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# A Review of Dental Caries Detection Technologies

A Peer-Reviewed Publication  
Written by Jeffery B. Price, DDS, MS

## Abstract

Caries diagnosis is one of the most basic diagnostic skills that oral healthcare professionals must learn; and yet, it remains one of the most difficult skills to reliably and predictably master. In this course we will review the various caries detection technologies available to assist the dental professional with this complex task.

## Educational Objectives:

- At the conclusion of this educational activity the participant will be able to:
1. Describe the rationale for adopting the new International Caries Detection & Assessment System (ICDAS) detection and assessment tool for dental caries
  2. Discuss the major technological advances in the field of caries detection
  3. Incorporate the 2012 radiographic selection criteria to more effectively utilize bitewing radiography as a diagnostic tool in caries diagnosis
  4. Assess the caries detection technologies that area currently available to the practicing dentist

## Author Profile

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## Author Disclosure

Jeffery B. Price, DDS, MS is a consultant with Sirona Dental and teaches many of their Galileos new users training courses. He also has an internet-based Cone Beam CT interpretation practice.

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4. Assess the caries detection technologies

## Abstract

Caries diagnosis is one of the most basic diagnostic skills that oral healthcare professionals must learn; and yet, it remains one of the most difficult skills to reliably and predictably master. In this course we will review the various caries detection technologies available to assist the dental professional with this complex task.

Many dental schools in the U.S. are adopting a new system for caries diagnosis—the International Caries Detection & Assessment System (ICDAS). We will introduce the ICDAS system and correlate it to the standard ADA recognized U.S. system of caries diagnosis. We will also discuss the importance of caries diagnosis in clinical practice today and also briefly touch on the issue of the ethics of caries diagnosis.

In this educational activity, we will review technologies to assist the dentist with the diagnosis of dental caries; however, it is extremely important to realize, especially for the young dental professional, that the diagnosis of a carious lesion is only one aspect of the entire management phase for dental caries. In fact, there are many aspects of managing the caries process besides diagnosis.<sup>1,2</sup> The lesion needs to be assessed as to whether the caries is limited to enamel or if it has progressed to dentin. A determination of whether the lesion is cavitated needs to be made since cavitated lesions continue to trap bacterial plaque and need to be restored. The activity level of the lesion needs to be determined. A single evaluation will only tell the clinician the condition of the tooth at that single point in time; but, is the demineralization increasing or, perhaps is it decreasing? Larger lesions will not require a detailed evaluation of activity, but smaller lesions will need this level of examination and follow-up.<sup>3</sup> Finally, the therapeutic or operative management options for the lesion need to be considered based on these previous findings.<sup>4</sup>

Caries detection is a basic task that all oral healthcare professionals are taught in school. In principle it is very simple—detect mineral loss in teeth visually, radiographically or by some other adjunctive method. There can be many issues that affect this task, including training, experience, and subjectivity of the observer; operating conditions and reliability of the diagnostic equipment. These factors and others can all

act in concert and often, the end result is that this ‘simple’ task becomes complex. A critical factor to consider is that most of the research on caries detection has focused on occlusal and smooth surface caries. There are two reasons for this—first of all, from a population standpoint, more new carious lesions are occlusal lesions today than in the past;<sup>5-8</sup> and, secondly, many studies rely on screening examinations without intraoral radiographic capability.<sup>9,10</sup>

## Caries Classifications

The standard American Dental Association (ADA) caries classification system designated dental caries as initial, moderate, and severe (see Figure 1). This was commonly modified with the term ‘incipient’ to mean demineralized enamel lesions that were reversible.<sup>11</sup> There have been many attempts over the years to develop one universal caries classification system that clinical dentists as well as research dentists can use not only in the U.S., but also internationally. As the result of the International Consensus Workshop on Caries Clinical Trials (ICW-CCT) held in 2002, the work on the International Caries Detection and Assessment System (ICDAS) was begun in earnest; and, today it has emerged as the leading international system for caries diagnosis.<sup>12,13</sup> The ICDAS for caries diagnosis offers a six-stage, visual-based system for detection and assessment of coronal caries. It has been thoroughly tested and has been found to be both clinically reliable and predictable. Among its greatest strengths are that it is evidence based, combining features from several previously existing systems and does not rely on surface cavitation before caries can be diagnosed (Figures 2 & 3). Many previous systems relied on conflicting levels of disease activity before a diagnosis of caries; but, with the ICDAS, leading cariologists have been able to standardize definitions and levels of the disease process. The ICDAS is gaining acceptance as the new and evolving standard for caries diagnosis internationally and here in the U.S..

