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Detection, Assessment, Diagnosis and Monitoring of Caries

Editor
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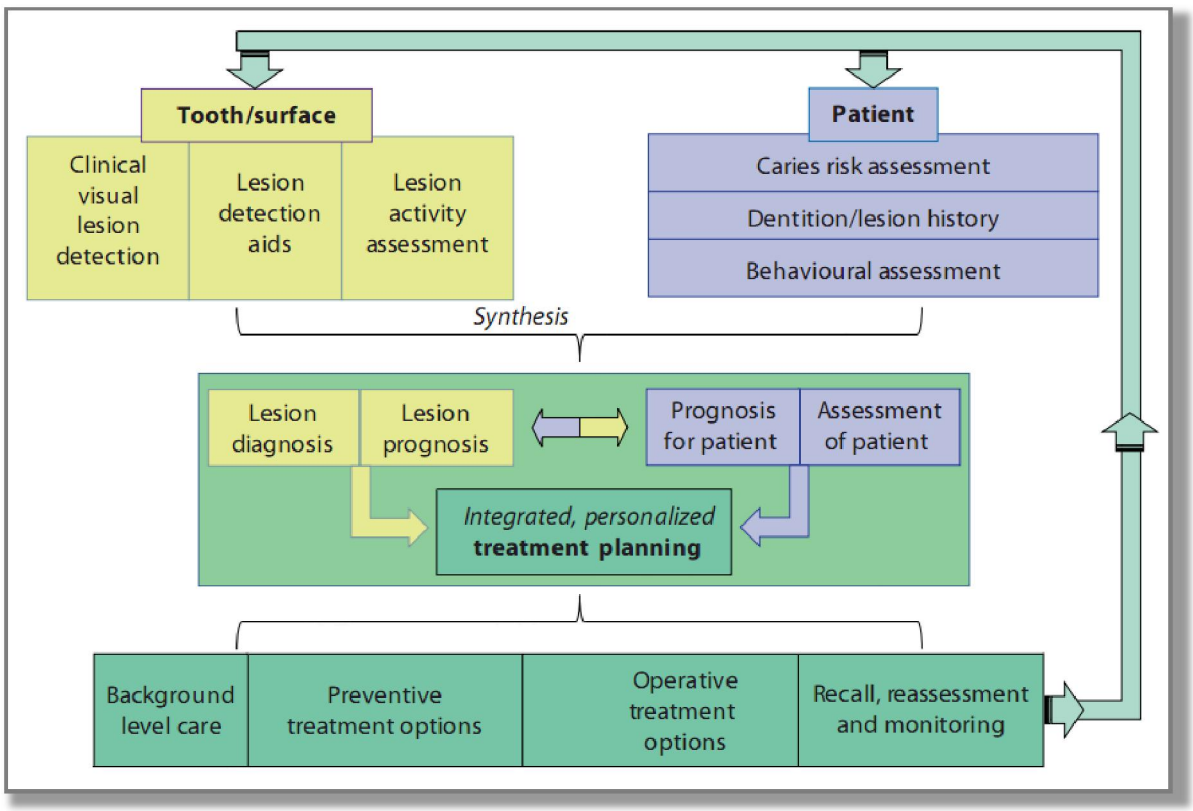

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Detection, Assessment, Diagnosis and Monitoring of Caries

Volume Editor

Nigel Pitts Dundee

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Introduction

How the Detection, Assessment, Diagnosis and Monitoring of Caries Integrate with Personalized Caries Management

