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HINTS & KINKS

Dental caries diagnostic thresholds: Which one? Why? When?

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Introduction

Nowadays, the epidemiological profile of dental caries has led the scientific community to developing new diagnostic technologies and methods. The proposal of more sensitive diagnostic criteria, capable of detecting all spectra of dental caries, has occupied an outstanding place in scientific debates (Mendes et al. 2010; Iranzo-Cortés et al. 2013).

Since the early 1900s (with Black's Classification System), many dental caries diagnostic thresholds, criteria and classification systems have been successfully developed (Fisher and Glick 2012). Currently, the central question is to register the presence and activity of incipient carious lesions, expanding the scope of the World Health Organization (WHO) diagnostic criteria and the Decayed, Missing, Filled (DMF) index (Silva et al. 2012; Iranzo-Cortés et al. 2013; WHO 2013).

However, reflections and discussions among oral health professionals and researchers about the conscientious choice among different dental caries diagnostic criteria within different contexts must be encouraged. This is the aim of this communication.

The contemporary context of caries detection in oral health surveys

There is a clear conception of dental caries disease as a continuum, controllable up to the frank cavitation stage. According to Nyvad (2004), "when dealing with diagnostic questions, one should bear in mind that the diagnosis is not a goal by itself. The ultimate goal of making a diagnosis is always to select the best possible treatment".

Traditionally, dental caries epidemiological surveys have been performed by clinical visual examination, in accordance with WHO criteria, and registered by the DMF index (WHO 2013). Simplicity and speed of examinations, low operating costs, worldwide acceptance and recognition by professionals, researchers and health authorities are some of the strengths of this methodology. The main criticism of the WHO criteria/DMF index is their limitation relative to not recording incipient carious lesions in enamel. This limitation may lead to underestimation of dental caries conceived as a continuum (Braga et al. 2009; Mendes et al. 2010; Fisher and Glick 2012). Additionally, the interpretation of "Missing" component, especially for the DMF-S (Surface) index, may lead to overestimation of the individual's caries experience (Broadbent and Thompson 2005). The DMF index provides information exclusively about dental caries lesions in dentin and their restorative or surgical treatment. Such information is complemented by the PUFA index which records the presence of severely decayed teeth with visible pulpal involvement (P/p), ulceration caused by dislocated tooth fragments (U/u), fistula (F/f) and abscess (A/a), which may be more serious than the caries lesions themselves (Monse et al. 2010).

In spite of conceptual and technological advancements in caries detection in the last few decades, the clinical visual examination continues to be the first and the most important step in disease diagnosis. The contribution of the International Caries Detection and Assessment System (ICDAS) to dental caries diagnosis is unquestionable. It detects carious lesions since D1 (first visible change in enamel) until D6 (extensive cavitation within visible dentin). Even when used by inexperienced examiners, ICDAS expands the spectrum of dental caries diagnosis in clinical, research, teaching and epidemiology settings (Ismail et al. 2007; Braga et al. 2009; Mendes et al. 2010; Downer

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2012). However, overestimation of operative treatment by inexperienced professionals may occur leading to waste of scarce resources from public health services, for example (Downer 2012; Fisher and Glick 2012).

Considering accuracy and precision issues, clinical visual examinations in accordance with WHO criteria and ICDAS produced similar results for cavitated carious lesions, in dental caries surveys (Ismail et al. 2007; Braga et al. 2009; Mendes et al. 2010; Downer 2012; Silva et al. 2012; Iranzo-Cortés et al. 2013; Frencken et al. 2013; Leal et al. 2017). However, kappa values below 0.65 and reduced discriminant power for incipient carious lesions under ICDAS may limit its usefulness in epidemiological surveys (Mendes et al. 2010). So, an eventual superiority of ICDAS over WHO criteria/DMF index or vice versa seems to be a flawed argument for deciding between them. Some authors consider ICDAS as an extended version of the WHO criteria (Downer 2012; Silva et al. 2012). The Caries Assessment Spectrum and Treatment (CAST) is another epidemiological instrument that covers the whole spectrum of dental caries detection (Frencken et al. 2013; Leal et al. 2017). The data collected by CAST can be easily converted to DMF-T index assuring comparison between them (de Souza et al. 2014; Leal et al. 2017). So, at the end, what really matters is the certainty of distinguishing between dental caries stages (enamel/dentin, active/inactive) and adequacy (logistics, resources and time) of diagnostic methods used in researches or epidemiological surveys.