Figure 1: ADA Caries Classification

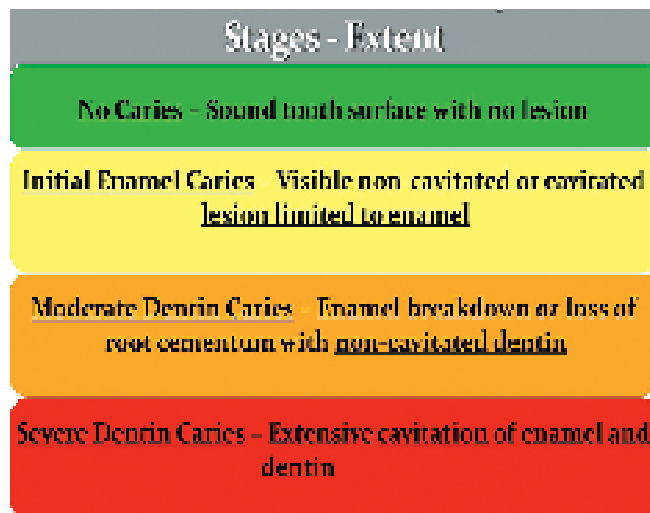
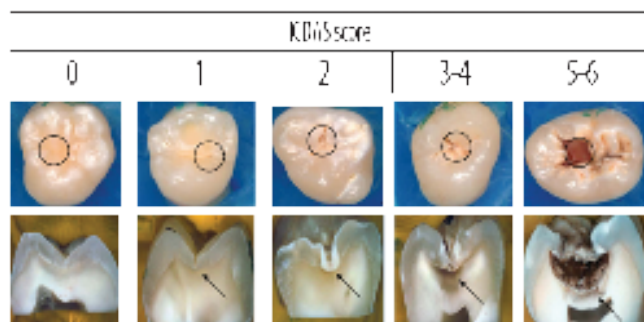


Figure 2: ICDAS Caries Classification

ICDAS Code	Description
0	Sound tooth surface
1	First visual change in enamel
2	Distinct visual change in enamel
3	Localized enamel breakdown due to caries with no visible dentin
4	Underlying dark shadow from dentin (with or without enamel breakdown)
5	Distinct cavity with visible dentin
6	Extensive distinct cavity with visible dentin

Figure 3: ICDAS Clinical examples correlated with sectioned teeth



courtesy of Dr. Andrea Ferriera—Zandona, Indiana University

### Ethics of Caries Diagnosis

One of the five principles of the American Dental Association’s Code of Ethics is non-maleficence, which states that oral healthcare professionals should ‘do no harm’ to his or her patients.<sup>14</sup> By enhancing their caries detection skills, dental practitioners can detect areas of demineralization and caries at the earliest possible stages. These teeth can then be managed with fluorides and other conservative therapies.<sup>15-17</sup> This scenario for managing teeth with early caries will hopefully make some inroads into the decades old practice of restoring small demineralized areas because they are going to need fillings anyway and you might as well fill them now instead of waiting until they get bigger.<sup>18</sup> Continuing to stress the preventive approach to managing early caries begins with early diagnosis; but, what better way to ‘do no harm’ to our patients than to avoid placing restorations in teeth with early demineralized enamel lesions?

### Continuum of Caries Diagnosis

One approach to categorizing the methods that oral healthcare professionals use for caries detection is to place them on a continuum beginning with the most simple, or least invasive, and work up to more sophisticated techniques. With that in mind, the first tool that oral professionals use for caries detection is purely visual—their eyes. The

earliest detectable changes within tooth structure affect the microporosity of enamel, which in turn affects the transmission of light through the enamel. Next of course would be color changes within enamel and dentin followed by defects within the enamel. These can all be detected visually with the clinician’s eyes using direct vision or vision assisted with a mirror and a standard dental operator light. In addition, a small, rounded-end dental explorer or probe can assist with the detection of small defects. The use of a sharp explorer for caries detection is now frowned upon by virtually all leading researchers in the field of caries research.<sup>19-21</sup> Traditionally, the first level of technology beyond the basic eyes of the examiner has been bitewing radiography—either conventional or digital. It has been shown that there is essentially no difference between the diagnostic capabilities of film and digital radiography when used for bitewings.<sup>10, 22, 23</sup>

### Visible Light

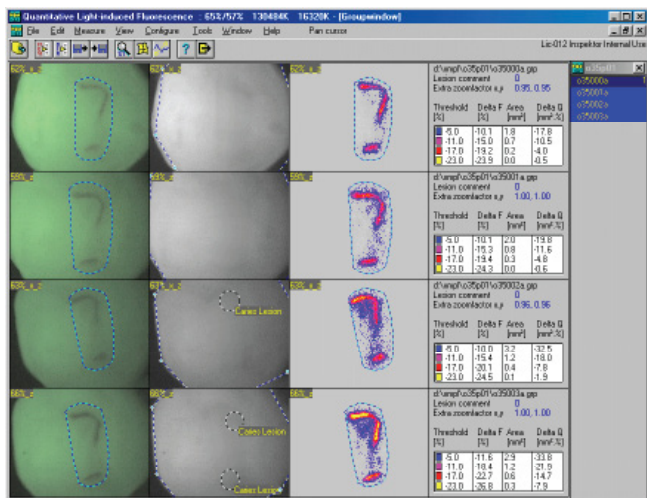
The next level along this continuum is the advanced use of visible light—fiber optic transillumination (FOTI) and digital imaging fiber optic transillumination (DIFOTI). The differential transmission of light through healthy tooth structure as compared to carious tooth structure can be detected. When using fiber optic light the operator is able to use a more focused and higher intensity light beam instead of an operator light, thereby increasing the potential to detect smaller carious lesions.<sup>24, 25</sup> The difference between these two technologies is that the DIFOTI system has a built-in CCD camera to allow for image capture of the tooth for documentation purposes. This can then be compared to a future image after fluoride therapy or in patient education efforts. The DIFOTI system has had mixed reviews in the literature and currently does not appear to be actively marketed in the U.S.<sup>26</sup>

