Christian Splieth (Editor)

Innovations in Preventive Dentistry

QUINTESSENCE PUBLISHING

Christian Splieth (Editor)

Innovations in Preventive Dentistry

QUINTESSENCE PUBLISHING

Berlin | Chicago | Tokyo
Barcelona | London | Milan | Mexico City | Moscow | Paris | Prague | Seoul | Warsaw
Beijing | Istanbul | Sao Paulo | Zagreb

A CIP record for this book is available from the British Library.
ISBN: 978-1-78698-099-1

QUINTESSENCE PUBLISHING
DEUTSCHLAND

Quintessenz Verlags-GmbH
Ifenpfad 2–4
12107 Berlin
Germany
www.quintessence-publishing.com

Editing: Elizabeth Ducker Publishing, UK
Layout and Production: René Kirchner, Quintessenz Verlags-GmbH, Berlin, Germany

Printed and bound in Croatia by Graficki Zavod Hrvatske d.o.o., Zagreb

Preface

Preventive dentistry is a cross-sectional success story that has produced a 90% caries decline in children and adolescents, as well as caries reductions in adults in many countries. Periodontology and orthodontics also offer great opportunities for prevention … and prevention in all fields of dentistry has grown from primary prevention through maintaining a healthy state to new concepts of secondary prevention, where initial lesions or imbalances are corrected with minimal intervention. In addition, therapy has shifted from repair to tertiary prevention to regain physiologic and healthy balances that ensure long-lasting therapeutic success.

In order to introduce these new developments and innovations into preventive and clinical dentistry for all ages, a group of internationally recognized specialists presents new diagnostic methods and offers options for putting these into practice both for primary prevention and for non- and minimally invasive treatment. With the introduction of a systematic, evidence-based approach in dentistry, new standards for clinical care are being established in all fields of dentistry, stressing prevention-oriented routines. The understanding of caries and periodontal disease has shifted from a focus on invasive treatment to controlling disease activity, and in orthodontics from mechanics to achieving physiologic function. The various chapters highlight this shift, in addition to a clinical view, the overall concept, interaction with general health, and the common risk-factor approach. The authors offer perspectives for tackling dental and medical problems in the vulnerable populations that exhibit most of the dental and medical disease.

Preventive dentistry has changed for epidemiologic, social, and scientific reasons. Professionals should manage this development actively for the benefit of patients in all fields of dentistry and for all ages.

Christian H. Splieth

Editor

Prof Dr Christian H. Splieth
Department for Preventive & Pediatric Dentistry
University of Greifswald
Greifswald, Germany

Contributors

Dr Mohamed H. Abudrya
Department for Preventive & Pediatric Dentistry
University of Greifswald
Greifswald, Germany

OA Priv Doz Dr Mohammad Alkilzy
Department for Preventive & Pediatric Dentistry
University of Greifswald
Greifswald, Germany

Assoc Prof Dr Azam Bakhshandeh
Department of Odontology
University of Copenhagen
Copenhagen, Denmark

Dr Irene Dige
Department of Dentistry and Oral Health
Aarhus University
Aarhus, Denmark

Prof Dr Henrik Dommisch
Department of Periodontology, Oral Medicine and Oral Surgery
Charité – Universitätsmedizin Berlin
Berlin, Germany

Dr Denise Duijster
Department of Social Dentistry
Academic Center for Dentistry Amsterdam
Amsterdam, The Netherlands

Prof Dr Kim R. Ekstrand
Department of Odontology
University of Copenhagen
Copenhagen, Denmark

Prof Dr Elena Figuero
Department of Dental Clinical Specialties, Faculty of Dentistry, University Complutense of Madrid
Madrid, Spain

Prof Dr Margherita Fontana
Department of Cariology, Restorative Sciences and Endodontics
University of Michigan School Dentistry
Ann Arbor, MI, USA

Prof Dr Carlos González-Cabezas
Department of Cariology, Restorative Sciences and Endodontics
University of Michigan School Dentistry
Ann Arbor, MI, USA

Dr Daniela Hoedke
Department of Periodontology, Oral Medicine and Oral Surgery
Charité – Universitätsmedizin Berlin
Berlin, Germany

Prof Dr Nicola Innes
School of Dentistry
College of Biomedical and Life Sciences
Cardiff University, Cardiff, UK

Prof Dr Karl-Friedrich Krey
Department for Orthodontics
University of Greifswald
Greifswald, Germany

Dr Line Staun Larsen
Department of Dentistry and Oral Health
Aarhus University
Aarhus, Denmark

Prof Dr Vita Mačiulskienė
Clinic of Dental and Oral Pathology, Faculty of Odontology
Lithuanian University of Health Sciences
Kaunas, Lithuania

Prof Dr Jukka H. Meurman
Department of Oral and Maxillofacial Diseases
University of Helsinki and Helsinki University Hospital
Helsinki, Finland

Dr Mhd Said Mourad
Department for Preventive & Pediatric Dentistry
University of Greifswald
Greifswald, Germany

Prof Dr Branca Heloisa Oliveira
Department of Community and Preventive Dentistry, School of Dentistry
Rio de Janeiro State University
Rio de Janeiro, Brazil

OÄ Dr Anja Ratzmann
Department for Orthodontics
University of Greifswald
Greifswald, Germany

OÄ Dr Ruth M. Santamaría
Department for Preventive & Pediatric Dentistry
University of Greifswald
Greifswald, Germany

Prof Dr Ana Paula P. Santos
Department of Community and Preventive Dentistry, School of Dentistry
Rio de Janeiro State University
Rio de Janeiro, Brazil

OA Dr Julian Schmoeckel
Department for Preventive & Pediatric Dentistry
University of Greifswald
Greifswald, Germany

Prof Dr Falk Schwendicke
CharitéCentrum für Zahn-, Mund- und Kieferheilkunde
Charité – Universitätsmedizin Berlin
Berlin, Germany

Prof Dr Murali Srinivasan
Clinic of General-, Special Care-, & Geriatric Dentistry, Center of Dental Medicine
University of Zurich
Zurich, Switzerland

