gil-Montoya JA, de Mello AL, Barrios R, Gonzalez-Moles MA, Bravo M. Oral health in the elderly patient and its impact on general well-being: a nonsystematic review. Clin Interv Aging. 2015;10:461–7.
11. Scannapieco FA, Cantos A. Oral inflammation and infection, and chronic medical diseases: implications for the elderly. Periodontol 2000. 2016;72(1):153–75.
12. Delwel S, Binnekade TT, Perez RS, Hertogh CM, Scherder EJ, Lobbezoo F. Oral health and orofacial pain in older people with dementia: a systematic review with focus on dental hard tissues. Clin Oral Investig. 2017;21(1):17–32.
13. Bomfim RA, de Souza LB, Corrente JE. Tooth loss and its relationship with protein intake by elderly Brazilians—a structural equation modelling approach. Gerodontology. 2018;35(1):51–8.
14. Silva JCM, Santos JFF, Marchini L. Factors influencing patients satisfaction with complete dentures: a qualitative study. Braz Dent Sci. 2014;17(2):83–8.
15. Munoz-Torres FJ, Mukamal KJ, Pai JK, Willett W, Joshipura KJ. Relationship between tooth loss and peripheral arterial disease among women. J Clin Periodontol. 2017;44(10):989–95.

16. Kato H, Takahashi Y, Iseki C, Igari R, Sato H, Sato H, et al. Tooth loss-associated cognitive impairment in the elderly: a community-based study in Japan. Intern Med. 2019;58:1411.
17. Takeuchi K, Ohara T, Furuta M, Takeshita T, Shibata Y, Hata J, et al. Tooth loss and risk of dementia in the community: the Hisayama study. J Am Geriatr Soc. 2017;65(5):e95–e100.
18. Saito S, Ohi T, Murakami T, Komiyama T, Miyoshi Y, Endo K, et al. Association between tooth loss and cognitive impairment in community-dwelling older Japanese adults: a 4-year prospective cohort study from the Ohasama study. BMC Oral Health. 2018;18(1):142.
19. Koka S, Gupta A. Association between missing tooth count and mortality: a systematic review. J Prosthodont Res. 2018;62(2):134–51.
20. Sanz M, Ceriello A, Buysschaert M, Chapple I, Demmer RT, Graziani F, et al. Scientific evidence on the links between periodontal diseases and diabetes: consensus report and guidelines of the joint workshop on periodontal diseases and diabetes by the International Diabetes Federation and the European Federation of Periodontology. J Clin Periodontol. 2018;45(2):138–49.
21. Azarpazhooh A, Tenenbaum HC. Separating fact from fiction: use of high-level evidence from research syntheses to identify diseases and disorders associated with periodontal disease. J Can Dent Assoc. 2012;78:c25.
22. Lockhart PB, Bolger AF, Papapanou PN, Osinbowale O, Trevisan M, Levison ME, et al. Periodontal disease and atherosclerotic vascular disease: does the evidence support an independent association?: a scientific statement from the American Heart Association. Circulation. 2012;125(20):2520–44.
23. van der Maarel-Wierink CD, Vanobbergen JN, Bronkhorst EM, Schols JM, de Baat C. Oral health care and aspiration pneumonia in frail older people: a systematic literature review. Gerodontology. 2013;30(1):3–9.
24. Masood M, Newton T, Bakri NN, Khalid T, Masood Y. The relationship between oral health and oral health related quality of life among elderly people in United Kingdom. J Dent. 2017;56:78–83.
25. Echeverria MS, Wunsch IS, Langlois CO, Cascaes AM, Ribeiro Silva AE. Oral health-related quality of life in older adults-longitudinal study. Gerodontology. 2019;36(2):118–24.
26. Bidinotto AB, Santos CM, Torres LH, de Sousa MD, Hugo FN, Hilgert JB. Change in quality of life and its association with oral health and other factors in community-dwelling elderly adults-a prospective cohort study. J Am Geriatr Soc. 2016;64(12):2533–8.
27. National_Institute_on_Aging. Obtaining an older patient's medical history. 2017. https://www.nia.nih.gov/health/obtaining-older-patients-medical-history.
28. Kossioni AE, Hajto-Bryk J, Janssens B, Maggi S, Marchini L, McKenna G, et al. Practical guidelines for physicians in promoting oral health in frail older adults. J Am Med Dir Assoc. 2018;19(12):1039–46.
29. Kossioni AE, Hajto-Bryk J, Maggi S, McKenna G, Petrovic M, Roller-Wirnsberger RE, et al. An expert opinion from the European College of Gerodontology and the European Geriatric Medicine Society: European policy recommendations on oral health in older adults. J Am Geriatr Soc. 2018;66(3):609–13.
30. Chen X, Zimmerman S, Potter GG, Sloane PD, Cohen LW, Reed D. Assessment of dentally related function in individuals with cognitive impairment: the dental activities test. J Am Geriatr Soc. 2017;65(3):580–5.
31. Delwel S, Binnekade TT, Perez R, Hertogh C, Scherder EJA, Lobbezoo F. Oral hygiene and oral health in older people with dementia: a comprehensive review with focus on oral soft tissues. Clin Oral Investig. 2018;22(1):93–108.
32. Skoskiewicz-Malinowska K, Malicka B, Zietek M, Kaczmarek U. Oral health condition and occurrence of depression in the elderly. Medicine (Baltimore). 2018;97(41):e12490.
33. Hybels CF, Bennett JM, Landerman LR, Liang J, Plassman BL, Wu B. Trajectories of depressive symptoms and oral health outcomes in a community sample of older adults. Int J Geriatr Psychiatry. 2016;31(1):83–91.
34. Hughes S, Gibbs J, Dunlop D, Edelman P, Singer R, Chang RW. Predictors of decline in manual performance in older adults. J Am Geriatr Soc. 1997;45(8):905–10.

35. Marchini L, Vieira PC, Bossan TP, Montenegro FLB, Cunha VPP. Self-reported oral hygiene habits among institutionalised elderly and their relationship to the condition of oral tissues in Taubate, Brazil. Gerodontology. 2006;23(1):33–7.
36. Singh ML, Papas A. Oral implications of polypharmacy in the elderly. Dent Clin North Am. 2014;58(4):783–96.
37. Thomson WM. Dry mouth and older people. Aust Dent J. 2015;60(Suppl 1):54–63.
38. Trentin MS, Verardi G, De CFM, de Carli JP, da Silva SO, Lima IF, et al. Most frequent oral lesions in patients with type 2 diabetes mellitus. J Contemp Dent Pract. 2017;18(2):107–11.
39. Kaye EK, Heaton B, Sohn W, Rich SE, Spiro A 3rd, Garcia RI. The dietary approaches to stop hypertension diet and new and recurrent root caries events in men. J Am Geriatr Soc. 2015;63(9):1812–9.
40. Thomson WM. Measuring change in dry-mouth symptoms over time using the xerostomia inventory. Gerodontology. 2007;24(1):30–5.
41. Haber J, Hartnett E, Allen K, Hallas D, Dorsen C, Lange-Kessler J, et al. Putting the mouth back in the head: HEENT to HEENOT. Am J Public Health. 2015;105(3):437–41.
42. Kayser-Jones J, Bird WF, Paul SM, Long L, Schell ES. An instrument to assess the oral health status of nursing home residents. Gerontologist. 1995;35(6):814–24.
43. Dickinson HWC, Leathey M. The development of the THROAT: the holistic and reliable oral assessment tool. Clin Eff Nurs. 2001;5(3):104–10.
44. Chalmers J, King P, Spencer A, Wright F, Carter K. The oral health assessment tool—validity and reliability. Aust Dent J. 2005;50(3):191–9.
45. Hussein AA, Helder MN, de Visscher JG, Leemans CR, Braakhuis BJ, de Vet HCW, et al. Global incidence of oral and oropharynx cancer in patients younger than 45 years versus older patients: a systematic review. Eur J Cancer. 2017;82:115–27.
46. Valdez JA, Brennan MT. Impact of oral cancer on quality of life. Dent Clin North Am. 2018;62(1):143–54.
47. Schimmel M, Christou P, Herrmann F, Muller F. A two-colour chewing gum test for masticatory efficiency: development of different assessment methods. J Oral Rehabil. 2007;34(9):671–8.
48. Halazonetis DJ, Schimmel M, Antonarakis GS, Christou P. Novel software for quantitative evaluation and graphical representation of masticatory efficiency. J Oral Rehabil. 2013;40(5):329–35.
49. Muller F, Hernandez M, Grutter L, Aracil-Kessler L, Weingart D, Schimmel M. Masseter muscle thickness, chewing efficiency and bite force in edentulous patients with fixed and removable implant-supported prostheses: a cross-sectional multicenter study. Clin Oral Implants Res. 2012;23(2):144–50.
50. Hasegawa Y, Ono T, Hori K, Nokubi T. Influence of human jaw movement on cerebral blood flow. J Dent Res. 2007;86(1):64–8.

Oral Health Promotion in Primary and Institutional Care

8

Barbara Janssens and Anastassia Kossioni

Abstract

Older adults have worse oral health compared to their younger counterparts, especially when they become frail or care dependent because of a number of structural, commercial, intermediate, and proximal determinants of oral health. Oral health deterioration can be clinically prevented by adopting a healthy diet, reducing tobacco consumption, and daily removal of the oral biofilm or plaque from the teeth and the dentures. Teeth and mucosa cleaning techniques and means should be adapted to the individual needs of older people and their caregivers, while caregivers should be educated to control responsive and challenging behaviours, particularly in patients with cognitive decline. Adequate oral health policies and legislations are necessary to promote the oral health of older people in the community and in institutional care.

Learning objectives

After reading this chapter, readers should be able to:

- Describe the broad determinants of oral health in vulnerable older adults.
- Apply tailor-made clinical oral health prevention strategies to patients.
- Implement strategies to integrate oral healthcare into general healthcare in different settings.

B. Janssens (✉)
Department of Oral Health Sciences, Special Needs in Oral Health, Gerodontology, Faculty of Medicine and Health Sciences, Ghent University, Ghent, Belgium
e-mail: barbarae.janssens@ugent.be

A. Kossioni
School of Dentistry, National and Kapodistrian University of Athens, Athens, Greece
e-mail: akossion@dent.uoa.gr

A. Kossioni (ed.), *Gerodontology Essentials for Health Care Professionals*, Practical Issues in Geriatrics, https://doi.org/10.1007/978-3-030-41468-9_8

8.1 Barriers to Good Oral Health, Oral Hygiene, and Dental Attendance in Older Adults

In order to improve the oral health of older adults and to integrate oral healthcare into general healthcare, it is important to know why older adults have worse oral health compared to their younger counterparts, especially when they become frail or care dependent. The answer to this question can be found within the broader determinants of (oral) health because many of these determinants impede us to achieve the improvements we aim for if we do not address them. Once we have a clear overview of these determinants, interventions to improve oral health can be designed taking into account that each intervention needs to be adapted to the barriers that apply to the specific situation where the intervention will take place. The determinants can be found on several levels and grouped as structural determinants, commercial determinants, intermediate determinants, and proximal determinants (Fig. 8.1). The following overview of determinants focusses especially on older adults and does not cover the whole spectrum but is meant to give a better understanding of the complexity of the problem of poor oral health among older adults.

8.1.1 Structural Determinants

Structural determinants include all the social and political mechanisms that generate, reinforce, and maintain social hierarchies and influence the socio-economic status of individuals within societies including macro-economic policy, educational systems, labour markets, fiscal policy, and welfare and health systems [1, 2]. This is well reflected in the example of sick people becoming poor in many countries all over the world due to the lack of a social safety net and welfare support. This is also the case for many care-dependent older adults. Moreover, in older adults we observe the endpoint of a possibly cumulative negative effect along the life course of these structural determinants resulting in a very diverse group within the overall population in terms of social position and living circumstances. The way healthcare systems adapt in order to cope with the ageing society has a potentially high impact on the (oral) health of older citizens. For example, the effect of current trends such as "ageing in place" and the expectation towards older adults to take a more proactive role in the management of their care dependency are still unclear and require good monitoring. Trade policies and globalisation can influence the traditional food intake of older adults and often introduce more sugar-containing foods. It is the responsibility of national policy makers and professional organisations to take action at this level. The professional organisations that can play a role are very diverse as they often represent people working around the same common risk factors. Examples of health policy actions to improve the oral health of older adults are given in Chap. 1.

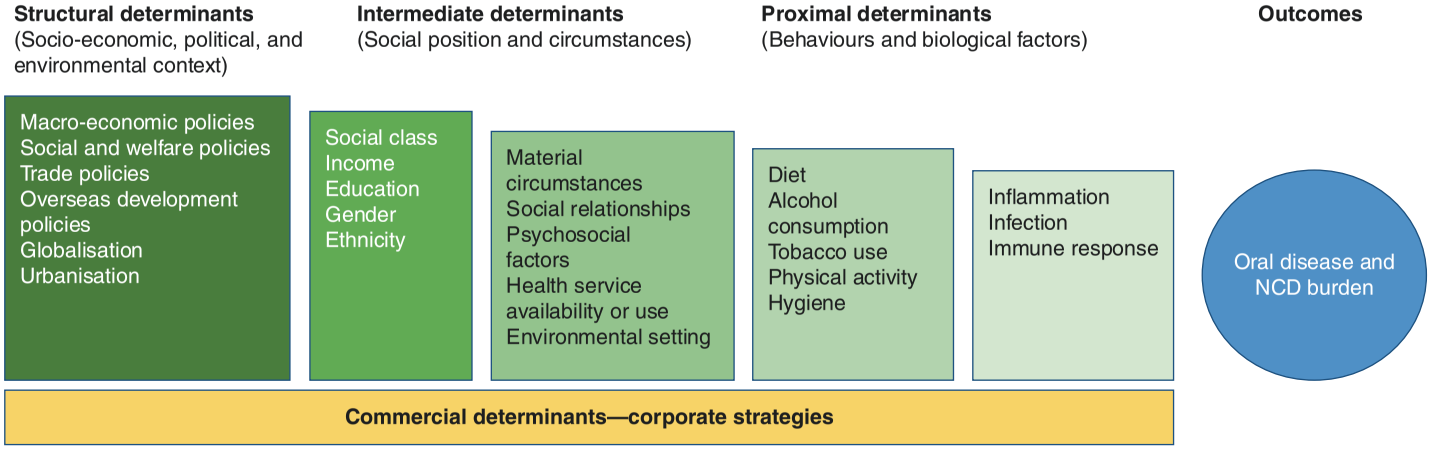

Fig. 8.1 The broader determinants of (oral) health (adapted from Peres MA, Macpherson LMD, Weyant RJ, Daly B, Venturelli R, Mathur MR, et al. Oral diseases: a global public health challenge. Lancet. 2019;394:249–60) [1]

8.1.2 Intermediate Determinants

Socio-economic position influences health through the circumstances in which people live, work, and age, and their risks for disease. These more specific intermediary factors include neighbourhood, housing conditions, social capital, psychosocial factors and social support, and access to healthcare.