Whenever possible, incipient carious lesions detection and risk factor evaluations as well clinical consequences of untreated dental caries must complement epidemiological data aiming to subsidize public health programs (Pitts and Stamm 2004; Monse et al. 2010; Downer 2012; Fisher and Glick 2012).

So how do we choose a diagnostic criterion?

Before choosing both diagnostic criteria and dental caries index, professionals should refer to some concepts in epidemiology. To know details of diagnostic criteria, methods and indexes should be the next steps for making a conscious choice (Nyvad 2004; Downer 2012).

Considering different professional profiles and knowledge among dentists, it is mandatory to differentiate the concept "diagnosis" from "detection". "Caries diagnosis" is a process that implies a human professional summation of elements of simple pattern of recognition, probabilistic considerations and hypothetical-deductive thinking. "Caries detection" consists of determining whether or not lesion is present by means of a dental caries examination (Nyvad 2004; Pitts and Stamm 2004; Broadbent and Thompson 2005).

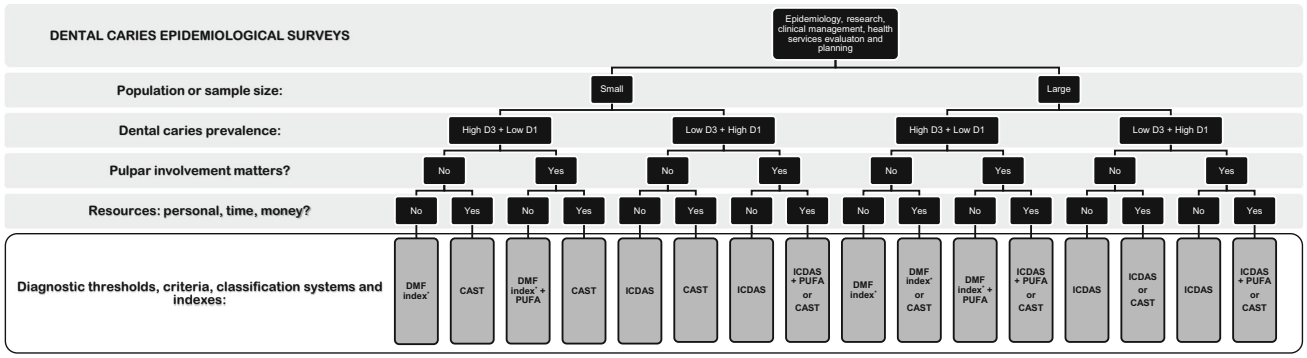
An instrument for recording dental caries should provide information to meet the needs of the clinical activities of experimental and descriptive epidemiology, screening and case finding (Downer 2012). The "screening" concept clearly illustrates the need for reflection before conducting an epidemiological survey. A screening test enables rapid triage of persons who probably have a disease from those who probably do not. If a screening aim was to identify schoolchildren who should receive atraumatic restorative treatment, what justifies the use of ICDAS? In this case, can CAST be a viable alternative? Pulpal involvement and, or periodontal status matters? However, if the aim of a clinical research was to verify the effect of fluoride therapies on populations, why use WHO criteria adaptations instead the ICDAS?

When epidemiology concepts are comprehended and considered, the use of WHO criteria/DMF index in oral health surveys enrolling a large number of subjects in large geographical areas does not seem to be inappropriate, flawed or outdated. However, well-conducted training and calibration processes are fundamental for its success.

Notwithstanding, if the scope of the oral health survey is to detect incipient carious lesions, ICDAS or CAST is the better choice than WHO criteria/DMF index. There is no impediment or contraindication to using ICDAS to detect cavitated carious lesions in oral health surveys. Yet time and resources for this task are higher than for WHO criteria or CAST both for training examiners (specific e-learning program is required) and for performing examinations (Braga et al. 2009; Iranzo-Cortés et al. 2013; de Souza et al. 2014). In some circumstances, these factors can be limiters.

Studies comparing ICDAS, CAST and WHO diagnostic criteria/DMF index at epidemiological surveys highlight their peculiarities (Broadbent and Thompson 2005; Braga et al. 2009; Mendes et al. 2010; Downer 2012; Silva et al. 2012; Iranzo-Cortés et al. 2013; de Souza et al. 2014; Castro et al. 2018). To discuss an eventual superiority of a diagnostic threshold (or method) over another, ignoring the confluence of factors as "dental caries stage and prevalence in population", "age of individuals examined" (Melgar et al. 2016), "resources allocated" and "opportunities of its use" in epidemiological surveys (Kühnisch et al. 2008; Downer 2012), seems to be superficial.