### Quantitative Light-Induced Fluorescence

It has been shown that tooth enamel has a natural fluorescence.<sup>27</sup> By using a CCD-based intraoral camera with specially developed software for image capture and storage, quantitative light-induced fluorescence (QLF) technology measures the refractive differences between healthy enamel and demineralized, porous enamel. Areas of caries and demineralization show less fluorescence (Figure 4). With the use of a fluorescent dye which can be applied to dentin, the QLF system can also be used to detect dentinal lesions in addition to enamel lesions.<sup>28</sup> A major advantage of the QLF system is that these changes in tooth mineralization levels can be tracked over time using the documented measurements of fluorescence and the images from the camera.<sup>29, 30</sup> In addition, the QLF system has demonstrated accurate results between examiners. It has also demonstrated a reliable ability to detect caries and avoid false negatives.<sup>27, 30</sup>



Figure 4. QLF output from Inspektor Research Systems BV, Amsterdam, The Netherlands



### Laser fluorescence

Laser fluorescence detection techniques such as the DIAGNOdent®, (KaVo USA) rely on the differential refraction of light as it passes through sound tooth structure versus carious tooth structure. As described by Lussi et al in 2004, a 650 nm light beam, which is in the red spectrum of visible light, is introduced onto the region of interest on the tooth via a tip containing a laser diode. As part of the same tip, there is an optical fiber that collects reflected light and transmits it to a photo diode with a filter to remove the higher frequency light wavelengths. This leaves only the lower frequency fluorescent light that was emitted by the reaction with the suspected carious lesion. This light is then measured or quantified, hence the name 'quantified laser fluorescence'.<sup>31,32</sup> One potential drawback with the laser fluorescence is the increased incidence of false-positive readings in the presence of stained fissures, plaque and calculus, prophy paste, existing pit and fissure sealants and existing restorative materials.<sup>24, 33</sup> A review of caries detection technologies published in the Journal of Dentistry in 2006 by Pretty that compared the laser fluorescence technology with other caries detection technologies such as ECM, FOTI and QLF showed that the laser fluorescence technology had an extremely high specificity or ability to detect caries.<sup>30</sup>

Figure 5.



### Electrical Conductance

The basic concept behind electrical conductance technology is that there is a differential conductivity between sound versus demineralized tooth enamel due to changes in porosity. Saliva soaks into the pores of the demineralized enamel and increases the electrical conductivity of the tooth.<sup>34</sup>

There has been a long-standing interest in using electrical conductance for caries detection. Original work on this concept was published as early as 1956 by Mumford.<sup>35</sup> One of the first modern devices was the Electronic Caries Monitor (ECM) which was a fixed-frequency device used in the 1990's. The clinical success of the ECM was mixed as evidenced by the lack of reliable diagnostic predictability.<sup>32</sup>

### Alternating current impedance spectroscopy

Alternating current impedance spectroscopy uses multiple electrical frequencies to detect and diagnose occlusal and smooth surface caries. CarieScan® is an example of this technology. By using compressed air to keep the tooth saliva free, one specific area on a tooth can be isolated from the remaining areas, and one small region of interest can be examined. If an entire surface needs to be evaluated, an electrolyte solution is introduced and the tip of the probe is placed over the larger area to allow for examination of the entire surface.<sup>32</sup> The diagnostic reliability of this device is more accurate and reliable than the ECM; and, according to the literature, stains and discolorations do not interfere with the proper use of the device. It appears to have good potential as a caries detection technology.<sup>34, 36, 37</sup>

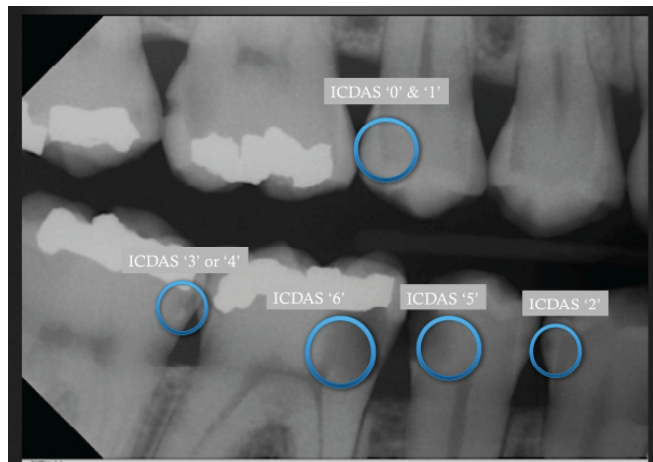
### Radiography

Most oral healthcare professionals that have been in practice a few years have developed routines that have resulted in distinctive practice personalities. These are generally good, but sometimes these routines may need to be evaluated to see if they still meet good scientific principles that are accepted by the profession. One of these routines may be the radiographic selection criteria that were recently updated by the ADA and FDA.<sup>38</sup> To paraphrase the conclusion of the update, radiographs should be made only when there is a reasonable expectation that the diagnostic information obtained from the radiograph will affect the treatment outcome. On a practical level, this means that dental practices should no longer have a policy of taking bitewings at pre-set intervals for all adult patients; but, rather, the decision to order radiographs should be personalized and based on clinical findings such as restorative history, caries risk, plaque score, etc. The radiographic selection criteria document will provide an excellent guide for today's oral healthcare professional.