8.1.2.1 Socio-Economic Status and Social Network

In older adults, low income and educational level are associated with poorer oral health (more caries, more edentulousness, less restorative treatment, and more removable dentures) and less frequent dental visits. They are life-long and better predictors than care dependency or age [3]. In case of many comorbidities, frequent hospitalisations, or admission to a nursing home, it can become difficult to pay all the medical costs and then there is no room for dental treatment. Having a broad social network and being married (versus single) has a positive effect on regular dental attendance and oral health [3]. Social capital (participation in social activities, volunteering) is also associated with good subjective oral health [4]. The social condition (i.e. education, marital status, social network, work status, gender, origin) while being young is a predictor of oral health as an older adult, irrespective of the social condition at old age [5]. The oral health gains during childhood have a positive effect throughout life. This, together with the cumulative character of oral diseases, is why a life-course approach is so important. Nevertheless, prevention strategies need to be present in and adapted to all age groups.

8.1.2.2 Environmental Setting

Ageing in a rural environment and/or with limited access to public transport can become a major barrier to access to dental care. If the living environment of an older adult changes from home to a nursing home, this has further negative impacts on oral health. First, many residents stop having dental visits. However, this figure changes from one country to another and might depend on the regulations and healthcare systems that are established especially for older adults. Second, many barriers have been reported at the level of the nursing homes contributing to poor oral health such as the absence of an oral healthcare policy, a lack of support for oral health from the care home management, a lack of adequate materials for daily oral hygiene, and a lack of care staff. Within the nursing homes, it is often not clear who is responsible for the oral healthcare of the residents [6–8].

8.1.2.3 Barriers Perceived by (Informal) Caregivers

In older adults with a high level of care dependency, it becomes necessary for (informal) caregivers to help with and eventually take over the daily oral hygiene routine. It is obvious that the barriers perceived by these caregivers have an important impact on the older adult's oral hygiene and therefore the progression of oral pathology. Two recent systematic reviews have given an overview of these barriers in a nursing home setting [8, 9]. The most important barriers are responsive behaviour of the

residents, a lack of knowledge and skills, a negative attitude, and time pressure among the care staff.

8.1.2.4 Gender

Men have worse oral health with more caries, more residual roots, and a lower restorative index, but women are more often edentulous despite having similar oral hygiene. The differences are probably the result of the irregular dental attendance of men compared to women.

8.1.2.5 Determinants Related to the Healthcare System

To make healthcare systems work optimally, they should meet some basic conditions: they must be accessible, acceptable, available, and of good quality [10]. We observe that current healthcare systems cannot always guarantee these basic conditions because they do not adapt to the various vulnerable groups in society such as the frail and care-dependent older adults.

Accessibility

One of the main barriers for older adults to visit the regular dentist is transport to the dental office. More than 75% of the frail and care-dependent older adults must appeal to a family member, acquaintance, or caregiver to go to the dentist [11]. Once arrived at the dental office, the environment is often not adapted to their needs in terms of wheelchair accessibility, adapted lighting, font of input forms, etc. For those not able to access a dental office, domiciliary dental care may not be available. In addition to physical accessibility, there is also financial accessibility. In many countries, oral health is not covered by government schemes or compulsory insurance, which increases the level of unmet dental needs. The costs for basic medical care and support are often extremely expensive that there is little left over for "extras" such as oral care. Moreover, incapacitated older adults often depend on the will of the family to invest in oral care. In some countries, dental professionals also experience financial barriers limiting access to care. They receive little or no extra fees for the often time-consuming home treatments and the extra administration that is often associated with care for the elderly. In some countries, working with a fee-for-service system, like Belgium, there is also no fee for primary prevention in persons over a certain age. The accessibility of care is also determined by a lack of self-confidence and knowledge among dental professionals to treat medically complex elderly people [8, 12, 13]. Older persons also often have difficulties finding the appropriate information about oral care due to a lack of access to the internet [14].

Acceptability

Oral healthcare provision and organisation should also be acceptable to older adults from an ethical and cultural perspective. Every generation has its norms, values, and beliefs. What is important for an older adult related to healthcare is not necessarily the same as for a younger person. Therefore, the perspective of the older person

himself must always be considered, without overlooking the diversity within this group. For example, older care-dependent people with an immigration background may not be very familiar with the existing healthcare system, while healthcare systems are often not flexible enough to adapt to their specific needs related to cultural and religious habits, and this can create additional challenges within, for example, nursing home environments.

Availability
In some countries or regions within countries, there is a shortage of oral care professionals to meet the needs of the population. For older adults, this shortage is even more pronounced because it is not only the number of oral care professionals that is important but also the discipline in which they acquire extra knowledge and that is where the shoe pinches. There is an imbalance between the number of older persons with specific care needs and the number of oral care professionals with specific knowledge and expertise in geriatric oral care. Moreover, products and services are also not always available, for example, the availability of mobile oral care at home or toothpaste with a higher concentration of fluoride to meet the older adults' needs.

Good Quality
Despite the fact that we are able to provide good quality treatment for the majority of the population, quality is sometimes lost due to the circumstances under which oral care professionals have to work when they perform home visits. Often, the desired treatment results are not achieved because the treatment time must remain short and the older person cannot be well positioned. The current mobile dental equipment also often fails to provide sufficient comfort to both the patient and the care provider.

8.1.2.6 Psychosocial Factors
Among older adults there are strong links between psychological state, social conditions, and biological health. This is also called the geriatric triad. The direct and indirect confrontation many older adults experience with care dependency and death make them vulnerable for psychological problems with possibly an important impact on their health-related behaviours if the social conditions are suboptimal. For example, if within a couple of older adults one of the partners dies, the remaining person grieves and can become depressed. This can influence the brushing frequency. Moreover, if the person who died was the one with cooking skills within the couple, this impacts the quality of food intake with a possible increase of processed and sugary foods.

8.1.3 Proximal Determinants

The proximal determinants include the behaviours and biological factors that can impact on (oral) health. In general, the biomedical approach to prevention prevails, and therefore these determinants are the most well known and unfortunately often

the only ones addressed in healthcare policies under the form of clinical preventive interventions and chair-side oral health advice. Traditionally, the proximal determinants are addressed by oral healthcare professionals but within the context of a multidisciplinary approach of frail and care-dependent older adults, a shortage of oral healthcare staff on different levels, and access to care, we should aim more and more for other (healthcare) professionals to address these determinants. Moreover, these determinants are often common risk factors for other chronic diseases, and therefore they can be easily approached by other professionals.

8.1.3.1 Age

Due to the cumulative nature of caries and periodontitis, the oral status of persons becomes worse with ageing: older adults are more affected by tooth loss and have more extended restorations than their younger counterparts. The ageing mouth is also more prone to new oral pathology and reduced functioning due to various changes with increasing age (more details on the ageing mouth in Chap. 2).

8.1.3.2 Frailty and Care Dependency

The oral health of older adults deteriorates as they become frail and care dependent. The deterioration is seen with both physical and cognitive decline and irrespective of being community-dwelling or institutionalised, and is related to the decreased ability to perform adequate oral hygiene. Therefore, if someone else takes over the daily oral care, it has a mediating effect. Moreover, if the cumulative burden of comorbidity becomes too high, older adults can reach a tipping point where oral care loses priority, and motivation for daily oral hygiene is lost. The risk for non-regular dental attendance is also higher in frail and care-dependent older adults.

8.1.3.3 Dry Mouth

Saliva plays a key role in maintaining good oral health and function. It moistens the oral cavity to facilitate speaking, swallowing, mastication, and the formation of a food bolus. Saliva protects teeth against caries, attrition, abrasion, and erosion and also protects the oral, pharyngeal, and oesophageal mucosa. Moreover, it contains many antibacterial, antiviral, and antifungal agents with a positive effect on the oral microbial flora, and it facilitates the healing of oral wounds. Saliva is also essential for the ability to taste and smell and contributes to the digestion of food [15]. Dry mouth comprises both the objective observation of a reduced salivary flow (salivary gland hypofunction or SGH) and the subjective feeling of dry mouth (xerostomia). SGH and xerostomia are closely related, and xerostomia is the primary symptom of SGH. The average daily flow of whole saliva varies in healthy persons between 0.5 and 1.5 L. When the daily flow is reduced by more than 50% of the normal flow, we consider SGH. In frail community-dwelling older adults, 15–23% have SGH and 17–40% have xerostomia. In institutionalised older adults, the prevalence of SGH is similar but the prevalence of xerostomia ranges between 20 and 72% [16]. The reduction in salivary flow between meals

mainly affects the progression of oral pathology [17]. The most important cause of dry mouth in older adults is polypharmacy (details in Chap. 4). Not only the number but also the type of medications have an influence. Half of the medications taken by nursing home residents potentially have a hyposalivatory effect, and when a person takes more than three different medications, a negative clinical impact can be expected [18, 19]. The clinical symptoms of hyposalivation are [1] functional alterations in chewing, swallowing, speaking, and flavour; [2] increased susceptibility for caries, gingivitis, periodontitis, oropharyngeal infections, halitosis, ulcers, and dental plaque formation; [3] morphological changes such as dry lips, pale and cracked oral mucosa, and atrophy and erythema on the back of the tongue; and [4] other manifestations such as pain and difficulty to wear a removable denture [20].

8.1.3.4 Oral Status

The oral status can be a risk factor for further deterioration. In case of a large amount of fixed restorations, gingival recessions, or partial dentures, it becomes difficult to maintain optimal oral hygiene [21, 22]. Moreover, the oral status is one of the most important predictors of regular dental attendance. Older adults with natural teeth maintain their dental visits compared to edentulous persons with or without removable dentures [23, 24].

8.1.3.5 Oral Health Behaviour and Health Literacy

The brushing frequency of older adults is lower compared to younger persons, especially when becoming frail and care dependent [25, 26]. The current generation of older adults has different views and beliefs on oral health than future generations and often considers bad oral health as part of the ageing process. The degree of importance persons attach to their oral health is one of the best predictors of dental care utilisation at old age. A lack of oral health knowledge among older adults together with negative attitudes results in a low perceived need compared to the objective treatment need [27]. The health literacy of older adults can be influenced in a negative way by difficulties to access and process the correct information (reading medication instructions, process chair-side information about prevention, access to the internet, etc.), and this can lead to irregular dental visits and worse oral health [28, 29].

8.1.3.6 Nutrition

Food patterns are important in the development of carious lesions. Frequent intake of carbohydrates (sugars and starches) increases the incidence of caries. Starches can be especially cariogenic because they become highly retentive once they are in the mouth [30]. In general, older adults present a healthier food pattern compared to younger persons, and most of them preserve an efficient swallowing function. They can also easily compensate for age-related changes that influence chewing by raising the number of chewing cycles [31, 32]. However, the taste perception and even more smell are reduced. Tongue coating and removable dentures can cover part of the taste buttons and further negatively impact

taste perception. As a consequence, older adults add more sugar and salt to their meals [33]. Many older adults have lost several teeth or are edentulous. This can cause chewing problems, and the avoidance of certain hard foods creates a preference for a soft diet rich in carbohydrates. Around half of the institutionalised older adults receive a diet with a modified texture due to dysphagia, but also due to chewing difficulties. As such, poor oral health can become a risk factor for malnutrition [34, 35]. Furthermore, institutionalised elders' nutritional intake contains more extrinsic sugars and carbohydrates and less fibres compared to home-dwelling elders [36, 37]. Moreover, the impact of sugar and carbohydrates increases in combination with hyposalivation and/or swallowing problems due to a reduced clearance of the mouth.

8.1.3.7 Smoking and Alcohol

Lifestyle factors, like smoking and alcohol, can have negative oral consequences in older adults, especially after a life-long accumulation process. As a consequence, oral cancer and edentulousness are relatively frequent among this group. Due to the survival of the fittest, smoking and alcohol problems are less frequently seen among the oldest old persons.

8.1.4 Commercial Determinants

Older adults are vulnerable to the influence of industry and often make food choices that are not the healthiest ones. In the area of oral health, the tactics used by the sugar industry are a major concern. There is a whole food industry focussed on care-dependent older adults, producing dietary supplements for people at risk for under- and malnutrition. These dietary supplements have the potential to be cariogenic and put older adults at risk for dental caries [38].

8.2 Clinical Prevention of Oral Pathology

The clinical prevention of oral health focusses on the above-mentioned proximal determinants of oral health and is something that requires our daily attention. Therefore, they can be best addressed by (informal) caregivers and other professionals involved in the daily care and functioning of older adults or in regular visitations (e.g. once a week) to provide care and support to patients with chronic conditions.

8.2.1 Nutrition

Nutritional intake and dietary habits are the most important factors to maintain good oral health. Therefore, all professionals involved in the daily food choice and preparation for frail and care-dependent adults can contribute substantially to their oral health. For dental caries, the story is straightforward: dental caries

Table 8.1 Nutritional intake and dietary habits in relation to caries

Increased risk for caries
• Sugar-sweetened drinks such as soda, fruit juices, energy drinks, sweetened tea and coffee
• Sucrose, glucose, fructose, lactose, maltose, and starches that are added (e.g. cookies, cake) or are naturally present in food
• Sticky and retentive foods such as dried fruits and caramel
• Slowly dissolving candies such as lollipops
• Very frequent intake of food or sipping sugar-sweetened drinks for a prolonged time
Decreased risk for caries
• Fresh fruits and vegetables
• Whole-grain and low-sugar bread, pasta, rice, and cereals
• Water, milk, and tea without sugar
• Proteins like unprocessed meat, cheese, fish, legumes, and eggs
• Sugar-free chewing gum and candies
• Leave at least 2 h between meals and limit the number of meals to 5

cannot develop without the presence of liquid or solid dietary fermentable carbohydrates such as sucrose, glucose, fructose, lactose, maltose, and starch, even in the absence of good oral hygiene (Table 8.1). The exposed dentine and root surfaces in an older adult's mouth are even more susceptible to caries because they start demineralising at a higher critical pH compared to enamel. Therefore, even complex carbohydrates found in whole foods such as potatoes, rice, cereals, and bread contribute to the caries process in older adults. To avoid dental caries, the amount of sugar should be less than 5% of the daily energy intake. The effects of carbohydrates will differ from one person or tooth to another and will depend on dietary habits, saliva, presence of fluoride, and the composition of the oral biofilm. Also the texture of the food is important and can become very relevant in case of texture modifications due to swallowing problems; sticky and slowly dissolving foods should be avoided.