Dr Nadezhda Stancheva
Private Practice
Frauenfeld, Switzerland

Prof Dr Livia M.A. Tenuta
Department of Cariology, Restorative Sciences and Endodontics
University of Michigan School Dentistry
Ann Arbor, MI, USA

Prof emeritus Svante Twetman
Department of Odontology
Faculty of Health and Medical Sciences
University of Copenhagen
Copenhagen, Denmark

Prof (em) Dr Cor van Loveren
Department of Cariology
Academic Center for Dentistry Amsterdam
Amsterdam, The Netherlands

Dr J. H. (Erik) Vermaire
Child Health – Oral Health Division
TNO Healthy Living
Leiden, The Netherlands

Prof Dr Egija Zaura
Department of Preventive Dentistry
Academic Centre for Dentistry Amsterdam
Amsterdam, The Netherlands

Prof Dr Stefan Zimmer
Department of Operative and Preventive Dentistry, Dental School
Witten/Herdecke University
Witten, Germany

Abbreviations

AAPD, American Academy of Pediatric Dentistry
ACFP, amorphous calcium fluoride phosphate
ACP, amorphous calcium phosphate
ACPA, anti-citrullinated protein antibody
AD, Alzheimer disease
ART, atraumatic restorative therapy
BL, bone loss
BMI, body mass index
BOP, bleeding on probing
CAL, clinical attachment level
CHALO, Child Health Action to Lower Oral Health and Obesity
CI, confidence interval
CPP, casein phosphopeptide
CRFA, Common Risk Factor Approach
CRP, C-reactive protein
DIFOTI, digital imaging fiber-optic transillumination
DHSW, Dental Health Support Worker
DM, diabetes mellitus
dmfs, decayed, missing, or filled surfaces
DMFT, decayed, missing, or filled teeth
EADPH, European Association of Dental Public Health
ECC, early childhood caries
EHCP, Essential Health Care Program
EPS, extracellular polymeric substances
FOTI, fiber-optic transillumination
GA, general anesthesia
GBR, guided bone regeneration
GER, guided enamel regeneration
GTR, guided tissue regeneration
GWAS, genome-wide association studies
HA, hydroxyapatite
IADR, International Association for Dental Research
ICDAS, International Caries Detection and Assessment System
IgA, immunoglobulin A
IL, interleukin
MFP, monofluorophosphate
MI, motivational interviewing
MIH, molar incisor hypomineralization
NCD, noncommunicable disease
NHS, National Health Service
NNT, number needed to treat
NOCTP, nonoperative caries treatment program
NRCC, nonrestorative cavity control
NSF, nano silver fluoride
OHI, oral hygiene instruction
OHRQoL, oral health-related quality of life
OR, odds ratio
ORCA, European Organisation for Caries Research
OSAS, obstructive sleep apnea syndrome
PAD, peptidylarginine deiminase
PD, probing depth
PISA, periodontal inflamed surface area
PMPR, professional mechanical plaque removal
PSI, Periodontal Screening Index
QLF, quantitative light-induced fluorescence
RME, rapid maxillary expansion
RR, relative risk
RRR, relative risk reduction
SaC, Specific affected Caries Index
SAPM, self-assembling peptide matrix
SDF, silver diammine fluoride
SDG, Sustainable Development Goal
S-ECC, severe early childhood caries
SES, socioeconomic status
SCT, social cognitive theory
SiC, Significant Caries Index
SMART, silver modified atraumatic restorative technique
SNP, single nucleotide polymorphism
SPT, supportive periodontal therapy
SSB, sugar-sweetened beverages
TMD, temporomandibular disorders
TNF, tumor necrosis factor
VAS, visual analog scale
WASH, water, sanitation, and hygiene
WHO, World Health Organization
WIC, Women, Infants, and Children program

Understanding caries

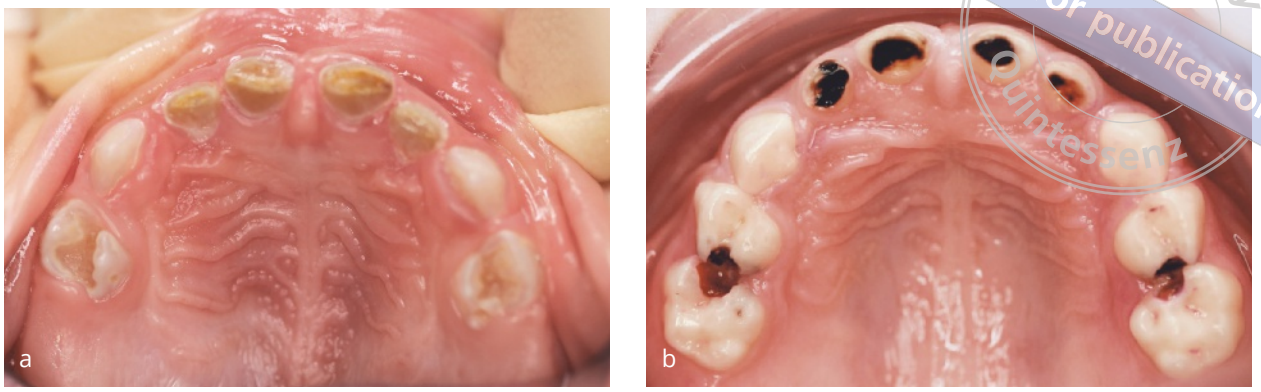
Christian H. Splieth, Mhd Said Mourad, Mohammad Alkilzy, Julian Schmoeckel, Ruth M. Santamaría

In their new consensus statement on the terminology of dental caries and dental caries management, the European Organisation for Caries Research (ORCA) and the International Association for Dental Research (IADR) define caries as "a biofilm-mediated, diet modulated, multifactorial, noncommunicable, dynamic disease resulting in net mineral loss of dental hard tissues. It is determined by biologic, behavioral, psychosocial and environmental factors. As a consequence of this process, a caries lesion develops."[1] This very modern definition is based on the concept that caries is an imbalance of demineralization and remineralization that results from a dysbiosis of the oral biofilm, the overconsumption of carbohydrates, and insufficient oral hygiene (Fig 1-1).