The intraoral bitewing technique is the most widely used radiographic examination for caries detection. The ICDAS classification system was developed primarily as a

visual based caries classification system; however, if dentists are to use this as their caries diagnosis tool, it must also apply to caries diagnosed from radiographs as well. The author has used the ICDAS caries definitions and applied them to the appearance of carious lesions on bitewing radiography (Figure 6).

Figure 6. A radiographic application of the ICDAS classification for interproximal caries compiled by the author; please note that this is not from the official ICDAS website.



The typical digital bitewing with rectangular collimation has an associated effective dose of  $\sim 1 \mu\text{Sv}$  (micro-Sievert), which is a very small amount of radiation. This is equal to about one eighth of the average person's daily radiation dose.<sup>39</sup> The use of ionizing radiation is a very minor limiting factor when considering the use of bitewing radiography.

One of the limitations with bitewing radiography is that the reliability and predictability of caries diagnosis using bitewings may not be as good as many believe.<sup>9,10,40</sup> For instance, in a 2002 study, Mileman and van den Hout compared the ability of Dutch dental students and practicing general dentists to diagnose dentinal caries on radiographs. The students performed almost as well as the experienced dentists.<sup>41</sup>

Computer aided diagnosis has been investigated as an improvement, given the documented limited diagnostic success with routine bitewing radiography, hence the field of computer-aided diagnosis has been applied to dental caries diagnosis.

### Computer-Aided Diagnosis

The use of Computer-aided diagnosis (CAD) of disease is well-established in medical radiology, having been utilized since the 1980's at the University of Chicago and other medical centers for assistance with the diagnosis of lung nodules, breast cancer, osteoporosis and other complex radiographic tasks.<sup>42</sup> A major distinction has been made in the medical community between automated computer diagnosis versus computer-aided diagnosis. The main dif-

ference is that in automated computer diagnosis, the computer does the evaluation of the diagnostic material, i.e., radiographs, and reaches the final diagnosis with no human input. In computer-aided diagnosis; both a medical practitioner and a computer evaluate the radiograph and reach a diagnosis separately. Depending on the practitioner's confidence level, he or she will then either make the final diagnosis or use the computer's diagnosis, if it is different from the practitioner's.<sup>43</sup>

The Logicon<sup>®</sup> system (Carestream Dental LLC, Atlanta, GA) is an example of CAD caries detection technology<sup>44</sup> (Figure 7 and 8). The software contains within its database, teeth with matching clinical images, radiographs and histologically known patterns of caries. As a tooth is radiographed and an interproximal region of interest is selected for evaluation, this database is accessed for comparison purposes. The software will then, in graphic format, give the dental professional a tooth density chart and calculate a probability displayed on a scale of 0 to 1.0 that the area in question is a sound tooth, decalcified or carious and if a restoration is required. In addition, the level of false positives can be adjusted, or specificity, that the clinician is willing to accept.<sup>43, 45, 46</sup>

Figure 7. The Logicon system



Figure 8. Logicon Result for each proximal surface.

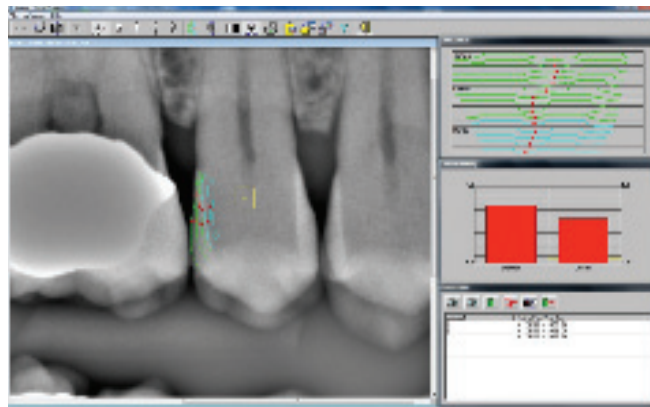


Image provided courtesy Dr. David C. Gakenheimer, Carestream Dental

In a 2011 study, Tracy et al described the use of CAD caries detection technology whereby twelve blinded dentists reviewed 17 radiographs from an experienced practitioner who meticulously documented the results that he obtained from the use of CAD technology. Over a period of three years, he followed and treated a group of patients and photographed the teeth that required operative intervention for documentation purposes. He also documented teeth showing no evidence of caries and teeth with no evidence of caries confined only to the enamel which did not require restoration. The study included a total of 28 restored surfaces and 48 non-restored surfaces in the 17 radiographs. His radiographic and clinical results were then compared to the radiographic diagnoses of the 12 blinded dentists on these 17 radiographs. The true positive, or actual diagnosis of caries when present, is where the CAD system proved to be of benefit. With routine bitewing radiographs and unadjusted images, the dentists diagnosed 30% of the caries. When the images were sharpened, only 39% of the caries were diagnosed. When using CAD, the caries diagnosis increased to 69%, a very significant increase in the ability to diagnose carious lesions. The other side of the diagnostic coin is specificity, or ability to accurately diagnose a sound tooth. Both routine bitewing and CAD images were equally accurate, diagnosing at a 97% and a 94% rate.<sup>45</sup> These results offer evidence that by using the CAD caries detection technology, dentists are able to confidently double the numbers of carious teeth that they are diagnosing without affecting their ability to accurately diagnose a tooth as being free from decay. CAD technology essentially serves as a reliable second opinion.