The relationship between nutrition and the onset of periodontal conditions is more complex as periodontitis is not only influenced by malnutrition but also by other factors such as genetics, tobacco smoking, and oral hygiene. Nevertheless, good nutrition with respect to both macro- and micronutrients can contribute to optimal periodontal health. Research has shown that vitamin C, D, and B_{12} deficiencies adversely impact periodontal health, and periodontal health can be considered as a sensitive marker for poor nutritional status. At the level of macronutrients, a diet with a lot of sugar and other carbohydrates does not only lead to caries but also increases the risk for gingival bleeding. Moreover, high intake of polyunsaturated fats and insufficient protein intake contribute to poor periodontal health [39].

The teeth should be further protected from dental erosion by limiting acidic foods and drinks and carbonated beverages between meals and by rinsing the mouth with plenty of water after their consumption. Moreover, as tooth loss and denture wearing deteriorate chewing efficiency and ability, individuals with severe tooth loss and denture wearers should receive appropriate dietary advice and food preparation counselling to improve nutritional intake.

More information about the relationship between oral health and (mal)nutrition can be found in Chap. 5.

8.2.2 Tobacco Smoking

Smoking among older adults has been identified as a critical geriatric health issue and is considered a major threat to the health and vitality of older people. Tobacco smoking poses substantial health risks at any age but is particularly dangerous for older adults as their already weakened host immune system becomes further suppressed, and they are already at heightened risk of cardiovascular disease, respiratory conditions, and cancer. The risk of oral disease increases as well in older smokers, especially after a life-long smoking habit, and is associated with oral cancer, periodontal disease, tooth loss, dental caries, and precancerous conditions. Furthermore, smoking has been associated with discoloration of teeth, restorations and dentures, altered taste and smell sensations, black hairy tongue, candidiasis, healing problems after tooth extractions, and bad breath (halitosis).

Smoking cessation is beneficial regardless of age and is important in older smokers because of the increased duration of exposure. The first effects of smoking cessation appear as early as 20 min after quitting. Within 3 months, the blood circulation and lung function start becoming normal, and the risk for coronary heart disease and cancer is reduced by 50% after 1 and 5 years, respectively. Moreover, improvements in already existing smoking-related pulmonary conditions such as chronic obstructive pulmonary disease (COPD) are apparent, as well as reduced mortality.

In 2008, the WHO identified six evidence-based tobacco control measures for reducing tobacco consumption worldwide (https://www.who.int/tobacco/mpower/en/). They are known under the acronym "MPOWER":

- **M**onitor tobacco use and prevention policies
- **P**rotect people from tobacco smoke
- **O**ffer help to quit tobacco use
- **W**arn people about the dangers of tobacco
- **E**nforce bans on tobacco advertising, promotion, and sponsorship
- **R**aise taxes on tobacco

For personal patient advice on smoking cessation, the "5As" approach has been suggested and this can be used by any professional involved in any aspect of the overall health and well-being of older adults [40]. The "5As" are ask, advise, assess, assist, and arrange follow-up for the patient. The first "A", involves questioning the patient on the smoking habit (duration, intensity, previous attempts of quitting, and willingness to quit). The second "A" includes advice on cessation and explaining the health benefits after cessation. The third "A" assesses the level of nicotine dependence making use of the "Heaviness of Smoking Index" and "the Fagerstrom test for Nicotine Dependence" and also assesses the patient's motivation by identifying the type of smoker: (1) contented smoker (no wish to stop smoking); (2) the

concerned smoker (no wish to quit immediately, but might do so within the next 6 months); and (3) a smoker preparing to stop with a wish to quit within a month. The fourth "A" assists the patient in quitting through family and pharmaceutical support. Finally, the fifth "A" involves following up with the patient to monitor their progress over a period of time (at 1 week, 1, 3, 6, and 12 months).

Smoking cessation programmes are as successful in older adults as in younger smokers, especially if they are tailored to them. Experiencing smoking-related health problems can also become driving forces for adopting cessation advice. More intensive and multimodal programmes delivered face-to-face, involving pharmacotherapy and behavioural interventions with rigorous methodology (e.g. with biochemical verification of cessation), and strict implementation are the preferred designs and often result in the best outcomes [41–43].

8.2.3 The Oral Biofilm

Daily oral hygiene to remove the oral biofilm or plaque is another key element to promote good oral health. This can become a very challenging task for frail and care-dependent older adults. Therefore, a third party is often needed to support, help with, or completely take over the performance of daily oral hygiene. The non-dental healthcare provider should be aware of the indicated procedures in order to educate the patients and their caregivers accordingly, when a dental professional is not available.

8.2.3.1 Natural Teeth, Implants, and Fixed Restorations

The best way to remove the biofilm from natural teeth, implants, and fixed restorations is by using a toothbrush in combination with fluoridated toothpaste.

The Toothbrush

Make sure the toothbrush is adapted to the needs of the older adult. In general, a toothbrush with soft round-ended nylon bristles is preferred and the brush head should be small to medium in size. A small head makes it easier to access hard-to-reach places in the mouth due to reduced opening of the mouth or missing teeth.

For some older adults, it is difficult to hold the toothbrush and you could try to adapt the toothbrush by making the handle bigger (e.g. foam tube or ergonomic grip; Fig. 8.2), make the toothbrush easier to hold (e.g. use a rubber band or utensil holder to attach the toothbrush to the hand; Fig. 8.3), or use a different toothbrush especially designed for people with difficulties to hold the brush (Fig. 8.4). For other older adults, it is difficult to brush due to reduced mobility of the wrist, they forget to brush all sides of the teeth, or they only open the mouth during a limited amount of time. In these situations, a three-headed toothbrush can be a good alternative as it brushes all surfaces of the tooth simultaneously (Fig. 8.5).

Fig. 8.2 How to adapt the handle of the toothbrush. (National Institute of Dental and Craniofacial Research; Tepe ©)

Fig. 8.3 How the make the toothbrush easier to hold. (National Institute of Dental and Craniofacial Research)

Fig. 8.4 Example of a specially designed toothbrush. (Piksters, Erskine oral care ©)

Fig. 8.5 Three-headed toothbrush. (Dr. Barman's ©)

Fig. 8.6 Examples of different phases of worn-out toothbrushes. Only the first toothbrush from the left is suitable for brushing. (Community Dentistry and Oral Public Health, Dental School, Ghent University, Belgium ©)

Powered toothbrushes may give better results in removing plaque compared to a manual toothbrush, but they are not compulsory to achieve adequate oral hygiene. The powered toothbrushes with oscillating-rotating heads (rotating in two directions) are preferred. They can be especially helpful in cases of reduced dexterity, many hard-to-reach places (small head), and when daily oral hygiene is taken over by a third party. Nevertheless, be careful when introducing an electric toothbrush in older adults with cognitive decline. They might have difficulties to use the toothbrush correctly, and the sounds and vibrations could scare them and provoke resistant behaviour.

The toothbrush should be replaced every 3 months or even earlier if it looks worn out (Fig. 8.6). An easy to apply trick for older adults is to change the toothbrush every first day of a new season (e.g. first day of spring).

The Toothpaste

When choosing a toothpaste, make sure it contains at least 1350–1500 ppm of fluoride. Try to look for a toothpaste with a mild flavour or one the patient is used to. Some persons do not like the strong mint taste, and this can provoke responsive behaviour. If the older adult has swallowing problems or if you are taking over oral hygiene and want to have a good view of what you are doing in the mouth, you should avoid toothpastes containing sodium lauryl sulphate (SLES). SLES is a foaming agent in many commercial toothpastes, and by avoiding it you will have better visibility and avoid the constant spitting and swallowing during brushing. You need to adapt the amount of toothpaste according to the number of teeth in the mouth. For a full set of 28–32 teeth, you need 1 cm of toothpaste, but on many occasions you only need a pea-sized amount or even less, as many older adults have lost some of their teeth (Fig. 8.7).

Different Degrees of Support During Brushing

Brushing the teeth requires a lot of cognitive skills and a good manual dexterity. Therefore, many older adults struggle with one or more steps within the whole process. It is important that they remain as independent as possible and are only offered

Fig. 8.7 Use a soft toothbrush with an adequate amount of toothpaste in accordance to the number of remaining teeth. For 28–32 teeth, 1 cm of toothpaste is enough. (Special Needs in Oral Health, Gerodontology, Oral Health Sciences, Ghent University ©)

help where and when needed. When the task is completely taken away from them in an abrupt way, it might generate resistant behaviour or low self-esteem. In the first stage of care dependency, you might only need to remind the patients to brush the teeth and encourage them to brush long enough. Little by little you can take over some of the tasks (e.g. opening and closing the toothpaste, perform interdental cleaning after the person has brushed with the normal toothbrush). In case of severe dementia, the whole process will be taken over. Occupational therapists can be very helpful to maintain or even improve the skills needed to adequately brush the teeth and can integrate tooth brushing in the ADL training (activities of daily living).

How to Position the Older Adult and Myself in Case I Give Oral Hygiene Support?

Make sure that the older adult is always in a safe position (Fig. 8.8a, b). If they are not able to stand for more than 5 min without help, they should be sitting. They should be able to see themselves in a (hand) mirror while brushing so that they keep a sense of control. The easiest way to brush someone else's teeth is to have the person sit on a (wheel) chair and stand behind her/his right shoulder (if left handed, behind the left shoulder). While brushing with the right hand, you put your left arm around the person's head and use the fingers of your left hand to open the mouth or move the cheeks to increase visibility. As such, you can control and act fast upon unexpected movements of the patient's head. Standing behind the person also makes your presence less threatening (Fig. 8.9a, b). If you choose to be in front of the person while brushing his/her teeth, please make sure that your eyes are at the same level.

Brushing: Step-by-Step Procedure

You should brush the patient's teeth every evening before going to bed and once more during the day. The total time you spend brushing will depend on the number of teeth in the mouth, the need for interdental cleaning, and the presence of a removable denture. You need at least 3 min for 28 teeth. Let the older person participate wherever he/she can, along the process.

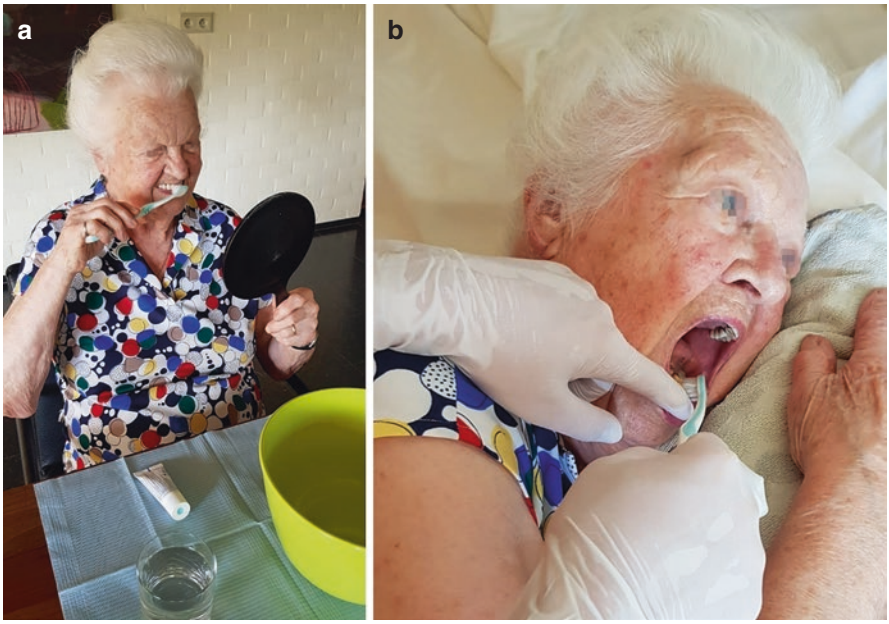

Fig. 8.8 (**a**, **b**) Make sure that the older adult is sitting or lying down safely while brushing. (Special Needs in Oral Health, Gerodontology, Oral Health Sciences, Ghent University ©)

Fig. 8.9 (**a**, **b**) Position yourself correctly while brushing someone else's teeth. (Special Needs in Oral Health, Gerodontology, Oral Health Sciences, Ghent University ©)

Before you start:

- Make sure that you are in a location with enough light and space to put everything needed (toothbrush, interdental brushes if needed, toothpaste, mirror, towel, damp gauzes, glass of water, bowl, gloves, etc.) within reach and to position yourself and the older adult in a convenient way. A bathroom is often not adequate, and it is easier to be in the living room or kitchen (see Fig. 8.10).
- Try to make contact and make sure that the older adult is relaxed (see also further down in the section related to responsive behaviour).

During the brushing procedure:

- Use the "tell-show-do method". Describe step by step with short and easy sentences what you will do, show it to the patient, and then provide the care as explained.
- Wash your hands before you start and wear disposable gloves that fit tight around your hands. Wear a face mask, if necessary, and take all necessary protective precautions for yourself and the patient.
- Remove (partial) dentures. Sometimes older adults can do this more easily themselves. In case of a partial denture with a metal frame or an overdenture on implants, you need to apply some force to remove the denture. Ask for professional help if you do not succeed.
- Give the older adult some water to rinse the mouth or drink to eliminate any remaining food and moisten the oral cavity.
- Check for any remaining food particles under the cheeks and remove them, if needed, with a damp gauze (see Fig. 8.11).
- Wet the toothbrush and apply the necessary amount of toothpaste as previously described.
- Place the toothbrush at an angle of 45° to the gumline while brushing with small circular movements.
- Make sure that you brush all surfaces of the teeth. Brush the upper teeth separately from the lower ones. Pay attention to the gumline and make sure that all exposed root surfaces are well cleaned as they are more vulnerable to carious lesions.
- To brush the inner side of the front teeth, it might be helpful to tilt the toothbrush vertically (see Fig. 8.12).

Fig. 8.10 Make sure that you have all the necessary teeth-cleaning equipment before starting. (Special Needs in Oral Health, Gerodontology, Oral Health Sciences, Ghent University ©)

Fig. 8.11 Do not forget to remove any remaining food debris from the mouth with a damp gauze. (Special Needs in Oral Health, Gerodontology, Oral Health Sciences, Ghent University ©)

Fig. 8.12 Tilt the toothbrush vertically to brush the inner teeth surfaces. (Special Needs in Oral Health, Gerodontology, Oral Health Sciences, Ghent University ©)

- Let the older adult spit, if needed, along the process or take away the excess foam with a damp gauze.
- After brushing the teeth, provide interdental cleaning, if needed, once a day (see below the sections on interdental cleaning).

After brushing:

- It is not needed to let the older adult rinse after brushing. By spitting and removing the foam with a damp gauze, some of the toothpaste will remain in the mouth after brushing, and this will provide extra protection against caries. It is not dangerous for the older person to swallow some of the remaining toothpaste.

