*Community Dental Health* (2012) **29,** 258–259

doi:10.1922/CDH_294Downer02

**Editorial**

# Do we really need another system for recording caries? Thoughts on ICDAS

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Dental caries has been described as a destructive process causing decalcification of tooth enamel leading to continued destruction of enamel and dentine and cavitation of the tooth. This definition rightly implies progression. Yet more than fifty years ago, when caries was rampant and the first rigorously conducted randomised controlled trials (RCT) of caries prophylactic agents were being conducted, it was recognised that enamel lesions (variously termed initial lesions, incipient caries, white spots etc.) could reverse, remineralise and disappear during the three-year course of a trial. Moreover, this occurred in both experimental and placebo control subjects and was apparently over and above diagnostic reversals attributable to intra-examiner error.

Nowadays dental caries is not a scourge. In public health it is its ubiquity rather than its morbidity that is important, albeit some deaths still occur as complications of dental abscess (Moles, 2008). Caries is the most common disease of the mouth and remains the major concern of dentists as a cause of pain, sleep deprivation, workplace absences, and physical disfigurement. From both the public health viewpoint, and that of clinical dentistry, valid and reliable recording methods are essential. At a more specific level, instruments for recording caries are required to fulfil the information needs of four distinct, but related, clinical activities: experimental epidemiology, descriptive epidemiology, screening and case finding.

Epidemiology may be loosely defined as "the study of the determinants of disease events in populations." It deals with disease distribution, cause and control. Descriptive epidemiology describes disease incidence, prevalence and distribution for archival purposes, to investigate possible associations or to generate hypotheses for experimental verification. Experimental epidemiology deals with the clinical testing of therapeutic agents ideally by RCT.

Screening is defined as "the presumptive identification of unrecognised disease or defect by the application of tests, examinations or other procedures which can be applied rapidly. Screening tests sort out apparently well persons who probably have a disease from those who probably do not" (Bhopal, 2002). Case finding is closely related to screening. However, whilst screening involves all individuals in a certain category (e.g., the dental inspection of infant school new entrants), case finding consists of investigating a smaller group of people based on the presence of risk factors (e.g., patients with a known high incidence of caries in dental practices).

It is possible that some all embracing instrument for recording caries could serve, simultaneously, the requirements of all these functions and it is timely to consider to what extent an existing unified caries index can achieve this objective. Over the past decade investigations have been carried out on a proposed "new" caries index - the International Caries Detection and Assessment System (ICDAS). Basically ICDAS is an extended version of the universally recognised and applied dmf/DMF index. A distinguishing feature is that it divides carious lesions into a number of categories of severity, through which the disease tends to progress, each with a number of well defined diagnostic features. Thus D1 refers essentially to the first visible change in enamel, D2 to distinct visible change, D3 to enamel breakdown, D4 to dentinal shadow, D5 to visible cavity into dentine, and D6 to extensive cavitation.

The division of the "D" element of DMF into progressive stages of severity is not a recent innovation. Based on pioneering work, notably by Otto Backer Dirks, caries prophylactic clinical trials in the nineteen sixties and seventies employed levels of severity designed to reflect caries progression. Four levels of caries measurement (C1 to C4) were typically employed (Rugg-Gunn *et al.*, 1973), each with well defined criteria; C1 and C2 corresponded approximately to ICDAS D1, D2 and D3 whilst C3 and C4 approximated to D4, D5 and D6.

The graded indices used in these early trials were investigated for their test-retest reliability and concurrent validity. For two RCTs reliability coefficients for three-year caries increments (clinical and radiographic data combined) were at the C1+ level, 0.79 and 0.83 respectively and at the C3+ level 0.90 and 0.89 (Rugg-Gunn *et al*., 1976). Clearly confining the analysis to unequivocal cavitation was more reliable than extending it to include incipient lesions. In an *in vitro* investigation of the concurrent validity of recordings of sound and carious fissure surfaces in a RCT (Downer *et al*., 1976) against a histological "gold standard", a sensitivity of 0.84 and specificity of 0.78 were reported at the C3+ level (Downer, 1975). A specificity of 0.78 implies that 22% of the recordings were false positives. Given the relatively small proportion of tooth surfaces with unequivocal carious lesions compared with the overwhelming non-cavitated majority, the fact that, not untypically, more than one fifth of the recordings were false positives is disturbing and indicates the possible extent to which inappropriate restorative dental treatment could occur. As regards discriminant ability, in the same RCT the three year reduction in DMFS increment at the C3+ level was 31.1% compared with 27.9% at the C1+ level. Inclusion of enamel lesions did not improve discrimination between the test and placebo control groups. It led rather to a loss of information.

