

Preface: an Editors' guide to reading the book

Take two Editors who have been friends for 30 years, add 30 respected cariologists from around the world and stir them to write, preferably together. The result should be a book that all with an interest in cariology will wish to read – if only to criticize it. This preface will map your journey through these pages highlighting features that we, the Editors, consider important.

Chapter 1 sets contemporary cariology in a historical perspective. One hundred years ago early scientists tried to understand the disease process as the essential basis for decision on treatment modalities. However, the technicalities of restoring teeth have often distorted the focus of daily dental practice. In addition, explosions of knowledge in all fields of science have made it difficult to perceive the best path to appropriate and cost effective health care. In Chapter 1 we briefly introduce how we think the core of dentistry has developed. In our opinion there are good reasons to claim that we lost our way in the middle of the twentieth century, distracted by apparently 'new' and 'better' knowledge. Throughout the book we wish the student to have the following clever statement in mind:

All basically scientific roads through any conceivable human culture may lead towards an exterior 'Rome'. But the same Rome shines with different light tuned to the form and direction of the particular path that people actually construct for their excursion to the external city of natural knowledge.

Stephen Jay Gould, Science Vol. 287 (2000).

Chapter 2 is about the secretion and composition of saliva, which is likely to be the single most important factor determining health and disease in the oral cavity. The chapter covers, often in great depth, a variety of aspects in secretory physiology, cell biology and biochemical and chemical fields. It may be difficult for the student to associate the wealth of information with clinical findings. It is frustrating that despite all our knowledge, what seems to matter most clinically for caries is the rather crude measurement of flow rate. We are convinced, however, that in years to come improved knowledge on composition of saliva will have direct relevance to patient care. The student

who grapples with this chapter is best placed to evaluate and use these developments.

Chapter 3 concerns the oral microflora and biofilms on teeth. A biofilm is a community of organisms with a collective physiology, responding in concert to the challenges of the environment. It is critical that the student appreciates that this community is no haphazard collection but the result of a complex and delicate interplay between the single species, the components in saliva and the immune responses of the host. We often forget that bacteria are essential for health. The health of humans is dependent on the refined interplay between the commensal microbial environment in the oral cavity, the host response and the innumerable external factors, physical and chemical, which constantly affect the balance. The knowledge and concepts presented in this chapter are fundamental to understanding the caries process. It explains why any attempt to play around with antimicrobial treatments should be carefully considered. Maybe this interference with normal ecological equilibrium will do more harm than good. Microbes, like ants, were here before us and will be with the world long after we are dead. It is thought provoking that if dental caries is caused by a 'dysfunction' of the commensal flora, strictly speaking it should no longer be described as an infectious disease.

Chapter 4 concerns the chemical interaction between the tooth and the oral fluids. The caries lesion is a result of loss of mineral from the dental tissues and this occurs over months and years. The metabolism in the biofilm results in fluctuating pH values at the interface between the apatite crystals and their immediate surroundings. Thus, the equilibrium between the tooth mineral and the plaque fluid is constantly interfered with. This chapter explains the basic chemistry behind caries dissolution.

Chapter 5 describes the clinical and histological manifestations of dental caries. The authors have presented lesion appearances, on different surfaces, to demonstrate how caries dissolution can manifest itself in many different ways depending on the variations in anatomical structures. The approach combines clinical features with histological appearances at varying stages of tissue destruction so

that the student can understand the dynamics of lesion progression. The publishers have decided to concentrate color illustrations for this and other chapters in plate sections, rather than having them interspersed with the text, in order to control the retail price of the book.

Chapter 6 introduces Part II, on caries diagnosis. It encapsulates the various biological process involved during lesion development as discussed in the previous chapters. The knowledge gained is now applied to the diagnostic process. It should be remembered that any diagnostic information obtained is only useful if it affects a subsequent clinical decision.