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Abstract

This chapter provides an overview of how the detection, assessment, diagnosis and monitoring of caries integrate with personalized caries management. The background includes the continuing burden of preventable disease that dental caries represents on a global scale. Despite this, and evidence that a purely restorative approach will not 'cure' the disease, preventive caries control has been slow to be adopted in many countries. Following a series of initiatives in the last decade, there is now a range of clinical criteria and tools that can be employed to help clinicians plan patient-centred comprehensive and preventively biased care for their patients. At the core is a sound foundation of lesion detection, assessment and diagnosis which, when combined with appropriate patient level risk information and monitoring, enables effective treatment planning. The International Caries Detection and Assessment System (ICDAS) can enable this process. The ICDAS provides clinical criteria and codes, together with a framework to support and enable personalized comprehensive caries management for improved long-term health outcomes. The target audience for this book comprises those with an interest in dental caries and its clinical management; this should in no way detract from the parallel missions in the domains of dental public health, research or education. If progress is to be made in this field, it is important that a compatible series of terms can be shared across the dental domains and across countries. This will ensure better clinical and patient understanding and help facilitate getting research findings into clinical practice in a more efficient way.

Dental caries continues to provide a very sizeable burden of preventable disease on a global scale [1, 2]. A 2009 editorial in *The Lancet* points out that 'oral health is a neglected area of global health and has traditionally registered low on the radar of national policy makers', that dentists prefer 'to treat rather than prevent oral diseases' and 'yet, globally, the burden of major oral diseases and conditions is high. Dental caries is one of the most common chronic diseases worldwide. 90%

of people have had dental problems or toothache caused by caries' [1]. Although the editorial properly focusses on ensuring that other professions also engage in caries prevention as 'good oral health should be everybody's business' [1], there is also much that can be achieved in parallel by the dental profession embracing a more preventive approach to caries management. An earlier *Lancet* review concluded that 'the approach to primary prevention should be based on common risk factors; secondary prevention and treatment should focus on management of the caries process over time for individual patients, with a minimally invasive, tissue-preserving approach' [2].

Despite these clear views, built on evidence and international consensus, and the knowledge that a purely restorative/surgical approach will not 'cure' the disease [3], preventive caries control has been slow to be adopted in many countries. This preventable disease still accounts for many general anaesthetics for children in hospital settings, and decades of restorative work have led many adults to accumulate restorations, more caries and serially repeated restorations. This produces, in many 'developed' countries, cohorts of seniors and older adults with many more retained teeth than their predecessors. These teeth have complex existing restorative work and exposed surfaces at risk to new and secondary caries as changes in saliva, dexterity and medication all combine to increase caries risk in individuals to varying extents.

In many countries, over a number of decades, there has been a failure to implement comprehensive caries prevention into mainstream general practice. The gap between what is taught in dental schools in clinical cariology and what is carried out and funded remains wide. At the same time the World Health Organization (WHO) and the World Health Assembly are giving advice to governments to re-orientate policies towards health promotion and prevention [4]. In framing policies and strategies for oral health, countries are being advised that 'particular emphasis should be laid on the following elements... Building of capacity *in oral-health systems oriented to disease prevention and primary health care,* oral-health services should be set up, *ranging from prevention, early diagnosis and intervention to provision of treatment and rehabilitation, and the management of oral health problems* of the population according to needs and to resources available' [4]. The resolution of the Sixtieth World Health Assembly – Oral health: action plan for promotion and integrated disease prevention – urges member states to adopt a number of 'measures to ensure that oral health is incorporated as appropriate into policies for the integrated prevention and treatment of chronic non-communicable and communicable diseases'. The other actions include recognition of the need 'to strengthen oral-health research and use evidence-based oral-health promotion and disease prevention in order to consolidate and adapt oral-health programmes, and to encourage the intercountry exchange of reliable knowledge and experience' [4].

The Purpose of this Book

The purpose of this book is to provide an up-to-date synthesis of the fields around the *detection, assessment, diagnosis and monitoring of caries* in which the available evidence is reviewed and current international views on best practice are summarized on how the information collected can be collated and synthesized to inform the planning, delivery and clinical evaluation of *patient-centred, comprehensive caries management*.

The evidence-based dentistry philosophy guides us to plan care that results in *doing the right thing, done right, at the right time for the right person.* This is why there is an increasing focus on patient-centred, personalized treatment plans, rather than a mechanistic focus, in which very different patients with different states of disease activity and different behaviours and needs end up with very similar 'automatic' care plans.