Thus, the prevention of caries aims to adjust and ensure a healthy balance of the oral microbiome, dietary intake, oral hygiene, and mineral supply to avoid a net loss in enamel and dentin of healthy teeth. Caries therapy can only be successful in the long run if this is achieved when demineralization has already taken place. Therefore, caries prevention and its treatment employ the same concept and are nowadays combined as caries control, management, or care.

This is also reflected in the ORCA/IADR definition of caries care, management, or control comprising "actions taken to interfere with mineral loss at all stages of the caries disease, including non-operative and operative interventions/treatment. The terms caries care/management/control may be more appropriate than the term 'caries prevention' and because of the continuous de- and remineralization processes, caries control needs to be continued throughout the life course."[1]

In consequence, the terms of caries prevention and therapy merge, which is not really surprising



Figs 1-1a and b Caries is nowadays understood as an imbalance between de- and remineralizing factors resulting in a net loss of minerals **(a)**. Thus, modern caries management modifies oral hygiene, diet, the biofilm, and the mineral equilibrium, keeping sound tooth surfaces healthy, inactivating existing caries lesions **(b)**, and preventing recurrent demineralization around restorations.

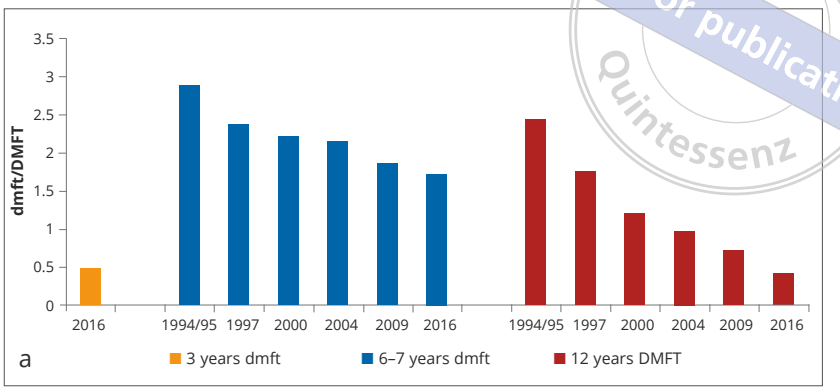
as restorative care and accompanying efforts to reduce caries activity have been viewed as secondary and tertiary prevention for a long time. Taking this into account, ORCA/IADR state that caries prevention "traditionally meant inhibition of caries initiation, otherwise called primary prevention. Primary, together with secondary and tertiary prevention, comprising nonoperative and operative treatments, are now summarized under caries care, management, or control."[1]

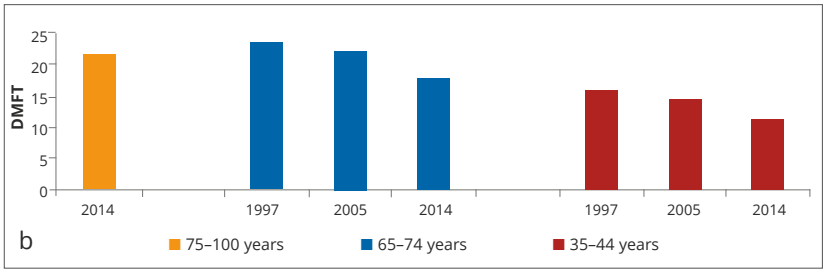
The following chapters regarding caries risk prediction, fluoride use, biofilm and diet control, and promoting oral health are based on this new understanding of caries. As in periodontal disease, the primary goal of all preventive and therapeutic approaches is to achieve a high quality of life by establishing a physiologic, regenerative balance to maintain proper oral health.

Caries epidemiology and its consequences

On a global level, a remarkable caries decline could be achieved for the permanent dentition in children and adolescents in many industrialized regions such as the US, Canada, Europe, or Oceania. Although Germany was not the first country to experience this, consecutive and recent national surveys for all ages allow for a detailed analyses, which reveal trends[2,3] that seem to be similar in many countries (Figs 1-2 and 1-3):

- Caries prevalence has reduced from ten or more affected permanent teeth in adolescents during the 1970s to a mean of less than one decayed, missing, or filled teeth (DMFT) in 12-year-olds nowadays.[4]
- About 90% of the caries burden can be prevented and tooth loss is almost eradicated in the permanent dentition in adolescents.[2,4]
- After the caries decline, 80% of the adolescents are caries-free on a DMFT level and this is not much changed by lowering the threshold to initial caries lesions.[3]
- Thus, the caries distribution is polarized and a so-called high-risk group of about 20% exhibits almost the complete caries burden.[2,4]
- The high-risk group is primarily associated with a low socioeconomic status that leads to less sufficient oral hygiene, fluoride exposure, and often more frequent sugar intake.[2,5]
- In the primary dentition and especially for early childhood caries, the situation is far from satisfactory in many countries.[6] In spite of a less pronounced caries decline in the primary dentition, caries patterns and distribution are equivalent to the situation in adolescents.[7]





Figs 1-2a and b Decayed, missing, and filled teeth (dmft/DMFT) in Germany in **(a)** schoolchildren,[3,7] adolescents,[3,4] and **(b)** adults. In many industrialized countries such as Germany, a remarkable caries decline has been recorded for the permanent dentition in adolescents, as well as in adults, and to a lesser extent for the primary dentition in schoolchildren.

Figs 1-3a to d A large percentage of children are caries-free (80%) **(a and b)**, while a small group of children (20%) **(c and d)** present with high caries rates (80%). The polarization of the caries distribution especially in children leads to two different preventive approaches: Maintaining the high degree of oral health in the majority group of the population and intensifying measures for the high caries risk group.