## Future of Caries Detection

### ICDAS

A major first step in the future of caries detection would be for wider international adoption of the ICDAS classification system for use in the diagnosis of caries, not only in epidemiological studies, but also in the daily practice of clinical dentistry. This would allow for the more widespread use of a common caries diagnosis language throughout dentistry so that when a dentist in Edinburgh, Scotland diagnoses a tooth with an ICDAS Class 2 occlusal carious lesion, a dentist in Atlanta, GA or Hamburg, Germany knows exactly what type of lesion the dentist has diagnosed and the treatment modalities available.

### Polarization-sensitive optical coherent tomography (OCT)

OCT uses near infrared light to image teeth with confocal microscopy and low coherence interferometry resulting in very high resolution images at ~10—20 microns. The accuracy of OCT is so detailed that early mineral changes in teeth can be detected in vivo after exposure to low pH

acidic solutions in as little as 24 hours by using differences in reflectivity of the near infrared light. In addition, tooth staining and the presence of dental plaque and calculus do not appear to affect the accuracy of OCT.<sup>(34)</sup> It is important to always keep in mind, the ultimate beneficiary of technology, the patient.

### Frequency-domain laser-induced infrared photothermal radiometry & modulated luminescence (PTR/LUM)

This technology relies on the absorption of infrared laser light by the tooth with measurement of the subsequent temperature change, which is in the 1° C or less range. This technology is utilized by the Canary System<sup>®</sup> (Quantum Dental Technologies). This optical to thermal energy conversion is able to transmit highly accurate information regarding tissue densities at greater depths than visual only techniques.<sup>(34)</sup> Early laboratory testing shows better sensitivity for caries detection for this technology than for radiography, visual or for laser fluorescence technology.<sup>34, 47, 48</sup>

Figure 9.



## Summary

Many oral healthcare professionals are quite surprised to learn that, as a group, they do not excel at diagnosing caries, especially interproximal caries using bitewing radiography. If dentists were able to diagnose teeth with 95+% accuracy with the basic tools of their eyes, probes and bitewing radiographs, there would be no market demand for any other caries detection technologies. Currently available technology and improvements in the future will enhance accuracy in detection of caries improving the oral health of the public.

## Bibliography

1. Axelsson P. An introduction to risk prediction and preventive dentistry: Quintessence Publishing Company; 2000.
2. Kidd E. Essentials of Dental Caries: The Disease and Its Management: The disease and its management: OUP Oxford; 2005.
3. Whitaker EJ. Primary, secondary and tertiary treatment of dental caries A 20-year case report. The Journal of the American Dental Association. 2006;137(3):348-52.
4. Fontana M, Zero DT. Assessing patients' caries risk. The Journal of the American Dental Association. 2006;137(9):1231-9.
5. NIH. Diagnosis and Management of Dental Caries Throughout Life. 2001 NIH Conference on Diagnosis and Management of Dental Caries Throughout Life; Washington, DC 2001.
6. Zandoná AF, Santiago E, Eckert G, Katz B, de Oliveira SP, Capin