Treatment plans are now more *comprehensive* than was typically the case some decades ago, as clinicians (and patients) focus on more holistic and long-term plans. These treatment plans are not just about restoring individual teeth and not just about dental caries, they look at the needs and preferences of individuals. Dentists now have many more facets of information that it can be useful to collate and more treatment options available to them. The public health moves advocating changes towards the shared planning of care with patients links well with patient/customer-centred dental practices wanting to be commercially successful and to have satisfied, motivated and loyal patients return to the practice over an extended period.

The target audience for this book comprises those with an interest in dental caries and its clinical management; this should in no way detract from the parallel missions in the domains of dental public health, research or education.

The Role of the International Caries Detection and Assessment System

The aims and treatment elements referred to above all link with aspects of the International Caries Detection and Assessment System (ICDAS) and its framework. There is no exclusive relationship, the individual elements outlined in this book can and do stand alone. However, the authors wish to share the potential of the ICDAS methodology to enhance and enable the processes for the *detection, assessment, diagnosis and monitoring of caries* as well as for planning *patient-centred, comprehensive caries management.* The readers should make their assessment of the utility of the various criteria and tools outlined.

The shared vision for the ICDAS is that:

- it is a clinical visual caries scoring system for use in clinical practice, dental education, research and epidemiology;

- it is designed to lead to better-quality information to inform decisions about appropriate diagnosis, prognosis and clinical management at both the individual and public health levels;
- it provides a framework to support and enable personalized comprehensive caries management for improved long-term health outcomes.

The ICDAS came about as a collaborative, open, system following a number of initiatives seeking to better understand and improve caries 'diagnosis' and clinical management in an increasingly 'evidence-based' environment. There had been a number of attempts in the cariology community to better manage caries pathology, caries diagnosis and introduce more logical clinical management [5]. In 2001 in the USA, the National Institutes of Health convened a consensus development conference on the 'Diagnosis and management of dental caries throughout life' [6]. This international event considered a series of systematic and narrative reviews of the evidence on, amongst other topics, clinical applications and outcomes of using indicators of risk in caries management [7]. At the same time the caries research community was also reviewing methodology, evidence and consensus around caries detection and assessment in clinical trials [8] and looked at a review of visual and visuotactile detection of dental caries [9] and modern concepts of caries measurement [10].

These developments led to an international volunteer group meeting on a series of occasions to build on these initiatives to form the ICDAS Committee. This work led the group to submerge a number of discrete individual systems they were using into a common system incorporating the best of what was available and what was already in the literature in order to develop an international system for caries detection and assessment 'to facilitate caries epidemiology, research and appropriate clinical management' [11]. This system has continued to evolve and has been trialled in a number of settings [12]. In addition to the clinical visual focus on lesion detection and activity, the system has been designed to work with the outputs from diagnostic tools for early caries detection [13]. The ICDAS has been established as a charitable, not-for-profit foundation, in order to try and support the shared ICDAS vision outlined above. Details of its work and publications can be found on the worldwide web at www.icdas.org/.

The Move towards a More Preventive Focus in Clinical Caries Management

The trends in clinical caries management in recent decades have been around more clearly discriminating between those lesions, in specific patients, that would typically have *preventive care advised* as opposed to those lesions where, on the basis of synthesized information, *operative care* would be *advised* [14]. In the latter case, operative intervention is only planned when specific thresholds have been exceeded and preventive care is also provided to try to deal with the causative factors, rather than just

the consequences of the disease. There has been a gradual international shift towards such an approach to minimal intervention dentistry [15], which has been supported by the Fédération Dentaire Internationale. Although the rates at which dentists in different countries have moved to embrace such a concept has been very variable [16], this now seems to be increasing globally. There are still gaps between current practice and international recommendations, and a blend of education and service development issues are needed to maintain progress and support some clinicians through a period of change.