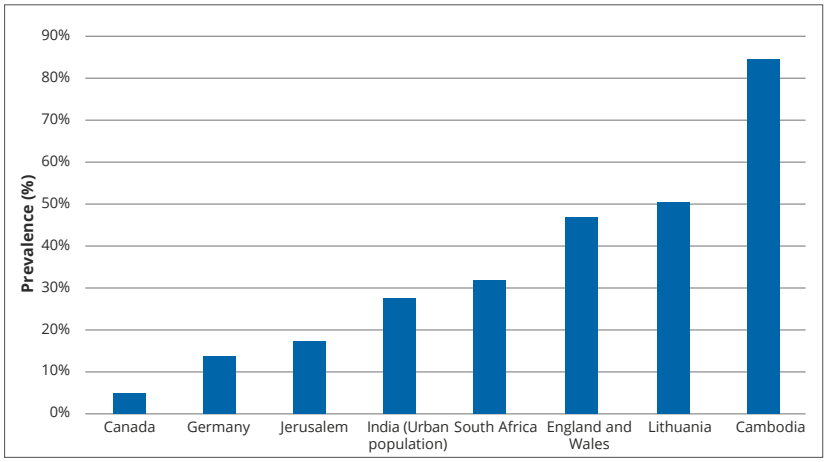


Fig 1-4 Global epidemiology of early childhood caries (ECC). ECC or caries in the primary dentition seem to be a persistent problem, with severe consequences for the affected children. Preventive approaches in almost all countries have to be intensified to mirror the success often achieved in the permanent dentition.[3,10-16]

This is also true for caries in adults.[2] Most likely a further caries decline will also increase the polarization in adults.

- Due to the caries distribution after a major caries decline, primary caries prevention needs a dual strategy of maintaining the high levels of oral health in the majority of the population and trying to find intensified measures to improve the situation in the risk group mostly characterized by a low socioeconomic status.[3]
- There is a realistic perspective that caries levels even in risk groups can be significantly reduced in the future, as the caries decline in this group was proportional to the reductions in the whole population, at least in German adolescents.[4]

In contrast to the general caries decline in many industrialized countries, caries levels in the emerging market economies are still at a high level for most of the population, or even on the rise due to increased wealth and sugar consumption.[8] This imposes a great challenge to these countries; in spite of choosing the restorative approach as was done by many Western countries, strengthening primary prevention would be a better choice.

The current epidemiologic situation of a polarized caries distribution calls for two distinctly different approaches to primary caries prevention: For the majority of the population, individual and professional prevention can reduce 90% of the caries burden and keep it at a tolerable very low level.

The so-called caries risk group that accumulates about 80% of the caries defects and the according treatment needs is characterized by a low socioeconomic status. It seems that outreach programs and tailored health regulations are necessary to achieve further health gains in the groups with often low self-efficacy or (oral) health literacy. A common risk factor approach and cooperation with other professionals are useful for risk grouptargeted prevention to strengthen health and probably also educational competencies in these individuals and their families.

Early childhood caries

Early childhood caries (ECC) appears to be a persistent and neglected topic with rather high levels in many countries (Fig 1-4), low treatment rates, and, therefore, severe consequences in many small children that clearly affects their well-being and quality of life.[9]

Only in recent years has research in caries epidemiology focused on early childhood, followed

Table 1-1 Mean caries prevalence data (dmft) for all kindergarten children in Greifswald, Germany, 2019, as well as mean values and care index for the subgroup of children with/without caries, fillings, and/or missing teeth due to caries (dmft = 0 and > 0, n ~ 1,500)[17]

Parameter	Age (years)				
	1 y	2 y	3 y	4 y	5 y
Mean dmft for all children	0.05	0.30	0.50	1.06	1.56
Proportion of children with dmft = 0	99%	95%	87%	76%	65%
Proportion of children with dmft > 0	1%	5%	13%	24%	35%
Mean dmft children with dmft > 0 (SaC)	4.50	5.5	3.88	4.49	4.43
Care index (mft/dmft) in %	0%	8%	17%	44%	69%

SaC, Specific affected Caries Index.

by representative surveys on the prevalence of ECC. Thus, ECC deserves special attention in order to draw conclusions that might deviate from the situation in the permanent dentition.

ORCA and IADR define ECC as "the early onset of caries in young children with often fast progression which can finally result in complete destruction of the primary dentition [Fig 1-1a]. An epidemiologic definition of ECC is the presence of one or more decayed (noncavitated or cavitated lesions), missing (due to caries), or filled surfaces, in any primary tooth of a child under [the] age of six." They also state that the appearance of ECC deviates from the common caries distribution where pits, fissures, and proximal surface dominate.[1]

"Due to the frequent consumption of carbohydrates, especially sugars, and inadequate to absent oral hygiene in small children, ECC demonstrates an atypical pattern of caries attack, particularly on smooth surfaces of upper anterior teeth."[1] This implies that typical ECC is a type of child neglect, as even minimal and easy preventive oral health measures are omitted for a considerable time. It is amazing that this can be found in so many children in developed and emerging countries.[6] It also calls for clearly intensified primary caries-preventive measures from the first tooth on.

The National German Oral Health Survey in Children and Adolescents revealed 14% of 3-year-olds had caries on a dmft level in Germany,[3] which is at the lower end of an international comparison. The mean value in the affected children (the newly introduced Specific affected Caries Index [SaC][17]) was 3.6 dmft, making pulpal involvement, subsequent toothache, and probably a treatment under general anesthesia (GA) due to the high number of carious teeth as well as the low compliance in these small children likely – or a painful, and potentially traumatic experience when extraction in uncooperative children is performed if GA is not available.[3]

A closer look reveals that in spite of a very low mean caries prevalence of 0.3 dmft in 2-year-olds, a small risk group of children develops "real" ECC from the first tooth onwards (Table 1-1). Here ECC is caused by infant feeding that provides a high sugar content and/or erosive drinks in combination with insufficient or a complete lack of oral hygiene.[18] Regarding the "epidemiologic" definition of ECC, in Germany the prevalence increases to almost 35% at a defect level until school age.[3,7] The care index of less than 50% is not satisfactory, and clearly lower than in the permanent dentition.[3] The young age of the children and the high burden of the disease in many countries make a primary preventive approach to manage the problem of ECC (see Chapters 5 and 9) more logical

than the secondary or tertiary prevention (see Chapters 12 to 14) via, for example, restorations or even extractions.