- O, et al. The Natural History of Dental Caries Lesions A 4-year Observational Study. *Journal of Dental Research*. 2012;91(9):841-6.
7. Marthaler T. Changes in dental caries 1953–2003. *Caries research*. 2004;38(3):173-81.
  8. Pitts N. Detection, assessment, diagnosis and monitoring of caries: Karger Basle, Switzerland; 2009.
  9. Bader JD, Shugars DA, Bonito AJ. Systematic reviews of selected dental caries diagnostic and management methods. *Journal of Dental Education*. 2001;65(10):960-8.
  10. Bader JD, Shugars DA, Bonito AJ. A systematic review of the performance of methods for identifying carious lesions. *Journal of public health dentistry*. 2002;62(4):201-13.
  11. Zero DT. Dental caries process. *Dental Clinics of North America*. 1999;43(4):635.
  12. Ismail AI, Sohn W, Tellez M, Amaya A, Sen A, Hasson H, et al. The International Caries Detection and Assessment System (ICDAS): an integrated system for measuring dental caries. *Community Dentistry and Oral Epidemiology*. 2007;35(3):170-8.
  13. ICDAS. International Caries Detection and Assessment System; [updated 2013; cited 2013 April 1, 2013]. Available from: <http://www.icdas.org/home>.
  14. ADA. Principles of Ethics and Code of Professional Conduct. Chicago, IL: American Dental Association, 2012 April 2012. Report No.
  15. Bravo M, Baca P, Llodra JC, Osorio E. A 24-month Study Comparing Sealant and Fluoride Varnish in Caries Reduction on Different Permanent First Molar Surfaces. *Journal of public health dentistry*. 1997;57(3):184-6.
  16. Marinho V, Higgins J, Logan S, Sheiham A. Fluoride mouthrinses for preventing dental caries in children and adolescents. *Cochrane Database of Systematic Reviews*. 2003;3(3).
  17. Petersson L, Lith A, Birkhed D. Effect of school-based fluoride varnish programmes on approximal caries in adolescents from different caries risk areas. *Caries research*. 2005;39(4):273-9.
  18. Baelum V, Heidmann J, Nyvad B. Dental caries paradigms in diagnosis and diagnostic research. *European journal of oral sciences*. 2006;114(4):263-77.
  19. Braga MM, Mendes FM, Ekstrand KR. Detection activity assessment and diagnosis of dental caries lesions. *Dental Clinics of North America*. 2010;54(3):479.
  20. Van Dorp C, Exterkate R, Ten Cate J. The effect of dental probing on subsequent enamel demineralization. *ASDC journal of dentistry for children*. 1988;55(5):343.
  21. Ekstrand K, Qvist V, Thylstrup A. Light microscope study of the effect of probing in occlusal surfaces. *Caries research*. 2009;21(4):368-74.
  22. Tyndall DA, Ludlow JB, Platin E, Nair M. A comparison of Kodak Ektaspeed Plus film and the Siemens Sidedix digital imaging system for caries detection using receiver operating characteristic analysis. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 1998 Jan;85(1):113-8. PubMed PMID: 9474625. Epub 1998/02/25. eng.
  23. Pretty IA, Maupome G. A closer look at diagnosis in clinical dental practice: part 3. Effectiveness of radiographic diagnostic procedures. *J Can Dent Assoc*. 2004 Jun;70(6):388-94. PubMed PMID: 15175119. Epub 2004/06/04. eng.
  24. Côrtes D, Ellwood R, Ekstrand K. An in vitro comparison of a combined FOTI/visual examination of occlusal caries with other caries diagnostic methods and the effect of stain on their diagnostic performance. *Caries Research*. 2003;37(1):8-16.
  25. Rochlen GK, Wolff MS. Technological advances in caries diagnosis. *Dental Clinics of North America*. 2011;55(3):441.
  26. Kincade K. Beyond x-rays: Part 1—Do optical caries detection systems really work? [Website]. [DrBicuspid.com](http://www.drBicuspid.com); 2008 [updated June 16, 2008]. Available from: [http://www.drBicuspid.com/\(F\(QuylyAqyKCaifj4LdyN3ztxxtSuDb-Vb1r5FdAYBJQKq8oQU0U6eLUyO\\_05\\_6E77q2IYpo6rPHUat96UFAkSubcXgUjmA8TTwVqrULx nkeT3idKaGpPAZ7UnHA5NePXE51MOeih9T3y61NjqOOEbDvc4l mHNq0Gm1JxPhfJ4EkM1\)\)/index.aspx?sec=sup&sub=img&pag=dis&ItemID=300676](http://www.drBicuspid.com/(F(QuylyAqyKCaifj4LdyN3ztxxtSuDb-Vb1r5FdAYBJQKq8oQU0U6eLUyO_05_6E77q2IYpo6rPHUat96UFAkSubcXgUjmA8TTwVqrULx nkeT3idKaGpPAZ7UnHA5NePXE51MOeih9T3y61NjqOOEbDvc4l mHNq0Gm1JxPhfJ4EkM1))/index.aspx?sec=sup&sub=img&pag=dis&ItemID=300676).