The focus is also around showing how the appropriate use of clinical visual caries detection and assessment methods, combined with additional information on lesion detection and lesion activity, as well as synthesized information about the individual patient, can enable improved health care plans and outcomes in clinical cariology. There has been an increasing consensus that although there is a lack of high-quality randomized trials directly addressing the issues in routine clinical practice, at the individual patient level there should be an increasing recognition of the importance of caries risk status and personalized recall intervals [17, 18].

In addition to the activities within the ICDAS Committee, over recent years there has been a wealth of parallel activities and developments taken forward by individuals working within organizations such as the European Organization for Caries Research, the International Association for Dental Research Cariology Group, the Caries Management by Risk Assessment Groups, the American Dental Association, the Fédération Dentaire Internationale, the American Dental Education Association Cariology Special Interest Group and the Scottish Dental Clinical Effectiveness Programme (SDCEP). Contributions from these individuals and groups are made in the subsequent chapters and are gratefully acknowledged.

One key challenge in this area is the conflicting use of seemingly similar but different terms in the description of caries, caries (carious) lesions and how they are characterized. This is particularly marked as one travels between the domains of clinical practice, dental education, research and epidemiology, and the confusion produced serves as a barrier to communication and advancing clinical care.

The book includes a consensus glossary of terminology developed with a number of key stakeholders as it is vitally important that all concerned with caries and its management are clear about what is meant by different stages of the caries process and understand the specific meanings attached to the terms: detection; assessment; diagnosis; monitoring.

Figure 1 shows an updated version of an earlier caries cube [10], outlining 3 different types of caries measurement. It relates the *detection of lesion extent* on the front face (classifying different stages of disease severity with ICDAS codes), the *assessment of lesion activity* on the top face (making a snapshot assessment at a single examination) and *monitoring of lesion behaviour over time* on the side face (where the status of lesions is monitored over a series of time points using appropriate ICDAS codes).