This chapter demonstrates how our conceptual understanding of dental caries has implications for its diagnosis. Moreover, it highlights that clinical decisions are made under conditions of uncertainty.

It is pointed out that dental caries may be recognized at three different levels: the tooth surface, the individual or the population. These distinctions are important because fundamentally different viewpoints on occurrence, causation, intervention and outcome of intervention will emerge depending on the perspective taken.

The link between a diagnosis and the subsequent intervention should not be set in concrete. It can vary as time goes on and between patients and populations. This means that a computational approach to the problem may lead to oversimplification and inappropriate outcomes.

We think that this chapter, because of its conceptual approach, may necessitate that the reader returns to it now and then in the light of experience.

Chapter 7 explores the diagnosis of the caries lesion. The chapter concentrates on clinical–visual diagnosis and discusses the additional benefit of radiographs and appropriate use of a probe. Emphasis is placed on today's attempts to differentiate active, ongoing, lesions from those where dissolution has ceased and the lesion is actually arrested. The decision about lesion activity is an important one because lesions considered to be in a stage of progression require active management whereas these diagnosed as arrested do not. Throughout the chapter it will be apparent that qualitative assessment of lesion activity inevitably must contain an element of doubt and weighting of evidence.

Chapter 8 is also about the diagnosis of the individual lesion, but now the emphasis is placed on an attempt to quantify mineral loss and/or porosity. These methods do not further advance attempts to classify disease activity at the time of examination. The authors stress that so far, with the possible exception of digital radiography, they are not to be considered routine methods for use in dental practice.

The final level in which the diagnosis of dental caries plays a key role is in epidemiology. This is about disease prevalence and incidence in populations. It tries to unravel associations between disease patterns, cultural behavior and socioeconomic conditions. Therefore, Chapter 9 con-

siders the principles of caries epidemiology with particular emphasis on how different diagnostic standards substantially influence our interpretation of how dental caries is distributed within and between populations. The term 'caries free' should always be interpreted with care, as it might just mean 'cavity free' but certainly not free of a spectrum of early signs of caries lesions.

If interpretations are to be generalizable it is important that the data derive from a representative population. Dentists must be careful not to assume that their particular practice represents any more than the dental state of those who choose to walk through the door. Hence, the true pattern of disease in the underlying population, as analyzed through epidemiology, may reveal an entirely different picture.

Part III of the book is about major factors that can play a role in lesion development and progression. Chapter 10 attempts to use the knowledge gathered thus far to question what is meant by 'treatment' and 'prevention' of caries, in a biological context. As a consequence, new concepts such as control of caries and non-operative treatment emerge.

For decades it has been claimed that a clean tooth never decays. Despite this, the relative role of oral hygiene in caries control is hotly debated and by many questioned as playing a key role. Chapter 11 therefore presents the evidence of the importance of plaque control at the level of the individual surface, the patient and the population.

The role of antimicrobials is debated in Chapter 12. If dental plaque cannot be brushed away should we fight it by chemical or antimicrobial means? The chapter summarizes present-day knowledge about the mechanisms of action of the different types of antimicrobial. It concludes that so far their use is rarely justified.

The presence of fluoride in the oral environment, together with the mother's educational background explains about 50% of the caries reduction in contemporary child populations. It is without doubt the most exciting development of the Editors' practicing lifetimes, and every dentist must have a thorough knowledge about how fluoride acts in the control of caries lesion development and progression. Chapter 13 introduces the reader to how fluoride came into dentistry and how it may be used most appropriately today based on our current understanding of cariostatic mechanisms. Fluoride from any source ingested during tooth formation results in varying degrees of hypomineralization in enamel, the severity of which is a direct result of the fluoride dose. Therefore, the chapter also includes sections on this dose–response relationship, as well as how dental fluorosis manifests itself clinically and histologically.