What of the performance of ICDAS as an instrument for use in experimental and descriptive epidemiology? Applied to visible proximal tooth surfaces and evaluated against a histological "gold standard", Ekstrand *et al*. (2011) demonstrated a Wkappa of >0.90 for ICDAS in predicting lesion depth confined to the enamel/outer third of dentine versus deeper lesions. In an analytical investigation of the validity of ICDAS in discriminating socioeconomic factors associated with the presence of caries at both the cavitated and non-cavitated thresholds, Mendes *et al*. (2010) showed that, when non-cavitated scores were used, the discriminant power decreased. Braga *et al*. (2009) compared ICDAS with the WHO system which includes only unequivocal cavitated lesions. They reported that ICDAS was comparable to the standard criteria when the cut-off point was Score 3. However, examination by ICDAS took twice as long as by the WHO method. These studies cast doubt on whether the use of the full range of ICDAS, as opposed to demarcation confined to the D3 cut-point, is appropriate in experimental and descriptive epidemiology.

For screening and case finding ICDAS seeks to classify lesions as active and inactive. Nelson *et al*. (2011) found that the kappa value for this binary assessment among three trained examiners was only within the "poor" to "good" range. It seems clear that ICDAS can only serve as an adjunct in determining lesion activity. A comprehensive clinical assessment would also need to take into account *inter alia* diet, oral hygiene and fluoride exposure. Elsewhere Diniz *et al*. (2011) in an *in vitro* study using a histological "gold standard" found that ICDAS had high sensitivity (0.83) but much lower specificity (0.79). Once again they showed a worrying incidence – over 20% – of false positives.

These data were selected from a handful of the numerous papers published recently on ICDAS. They serve only to illustrate potential shortcomings in aspects of the system's performance and are not comprehensive. To take a broader perspective on the arguments it is perhaps useful to seek analogies from oncology. For example, in order to standardise the incidence of cancer worldwide, the data collected by national cancer registries includes only unequivocal malignant lesions. However, the Kerala study of screening for oral cancer (Sankaranarayanan *et al*., 2005) classified lesions as 'normal', 'non-referable' and 'referable'. Referable lesions included white patch, ulcerated white patch and red patch – potentially malignant lesions falling under the heading of leukoplakia and erythroplakia. Yet leukoplakia does not inevitably progress to oral cancer. Unless confirmed histologically as malignant it would not be counted in cancer registry data. The inclusion of only unequivocal carious lesions in the WHO data bank is consistent with WHO's general recording of disease prevalence and incidence.

With regard to leukoplakia only a fraction of lesions progress to malignancy. Nevertheless, leukoplakia is potentially life-threatening. Therefore seeking to maximise sensitivity in case finding at the expense of some loss of specificity is fully justified. Similarly, with caries a proportion of incipient lesions – possibly the majority – do not progress to cavitation even in the absence of intervention. Caries is not a life-threatening disease therefore, in contrast, the emphasis should be heavily on specificity. In another analogy, there are indications that screening for breast cancer with mammography leads to an unwanted increase in aggressive treatment (Campbell, 2011). The use of ICDAS as a case-finding instrument could also lead to over-zealous intervention and a waste of scarce resources if it is unable to differentiate consistently between incipient or lesions that will progress to cavitation and those that will not.

The main claim that can be made for ICDAS is probably that it attempts to standardise caries diagnosis and treatment planning on an international basis. Arguably, as an instrument for use in population screening and experimental and descriptive epidemiology, it offers no advantages.

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