- Clean the lips of the older adults and put some lip balm if needed.
- Clean the toothbrush extensively under running water, leave it upright in a cup to air dry, and store it under clean conditions in a distance from the toilet (see Figs. 8.13 and 8.14a–c).
- If applicable, clean also the extra grip and handle of the toothbrush.
- If you want to check whether you brushed the teeth adequately, you can use a disclosing agent to colour the remaining plaque. This may also convince the older person to receive assistance with daily oral hygiene (see Fig. 8.15).

Fig. 8.13 Good example of storing the toothbrush under hygienic and dry circumstances. (Community Dentistry and Oral Public Health, Dental School, Ghent University, Belgium ©)

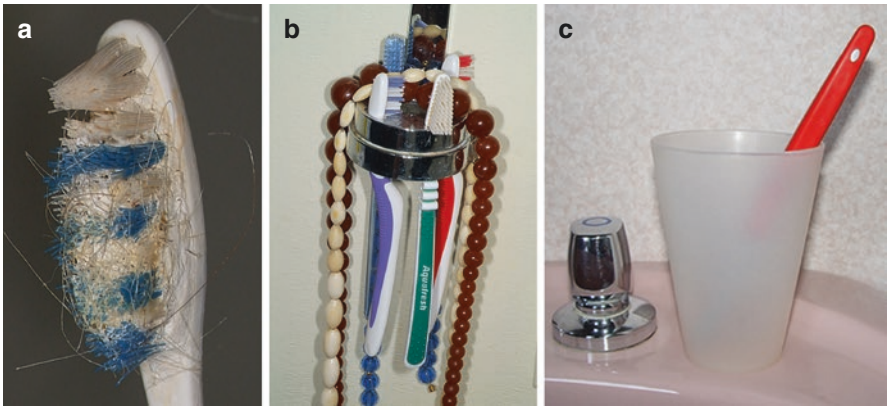

Fig. 8.14 (**a–c**) Examples of storing the toothbrush in a wrong way. (Community Dentistry and Oral Public Health, Dental School, Ghent University, Belgium ©)

Fig. 8.15 Disclosing agents can help to assess the oral hygiene skills of the older adult or the caregiver. (Tri Plaque ID Gel, GC ©)

Interdental Cleaning

If the older adult has two or more remaining teeth standing one next to another, you need to clean the space between them with an interdental brush, because a normal toothbrush will not be able to do that. For older adults, dental floss is often not suitable as it is difficult to handle. Moreover, the interdental spaces may be too large to be adequately cleaned with dental floss. The interdental brushes come in different sizes, and every brand uses a different colour code to indicate the size. Some interdental brushes have a conical head that can adapt more easily to the different interdental spaces (Fig. 8.16a–c). Some persons need several sizes to clean their mouth. A dental professional can advise on the best size(s) for each mouth. Interdental cleaning should be performed at least once a day preferably in the evening before going to bed. Interdental brushes are also used to clean the area under and around dental implants, crowns, and bridges. Interdental brushes wear down faster than a normal toothbrush and should be replaced more or less after 2–3 weeks, depending on the amount of interdental spaces and the dexterity of the user.

Interdental Brushing: Step-by-Step Procedure

Before brushing:

- Make sure that you have cleaned the teeth first with a normal toothbrush following the procedure previously described.

During the brushing procedure:

- Take the interdental brush between your thumb and forefinger and place it on the gumline between the teeth. Push it gently between the teeth. If you need to force it or if it bends over, then the interdental brush is too big and you should consider a smaller size for this particular space.
- Move the brush back and forth between the two teeth, and then move to the next interdental space until you have cleaned them all (Fig. 8.17a, b).
- If the interdental brush becomes dirty, as well as after cleaning all the interdental spaces, rinse the brush with water.

Fig. 8.16 (**a**–**c**) Interdental brushes come in different sizes and shapes. A dental professional can advise on the best size and shape for each situation. (Interprox, Dentaid ©; Sunstar GUM ©)

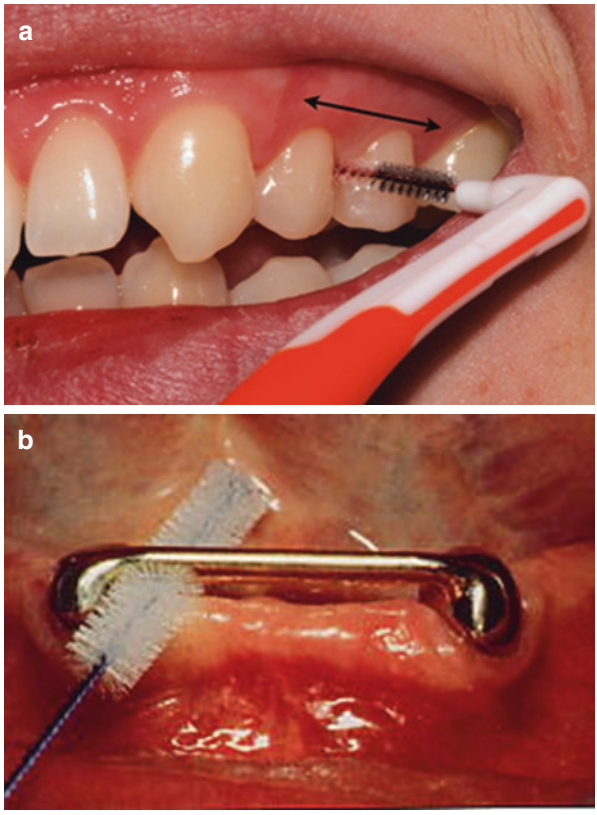

Fig. 8.17 (**a**, **b**) How to position and move the interdental brush. (Community Dentistry and Oral Public Health, Dental School, Ghent University, Belgium ©)

After brushing:

- Store the interdental brush under dry and clean conditions together with the normal brush.

Although interdental brushes are preferred for interdental cleaning, some older adults have the habit of using toothpicks. Make sure to use toothpicks and not a cheese skewer. Toothpicks have a triangular shape and are made of wood that does not splinter. When they become wet, the wood becomes a bit softer and adapts easily to the interdental space (Fig. 8.18a). There are also flexible rubber toothpicks available in different sizes in the market. They might be less harmful compared to the wooden ones (Fig. 8.18b). Toothpicks can be handled in the same way as interdental brushes, but are for single use.

Responsive and Challenging Behaviour Towards Brushing

Responsive behaviours to oral healthcare can make daily oral hygiene time-consuming, disruptive, and distressing for the caregiver but also for the older adult him/herself. They can include different forms of physical or verbal actions such as grabbing, screaming, and resisting care. It occurs especially among people with dementia with a prevalence of 63.4% and increases with the dementia severity. If it occurs frequently, check whether oral pain could be the trigger, and if so, try to solve the problem as soon as possible. Some older adults are more relaxed and calmer at certain points during the day (e.g. after lunch or after the daily intake of certain medications). Try to take advantage of these moments for brushing. There is no such thing as a magical trick to manage the responsive behaviour, but there are several techniques and adaptations that can be made to the daily oral hygiene routine. A study carried out to test the effectiveness of these techniques showed that the chances to gain assent and complete mouth care doubled, and the time spent on mouth care has increased. However, the amount of responsive behaviour and its intensity remain the same. As such, it can be stated that these techniques help caregivers to manage better with the situation when care responsive behaviour is occurring [44]. The following techniques or behaviours can be applied:

Environment: Make sure that the older adult is in a calm and familiar environment with enough light so they can see what is happening around them, and ensure that they can see themselves in a (hand)mirror to access procedural or implicit memories.

Approach and Communication: Try to approach the older adult from the diagonal front because it can be frightening for them to stand in front and put yourself at eye-level or even lower while making the first contact. During the first moments of contact, your body language is most important and you should have a smiling and friendly expression on your face. It is helpful to make physical contact by taking their hand or putting your hand on their arm while making eye contact. Speak with a calm and friendly voice and avoid elderspeak (talking to an older adult as if he/she was a child). Give clear, one-step explanations for what you are doing while providing care. Reassure the older person during brushing and give positive feedback.

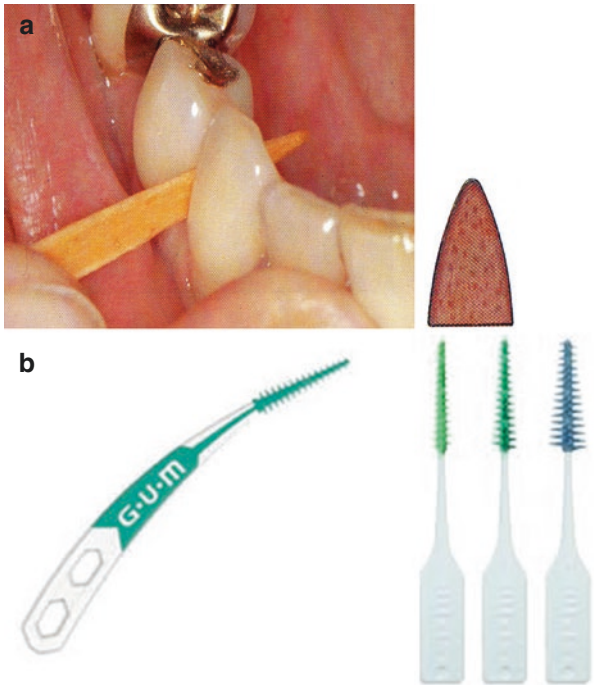

Fig. 8.18 (**a**, **b**) Wooden or rubber toothpicks can also be used by older adults for interdental cleaning. (Community Dentistry and Oral Public Health, Dental School, Ghent University, Belgium ©; Sunstar GUM ©)

Bridging: If the older adult is engaged with you, you can show and describe the toothbrush and mimic brushing your own teeth while smiling. In the next step, you give the older adult his/her toothbrush so that he/she can mimic your behaviour and starts brushing.

Chaining: If bridging does not have the expected results, you can go a step further, guide the older adult's hand towards his/her mouth, and describe the action that needs to be undertaken. Afterwards, you let the person take over and continue brushing the teeth. While guiding their hand towards their mouth, it can be helpful to put your hand on their shoulder on the same side and put a light pressure. This will help to avoid an opposite movement by the patient.

Hand-over-hand: If chaining does not trigger the brushing movement, you can gently place you hand over the older adult's hand and start brushing together (Fig. 8.19). You can also use this technique the other way around, hold the toothbrush yourself and put the patient's hand on top of your hand. This will give you more control over the process while the patient is still participating. The latter can also be used when taking out someone's removable denture. If the person does not open the mouth, you can start brushing the outer surface of the teeth and often, as he/she relaxes during the process, he/she starts opening the mouth spontaneously.

Distraction: If the hand-over-hand technique is not successful, you can give the patient a toothbrush in the hand and use yourself another one to brush. You can also

Fig. 8.19 Hand-over-hand technique (Special Needs in Oral Health, Gerodontology, Oral Health Sciences, Ghent University ©)

give them a familiar item (e.g. a stuffed animal) in the hands to distract them, sing one of their favourite songs, or put on some music they like.

Rescuing: If you do not succeed in building up a positive contact and the attempts of providing care do not give any positive result, tell the patient that you will stop for now and try later during the day. You can also ask another person to take over and provide the care. When they suddenly have another person in front providing mouth care, surprisingly positive results may occur.

Sometimes, the conditions are too difficult to be handled alone, due to the behaviour or the positioning of the patient. Therefore, if needed, you should ask help from another person to assist you holding the hands or positioning the body of the older adult. To prevent the patient from biting or sucking the toothbrush, you can make use of the two-toothbrush technique: use the handle of the second toothbrush to pull the cheek back and let the teeth rest while you brush with the other toothbrush (See Fig. 8.20).

8.2.3.2 Removable Dentures

Many older adults wear in one or both jaws a complete or full removable denture (Fig. 8.21a, b). Other older adults wear a partial denture, if there are still some natural teeth left. The partial denture can have an acrylic base (with clasps; Fig. 8.22) or a metal framework that attaches to the remaining teeth (Fig. 8.23). Some dentures are attached to dental implants to give them more stability and retention; these are called implant-retained overdentures (Fig. 8.24).

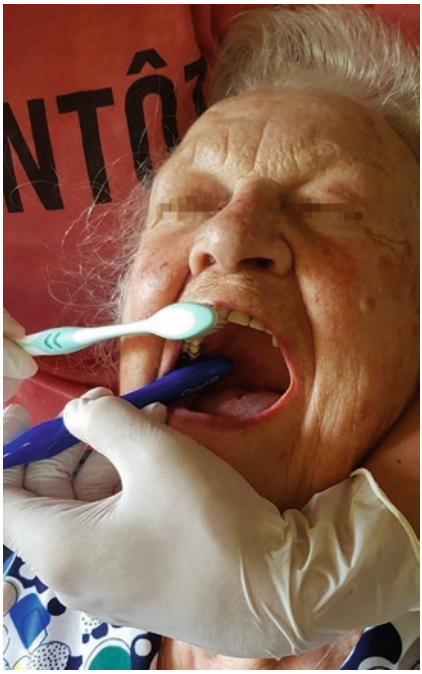

Fig. 8.20 The two-toothbrush technique (Special Needs in Oral Health, Gerodontology, Oral Health Sciences, Ghent University ©)

Dentures should be rinsed with water after each meal and cleaned twice a day as they can accumulate plaque and calculus similar to natural teeth. If a good daily denture hygiene is not provided, it can contribute to local infections, malodours, staining of the dentures, and disturbed taste. Moreover, it can affect general health by increasing the risk for pneumonia and MRSA infections (methicillin-resistant *Staphylococcus aureus*) [45, 46]. At the time this chapter was written, there was a consensus that dentures should be removed from the mouth at night and that daily mechanical cleaning, usually combined with chemical methods, is necessary to achieve optimal results [47]. However, due to a lack of scientific evidence there is still no consensus about the best way to store the dentures when they are not placed in the mouth of frail older people, and the recommendations differ a lot from one country to another. The care provider should ask a dental professional about the best evidence-based practices to store the dentures of the patient.

Mechanical cleaning: The easiest and most commonly used mechanical cleaning method is to brush the denture with a denture brush (Fig. 8.25a–c) and a non-abrasive denture cleanser (Fig. 8.26). This can be a specialised product or a neutral soap. Normal toothpaste should be avoided because it can affect the integrity of the acrylic base and can therefore promote the attachment of bacteria to the denture. Ultrasonic cleaning could be a good alternative mechanical method for brushing.