Chapter 14 distills a vast literature on diet and caries. Much of the evidence on sugar and caries is now old history, and some of these experimental protocols would not stand up to contemporary scrutiny. Despite this, the volume of effort argues strongly for the importance

of the relationship. That said, some aspects of the evidence are conflicting or maybe a little confusing; for instance, can starch be dismissed as blameless in the story?

One of the most important questions addressed in this chapter is the relative role of dietary control in the post-fluoride era. Another relevant question is what matters more, the total amount of sugar consumed or the frequency of intake? The evidence conflicts and yet as dentists we may need to give advice on the matter. Many of us favor advising patients to confine sugar to mealtimes, eat or drink it and enjoy it, but try to avoid the between-meal sugar intake. Fortunately, frequency and amount are linked, so if we advise in this way, we may be covering both options.

It is salutary to realize that human experiments on diet and caries are virtually impossible to design ethically. Thus, we must take every opportunity to evaluate current eating patterns and their likely role in dental health.

Chapter 15 concerns operative dentistry. In line with the other chapter headings on oral hygiene, antimicrobials and diet the title includes the words, 'The role of ...'. To some this very title will be an anathema because they contend that operative dentistry has *no* role in caries prevention; all it can do is replace, rather inadequately perhaps, damaged tooth tissue. Perhaps this attitude comes as an overreaction to an unfortunate attitude to operative dentistry that appeared prevalent in the middle of the twentieth century. The Editors were at dental school during this period, and cariology and the management of caries seemed to have no place in the departments of adult dentistry when we were students. Caries was presented as a disease of children, managed preventively in this age group, but in adults caries was 'treated' by filling holes in teeth. This attitude, once inculcated, dies hard and there will still be departments of operative dentistry where the science of disease processes is not the bedrock of the teaching.

Thus, the chapter begins provocatively by asking you questions about attitudes and practices in the school where you study. Your answers may well depend on the country in which your school is located. In Scandinavia it has been common practice for operative dentistry to be within a department of cariology for many years. In other countries, for instance the UK, there is no school with a department of cariology. Indeed, the word is so foreign to the parlance that letters addressed to the only professor of cariology are routinely sent to cardiology!

Yet it was not always thus. When G.V. Black, whom many would consider to be the father of modern operative dentistry, wrote his original operative textbook in two volumes in the early twentieth century, the first of these was devoted entirely to the disease processes of caries and erosion. So what went wrong in the intervening years and why is it such an apparent struggle to bring what appears to be straightforward logic to the problem? Perhaps a fascination with matters technical is to blame. Perhaps a misconception that

the caries lesion was the problem, because it caused pain, deflected attention away from the cause of lesion development. Alternately, the patient's perceptions and wishes were and are all important: 'here is my mouth, you take care of it and fill the holes'.

The chapter will take the reader through the various surfaces where lesions occur. On each surface the role of operative treatment is to restore the integrity of the tooth surface so that the patient can clean. Thus, on a smooth surface no restoration may be needed but a cavitated approximal or occlusal surface may be impossible to clean. To put it at its simplest, the role of operative dentistry is to facilitate plaque control.

In some ways, Chapters 15 and 16 are about the same topic: the progression from diagnosis to a treatment decision. It is intriguing therefore that the two approaches are as different as chalk from cheese. The Editors have decided to leave these glaring inconsistencies for the delectation of the reader! This is not just laziness. It demonstrates how people can synthesize the same information and approach the same problem from totally different directions, sometimes coming to very different conclusions. Read again the statement by Stephen Gould at the beginning of this Preface. No wonder Chapter 16 shows that dentists are inconsistent in their treatment planning decisions.

However, perhaps a little comment from the Editors about these two different approaches is appropriate. In Chapter 15 the decision making is presented as it is experienced in the clinic, whereas the author of Chapter 16 has taken a computational approach. Rather intriguingly, both chapters seem to contend the decisions are not that difficult provided the dentist evaluates the evidence.