  27. Angmar-Månsson B, Ten Bosch J. Quantitative light-induced fluorescence (QLF): a method for assessment of incipient caries lesions. *Dentomaxillofacial Radiology*. 2001;30(6):298-307.
  28. Pretty IA, Maupome G. A closer look at diagnosis in clinical dental practice: part 5. Emerging technologies for caries detection and diagnosis. *J Can Dent Assoc*. 2004 Sep;70(8):540, a-i. PubMed PMID: 15363214. Epub 2004/09/15. eng.
  29. Amaechi BT, Higham SM. Quantitative light-induced fluorescence: a potential tool for general dental assessment. *Journal of biomedical optics*. 2002;7(1):7-13.
  30. Pretty IA. Caries detection and diagnosis: novel technologies. *Journal of dentistry*. 2006;34(10):727-39.
  31. Lussi A, Hibst R, Paulus R. DIAGNOdent: an optical method for caries detection. *Journal of Dental Research*. 2004;83(suppl 1):C80-C3.
  32. Tranaeus S, Shi XQ, Angmar-Månsson B. Caries risk assessment: methods available to clinicians for caries detection. *Community dentistry and oral epidemiology*. 2005;33(4):265-73.
  33. Lussi A, Imwinkelried S, Pitts N, Longbottom C, Reich E. Performance and reproducibility of a laser fluorescence system for detection of occlusal caries in vitro. *Caries research*. 1999;33(4):261-6.
  34. Amaechi BT. Emerging technologies for diagnosis of dental caries: The road so far. *Journal of Applied Physics*. 2009;105(10):102047--9.
  35. Mumford J. Relationship between the electrical resistance of human teeth and the presence and extent of dental caries. *Br Dent J*. 1956;100(239-244):10.
  36. Pitts N, Losb P, Biesak P, Maslaski M, Czajczynska-Waszkiwicz A, Longbottom C, et al. Ac-Impedance Spectroscopy technique for monitoring dental caries in human teeth. *Caries Res*. 2007;41(4):321-2.
  37. Pitts NB. How Electrical Caries Detection and Monitoring With CarieScan Can Help Deliver Modern Caries Management. *Oral Health*. 2010;100(7):34.
  38. ADA. Dental Radiographic Examinations: Recommendations for Patient Selection and Limiting Radiation Exposure. 2012.
  39. Price JB. A Review of Intraoral Radiology 2013 April 11, 2013; (January 2013);[11 p.]. Available from: [http://www.ineedce.com/courses/2379/PDF/1212cei\\_Price\\_web.pdf](http://www.ineedce.com/courses/2379/PDF/1212cei_Price_web.pdf).
  40. Dove SB. Radiographic diagnosis of dental caries. *Journal of Dental Education*. 2001;65(10):985-90.
  41. Mileman P, Van Den Hout W. Comparing the accuracy of Dutch dentists and dental students in the radiographic diagnosis of dental caries. *Dentomaxillofacial Radiology*. 2002;31(1):7-14.
  42. Doi K. Computer-aided diagnosis in medical imaging: historical review, current status and future potential. *Computerized medical imaging and graphics: the official journal of the Computerized Medical Imaging Society*. 2007;31(4-5):198.
  43. Gakenheimer DC. The efficacy of a computerized caries detector in intraoral digital radiography. *The Journal of the American Dental Association*. 2002;133(7):883-90.
  44. Yoon DC, Wilensky GD, Neuhaus JA, Manukian N, Gakenheimer DC. Quantitative dental caries detection system and method. *Google Patents*; 1998.
  45. Tracy KD, Dykstra BA, Gakenheimer DC, Scheetz JP, Lacina S, Scarfe WC, et al. Utility and effectiveness of computer-aided diagnosis of dental caries. *General dentistry*. 2011;59(2):136.
  46. Gakenheimer D, Farman T, Farman A, Benjamin S, Huysing P, Chang H, et al., editors. *Advancements in automated dental caries detection using DICOM image files*. International Congress Series; 2005: Elsevier.
  47. Jeon RJ, Matvienko A, Mandelis A, Abrams SH, Amaechi BT, Kulkarni G. Detection of interproximal demineralized lesions on human teeth in vitro using frequency-domain infrared photothermal radiometry and modulated luminescence. *Journal of biomedical optics*. 2007;12(3):034028--13.
  48. Jeon R, Sivagurunathan K, Garcia J, Matvienko A, Mandelis A, Abrams S, editors. *Dental diagnostic clinical instrument*. *Journal of Physics: Conference Series*; 2010: IOP Publishing.
  49. Gakenheimer DC. Personal e-mail. In: Price JB, editor. 2013.