Fig. 8.21 (**a**, **b**) A full denture. (Special Needs in Oral Health, Gerodontology, Oral Health Sciences, Ghent University ©)

Fig. 8.22 A partial acrylic-based denture. (Special Needs in Oral Health, Gerodontology, Oral Health Sciences, Ghent University ©)

Fig. 8.23 A partial denture with a metal framework. (Special Needs in Oral Health, Gerodontology, Oral Health Sciences, Ghent University ©)

Fig. 8.24 An implant-retained overdenture. (Photo courtesy of Professor Hercules Karkazis, Athens, Greece ©)

Fig. 8.25 (**a**–**c**) Denture brush with bristles on both sides. (Special Needs in Oral Health, Gerodontology, Oral Health Sciences, Ghent University ©; Lactona ©; Piksters, Erskine oral care ©)

Fig. 8.26 Use a specialised product or neutral soap to brush the denture. (Corega ©)

The denture brush is characterised by having bristles on both sides of its head. The smallest amount of bristles has a rectangular shape making it easier to brush the inner surface of the denture (Fig. 8.25a–c). Make sure to use a good quality denture brush because there are big differences in effectiveness and durability between brushes.

Chemical cleaning: This can be achieved by soaking the denture on a daily basis in water with a denture cleanser after mechanical cleaning and provides extra chemical breakdown of the remaining plaque and some level of disinfection (Fig. 8.27). However, the effects of the prolonged use of cleansing tablets in the dentures' material require more scientific evidence. There are several denture cleansers in the market with different chemical formulations. It is very important to follow the instructions mentioned by the manufacturer to achieve optimal results. Chemical cleaning can also include soaking the denture in a mix of water and white vinegar to remove calculus, but this method should be avoided for partial dentures with a metal frame. Denture cleansers can only be used outside of the mouth. Especially in persons with cognitive decline, there is a risk for misuse (e.g. the tablet can be seen as a dissolvable painkiller) and extra precautions should be taken.

Daily Denture Hygiene: Step-by-Step Procedure

Before brushing:

- Make sure you have all the necessary materials to clean the denture (denture brush, denture cleanser, damp gauze, gloves, soft toothbrush, storage box; Fig. 8.28).
- Take the denture out of the mouth and rinse it thoroughly with water.

Fig. 8.27 Chemical cleaning of the denture (Special Needs in Oral Health, Gerodontology, Oral Health Sciences, Ghent University ©)

Fig. 8.28 Make sure that you have all the necessary materials in place before you start brushing the denture. (Special Needs in Oral Health, Gerodontology, Oral Health Sciences, Ghent University ©)

- Give the older adult some water to rinse in order to remove food particles from the mouth.
- Remove remaining food debris from the mouth with a damp gauze.
- Clean the palate and the alveolar ridges covered by the denture with a soft toothbrush (Fig. 8.29).

During cleaning procedure:

- It is best to clean the denture above a sink or bowl filled with water to prevent damage of the denture if it drops.

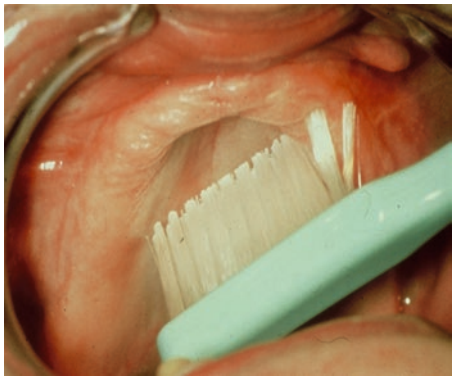

Fig. 8.29 Clean the palate and the alveolar ridges covered by the denture. (Community Dentistry and Oral Public Health, Dental School, Ghent University, Belgium ©)

- Brush the inside and outside surface of the denture as shown in Fig. 8.30a–d. Pay special attention to the inside part as there is often more plaque accumulation due to the lack of natural cleaning by the tongue and saliva and the roughness of the surface.
- When holding a lower acrylic denture in the palm of your hand, do not put too much pressure to prevent the denture breaking in two (Fig. 8.30d).
- After mechanical cleaning, the denture should be rinsed with water.
- Soak the denture in water with a denture cleanser following the instructions of the manufacturer.

After cleaning:

- The denture should be rinsed under running water after cleaning.
- Rinse the denture brush with water and store in a dry and hygienic place similar to the toothbrush.
- The denture should be left outside of the mouth overnight (Fig. 8.31). Currently, there is no scientific evidence on the best storage method (dry, in clean water, or in a denture cleanser solution). Some recommendations advise to soak them in water to prevent warping or cracking, and add a denture cleanser to lower the bacterial load, but others advise to store them dry in a clean denture storage box to avoid candida infections. The non-dental health-care provider and the caretaker should consult the dentist for the preferable storage method for individual patients.
- Rinse the denture before putting it back in the mouth.
- If applicable, make sure that the natural teeth are also adequately brushed before putting the denture back in the mouth.

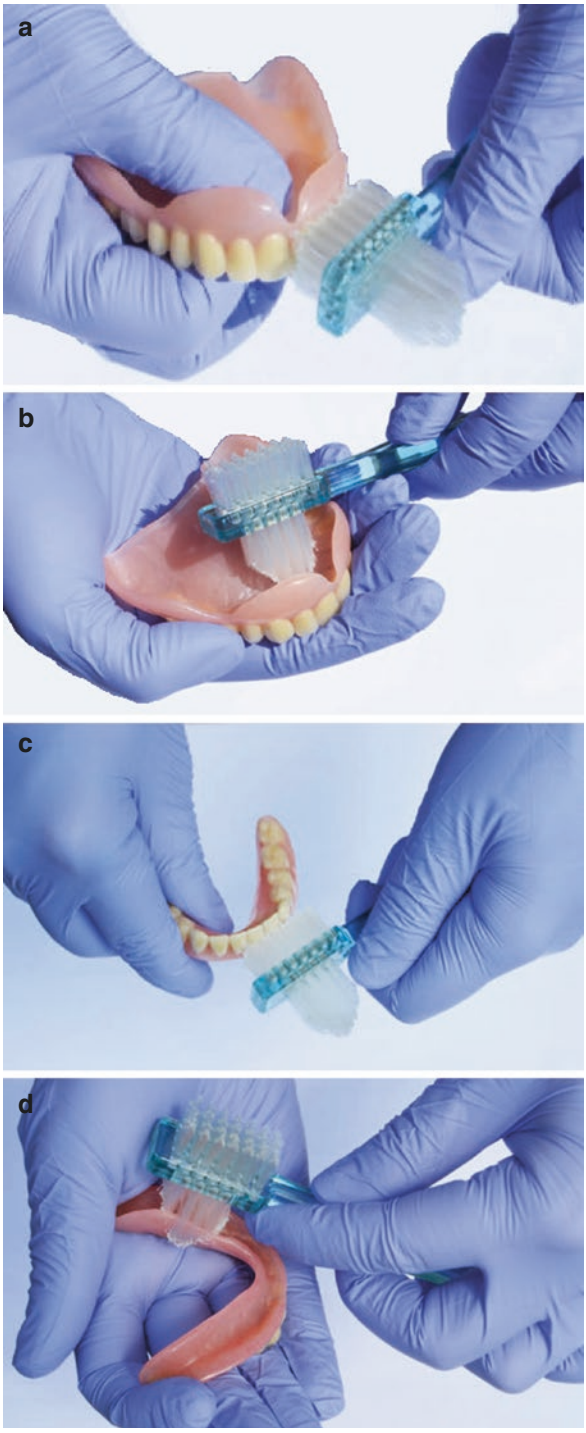

Fig. 8.30 (**a**–**d**) How to hold and brush a denture. (Gezonde Mond ©)

Fig. 8.31 A denture storage box

Fig. 8.32 Tongue with tongue plaque. (Community Dentistry and Oral Public Health, Dental School, Ghent University, Belgium ©)

8.2.3.3 Tongue

Plaque does not only accumulate on the teeth or dentures but also on the dorsum of the tongue (Fig. 8.32). The best method to clean the tongue is by using a tongue scraper because it provokes less gagging compared to a normal toothbrush, and the coating can easily be brought forward and removed from the tongue. Tongue scraping is beneficial to reduce oral malodour and improve taste perception [48, 49]. There is still no or little evidence for further beneficial effects, and there is no evidence and no existing guideline on how the tongue scraper should be best used.

There are different models of tongue scrapers (Fig. 8.33a–d). Some have a brush integrated to loosen up the coating before scraping, others are from plastic and have a shape adapted to the surface of the tongue.

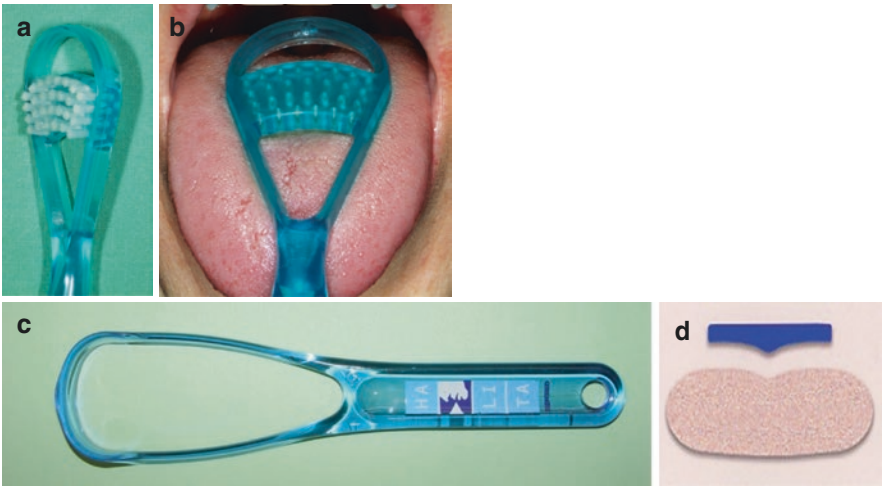

Fig. 8.33 (**a**–**d**) Tongue scrapers. (Community Dentistry and Oral Public Health, Dental School, Ghent University, Belgium ©; Halita, Dentaid ©)

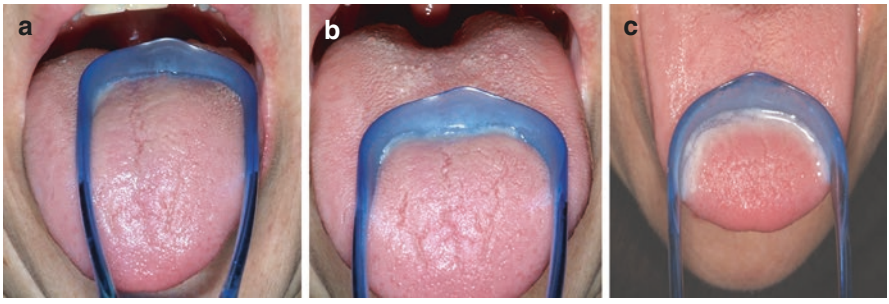

Fig. 8.34 (**a**–**c**) How to use a tongue scraper. (Community Dentistry and Oral Public Health, Dental School, Ghent University, Belgium ©)

To use the tongue scraper, we suggest the following:

- Ask the older adult to pull out the tongue and hold it between your fingers with a damp gauze.
- Put the scraper in the middle on the back of the tongue and move the scraper forward (Fig. 8.34a–c).
- Remove the coating from the scraper with a damp gauze or water.
- Repeat this movement on the left and right side of the tongue.

8.2.4 Fluoride

As many older adults are at high risk for oral pathology, extra measures need to be taken to provide optimal prevention. First of all, sugar consumption needs to be under control and second, extra chemical prevention can be added to the daily oral hygiene habits. Most of the extra measures need to be applied by a dental professional and include the application of varnishes with fluoride or chlorhexidine and the application of silver diamine fluoride. Nevertheless, there are some adaptations to the daily oral hygiene routine in order to reduce further the risk for oral caries including the use of a toothpaste with a higher fluoride concentration.

8.2.4.1 Highly Concentrated Fluoride Toothpaste

Replacing the conventional toothpaste (1100–1450 ppm fluoride) by a toothpaste with 5000 ppm fluoride reduces the risk for root caries in older adults about 50%. Furthermore, it increases the fluoride concentration available in saliva during the day and reduces the amount of plaque and bacteria compared to a conventional toothpaste. There is no evidence of the additional effect of a toothpaste with 2500–2800 ppm fluoride, but it can be expected that it may offer additional protection compared to the conventional toothpastes. Based on current evidence, highly fluoridated toothpastes should be considered standard of care for frail and care-dependent older adults who have difficulties in maintaining good oral hygiene, as well as for older people with a dry mouth.

If these toothpastes are not available, a 1450 ppm fluoride toothpaste with 1.5% arginine is a good alternative, resulting in a 20% reduction of caries risk [50, 51].

Mouth rinses with sodium fluoride also offer additional protection, but in frail and care-dependent older adults they are often avoided, because of the risk of choking while rinsing in patients with swallowing disorders and the risk of swallowing the mouth rinse in patients with cognitive impairment. Oral hygiene instructions should be as simple as possible for older adults, but there is always a risk of lower compliance for practices additional to normal tooth brushing.

8.2.5 Moistening the Oral Cavity

When older persons suffer from dry mouth, it is important to assess whether the symptoms could be related to medication intake or not. If so, the first step should be to stop, adapt the dose, or replace the causal medication by an alternative to reduce the symptoms of dry mouth. In general, to prevent dry mouth, care providers should strive for the lowest number of medications possible.

If the latter is not possible, and in all other cases, the management of dry mouth in older adults consists preferably of local moistening of the oral cavity. Till now, there is not enough evidence to recommend a certain therapeutic strategy [20]. There is some positive evidence that in patients with purely drug-related dry mouth the use of 1% malic acid, along with xylitol and fluoride (Xeros Dentaid Spray, Dentaid©), to compensate for the harmful effects of the acid, could be beneficial in terms of reducing xerostomia and providing a short-term effect of increased salivary flow rates [52]. Nevertheless, the possible long-term adverse effects on the enamel have not been studied. Single lubrication of the oral mucosa with water or a saliva substitute is also positive with respect to xerostomia. In any case, the treatment should be continued for as long as the aetiology exists and the effects are short. Chewing gum also increases saliva production, but there is no strong evidence that it improves dry mouth symptoms and can be difficult to use in older adults with cognitive impairment, chewing problems, or complete dentures as the chewing gum may stick to the acrylic teeth and displace the dentures [53].

Moreover, dietary advice should include avoidance of dry and spicy foods as well as alcohol intake. The patient and the carers should be advised on the catastrophic effects of xerostomia on oral health and the need for intensive oral hygiene, diet control, and regular dental visits. The frequency of dental visits for older patients with dry mouth should be every 3 months. At these occasions, the oral cavity should be examined for new carious lesions and soft tissue infections or inflammation.

8.2.6 Use of Denture Adhesives

For some older adults, the use of denture adhesives may be beneficial as they improve the sense of security, comfort, and satisfaction with their dentures. Moreover, they improve retention and stability of the denture; they offer better chewing ability and reduced build-up of food debris beneath the dentures. In general, they are used by denture wearers to compensate for a loss in retention and stability when the fit of the denture is deteriorating, but this is not the aim of denture adhesives. Denture adhesives should not be used in ill-fitting dentures, and the patients should seek dental care to improve the dentures' fit. Moreover, there is limited evidence of potentially harmful effects of their long-term use; therefore, they should be used for a time period up to 6 months. There is also limited evidence on the effectiveness of denture adhesives when the older adult suffers from dry mouth. In this case, a gel-type oral moistener is probably more beneficial [54]. Removing the denture adhesives from the oral tissues may be very challenging for a frail older person and their caregivers.