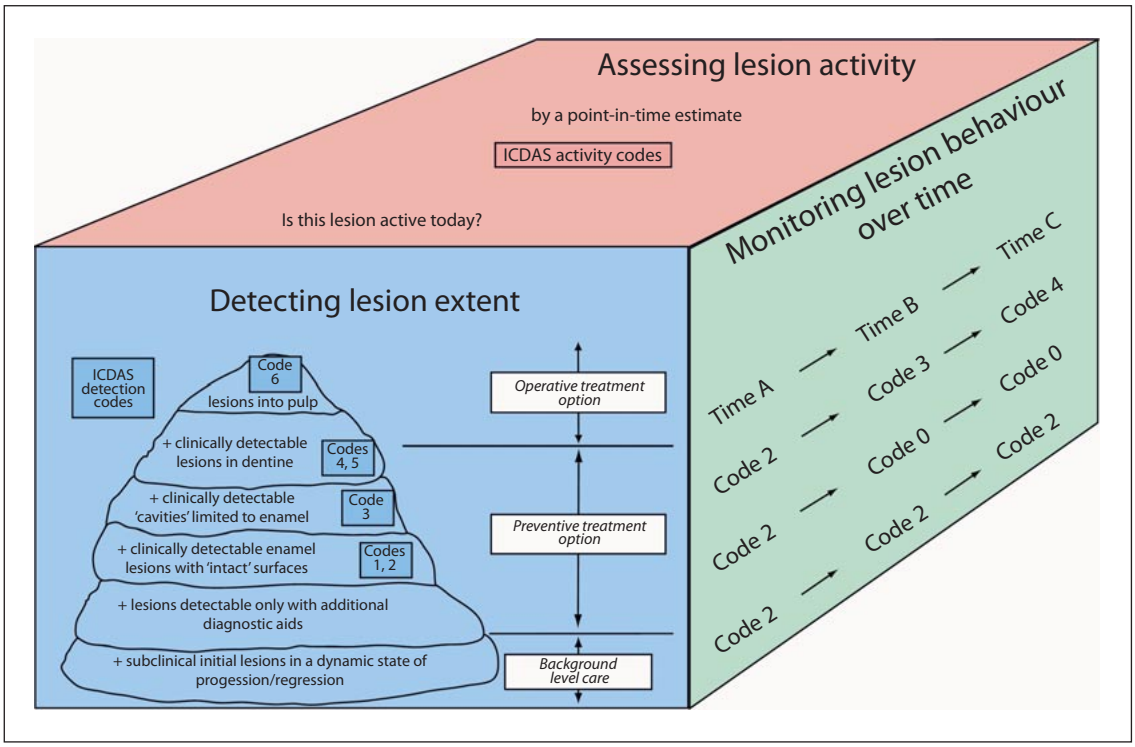


Fig. 1. The caries cube: relating the detection of lesion extent, assessment of lesion activity and monitoring of lesion behaviour over time.

It is important to understand the different clinical uses of these 3 types of caries measurement, all of which contribute to planning and assessing personalized caries management.

The ICDAS-enabled framework for patient-centred caries management has been used as the backbone structure for this volume. It outlines the information needs and the information flow required. Figure 2 comprises a graphic outlining the clinical framework. The ways in which the information is collected are outlined in the respective chapters which align to the framework. The chapter on personalized treatment planning [this vol., pp. 128–143] considers in more depth how the information is synthesized.

Chapter authors have been selected for their expertise in the various elements of cariology that the book and framework address. In some cases multiple authors have been selected to blend international evidence, practice and views in developing areas. For key chapters where the ICDAS Committee has built a consensus over an extended period, lead authors have written on behalf of the Committee.

The individual chapters of this volume are:

Clinical visual lesion detection (for the ICDAS Committee)
Traditional lesion detection aids
Novel lesion detection aids
Lesion activity assessment (for the ICDAS Committee)
Patient caries risk assessment
Dentition and lesion history
Assessing patient's health behaviours
Personalized treatment planning (for the ICDAS Committee)
Background level care
Traditional preventive treatment options
Novel preventive treatment options
Traditional operative treatment options
Novel operative treatment options
Recall, reassessment and monitoring
Implementation: improving caries detection, assessment, diagnosis and monitoring
Glossary of key terms (produced in collaboration with the ICDAS, European Organization for Caries Research and American Dental Education Association Cariology Special Interest Group – Caries Glossary Groups)

Where possible the chapters employ a consistent use of the key caries terminology as defined in the chapter by Longbottom et al. [this vol., pp. 209–216], based upon the work undertaken by the various groups to harmonize terminology in this area. The groups plan to continue the development of the glossary further. Given the differing needs and background of various 'users', and specifically groups as different as researchers (needing precision) and practitioners (needing simpler clarity), the glossary will be split into the 4 domains with levels of detail appropriate for clinical practice, dental education, caries research and caries epidemiology.

Where possible, chapters have included an estimation of the level of evidence that currently supports work in the field (see below), a list of research priorities (based on the gaps in the evidence base) as well as a list of implementation priorities (for getting research findings into practice).

Grading of Recommendations

The grading of recommendations for clinical practice on the basis of the strength of evidence reviewed is a complex and developing field. There are varieties of systems described and in place to do this, and all have been considered. It is a complex task to link the strength of evidence pertaining to a specific clinical intervention (as determined by the quality of the research available in the literature, including consideration of the study design and rigour) with a recommendation to use the intervention