Chapter 17 is about caries removal. It was challenging to write because the evidence for the current operative paradigm of removing infected tissue before tooth restoration seems scant. Indeed, what evidence there is appears to indicate that current practice may even be detrimental to the pulpo-dentinal complex by interfering too soon and too vigorously in active lesions before the natural defense reactions of sclerotic and reparative dentin have had a chance to work.

The argument presented is that it may not be necessary to remove infected demineralized tissue in order to arrest the caries process. This argument makes total sense if it is accepted that the process takes place in the biomass and the infected caries lesion is merely a reflection of this process. Perhaps the bacteria in the demineralized tissue are merely opportunistic squatters rather than major players in the game once the overlying biomass, designated as plaque, has been removed.

However, this suggestion, although possibly logical biologically, is contentious. At present there is too little research on which to base decisions. In other words, an evidence base for practice is missing. The practitioner must therefore rely on 'current practice' as the only evidence

available. There is an urgent need to design randomized clinical trials where varying amounts of infected tissue are removed and the results followed longitudinally.

What seems to be needed in the research effort is a way of looking into the pulpo-dentinal complex to assess its reaction to leaving or removing infected tissue. On the face of it, the residual bacteria might be expected to damage the pulpo-dentinal complex, but too little is known of how this bacterial community reacts once it is sealed off from the mouth.

For the sake of completeness in this textbook, tooth restoration is briefly addressed in Chapter 18, but it is important to stress that the coverage of the subject is a bird's-eye view of principles rather than practical details. As such, the chapter is not a condensed version of a classical restorative textbook.

Materials science has made enormous strides since G.V. Black spent time working on amalgam. This remarkable dentist addressed the problems of operative dentistry with total logic. First he studied the disease, clinically and microscopically. Then he applied this knowledge to preventing the problem by plaque removal and designing cavities to try to place their margins in areas where plaque did not stagnate. He had to design instruments to prepare cavities and a material to fill the tooth. He then made restorations to the highest technical standards possible, given the limitations of the equipment and materials of the day. The approach is exemplary and it is the approach taken in this chapter 100 years later.

Thus, the available materials are briefly described. What is particularly interesting here is the potential conflict between the materials scientist and the clinician. The authors came to vigorous discussion, with the clinicians not favoring the handling characteristics of material that the materials scientist saw as being 'ideal'.

Then fastidious clinicians take up the story, showing, mainly pictorially, ways in which restorations may be placed. Notice the concentration on technical perfection. After all, if the whole aim of restoration is to make the tooth cleanable, perfect junctions between tooth and filling are important. An evidence base for suggested techniques is given, although unfortunately this is often based on laboratory studies. These short-term experiments are easy to perform but their relevance in clinical practice is often not tested in longitudinal, randomized, controlled clinical trials. Such studies are time consuming and expensive. The results may say more about the quality of the operator or the diligence of the patient in home care than about the material or the technique. Long-term follow-up is essential, but over the years patients are lost to recall and manufacturers change their products. Small wonder that such research is unpopular and all too rarely conducted in a sufficiently scientific manner.

Chapter 19 is about the prognosis for caries and restorations. The decline in dental caries reflects a slowing

of the rate of disease progression. Thus, for some patients and some tooth surfaces the contemporary caries challenge may result in a progression rate so slow that the caries process never presents at a clinical level detectable by the dentist. Alternately, lesions may present later in life, perhaps at the level of cavitation, when the patient is in their twenties or thirties. Both patients and professionals have come to expect that once a person is 'caries free' as a child, a carious cavity will never appear and thus they are lulled into a false sense of security. However, sometimes a regular patient will present with pain and radiographs occasionally reveal lesions apparently hidden to clinical examination. As already emphasized, these lesions could probably be diagnosed by a careful clinical-visual examination, but a false sense of security may have lulled the dentist into performing only a peremptory examination.