The following user guidelines [54] were developed based on evidence and expert opinions:

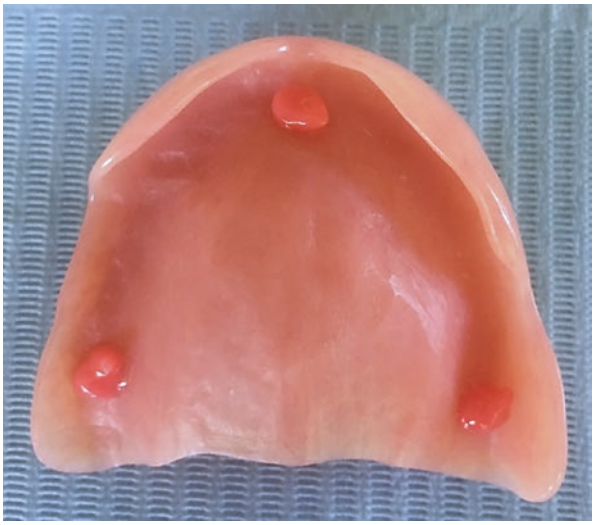

Fig. 8.35 Apply only a small amount of denture adhesive on a clean denture. (Special Needs in Oral Health, Gerodontology, Oral Health Sciences, Ghent University ©)

- Apply a small amount of denture adhesive cream to a clean and dry denture (Fig. 8.35). One application per day should be sufficient.
- After application, place the denture in the mouth and firmly clench the teeth for a few seconds. If the adhesive cream overflows, too much quantity has been applied, and it should be removed rather than swallowed. Patients should not consume food or drink within the first 5 min after the application.
- Before sleep, the denture should be removed, and both the denture and the oral cavity should be thoroughly cleaned to remove any remaining adhesive material.

8.2.7 Denture Labelling

Dentures should be labelled with the individual's name either during fabrication or afterwards. This could prevent denture loss during hospitalisation as well as in nursing homes.

8.3 Integration of Oral Healthcare into General Healthcare for Care-Dependent Older Adults

In order to improve oral healthcare for care-dependent adults, it is important to integrate oral care into general healthcare. The higher we can make changes in the hierarchy of determinants as described in the beginning of this chapter, the

more successful our efforts will be. As there are multiple and diverse determinants and barriers to good oral health, the necessary interventions to improve it will be complex by nature and time-consuming. Moreover, many different care professionals should contribute, and the older adults themselves should also be involved. A joint position statement by the European College of Gerodontology and the European Geriatric Medicine Society grouped the necessary action plans into educational initiatives, health policies development, and citizens empowerment and involvement [55]. The following sections describe several key fields of action.

8.3.1 Oral Health Should Be Supported by Policies, Legislation, and Care Organisations

Interventions to promote the oral health of older adults will only be sustainable and effective if they are supported by adequate policies and legislations. Governments should organise health promotion campaigns targeted towards older adults and should be responsible for the design of a person-centred and integrated healthcare system, aligned to the needs of older adults, providing financial and physical access. Evidence-based policies should be in place to promote the integration of oral health into general health and healthy ageing policies and make the easy choice a healthy choice. Within elderly care organisations, the management should provide, establish, and support protocols to promote oral health [55].

8.3.2 Barriers at Individual, Organisational, and Environmental Level Are Taken into Account

Every older adult lives with his own personal needs and expectations in a unique environment. Every intervention to promote oral health at a personal and at an organisational level should consider the determinants described in Sect. 8.1 and address as many as possible. The determinants can act not only as barriers (e.g. lack of knowledge of care staff, limited reimbursement of oral care) but also as enablers (e.g. mobile oral care available in a care organisation) to the intervention. Therefore, each intervention to promote oral health should be flexible enough to be context specific in order to be sustainable and effective.

8.3.3 Older Adults and Their Direct Carers Have an Expert They Can Address

Every older adult should have a regular dentist. Family members and the patient's physician should know the dentist's contact details and be aware of his/her

possible retirement schedule. Dental professionals should keep an eye on their older patients who suddenly miss their routine dental appointments. Every home care organisation and nursing home should have an oral healthcare team. In a nursing home, the oral healthcare team should comprise of at least one nurse or nurses' aide per ward, a general practitioner, and if possible an occupational therapist and a speech therapist. In a homecare organisation, the team will consist of several carers performing the home visits, and they should be coordinated by a central administrator. The oral healthcare team is coordinated by one of its members, and the members of the team are the first point of contact when someone experiences a problem related to oral health. The oral healthcare team needs to ensure that every older adult has the necessary materials for daily oral hygiene. They should also design an oral healthcare plan (see Sect. 8.3.5) for each person and provide training and education to the care staff in their organisation. They should also organise and coordinate the visits of the older adults to a dental professional and take the lead when oral health is being discussed during a multidisciplinary meeting.

8.3.4 All the (Informal) Carers and Older Adults Receive Adequate Education and Training

Daily oral hygiene routines need to be adapted to the changes in an older adult's mouth. First of all, the older adult should be made aware of the best routines by a dental professional. However, when an older adult is not regularly attending a dental professional or with increasing care dependency, a non-dental professional should be able to support and provide daily oral hygiene and be aware of the materials that are needed. Moreover, they should be able to judge whether an older adult is in need of an urgent dental visit, perform an oral health risk assessment, and recognise the basic oral pathologies. This cannot be achieved without being adequately educated and trained on these topics. Theoretical knowledge can be achieved by (online) educational modules provided by a dental professional, and learning ideally takes place for the first time during undergraduate education and repeated afterwards during continuing professional development. Nevertheless, many caregivers lack education during their undergraduate education. The easiest way to educate caregivers within an organisation is to use the train-the-trainer principle. This means that the oral healthcare team (see Sect. 8.3.3) should be trained intensively by a dental professional so that the individual members of the team can afterwards pass their knowledge to the remaining care staff in the organisation. Theoretical education does not suffice and should be accompanied by practical training to have the opportunity to apply the gained knowledge first on each other, and afterwards on the older patient. When general medical practitioners are adequately

educated on oral health, they are key partners to ensure referral to a dental professional when needed (see Chap. 7).

8.3.5 All Older Adults Have an Oral Healthcare Plan Being Part of Their General Care Plan

Irrespective of the place of residence, older adults should have a regular oral health assessment performed by educated geriatricians, elderly care physicians, family physicians/general medical practitioners, nurses or nurses' aides, or other healthcare professionals involved in elderly care with support from a dental professional if needed. After admission to a nursing home, an oral health screening and assessment should take place as soon as possible. The tools to perform such an assessment are described in Chap. 7. However, an oral healthcare plan comprises more than a clinical assessment and also documents the complaints of the older adult and his/her beliefs and priorities towards oral health. It also requires input from the family if the patient is cognitively impaired. Altogether, this creates the basis to decide on the urgency and frequency of a consultation with a dental professional and also gives guidance for the daily oral hygiene procedures. The oral healthcare plan establishes who will perform daily oral hygiene, when is the most appropriate timing to perform it, what level of support is needed, and which materials are needed. As such, the oral healthcare plan is very dynamic and individualised and should be adapted to the changes in the mouth and the general care dependency. It can also be used to structure the referral and communication process with a dental professional. The individual oral healthcare plan can contain relevant information for the dental professional (e.g. medication, contact person, relevant comorbidities, and information about advanced care planning) and space to give feedback to the carers/family about oral hygiene or follow-up care after a dental treatment. The oral healthcare plan gives a sense of shared responsibility and avoids discussions between caregivers. Within an organisation (e.g. nursing home, homecare organisation), they can be used to measure care processes, assess workload, and monitor clinical outcomes both at individual and organisational levels. The regular and sustained follow-up of oral health by means of the oral healthcare plan promotes the early detection of (oral) problems and might prevent emergencies and further (oral) deterioration.

8.4 Conclusion

Knowledge of the broader determinants of (oral) health is essential if we want to design and implement oral health promotion interventions for older adults. If we neglect them, our efforts at the level of clinical prevention will have limited effects.

Oral healthcare interventions in older adults are complex in nature and should involve different stakeholders to achieve long-term results. At the level of clinical prevention, it is important not to neglect the role of dietary sugars, apply correct protocols to remove the biofilm from the teeth and dentures, and establish regular oral screenings by educated care providers.

References

1. Peres MA, Macpherson LMD, Weyant RJ, Daly B, Venturelli R, Mathur MR, et al. Oral diseases: a global public health challenge. Lancet. 2019;394:249–60.
2. Watt RG, Sheiham A. Integrating the common risk factor approach into a social determinants framework. Community Dent Oral Epidemiol. 2012;40:289–96.
3. Gülcan F, Ekbäck G, Ordell S, Lie SA, Åstrøm AN. Social predictors of less frequent dental attendance over time among older people: population-averaged and person-specific estimates. Community Dent Oral Epidemiol. 2016;44:263–73.
4. Rouxel P, Tsakos G, Demakakos P, Zaninotto P, Chandola T, Watt RG. Is social capital a determinant of oral health among older adults? Findings from the English Longitudinal Study of Ageing. PLoS One. 2015;10:1–17.
5. Gülcan F, Ekbäck G, Ordell S, Lie AA, Åstrøm NN. Inequality in oral health related to early and later life social conditions: a study of elderly in Norway and Sweden. BMC Oral Health. 2015;15:1–10.
6. Vanobbergen JN, De Visschere LM. Factors contributing to the variation in oral hygiene practices and facilities in long-term care institutions for the elderly. Community Dent Health. 2005;22:260–5.
7. De Visschere L, de Baat C, De Meyer L, van der Putten G-J, Peeters B, Söderfelt B, et al. The integration of oral health care into day-to-day care in nursing homes: a qualitative study. Gerodontology. 2015;32:115–22.
8. Göstemeyer G, Baker SR, Schwendicke F. Barriers and facilitators for provision of oral health care in dependent older people: a systematic review. Clin Oral Investig. 2019;23:979–93.
9. Hoben M, Clarke A, Huynh KT, Kobagi N, Kent A, Hu H, et al. Barriers and facilitators in providing oral care to nursing home residents, from the perspective of care aides: a systematic review and meta-analysis. Int J Nurs Stud. 2017;73:34–51.
10. World Health Organization. World report on ageing and health. WHO Press: Geneva [Internet]. 2015. www.who.int.
11. National Institute for Health and Disability Insurance (NIHDI). PBN: Pilootproject Mondzorg voor Personen met Bijzondere Noden 2011 [Internet]. 2011. http://www.specialdent.be/library/documents/201_pilootproject-mondzorg-voor-personen-met-bijzondere-noden-pbn-.pdf.
12. Bots-Vantspijker PC, Vanobbergen JNO, Schols JMGA, Schaub RMH, Bots CP, De Baat C. Barriers of delivering oral health care to older people experienced by dentists: a systematic literature review. Community Dent Oral Epidemiol. 2014;42:113–21.
13. Bots-VantSpijker PC, Bruers JJM, Bots CP, Vanobbergen JNO, De Visschere LMJ, De Baat C, et al. Opinions of dentists on the barriers in providing oral health care to community-dwelling frail older people a questionnaire survey. Gerodontology. 2016;33:268–74.
14. Clarke CS, Round J, Morris S, Kharicha K, Ford J, Manthorpe J, et al. Exploring the relationship between frequent internet use and health and social care resource use in a community-based cohort of older adults: an observational study in primary care. BMJ Open. 2017;7:3.

15. Dawes C, Pedersen AML, Villa A, Ekström J, Proctor GB, Vissink A, et al. The functions of human saliva: a review sponsored by the World Workshop on Oral Medicine VI. Arch Oral Biol. 2015;60:863–74.
16. Liu B, Dion MR, Jurasic MM, Gibson G, Jones JA. Xerostomia and salivary hypofunction in vulnerable elders: prevalence and etiology. Oral Surg Oral Med Oral Pathol Oral Radiol. 2012;114:52–60.
17. Affoo RH, Foley N, Garrick R, Siqueira WL, Martin RE. Meta-analysis of salivary flow rates in young and older adults. J Am Geriatr Soc. 2015;63:2142–51.
18. Bardow A, Nyvad B, Nauntofte B. Relationships between medication intake, complaints of dry mouth, salivary flow rate and composition, and the rate of tooth demineralization in situ. Arch Oral Biol. 2001;46:413–23.
19. Janssens B, Petrovic M, Jacquet W, Schols JMGA, Vanobbergen J, De Visschere L. Medication use and its potential impact on the oral health status of nursing home residents in Flanders (Belgium). J Am Med Dir Assoc. 2017;18:809.e1–8.
20. Gil-Montoya JA, Silvestre FJ, Barrios R, Silvestre-Rangil J. Treatment of xerostomia and hyposalivation in the elderly: a systematic review. Med Oral Patol Oral Cir Bucal. 2016;21:e355–66.
21. Jablonski RA, Munro CL, Grap MJ, Elswick RK. The role of biobehavioral, environmental, and social forces on oral health disparities in frail and functionally dependent nursing home elders. Biol Res Nurs. 2005;7:75–82.
22. Preshaw PM, Walls AWG, Jakubovics NS, Moynihan PJ, Jepson NJA, Loewy Z. Association of removable partial denture use with oral and systemic health. J Dent. 2011;39:711–9.
23. Astrom AN, Ekback G, Nasir E, Ordell S, Unell L. Use of dental services throughout middle and early old ages: a prospective cohort study. Community Dent Oral Epidemiol. 2013;41:30–9.
24. Holm-Pedersen P, Vigild M, Nitschke I, Berkey DB. Dental care for aging populations in Denmark, Sweden? Norway, United Kingdom, and Germany. J Dent Educ. 2005;69:987–97.
25. Gisle L, Demarest S. Gezondheidsenquete 2013 Rapport 2: Gezondheidsgedrag en leefstijl [Internet]. https://his.wiv-isp.be/nl/. 2014. http://www.vigez.be/themas/voeding-en-beweging/cijfers/beweging.
26. Niesten D, Witter DJ, Bronkhorst EM, Creugers NHJJ. Oral health care behavior and frailty-related factors in a care-dependent older population. J Dent. 2017;61:39–47.
27. Kiyak HA, Reichmuth M. Barriers to and enablers of older adults' use of dental services. J Dent Educ. 2005;69:975–86.
28. Bennett IM, Chen J, Soroui JS, White S. The contribution of health literacy to disparities in self-rated health status and preventive health behaviors in older adults. Ann Fam Med. 2009;7:204–11.
29. Batista MJ, Lawrence HP, De Sousa MDLR. Oral health literacy and oral health outcomes in an adult population in Brazil. BMC Public Health. 2017;18:1–9.
30. Bradshaw DJ, Lynch RJM. Diet and the microbial aetiology of dental caries: new paradigms. Int Dent J. 2013;63(Suppl 2):64–72.
31. Peyron MA, Woda A, Bourdiol P, Hennequin M. Age-related changes in mastication. J Oral Rehabil. 2017;44:299–312.
32. Namasivayam-MacDonald AM, Barbon CEA, Steele CM. A review of swallow timing in the elderly. Physiol Behav. 2018;184:12–26.
33. Winkler S, Garg AK, Mekayarajjananonth T, Bakaeen LG, Khan E. Depressed taste and smell in geriatric patients. J Am Dent Assoc. 1999;130:1759–65.
34. Huppertz VAL, van der Putten GJ, Halfens RJG, Schols JMGA, de Groot LCPGM. Association between malnutrition and oral health in Dutch nursing home residents: results of the LPZ study. J Am Med Dir Assoc. 2017;18:948–54.