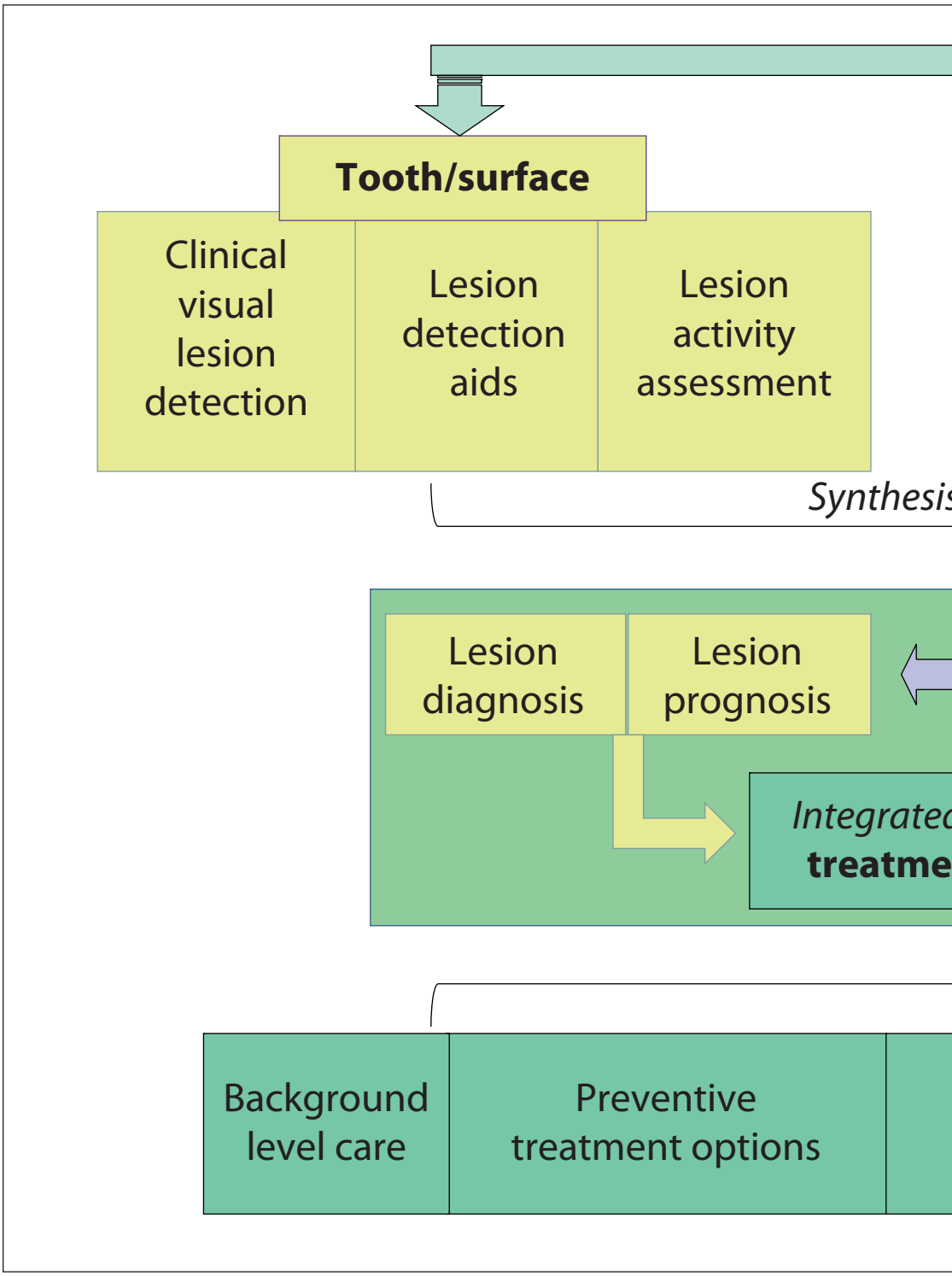