This chapter presents contemporary caries rates and restorative survival times. It must be remembered that the data are means and in terms of an individual patient arithmetic means are meaningless. To state the obvious, each patient will have an individual pattern of caries risk and disease progression.

The section on prognosis of restorations is based on many studies concerning reasons for the replacement of restorations in general practice. A dentist's diagnosis of recurrent caries is the most frequent reason given for replacement of fillings, and in adults most operative dentistry is replacement dentistry. The authors question the validity of many of these diagnostic decisions, and suggest refurbishment and repair of restorations as a sensible alternative to replacement. They also point out that the evidence demonstrates that the caries process cannot be managed by filling alone.

Chapter 20, on caries control for the individual patient, is written by two dentists who relished the challenge of writing down what they actually do for patients based on the evidence presented in this book.

Now we move from working in daily practice with the single patient to the very complex stage of providing cost-effective health care for the population at large. Dealing with health and disease in populations involves more than just dealing with the sum of disease in individuals. Dental caries is no different from most other chronic diseases in having a multifactorial etiology: they are all highly influenced by the effect on environment of cultural, behavioral and socioeconomic factors. Training and educational backgrounds, knowledge and attitudes at any given time, in any society, are all highly relevant to disease patterns, irrespective of whether we are dealing with dental caries, obesity, cardiovascular diseases or a variety of cancers.

Hence, when discussing how most effectively to control caries in populations (Chapter 21) we will inevitably have to consider these societal factors. This challenges the individual dentists, working in often rather isolated settings,

because they feel so helpless to solve these problems relating to, for example, poverty and lack of social security in underprivileged groups. However, it is mandatory that each single dentist sees his or her own contribution as a piece in the jigsaw of societies' attempts to provide the best possible health care. It is with this in mind that the reader should approach this chapter. One very important consideration growing out of these reflections is whether a disease as ubiquitous as dental caries, although highly skewed in its severity of manifestations, should best be coped with at population level through a 'high-risk strategy' or a 'whole-population strategy'. To understand these concepts, and the crucial importance of their implications, the reader should consider this chapter carefully.

Chapter 21 also leads directly to the arguments presented in the final chapter in this book. Chapter 22 addresses the question of whether it is possible to predict who is likely to develop dental caries to a certain extent in a given period. This question is logically derived from the fact that the distribution of caries lesions is highly uneven within contemporary populations at any age.

Caries risk is defined as the probability of an individual developing a certain number of cavities during a specified period. It would be an advantage if we could predict the relative caries risks of the individuals in our care. To be successful in such an exercise would require that the occurrence of caries within the population is low enough to justify the effort and expense involved, that we have accurate, acceptable and feasible measures for identifying subjects at risks and, finally, if identified, that we have effective and feasible measures through which further lesion progression can be controlled.

This chapter covers these very important questions and emphasizes that just because fairly strong associations have

been found between caries experience and a number of factors, such as past caries experience, microbial counts and salivary parameters, this does not imply that such factors may be successfully applied for predicting future caries experience.

The Editors consider this chapter to be an elegant example of how highly relevant clinical questions can be addressed in a scientific manner. The chapter is thus an excellent example of how daily clinical behavior can be based on available evidence.

We can do no better than end this Preface with quotes from this final chapter, 'the prevention of dental caries should still primarily be based on the population strategy'. This is full accord with the conclusions reached in Chapter 21. 'Instead of being too concerned with predicting the future, clinical dentists should focus on giving due consideration to the control of carious lesions that their patients have at present. Appropriate treatment of existing initial lesions, the precondition of which is proper self-care, also helps to prevent the onset of future carious lesions'. This approach is in full accord with the views expressed in Chapter 20, which discusses caries control for the individual patient.

When we set out on the production of this book we did not expect 30 scientists and clinicians to be able to produce chapters showing such a uniform 'light shining from Rome'.

We hope that the scientific evidence and experience presented in the book will enable the reader to perform evidence-based dental care within the field of cariology and restorative dentistry.

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