35. Toniazzo MP, de Amorim PSA, FWMG M, Weidlich P. Relationship of nutritional status and oral health in elderly: systematic review with meta-analysis. Clin Nutr. 2018; 37:824–30.
36. Mendonça N, Hill TR, Granic A, Davies K, Collerton J, Mathers JC, et al. Micronutrient intake and food sources in the very old: analysis of the Newcastle 85+ study. Br J Nutr. 2016;116:751–61.
37. Keller HH, Carrier N, Slaughter SE, Lengyel C, Steele CM, Duizer L, et al. Prevalence and determinants of poor food intake of residents living in long-term care. J Am Med Dir Assoc. 2017;18:941–7.
38. Castro RJ, Giacaman RA, Arthur RA, Maltz M. Cariogenicity of a milk-based drink used as a dietary supplement for older adults using a root caries experimental model. Caries Res. 2019;53:76–83.
39. Hujoel PP, Lingström P. Nutrition, dental caries and periodontal disease: a narrative review. J Clin Periodontol. 2017;44:S79–84.
40. Five Major Steps to Intervention (The "5A's"). Content Last Rev. 2012. Agency Healthcare Research Quality. Rockville. https://www.ahrq.gov/professionals/clinicians-providers/guidelines-recommendations/tobacco/5steps.html.
41. Agnihotri R, Gaur S. Implications of tobacco smoking on the oral health of older adults. Geriatr Gerontol Int. 2014;14:526–40.
42. Zbikowski SM, Magnusson B, Pockey JR, Tindle HA, Weaver KE. A review of smoking cessation interventions for smokers aged 50 and older. Maturitas. 2012;71:131–41.
43. Chen D, Wu LT. Smoking cessation interventions for adults aged 50 or older: a systematic review and meta-analysis. Drug Alcohol Depend. 2015;154:14–24.
44. Jablonski RA, Kolanowski AM, Azuero A, Winstead V, Jones-Townsend C, Geisinger ML. Randomised clinical trial: efficacy of strategies to provide oral hygiene activities to nursing home residents with dementia who resist mouth care. Gerodontology. 2018;35(4):365–75.
45. Rossi T, Peltonen R, Laine J, Eerola E, Vuopio-Varkila J, Kotilainen P. Eradication of the long-term carriage of methicillin-resistant Staphylococcus aureus in patients wearing dentures: a follow-up of 10 patients. J Hosp Infect. 1996;34:311–20.
46. Iinuma T, Arai Y, Abe Y, Takayama M, Fukumoto M, Fukui Y, et al. Denture wearing during sleep doubles the risk of pneumonia in the very elderly. J Dent Res. 2015;94:28S–36S.
47. Bartlett D, Carter N, Baat C De, Duyck J, Goffin G, Müller F. White paper on optimal care and maintenance of full dentures for oral and general health [internet]. 2018. https://www.dentalhealth.org/Handlers/Download.ashx?IDMF=81d96249-f307-4e21-aaea-1c861730710e.
48. Kuo YW, Yen M, Fetzer S, D Lee J. Toothbrushing versus toothbrushing plus tongue cleaning in reducing halitosis and tongue coating: a systematic review and meta-analysis. Nurs Res. 2013;62:422–9.
49. Quirynen M, Avontroodt P, Soers C, Zhao H, Pauwels M, Van Steenberghe D. Impact of tongue cleansers on microbial load and taste. J Clin Periodontol. 2004;31:506–10.
50. Wierichs RJ, Meyer-Lueckel H. Systematic review on noninvasive treatment of root caries lesions. J Dent Res. 2015;94:261–71.
51. Ekstrand KR. High fluoride dentifrices for elderly and vulnerable adults: does it work and if so, then why? Caries Res. 2016;50:15–21.
52. Gómez-Moreno G, Cabrera-Ayala M, Aguilar-Salvatierra A, Guardia J, Ramírez-Fernández MP, González-Jaranay M, et al. Evaluation of the efficacy of a topical sialogogue spray containing malic acid 1% in elderly people with xerostomia: a double-blind, randomized clinical trial. Gerodontology. 2014;31(4):274–80.
53. Furness S, Worthington H V, Bryan G, Birchenough S, McMillan R. Interventions for the management of dry mouth: topical therapies. Cochrane Database Syst Rev. 2011;(12):CD008934.

54. Bartlett D, Carter N, Felton D, Goffin G, Kawai Y, Muller F. White paper on guidelines for the use of denture adhesives and their benefits for oral and general health [internet]. Oral Health Foundation; 2019. p. 1–56. https://www.dentalhealth.org/Handlers/Download.ashx?IDMF=aa48e389-9c7f-40b1-9d47-ac1dcb599897.
55. Kossioni AE, Hajto-Bryk J, Maggi S, McKenna G, Petrovic M, Roller-Wirnberger RE, et al. An expert opinion from the European College of Gerodontology and the European Geriatric Medicine Society: European policy recommendations on oral health in older adults. J Am Geriatr Soc. 2018;66:609–13.

Interprofessional Collaborative Practice (ICP) in Gerodontology

9

Regina Roller-Wirnsberger and Anastassia Kossioni

Abstract

Geriatric care is based on integrated, person-centred treatment goals that have a positive impact on the patient's quality of life. A comprehensive geriatric assessment is based on the employment of an interdisciplinary team of different healthcare professionals that vary between care settings, human and financial resources available, and individual conditions. Effective team working requires certain attitudes and skills including cooperation, assertiveness, responsibility, communication, autonomy, and coordination. Oral health in frail and care-dependent older persons, who usually do not have access to dental care, relies on interprofessional collaboration. Members of this team may include dentists, dental hygienists, physicians, nurses, dietician/nutrition experts, speech therapists, pharmacists, occupation and physical therapists, psychologists, social workers, formal and informal carers, and others involved into the complex care of older patients with complex care needs. Defining a clear role for dentists and other care providers in the interprofessional geriatric care teams in relation to gerodontology will have a positive impact on the older persons' oral health.

R. Roller-Wirnsberger (✉)
Department of Internal Medicine, Medical University of Graz, Graz, Austria
e-mail: Regina.Roller-Wirnsberger@medunigraz.at

A. Kossioni
School of Dentistry, National and Kapodistrian University of Athens, Athens, Greece
e-mail: akossion@dent.uoa.gr

A. Kossioni (ed.), *Gerodontology Essentials for Health Care Professionals*,
Practical Issues in Geriatrics, https://doi.org/10.1007/978-3-030-41468-9_9

Learning Objectives
After reading this chapter, readers should be able to:

- Know the basic concept of interprofessional collaborative practice (ICP).
- Embrace the concept of older care based upon interprofessional collaborative practice within the "geriatric team".
- Describe general core competences agreed for all professions involved in ICP in healthcare.
- Critically reflect upon the impact of gerodontology in the context of ICP-based geriatric care.
- Offer examples of ICP in gerodontology care.

9.1 What Is Interprofessional Collaborative Practice?

Concerns about the quality and safety of healthcare delivery continue to mount, and the deficiencies cannot be addressed by any health profession alone. Interprofessional collaborative practice (ICP) is the process, in which different professions work together to impact outcome results of patients in healthcare. Within the collaboration, expertise and professional competence of every profession involved shall be valued. Besides professional competences, factors like communication, understanding each other's role within the care process, power dynamics, and different views and approaches to goal setting and the care process itself, impact sustainability of interprofessional work in healthcare systems [1].

As may be seen from Fig. 9.1, patients and care givers are at the centre of coordinated and interprofessional care. ICP is relationship focused and community based. Interprofessional team-based care is further defined as care delivery by intentionally created, usually relatively small work groups, whose members recognise themselves as having both a collective identity and a shared responsibility for a patient or group of patients [2]. ICP differs from interprofessional collaboration in terms of hierarchy in the teams, role clarification of team members, responsibilities within the team, communication structures, and relation to patients and relatives. Hierarchy structures in ICP teams are flat with no central leader and clear role description for members with intentionally thought input from team partners. To facilitate the goal-oriented care in ICP, communication is seamless, dynamic, and effective between team members [2]. In a recently published meta-analysis, a positive impact and effectiveness of educational intervention by IPE programmes was shown for various disciplines of healthcare [3].

Built on this knowledge, a set of interprofessional core competences has been discussed for all professions involved into the healthcare pathway. Professionals are expected to work with individuals of other professions to maintain a climate of mutual respect and shared values. They shall use the knowledge of one's own role and of other professions' roles to appropriately assess and address the healthcare needs of the patients and populations served. To preserve collaboration for the faith of the patients, professionals involved into ICP shall communicate with patients,

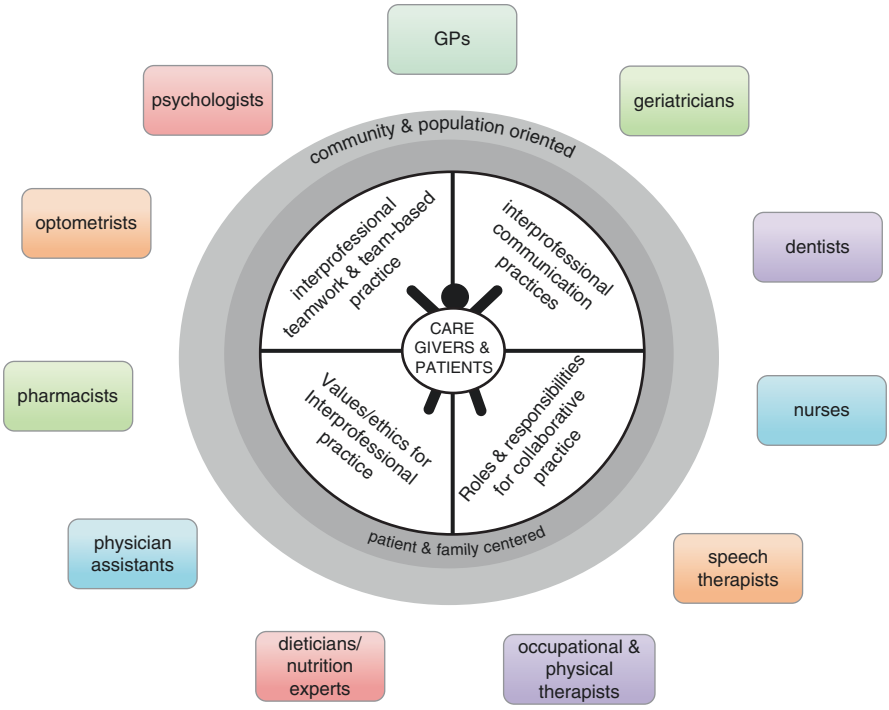

Fig. 9.1 The core framework for interprofessional collaborative practice

families, communities, and other health professionals in a responsive and responsible manner that supports a team approach to the maintenance of health and the treatment of disease. To actively support teamwork, members in an ICP team shall apply relationship-building values and the principles of team dynamics to perform effectively in different team roles to plan and deliver patient/population-centred care that is safe, timely, efficient, effective, and equitable [2].

Attitudes and skills to be covered through education for ICP have been defined in the 1990s of the last century independent from professions involved in ICP [4].

(1) Cooperation: acknowledging and respecting other opinions and viewpoints while maintaining the willingness to examine and change personal beliefs and perspectives; (2) assertiveness: supporting one's own viewpoint with confidence; (3) responsibility: accepting and sharing responsibilities, and participating in group decision-making and planning; (4) communication: effective sharing of important information and exchanging of ideas and discussion; (5) autonomy: ability to work independently; and finally (6) coordination: efficient organisation of group tasks and assignments are domains every profession involved in an ICP care pathway shall be capable of.

The distinction between multidisciplinary/interdisciplinary practice and interprofessional collaborative practice is grounded in the organisational structure and the difference between "group working together" and/or "team

collaboration". The two settings differ in terms of their accountability to the collective they serve, the type of work they produce and the style of their interactions [5]: Teams and team members are generally accountable to each other. The team members deliver a collective product that cannot be produced by any one member alone. Complementary skills of team members are brought together in a structured and aligned way. In contrast, interprofessional/multi-professional group working often requires far less inter-dependent work or complementarity. It is essential for effective teamwork (and therefore interprofessional collaborative practice) to understand necessary skills for teambuilding. Effective teams serve their clients, grow as a team, and contribute to individual team members' learning and well-being [6].

Group members may find themselves working next to each other based on related expertise. The inter-dependence, however, that exists among them is relatively low; tasks can generally be completed, outcomes can be produced, and work can be organized with minimal input, discussion, and collaboration from other group members [5].

It is proven that goal setting and role clarification are often sufficient for helping teams to improve their functioning and productivity. However, also environment impacts the effectiveness of any team, even with the most deliberate teambuilding efforts. Reimbursement and incentive structures, and training programmes adapted to the need of ICP are key elements to drive teamwork also in healthcare and to facilitate ICP for overall improving integrated care and overcoming silo-based medical care in many systems.

In the care of geriatric patients, the collaborative and multi-professional approach has been proven effective in terms of re-admissions to hospital [7]. However, the evidence of an overall positive impact of interprofessional collaborative care when compared to usual patient care seems to be conflicting. In a recent systematic Cochrane review [8], authors found only few studies of adequate design to test the hypothesis of an impact of ICP on patient outcomes. Research in the area of ICP is complicated by the use of varied terms such as collaboration, communication, coordination, and teamwork, as well as the overlap of the field with other fields of study which also examine how healthcare is organised and delivered. Nevertheless, due to the difficulties health professionals encounter when collaborating in clinical practice, it is encouraging that research on the number of interventions to improve ICP has increased.