The decline of the prevalence and severity of dental carious lesions in the last four decades is evident. However, the disease is prevalent in all age groups remaining as the main oral health problem around the world affecting aspects of the individuals' lives from different ways (Frazão 2012; Frencken et al. 2017). Once such decline and the subsequent disease pattern are different for each age group, the implications on research, human resources and oral healthcare services must be different too. Nowadays, a



* Incipient carious lesions in enamel can be successfully registered by the DMF index derived from criteria other than WHO as seen in studies at Fyffe et al. (2000), Assaf et al. (2006) and Nyvad and Baelum (2018).

Fig. 1 Decision tree to select the diagnostic threshold, criteria, classification systems and indexes

children minority from the 6-year-old and below groups concentrates the most dentine carious lesions. The WHO databank data from 2000 to 2015 show that median prevalence of dentine carious lesions and DMF-T index, for 12-year-old children from the upper–middle-income countries, is of 69.4% and 2.1, respectively. The decline of prevalence and severity of cavitated dentine carious lesions was substantial for adolescents and adults in the same period. The mean percentage of the D-component (from the DMF-T index) was low (9.6%) in the high-income group and high (53.6%) in the low-income group. The number of teeth present among adults and elderlies around the world is growing nowadays (Frazão 2012; Frencken et al. 2017). The burden of dental caries still remains related to the cavitated dentine carious lesions (Frazão 2012; Frencken et al. 2017). However, the prevalence and relevance of initial dental caries for oral health planning in public services cannot be neglected nowadays (Assaf et al. 2006; Melgar et al. 2016). Thus, the reflection on the prevalence of the disease according to injury stages and age groups can be a fundamental step in selecting the most appropriate criterion/index for each case.

Still in the meantime, the allocation of resources depends directly from dental caries threshold selected. To detect D1 carious lesions in epidemiological surveys, CPI probe, air compressor, suction device, tweezers, dental mirror, cotton rolls, head loupe, professional tooth cleaning with a small rotating brush must be available to examiners (Kühnisch et al. 2008; Melgar et al. 2016). Furthermore, as that examination is more complex, its training and calibration sessions for such surveys will require more time too when compared to traditional WHO diagnostic criteria (Frazão 2012; Melgar et al. 2016). All that structure to detect D1 carious lesions implies on financial resources. This can be a limiter factor to perform epidemiological surveys, especially when leading with a large number of individuals (Kühnisch et al. 2008). On the other hand, the examinations for D3 carious lesions detection, according to WHO methodology, are simpler. They include the use of a CPI probe (to remove debris), a dental plane mirror and natural lighting (WHO 2013). Whenever are available auxiliary resources (the same used for D1 carious lesions detection) must be adopted (Assaf et al. 2006). Under that threshold, the dental caries experience is underestimated, to a greater or a lesser extent, depending on the prevalence of the disease in the different groups, because the dental caries lesions over enamel surfaces are not considered (Assaf et al. 2006). In this sense, the PUFA index requires no instruments (Monse et al. 2010). But the additional time to the dental caries visual examinations to register pulpal conditions must be considered too. Thus, the complexity of selecting the most appropriate index/criterion increases substantially when considering different factors, such as prevalence, age groups and resources (financial, time and personal).

Besides those factors, the population or sample size to be examined determines the "opportunities" of the use of each dental caries detection method (kind of examinations, diagnostic criteria, threshold and/or systems) (Deep 2000). A scheme aiming to help professionals to answer the questions "Which caries diagnostic threshold to adopt?", "Why?" and "When?" is presented as follows (Fig. 1).

Final considerations

As in clinical decision-making, the selection of diagnostic threshold, criteria or system must be an act of balance too. Each diagnostic criterion/dental caries index is good for the purpose for which it was conceived. This knowledge must guide professionals elaborating healthcare policies, planning, services in public health and the management of health/disease in individuals (Nyvad 2004). Thus, there is no single diagnostic system suitable for all settings (Pitts 1991; Fisher and Glick 2012). The answers to the questions

"Which dental caries diagnostic threshold?", "Why?" and "When?" will depend from the exactness between what is investigated and diagnostic method in a specific moment in time. Those answers should be a process of insightful reflection by researchers and oral health professionals.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Human and animal rights participants No human participants were involved in this manuscript. Discussions, insights and considerations in this manuscript are exclusively made upon results of published scientific articles.

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