Caries diagnostics

Analogous to the above-mentioned definition of caries as a net loss of minerals, caries diagnostics would assess the change of minerals over time. As caries is a process, this implies that a one-time diagnosis requires a continuous sampling technique or is even per se impossible.

The ORCA/IADR consensus solves this problem by stating that "caries diagnosis is the clinical judgment integrating available information, including the detection and assessment of caries signs (lesions), to determine presence of the disease."[1] This is especially crucial for secondary or tertiary prevention, with the signs or symptoms of caries already being clearly present in an individual. "The main purpose of clinical caries diagnosis is to achieve the best health outcome for the patient by selecting the best management option for each lesion type, to inform the patient, and to monitor the clinical course of the disease."[1] This is relevant to all levels of prevention, as many teeth and surfaces within one individual often present different stages of the caries process.

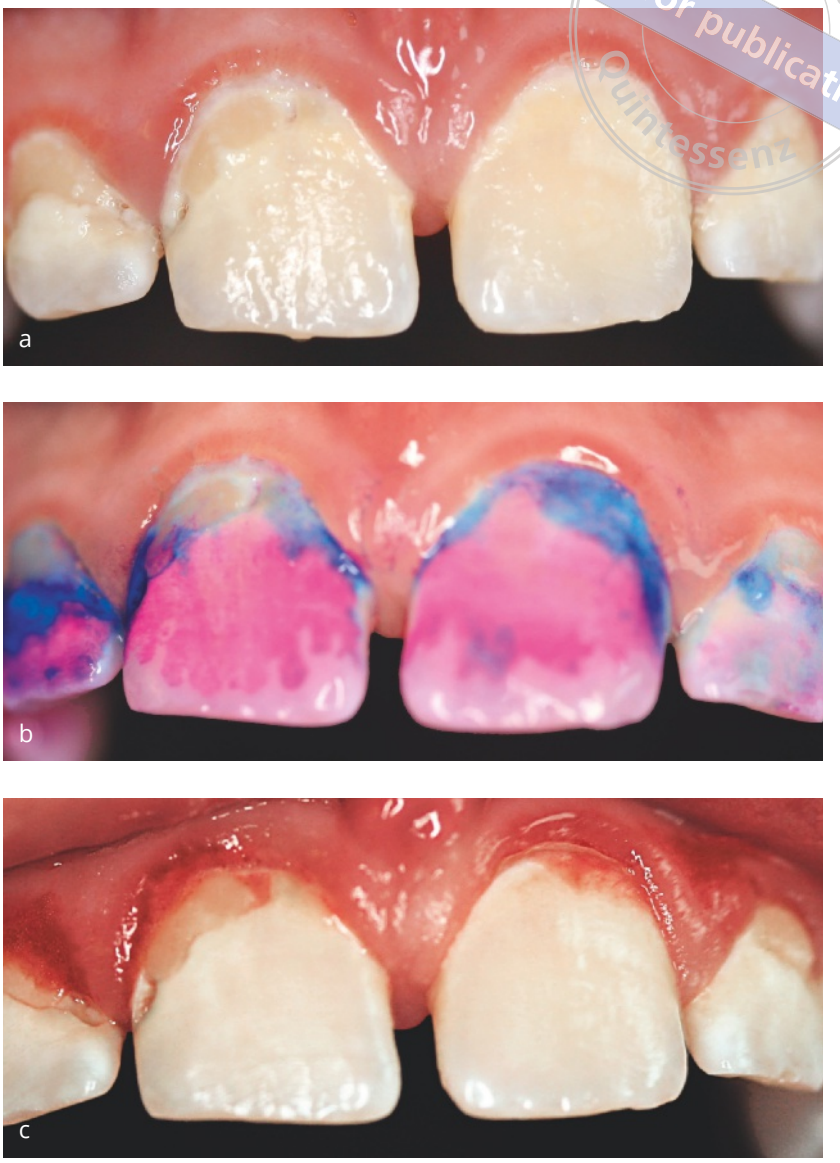
It is important to comprehend that the diagnosis of caries as a process or caries activity differs from the diagnosis of past mineral loss or even cavitation, which was traditionally defined as "caries diagnostics." According to ORCA/IADR, caries activity "is a concept that reflects the mineral balance, in terms of net mineral loss, net mineral gain, or stasis over time."[1] Caries active implies caries initiation or progression; caries inactive implies caries arrest or regression.[19] The diagnosis of caries activity can actually be used as the gold standard for the success of preventive measures because they should reduce the net mineral loss to zero or even remineralize existing lesions. The detection of cavitation due to caries is a comparatively crude diagnostic approach.

Clinical examination

A regular, visual-tactile examination of the mouth and teeth is part of the standard routine in dentistry. However, active initial caries lesions, which are the crucial part of the diagnosis, can only be assessed clinically after removal of the dental plaque and drying of the teeth using sufficient lighting. It is important that no force is applied with a pointed probe during the examination of initial lesions, as this can destroy the intact surface and, therefore, reduce the chance of defect-free remineralization.[20]

The International Caries Detection and Assessment System[21] offers a detailed diagnosis of the various caries stages from 0 (healthy) to 6 (deep caries). In daily practice, however, it is usually sufficient in the diagnosis of caries to distinguish between healthy surfaces, initial lesions, moderate stage lesions, and cavitated lesions, as well as their degree of activity.[21-23]

The clinical caries and activity diagnosis allows a fairly precise therapy decision and selection of the right level of care involving primary, secondary, or tertiary prevention. This makes the traditional concept of caries treatment obsolete. A merely restorative approach to caries would fail, as was often the case, due to the persisting net loss of minerals, leading to "secondary" caries, which is actually the nontreated caries activity that had originally led to the first cavitation.