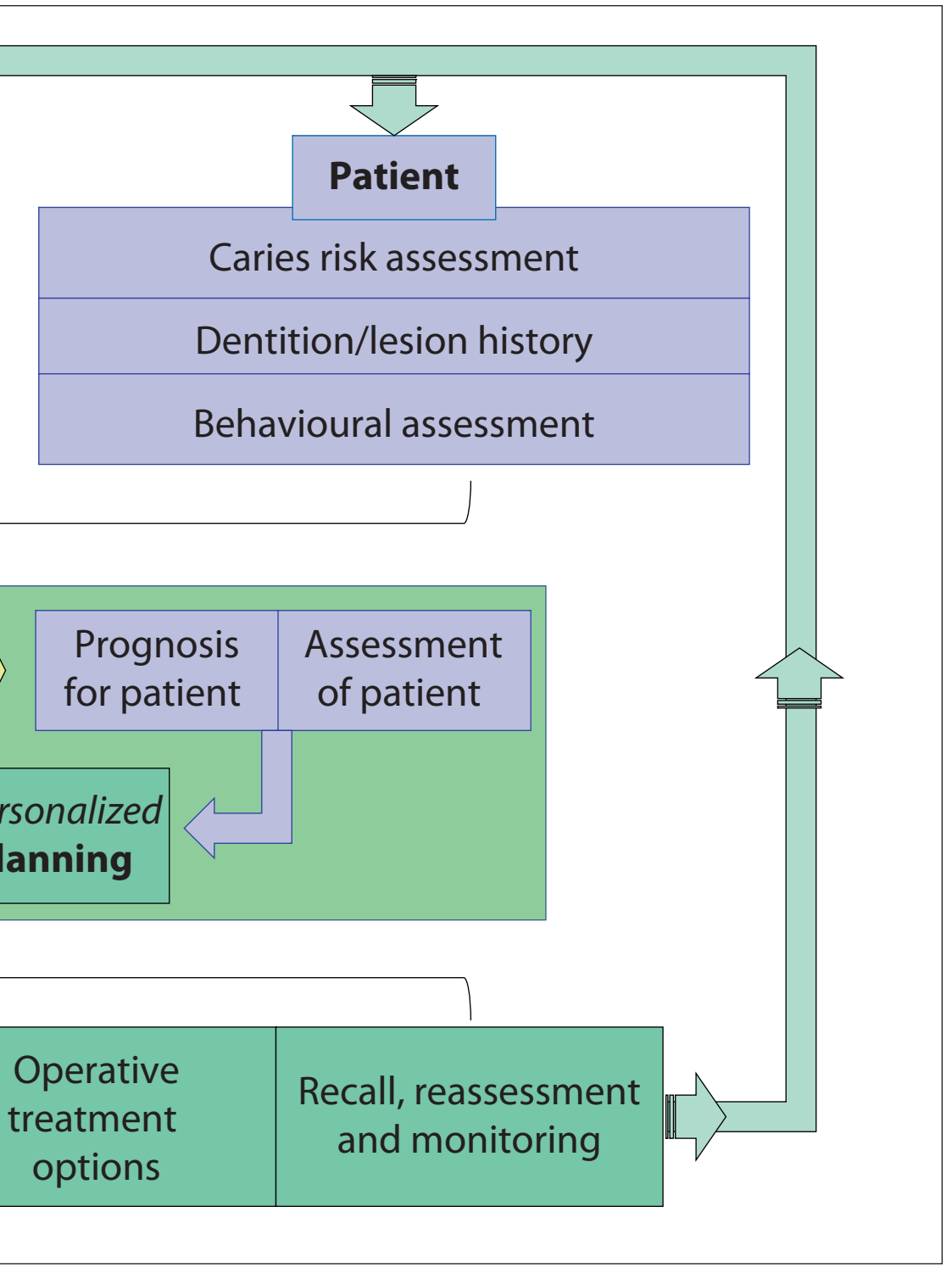