9.2 Why It Is Important in the Care for the Elderly People

In the science advice document released by the European Academies of Science "Transforming the future of ageing" [9] science experts and authors clearly advocate for integrated care delivery throughout the whole lifespan to effectively impact on healthy lifetime as also defined in the Report on Ageing, released by WHO in 2015 [10]. Integration addresses longitudinal care pathways as well as horizontal integration of care intervention through linkage of processes currently delivered in

a fragmented way in many healthcare systems, and development of healthcare delivery towards individualised and person-centred treatment goals [1]. This approach implies a strong linkage of professionals integrated in the care of patients at any age, particularly of importance for patients with complex care needs, such as old and vulnerable groups.

In geriatric medicine, the concept of ICP has a long-standing tradition [11]. Geriatric medicine is patient-centred and anchors on patients' preferences, healthy life expectancy, prognosis, and skilled clinical decision-making. The comprehensive geriatric assessment (CGA), as multidimensional diagnostic process, builds the ground to judge or decide the amount, value, quality, and importance of an issue for the patient and the decision that is made by professionals. CGA is an instrument designed to quantitatively evaluate patient's capacities in different domains [7]. The hallmark for sustainable geriatric work based upon CGA is the employment of an interdisciplinary team. This team generally includes several different healthcare professionals. The composition of team members is flexible and varies between care settings in which older patients are cared for. The team composition and number of team members also varies according to local specificities and financial resources. Each member of the team has specific skills and tasks. However, none of the team members is able to deliver the optimum of care aimed for in a stand-alone process. Hierarchies are usually flat, despite the overall process management is carried by geriatricians trained for this interprofessional and collaborative care delivery [12]. Multi-disciplinarity alone is not enough to address the complex care needs of older people. Maintenance of high-standard communication within a team but also across care settings is key to deliver the integrated care settings for this population to avoid unnecessary services and to reduce length of hospital stay, re-admission to hospital, increased nursing needs or preterm admission to long-term care [13].

9.3 Who Are the Team Members and What Are Their Roles

The geriatric care team includes several different health and social care professionals, depending on care setting and the human and financial resources available. Generally said, physicians (geriatricians, general practitioners, family physicians, internists, physical rehabilitation specialists, or old age psychiatrists) are anchored in a geriatric team. Alongside physicians, healthcare professionals like nurses, physiotherapists, dieticians/nutritionists, pharmacists, dental professionals, speech therapists, psychologists, social care workers, and others are involved into the complex care of older patients with complex care needs. None of those professions can deliver person-centred care for this population solely on its own. The patient outcome does not only depend on the individual competences but strongly depends on the capacity of the team to work collectively and in tight connection [14]. The care plan joins together from different perspectives of team members and is closely monitored by the whole team. Each team member has specific skills and the individual roles in the integrated care process are

well defined for each team member. However, core skills and attitudes towards person-centred care of older people based upon the process of shared decision-making must be shared by all team members [15]. To make the teams work most efficiently, it is necessary to avoid overlap of competences and avoid waste of human resources. Effective team working around complex care for geriatric patients therefore requires appropriate integration of tasks towards the team members' capacities and role models. This model of interprofessional collaborative practice also requires the capacity of each profession to acknowledge professional boarders of competence and the skill to detect gaps to be addressed by another profession involved into the team. In addition, each team member must be able to anticipate possible interaction of interventions set by different team members for the patient and must be able to communicate information needed to optimize the treatment plan developing complementary interventions to reach a goal set within the team [16] and the patient itself as well as formal and informal care givers. Those are also considered part of the "team" and communication pathways are centred around patient wishes and preferences. This is key for the success of geriatric care and to deliver care based upon the process of shared decision-making [17].

Leadership is an important skill to guide the work of a geriatric team. Usually, the role of leadership can rotate between team members according to actual patient needs and wishes. The lead is especially important to avoid overload with work of one profession involved and to maintain the roles decided within the team. This structure helps to avoid conflicts and facilitates communication. It seems noteworthy to mention that leadership in interprofessional collaborative practice does not imply a hierarchical structure and close communication and feedback rules aim at overcoming potential of conflicts. As the structure and processes in the geriatric teams are not rigid, the success of the interprofessional work strongly depends on each team members' capacity to contribute to flat hierarchies, respecting each team member's skills as an important feature for the success of the collaborative practice approach.

9.4 Application in Gerodontology Care

Gerodontological care processes have come into focus of personalised care for older people. Gerodontological care is characterised by collaboration among dentists, dental hygienists, GPs, family physicians, nurses, geriatricians, internists, dietician/nutrition experts, speech therapists, pharmacists, occupational and physical therapists, psychiatrists, psychologists, social workers, and other professionals involved in the care for the elderly. Likewise, the composition and structure in "geriatric teams", processes and structure of collaboration varies between care settings and environment of care delivery. In an "Expert Opinion Statement", launched by the European College of Gerodontology (ECG) and the European Geriatric Medicine Society (EuGMS), experts in the field of gerodontology and older care stated that "frail persons often do not receive routine dental care, due to

a number of barriers and misconceptions. These hindrances include person-related issues, lack of professional support, and lack of effective oral health policies" [18]. The group detected several barriers for efficient gerodontological care delivery, one of those grounded in lack of interprofessional training, knowledge, and structural environment to support ICP in gerodontological care of older people. Although gerodontology is included in many undergraduate dental curricula, geriatric oral health programmes for non-dental healthcare professions at all educational levels are still scarce [18]. This situation is key as it also reflects the current care provision, which is fragmented and not delivered in a collaborative approach. One strategy to overcome these barriers is to define clear roles for dental care professionals during interprofessional collaborative practice in geriatric teams in institutions. Hospitals and nursing care homes, which often provide such integrated and interprofessional care teams within their structure, may easily adopt this spectrum of dental care into their processes. The integration of such competences, however, requires the inclusions of minimal training content for all healthcare professionals already during undergraduate training. Such competencies have been defined by the group of ECG and EuGMS earlier [18, 19]. They include basic skills on how to perform an initial oral examination and communicate dental care in the context of complex "geriatric" care, know the principles of oral disease prevention, including dental caries and periodontal disease, denture-related diseases, hyposalivation and xerostomia (feeling of dry-mouth), and oro-pharyngeal cancer. Likewise, basic competences as outlined by IPEC [2] in their framework for training interprofessional collaborative practice need to be acquired by all professions involved into the comprehensive care approach also including gerodontological care.

Good practice examples for ICP in gerodontology in different care settings, as well as interprofessional education courses in gerodontology [20] have been published, including quantitative and qualitative evaluation. Data on exploitation of comprehensive care approach including dental care have been published for nursing and care home settings. Dental hygienists already provide dental care to aged care residents in Japan, Sweden, and the United States [21]. However, qualitative studies from different groups show conflicting views and tensions between disciplines on the topic of interprofessional practice, defined as "the ability of health professionals to work effectively together to manage complex practice situations requiring communication, cooperation and collaboration across different professional groups" [22]. This indicates that a staged process might be necessary to reach the goal of integration of dental procedures for older people with the geriatric care process, and based upon ICP. Nonetheless, there is a trend to implement this model of healthcare more broadly. In 2010, the World Health Organization advocated for interprofessional education as a core component in all health professionals' education to equip them to work interprofessionally [1]. Based upon these recommendations, scientific societies and professional organisations already advocate for an interprofessional collaborative practice approach for older care, also including dental care aspects within geriatric care delivery [18].

Case Study. A Gerodontology ICP Example for a Nursing Home Setting

Mrs. X is a 85-year-old woman living in a nursing home. She has a medical history of hypertension, diabetes, vision and hearing impairment, depression, and early signs of dementia. She receives nine different medications for her health problems and faces some limitations in self-care. In the past few weeks, she presented lack of appetite and signs of oral discomfort when eating or drinking. Mrs. X enjoys sucking slowing dissolving candies between meals, because, as she says, she feels her mouth "refreshed". She performs oral hygiene herself without any help or supervision from the staff. The nursing home physician during the general medical assessment assessed the oral structures and observed many decayed teeth. Therefore, he advised the chief nurse to call a dentist. A dentist visited Mrs. X and recorded 22 natural teeth, most of them decayed–five with deep cavities—causing oral pain triggered by cold and percussion. Poor oral hygiene and hyposalivation were also recorded. The last dental visit was performed 14 months ago, before entering the nursing home.

In order to comprehensively and efficiently manage the patient's problems and prevent further deterioration an ICP approach is necessary. The care team structure in this setting includes the physician(s), the formal carers including the administration, the dentist, the dental hygienist (if available), the dietician, and the patient's informal carers (family, etc.). The dentist will assess the oral tissues and perform any necessary preventive, conservative, and restorative interventions. A tailor-made oral health prevention and promotion treatment plan will be developed. It is certain that severe oral health deterioration will continue unless hyposalivation, accumulation of dental plaque, and unhealthy dietary habits will be efficiently controlled. The dentist should collaborate with the physician(s) to evaluate and modify the medications regiment by replacing those with a hyposalivation-inducing effect with others less damaging to the salivary function. As the patient presents activity limitations due to vision impairment and mental conditions, the nursing home staff needs to supervise or perform daily oral hygiene for the resident, after receiving individualised oral health instructions by the dentist. Early detection of any further oral deterioration is necessary by regular initial oral health assessments performed by the nursing home physician and/or nurses, who will call the dentist when necessary. The care team should also collaborate with a dietician to modify cariogenic diet and limit sugary, sticky, and acidic foods and drinks particularly between meals. Finally, regular dental visitations should be planned by the nursing home and the informal carers to professionally control dental plaque and make necessary adaptations to the individualised oral healthcare plan.

9.5 Conclusions

Interprofessional collaborative practice (ICP) is a key element of person-centred care for geriatric patients nowadays. The concept has been proven effective in terms of resubmission to hospital and health-related quality of life. Best practice models, including dental professionals, have been described in this cohort of older people. Special attention must be drawn in the context of ICP on gerodontological care of geriatric patients. A clear role model within the team members including defined core knowledge and skills necessary to screen and prevent people from dental problems is necessary to provide complex care for those patients. In this context, the European College of Gerodontology and the European Society of Geriatric Medicine have published core competences on gerodontology for physicians [18]. The space on basic geriatric core knowledge and skills for all healthcare professionals still needs to be defined. Moreover, missing training requirements to support ICP in gerodontology at the moment are interprofessional training sessions between medical doctors, dentists, and all other healthcare professionals involved in the complex care pathway of geriatric patients. Future work will involve many professions and also will leave space for new role models in older care, as well as the development of new healthcare professions for case management in this context.

References

1. Gilbert JH, Yan J, Hoffman SJ. A WHO report: framework for action on interprofessional education and collaborative practice. J Allied Health. 2010;39 Suppl 1:196–7.
2. Interprofessional Education Collaborative. Core competencies for interprofessional collaborative practice: 2016 update. Washington: Interprofessional Education Collaborative; 2016.
3. Guraya SY, Barr H. The effectiveness of interprofessional education in healthcare: a systematic review and meta-analysis. Kaohsiung J Med Sci. 2018;34(3):160–5.
4. Schmitt M, Blue A, Aschenbrener CA, Viggiano TR. Core competencies for interprofessional collaborative practice: reforming health care by transforming health professionals' education. Acad Med. 2011;86(11):1351.
5. Katzenbach JR. The myth of the top management team. Harv Bus Rev. 1997;75(6):82–91.
6. Hackman JR, Hackman RJ, Press HB. Leading teams: setting the stage for great performances. Brighton: Harvard Business School Press; 2002.
7. Ellis G, Gardner M, Tsiachristas A, Langhorne P, Burke O, Harwood RH, et al. Comprehensive geriatric assessment for older adults admitted to hospital. Cochrane Database Syst Rev. 2017;9:CD006211.
8. Reeves S, Pelone F, Harrison R, Goldman J, Zwarenstein M. Interprofessional collaboration to improve professional practice and healthcare outcomes. Cochrane Database Syst Rev. 2017;6:CD000072.
9. SAPEA. Transforming the future of ageing. Berlin: SAPEA; 2019.
10. Beard JR, Officer A, de Carvalho IA, Sadana R, Pot AM, Michel JP, et al. The world report on ageing and health: a policy framework for healthy ageing. Lancet. 2016;387(10033):2145–54.
11. Michel JP, Walston JD. Oxford textbook of geriatric medicine. Oxford: Oxford University Press; 2018.

12. Piers RD, Versluys KJJ, Devoghel J, Lambrecht S, Vyt A, Van Den Noortgate NJ. A typology of interprofessional teamwork in acute geriatric care: a study in 55 units in Belgium. J Am Geriatr Soc. 2017;65(9):2064–70.
13. Zwarenstein M, Goldman J, Reeves S. Interprofessional collaboration: effects of practice-based interventions on professional practice and healthcare outcomes. Cochrane Database Syst Rev. 2009;3:CD000072.
14. Deschodt M, Flamaing J, Haentjens P, Boonen S, Milisen K. Impact of geriatric consultation teams on clinical outcome in acute hospitals: a systematic review and meta-analysis. BMC Med. 2013;11:48.
15. Hickman LD, Phillips JL, Newton PJ, Halcomb EJ, Al Abed N, Davidson PM. Multidisciplinary team interventions to optimise health outcomes for older people in acute care settings: a systematic review. Arch Gerontol Geriatr. 2015;61(3):322–9.
16. Arbaje AI, Maron DD, Yu Q, Wendel VI, Tanner E, Boult C, et al. The geriatric floating interdisciplinary transition team. J Am Geriatr Soc. 2010;58(2):364–70.
17. van de Pol MH, Fluit CR, Lagro J, Slaats YH, Olde Rikkert MG, Lagro-Janssen AL. Expert and patient consensus on a dynamic model for shared decision-making in frail older patients. Patient Educ Couns. 2016;99(6):1069–77.
18. Kossioni AE, Hajto-Bryk J, Maggi S, McKenna G, Petrovic M, Roller-Wirnsberger RE, et al. An expert opinion from the European College of Gerodontology and the European Geriatric Medicine Society: European policy recommendations on oral health in older adults. J Am Geriatr Soc. 2018;66:609–13.
19. Kossioni AE, Hajto-Bryk J, Janssens B, Maggi S, Marchini L, McKenna G, et al. Practical guidelines for physicians in promoting oral health in frail older adults. J Am Med Dir Assoc. 2018;19(12):1039–46.
20. Kossioni AE, Marchini L, Childs C. Dental participation in geriatric interprofessional education courses: a systematic review. Eur J Dent Educ. 2018;22(3):e530–41.
21. Hopcraft MS, Morgan MV, Satur JG, Wright FAC. Utilizing dental hygienists to undertake dental examination and referral in residential aged care facilities. Community Dent Oral Epidemiol. 2011;39:378–84.
22. Kaufman LB, Henshaw MM, Brown BP, Calabrese JM. Oral health and interprofessional collaborative practice: examples of the team approach to geriatric care. Dent Clin North Am. 2016;60(4):879–90.