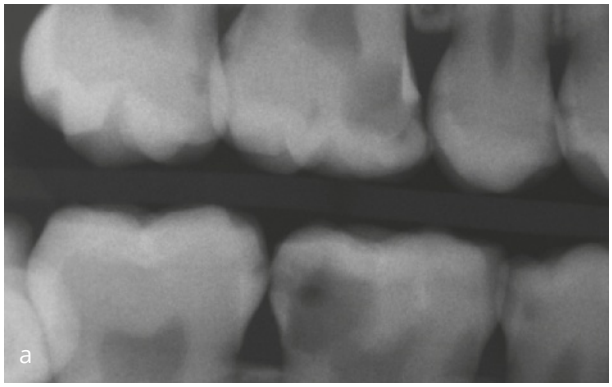


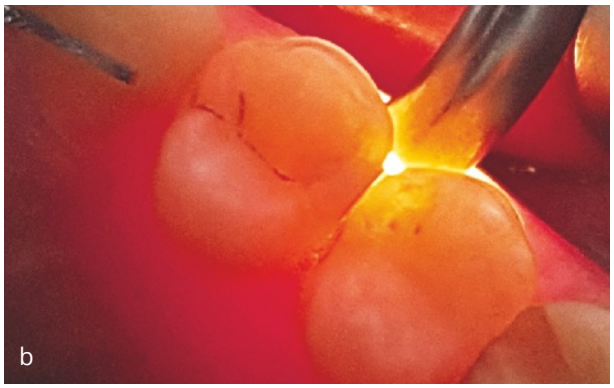
Figs 1-5a to c Maxillary anterior teeth: **(a)** before plaque removal, **(b)** after staining, and **(c)** after brushing. Active caries lesions can only be diagnosed on cleaned tooth surfaces, and gingivitis becomes clearer for the patient as a result of bleeding during cleaning.

Caries activity

The degree of caries activity is superior to the assessment of the caries risk (see Chapter 17). While risk refers to the conversion of a healthy state to disease, the diagnosis of caries activity actually uses the knowledge of the disease process to record its early signs, whether heavy plaque in stagnation areas, accompanying gingivitis, or initial caries lesion. These should be carefully viewed after cleaning and drying the teeth (Fig 1-5) and differentiated into a probably active or inactive initial lesion.

It is important to note that inactivation is possible at any stage from initial enamel lesion to deep dentinal caries (see Fig 1b),[21,23] and it can be achieved by disturbing the dental biofilm (eg, by brushing teeth) and by influencing the de- and remineralization processes (eg, with fluorides). In spite of being classically primary preventive measures, they are "therapeutic" here and can be perceived as nonoperative caries treatment or management, which should result in a net gain of minerals.





Figs 1-6a and b Bitewing radiographs **(a)** allow a staging of proximal lesions and planning of primary preventive measures (flossing and fluorides, see Chapter 7), secondary prevention such as nonoperative treatment of initial lesions with cleaning and fluorides, proximal sealing or infiltration, and tertiary prevention meaning restorative care. This can be supported by fiber-optic transillumination (FOTI) **(b)**, digital imaging fiber-optic transillumination (DIFOTI), or quantitative light-induced fluorescence (QLF).

Further diagnostics

If proximal caries is present or going to be expected, a radiographic examination should be considered since proximal caries rarely occurs in an isolated spot and pulpal involvement can be assessed (Fig 1-6). Bitewing radiographs are still considered to be the gold standard in proximal caries diagnostics.[24]

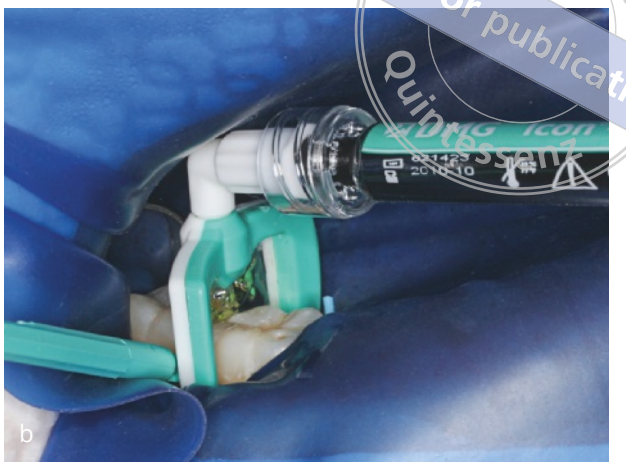
Another method to monitor proximal surfaces is fiber-optic transillumination (FOTI), which is particularly suitable for the first examination of "apparently healthy" proximal surfaces,[25] especially if a proximal lesion has already been detected on another tooth. In addition, several new caries diagnostic systems such as digital imaging fiber-optic transillumination (DIFOTI) and quantitative light-induced fluorescence (QLF) have been available on the market for several years with the aim of providing reliable results in caries diagnosis. Still, reviews stress that they can be used as adjunct tools, but they should not substitute x-rays completely, and do not overrule the clinical verification.[26]

Current concepts and treatment approaches in caries management

Primary caries prevention is traditionally considered as the "real" prevention, aiming to maintain the health of sound teeth that are at risk for caries. The concepts of the classical preventive measures are based on a variety of approaches. In several chapters, this book looks at their current evidence base and provides clinical recommendations on how to implement these nowadays, eg for fluorides (see Chapter 3), plaque removal via tooth brushing or flossing (see Chapters 6 and 7), diet control (see Chapter 4), or probiotics (see Chapter 11).

> A key issue of primary caries prevention is a change from caries activity to inactivation or, in other words, from predominantly demineralization to remineralization of dental hard tissues, which involves behavior change in the patients or caretaker (see Chapter 9). Especially after the caries decline, oral diseases are concentrated on a minority group, linked to the socioeconomic status.[27] Thus, future gains in oral health must have a focus on this group, possibly employing all levels from individualized, group- and population-based prevention, outreach programs, and a common risk factor approach (see Chapter 5).

Secondary caries prevention aims to arrest or even remineralize initial caries lesions with nonoperative or minimally invasive techniques. These



Figs 1-7a and b Minimally invasive treatment of approximal initial caries lesions by **(a)** therapeutic sealants and **(b)** caries infiltration with Icon (DMG Dental).

techniques involve nonrestorative caries control, which implements primary caries-preventive measures but employs them for initial or even cavitated caries lesions (see Chapter 14). This can be enhanced with silver fluoride products or other fluorides (see Chapters 3 and 12), antimicrobials, or biomimetic remineralization using self-assembling peptides (Curodont Repair, Credentis),[28] that work like a magnet for attracting minerals (see Chapter 13).