Fig. 2. The clinical framework for implementing ICDAS-enabled, patient-centred caries management.


Patient
Caries risk assessment
Dentition/lesion history
Behavioural assessment
Prognosis for patient
Assessment of patient
rsonalized
lanning
Operative treatment options
Recall, reassessment and monitoring

for an individual patient. This challenge is greater still in cases where randomized controlled trial methodology is difficult or inappropriate and where evidence for new treatments is limited but is superior to current practice.

Having considered the available options, for this volume we have used, where appropriate, the system developed by the SDCEP. One of the major concerns that the SDCEP had with the existing systems was that there were occasions where the guidance development groups wished to highlight recommendations where there were existing legal professional regulatory requirements which were therefore considered to be mandatory (as in radiation protection and prevention of cross-infection). It was also considered that there was a number of areas where there was a general consensus regarding good professional practice yet there was no (or there was unlikely to be any) supporting evidence (in the foreseeable future). To incorporate these two situations into the grading system, a modified version of the GRADE system was developed using the SIGN (www.sign.ac.uk) levels of evidence (table 1). This scheme has been in place for the production of the first 3 guidance documents produced by the SDCEP and is being kept under review. In the chapters concerned, the recommendations are coded as R_m, R_s, R_w or R_e corresponding to the categories set out in table 1. In cariology there will be few recommendations which are legally considered as mandatory (R_m).

Other Applications of the ICDAS

The ICDAS aims to enhance the detection, assessment, diagnosis and monitoring of caries. As has been stated above, the target audience for this book comprises those with an interest in dental caries and its clinical management. It is vital to realize that this clinical focus should in no way detract from the parallel ICDAS missions (to lead to better-quality information to inform decisions about appropriate diagnosis, prognosis and clinical management at both the individual and public health levels) in the domains of dental public health/epidemiology, clinical research or dental education.

Dental Public Health/Epidemiology Example of the ICDAS

The ICDAS detection codes can and have been employed in epidemiological surveys of caries prevalence and health surveillance [19]. Figure 3 shows the 'Pitts adaptation' of the so-called WHO 'stepwise' approach to surveillance of non-communicable diseases for use with oral health indicators and the ICDAS options that this offers for use in dental public health/epidemiology.

In this approach step 1 addresses *questionnaire data* ('core' concerns pain, 'enhanced' is for oral health impact, and 'supplements' include estimates of quality of

Table 1. SDCEP grading scheme for recommendations

Symbol	Basis for recommendation
R_m	These recommendations are legal or professional regulatory requirements and are therefore considered to be **mandatory**
R_s	These recommendations are supported by **strong** evidence with limited bias (level 1++/1+/2++/2+)[1]
R_w	These recommendations are supported by **weak** evidence with some potential for bias (level 2+/3)[1]
R_e	These recommendations are based on a consensus of expert opinion (level 4)

[1] Referring to the SIGN evidence grading system (www.sign.ac.uk): level 2+ studies are regarded as strong evidence when the study designs are appropriate to address the question being considered. By contrast, level 2+ studies are regarded as weak evidence when they are not the most appropriate design, for example when addressing therapy questions

life), while step 2 comprises *physical measurements* of disease (which range from 'core', an ICDAS-approved modification for epidemiology in which air for drying is not available and cotton wool/gauze is used. In this case code 1 is combined with core 2 (as Code 1+2), and only codes 0 and 2–6 are used, to 'enhanced' where the full ICDAS codes 0–6 are used, to 'supplements' which is ICDAS + the use of caries detection aids). Step 3 is for *biochemical measurements* – as in cardiovascular disease (which is where future technology and caries activity assessments are expected to contribute to caries assessments in the future). It should be stressed that epidemiological data collected with ICDAS codes can also be computed to give backward-compatible D_3MF values in addition to the more complete ICDAS caries values.

Dental Education Example of the ICDAS

The ICDAS codes can and have been taught in dental education settings over the last few years. Examples include developments at the University of Indiana of caries risk forms and clinical management forms which have been in use for some time and where students are familiarized with the ICDAS codes, with the momentum achieved by the Caries Management by Risk Assessment (CAMBRA) groups and adoption of ICDAS by schools such as New York University. The teaching at the University of Copenhagen embraces the ICDAS for both dentists and hygienists, and in Scotland the teaching of the ICDAS is set to spread across all Scottish schools through the SDCEP process. In Australia minimally invasive dentistry has been taught for some years, and increasingly ICDAS codes are used [20].