For management of initial caries lesions with intact macroscopic enamel surfaces, plaque control and fluoridation play a central role in arresting the lesions, promoting remineralization, and consequently avoiding further lesion progression to visible cavitation. It is known that tooth brushing with fluoridated toothpaste is the most cost-effective strategy for controlling caries lesions.[29,30]

In addition, individualized preventive strategies that take into consideration patient's caries risk/activity as well as involve parents and other care takers are key factors for successful intervention in caries control. One of the most effective caries prevention strategies is the "Next model."[31,32] These techniques are especially needed in patients with reduced cooperation, such as small children, persons with handicap, chronically ill patients, or elderly patients (see Chapter 16).

As minimally invasive techniques, therapeutic sealants can be used (see Chapter 10), even on proximal surfaces (Fig 1-7a).[33] Another option is caries infiltration (Icon, DMG Dental; Fig 1-7b), where a resin-like material is diffused in the porous initial caries lesion.[34]

"Tertiary" caries prevention tries to prevent progression of the disease and subsequent complication. Traditionally, complete removal of carious tissue with subsequent restorative treatment was regarded as the standard treatment for carious teeth. In recent years, there has been a paradigm shift in caries understanding: Caries is no longer understood as an infectious disease, but as the result of an ecologic imbalance, which is triggered, for instance, by the frequent consumption of fermentable carbohydrates (see above). In the biofilm, among other things, carbohydrates are metabolized to acids, which cause demineralization of the tooth structure. Not only in the field of primary caries prevention is this of fundamental importance, but also for the treatment of cavitated caries lesions, dentin demineralization, and (amount of) removal of carious tissues. For instance certain techniques encourage inactivation

of caries lesions without carious tissue removal, such as nonrestorative cavity control,[35,36] presented in Chapter 14. Here, also the silver agents[37] (see Chapter 12) or sealing techniques with no carious tissue removal using preformed metal crowns like the Hall Technique[35] are part of the modern caries management spectrum.

Thus, it is possible to control or arrest caries by disturbing the biofilm and influencing the de- and remineralization processes at any time and stage during lesion development.[38,39] For cavitated caries lesions, biologically based techniques such as the selective (to firm, to leathery, to soft dentin) or stepwise carious tissue removal are currently advocated. These techniques are recommended for the management of shallow, moderately deep, and deep lesions in vital teeth in order to prevent pulpal exposure and to preserve the pulp vitality of the carious tooth.[40]

References

1. Machiulskiene V, Campus G, Carvalho JC, et al. Terminology of dental caries and dental caries management: Consensus Report of a Workshop Organized by ORCA and Cariology Research Group of IADR. Caries Res 2020;54:7–14.
2. IDZ. Fünfte Deutsche Mundgesundheitsstudie – DMS V. Köln, 2016.
3. Team DAJ. Epidemiologische Begleituntersuchungen zur Gruppenprophylaxe 2016. 1st ed. Bonn: Deutsche Arb.-Gemeinsch. f. Jugendzahnpflege, 2017.
4. Splieth CH, Santamaria RM, Basner R, Schüler E, Schmoeckel J. 40-year longitudinal caries development in german adolescents in the light of new caries measures. Caries Res 2019;53:609–616.
5. Schmidt CO, Fahland RA, Franze M, et al. Health-related behaviour, knowledge, attitudes, communication and social status in school children in Eastern Germany. Health Educ Res 2010;25:542–551.
6. Chen KJ, Gao SS, Duangthip D, Lo ECM, Chu CH. Prevalence of early childhood caries among 5-year-old children: a systematic review. J Investig Clin Dent 2019;10:e12376.
7. Santamaria RM, Schmoeckel J, Basner R, Schüler E, Splieth CH. Caries trends in the primary dentition of 6- to 7-year-old schoolchildren in Germany from 1994 to 2016: Results from the German National Oral Health Surveys in Children. Caries Res 2019;53:659–666.
8. Kassebaum NJ, Bernabé E, Dahiya M, Bhandari B, Murray CJL, Marcenes W. Global burden of untreated caries: a systematic review and metaregression. J Dent Res 2015; 94:650–658.
9. Vollú AL, da Costa MdEPR, Maia LC, Fonseca-Gonçalves A. Evaluation of oral health-related quality of life to assess dental treatment in preschool children with early childhood caries: a preliminary study. J Clic Pediatr Dent 2018;42:37–44.
10. DPHEP. National Dental Epidemiology Programme for England: oral health survey of five-year-old children 2015. London: Public Health England, 2016.
11. Turton B, Chher T, Sabbah W, Durward C, Hak S, Lailou A. Epidemiological survey of early childhood caries in Cambodia. BMC Oral Health 2019;19:107.
12. Slabsinskiene E, Milciuviene S, Narbutaite J, et al. Severe early childhood caries and behavioral risk factors among 3-year-old children in Lithuania. Medicina (Kaunas, Lithuania) 2010;46:135–141.
13. Prakash P, Subramaniam P, Durgesh BH, Konde S. Prevalence of early childhood caries and associated risk factors in preschool children of urban Bangalore, India: a cross-sectional study. Eur J Dent 2012;6: 141–152.
14. Livny A, Assali R, Sgan-Cohen HD. Early childhood caries among a Bedouin community residing in the eastern outskirts of Jerusalem. BMC Public Health 2007;7:167.
15. Postma TC, Ayo-Yusuf OA, van Wyk PJ. Socio-demographic correlates of early childhood caries prevalence and severity in a developing country: South Africa. Int Dent J 2008;58:91–97.
16. Colak H, Dülgergil CT, Dalli M, Hamidi MM. Early childhood caries update: a review of causes, diagnoses, and treatments. J Nat Sci Biol Med 2013;4:29–38.
17. Schmoeckel J, Santamaría RM, Basner R, Schüler E, Splieth CH. Introducing a specific term to present caries experience in populations with low caries prevalence: Specific affected Caries index (SaC). Caries Res 2019;53: 527–531.
18. Pine CM, Adair PM, Nicoll AD, et al. International comparisons of health inequalities in childhood dental caries. Community Dent Health 2004;21(1 Suppl):121–130.
19. Fontana M, Gonzalez-Cabezas C. Evidence-based dentistry caries risk assessment and disease management. Dental Clin North Am 2019;63:119–128.
20. Ekstrand K, Qvist V, Thylstrup A. Light microscope study of the effect of probing in occlusal surfaces. Caries Res 1987;21:368–374.
21. ICDAS Foundation. International Caries Classification and Management System (ICCMS). https://www.iccms-web.com/. Accessed 4 September 2019.
22. Nyvad B, Machiulskiene V, Baelum V. Construct and predictive validity of clinical caries diagnostic criteria assessing lesion activity. J Dent Res 2003;82:117–122.
23. Nyvad B, Machiulskiene V, Baelum V. Reliability of a new caries diagnostic system differentiating between active and inactive caries lesions. Caries Res 1999;33: 252–260.
24. Bin-Shuwaish M, Dennison JB, Yaman P, Neiva G. Estimation of clinical axial extension of Class II caries lesions with ultraspeed and digital radiographs: an in-vivo study. Oper Dent 2008;33:613–621.
25. Heinrich-Weltzien R, Haak R, Buchalla W, Kühnisch J. Kariesdiagnostik - Eine Herausforderung für den Zahnarzt? DDZ 2008;117:160–168.

26. Winand C, Shetty A, Senior A, et al. Digital imaging capability for caries detection: a meta-analysis. JDR Clin Trans Res 2016;1:112–121.
27. Schwendicke F, Dörfer CE, Schlattmann P, Foster Page L, Thomson WM, Paris S. Socioeconomic inequality and caries: a systematic review and meta-analysis. J Dent Res 2015;94:10–18.
28. Alkilzy M, Santamaria RM, Schmoeckel J, Splieth CH. Treatment of carious lesions using self-assembling peptides. Adv Dent Res 2018;29:42–47.
29. Walsh T, Worthington HV, Glenny A-M, Marinho VC, Jeroncic A. Fluoride toothpastes of different concentrations for preventing dental caries. Cochrane Database Syst Rev 2019;3:CD007868.
30. Twetman S. Prevention of early childhood caries (ECC): review of literature published 1998-2007. Eur Arch Paediatr Dent 2008;9:12–18.
31. Ekstrand KR, Christiansen MEC. Outcomes of a non-operative caries treatment programme for children and adolescents. Caries Res 2005;39:455–467.
32. Ekstrand KR, Christiansen MEC, Qvist V. Influence of different variables on the inter-municipality variation in caries experience in Danish adolescents. Caries Res 2003;37:130–141.
33. Alkilzy M, Berndt C, Meller C, Schidlowski M, Splieth C. Sealing of proximal surfaces with polyurethane tape: a two-year clinical and radiographic feasibility study. J Adhes Dent 2009;11:91–94.
34. Abdullah Z, John J. Minimally invasive treatment of white spot lesions--a systematic review. Oral Health Prev Dent 2016;14:197–205.
35. Santamaría RM, Innes NPT, Machiulskiene V, Schmoeckel J, Alkilzy M, Splieth CH. Alternative caries management options for primary molars: 2.5-year outcomes of a randomised clinical trial. Caries Res 2018;51:605–614.
36. Gruythuysen RJM, van Strijp AJPG, van Palestein Helderman WH, Frankenmolen FW. Niet-restauratieve behandeling van cariës in het melkgebit: doelmatig en kindvriendelijk. Ned Tijdschr Geneeskd 2011;155:A3489.
37. Chibinski AC, Wambier LM, Feltrin J, Loguercio AD, Wambier DS, Reis A. Silver diamine fluoride has efficacy in controlling caries progression in primary teeth: a systematic review and meta-analysis. Caries Res 2017;51:527–541.
38. Fejerskov O, Kidd EAM. Dental Caries: The disease and its clinical management, 2nd ed. Oxford: Blackwell Munksgaard, 2008.
39. Kidd E. The implications of the new paradigm of dental caries. J Dent 2011;39(Suppl 2):S3–S8.
40. Schwendicke F, Frencken JE, Bjørndal L, et al. Managing carious lesions: consensus recommendations on carious tissue removal. Adv Dent Res 2016;28:58–67.

Prevention is better than healing … or treatment. Thus, preventive dentistry is a cross-sectional challenge for all fields in dentistry, and one that has already achieved great success, as shown by the caries decline in many countries. The walls between prevention and treatment have recently fallen in caries and periodontal disease, as well as in orthodontics, where guidance of function and space maintenance are a combination of prevention and treatment.

This book discusses new developments and innovations in preventive dentistry, from primary "real" prevention to secondary prevention by inactivating initial lesions, and on to tertiary prevention to avoid subsequent progression and complications of manifest oral disease. This evidence base is then translated into clinical dental practice.

The book addresses everyone interested or involved in dentistry, including students, the whole dental practice team, educators, health scientists, and policy makers, who want to gain insight into these up-to-date clinical practices and future developments. It intends to make an impact on teaching and all fields of clinical dentistry – not by giving cookbook recipes, but by pointing out the rationale behind the changes in our routines.

Presented by an international group of recognized specialists in their fields, the topics include the new understanding and management of caries and periodontal disease, prevention of orthodontic problems, diagnostic approaches, the role of diet and according recommendations for oral health, routes to better oral hygiene, changes in oral disease patterns and their consequences, non- and minimally invasive caries treatment, current fluoride guidelines including the use of silver fluorides, risk management, a common risk-factor approach, facilitating behavior changes, sealants, and probiotics. This broad spectrum is elucidated for the most relevant dental problems from early childhood to seniors to implement preventively oriented dental practice.

ISBN: 978-1-78698-099-1
9 781786 980991
www.quintessence-publishing.com