## Author Profile

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## Author Disclosure

Jeffery B. Price, DDS, MS is a consultant with Sirona Dental and teaches many of their Galileos new users training courses. He also has an internet-based Cone Beam CT interpretation practice.

## Online Completion

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## Questions

- Detection of caries is part of a process that includes which of the following additional steps?
  - Caries assessment
  - Progression of the lesion past the DEJ
  - Determination of whether the lesion is cavitated
  - All of the above
- The standard ADA caries classification system follows which of the following dental caries designations?
  - Small, medium and large
  - Initial, moderate and severe, with a modifier for incipient
  - Pit and fissure caries only
  - Smooth surface caries only
- How did the ICDAS get its start?
  - In response to a research project from Proctor & Gamble and Colgate
  - By the European research group, ORCA
  - By a U.S. research group from NIH
  - After a 2002 International Consensus Workshop on Caries Clinical Trials
- All of the following are characteristics of the ICDAS classification system EXCEPT which ONE?
  - Bitewing radiographs are a vital part of the system and must be used
  - ICDAS is evidence based
  - Several existing caries diagnosis systems have been combined into the ICDAS system
  - Surface cavitation is not necessary in order to use the ICDAS system
- Early caries detection allows for which of the following?
  - Identification of demineralized enamel lesions that can be restored before they become larger
  - Identification of demineralized enamel lesions that can be managed with fluoride and other forms of therapy in attempts to prevent the need for restorations
  - It serves no clinical purpose
  - It is only helpful in caries research and not in clinical practice
- The most basic caries detection tool is which of the following?
  - Sharp explorer tip
  - Electric caries monitor
  - Electrical conductance
  - Visual, or the eyes
- Which of the following types of probes is currently recommended for manual exploration of the surface of a tooth for the presence of caries?
  - Sharp-tipped explorer
  - An old explorer
  - A small, rounded-end or blunt explorer
  - Probing should never be attempted for caries diagnosis
- The DIAGNOdent system is what type of system?
  - Visual only
  - Laser fluorescence
  - Electrical conductance
  - Light to thermal energy conversion
- Laser fluorescence caries detection technology detects which of the following?
  - Saliva collection within porous enamel pits
  - Differences in light refraction as a laser beam of light passes through sound enamel and carious tooth structure within the region of interest
  - Electrical conductivity differences within enamel rods and prisms which have structural differences in sound versus carious tooth structure
  - Laser beam deflections at the interface of the dentin and enamel
- Which of the following is a major drawback in the use of the electrical conductance technology?
  - Increased false-positive findings in the presence of clean, dry teeth
  - Increased false-negative findings in the presence of stained pits and fissures, plaque and calculus, prophylaxis paste and existing restorations
  - Increased false-positive findings in the presence of stained pits and fissures, plaque and calculus, prophylaxis paste and existing restorations
  - The high operational cost for supplies to use the machine
- Which of the following best describes how the electrical conductance measurement (ECM) system works?
  - Any of the existing commercial apex locators can be adapted for caries measurement by fitting a special electrode that touches the tooth and the readout then gives a measurement of caries likelihood
  - The electrical resistance of healthy enamel is different from carious tooth structure; and, the ECM system detects this difference in electrical resistance
  - ECM uses a combination of electrical current and laser beams to measure total electromagnetic energy flow in the tooth to determine the likelihood of caries
  - ECM uses a combination of electrical current and visual feedback with the associated tooth color changes seen in areas of high caries activity when an electrical current is applied to teeth
- Which of the following statement is most accurate in describing interest in ECM systems?
  - Interest in ECM is a relatively new phenomenon, the Electronic Caries Monitor was the first attempt at testing electrical currents in teeth in the 1990's
  - Because of the use of high voltage electricity, ECM systems are inherently unsafe in the mouth
  - The wet conditions in the mouth and subsequent saliva contamination of the tooth are potential sources for unreliable diagnoses.
  - A rubber dam must be used with ECM systems
- The CarieScan device is an example of which type of caries detection technology?
  - Electrical current measurement
  - Laser fluorescence
  - Low dose radiography
  - Alternating current impedance spectroscopy
- What is the basic technology behind alternating current impedance spectroscopy?
  - Using steady energy electrical currents to measure the resistance in tooth structure
  - Detecting and measuring the changes in reflected laser beam energies and displaying them on an oscilloscope in real time to detect differences in mineralization levels of the tooth
  - The use of multiple electrical frequencies to detect and diagnose occlusal and smooth surface caries
  - Constantly alternating the electrical energy in an ECM device until the single best electrical current is found for caries detection
- Which of the following is true, when comparing regular ECM and CarieScan?
  - ECM is more reliable because the operation is simpler
  - Research has shown that CarieScan appears to be more accurate and reliable than ECM
  - Stained teeth significantly interfere with the operation of both instruments
  - The ECM appears to have a better long term potential than CarieScan
- Which of the following best describes when to order bitewing radiographs?
  - Bitewings should be taken when there is a reasonable expectation that helpful diagnostic information will be found on them
  - All adults should have bitewings every six months
  - All adults should have bitewings every year
  - All adults should have bitewings every two years
- A good radiography resource for today's dental clinician is which of the following?
  - An insurance company's benefits handbook
  - A dental school textbook from 1980
  - The 2012 ADA/FDA publication 'Dental Radiographic Examinations'
  - The TV show, Dr. Oz
- What is the approximate effective radiation dose of a digital bitewing?
  - 5  $\mu$ Sv
  - 2  $\mu$ Sv
  - 3  $\mu$ Sv
  - 1  $\mu$ Sv
- What is the typical daily background radiation dose for the average person in the U.S.s?
  - No radiation
  - 1  $\mu$ Sv
  - 8  $\mu$ Sv
  - 20  $\mu$ Sv



## Questions (continued)

20. Which of the following statements apply to bitewing radiography for use in caries detection?
- The radiation dose is very low and should not be a limiting factor in the use of bitewings when selection criteria guidelines are followed
  - The public's concern about radiation is justified since the radiation dose with bitewings is very high
  - The radiation dose is so low that bitewings should be taken at every recall visit
  - The high dose with bitewings prohibit their continued use in dentistry
21. Which of the following statements is most accurate?
- Generally, dentists are close to perfect when diagnosing caries on bitewing radiographs, even when the interproximal contacts have too much horizontal overlap
  - About ten years ago in one study, it was shown that dentists improve their caries diagnosis skills over time while in practice
  - The reliability and predictability of caries diagnosis using bitewing radiographs is generally not as good as most dentists believe
  - Dutch dentists are better at caries diagnosis than American dentists
22. Which of the following best describes automated computer diagnosis as used in radiography?
- The computer assesses the radiograph and using a programmed database of information renders a diagnosis
  - A medical practitioner and a computer both assess a radiograph and arrive at a radiograph; depending on the practitioner's confidence level, he or she will either use his or her own diagnosis or the computer's diagnosis, if it is different
  - A radiologic technologist directs a computer program to 'read' the radiograph and then submits the final diagnosis directly to the patient's medical record without the need for a radiologist supervision
  - Automated computer diagnosis is most commonly used in primary care settings such as free-standing ambulatory health centers that manage minor trauma and minor emergency cases
23. Which of the following best describes Computer-Aided Diagnosis (CAD) as used in radiography?
- The computer assesses the radiograph and using a programmed database of information renders a diagnosis
  - A medical practitioner and a computer both assess a radiograph and arrive at a radiograph; depending on the practitioner's confidence level, he or she will either use his or her own diagnosis or the computer's diagnosis, if it is different
  - A radiologic technologist directs a computer program to 'read' the radiograph and then submits the final diagnosis directly to the patient's medical record without the need for a radiologist supervision
  - Automated computer diagnosis is most commonly used in primary care settings such as free-standing ambulatory health centers that manage minor trauma and minor emergency cases
24. Advanced systems of radiographic diagnosis using computers and digital radiographs for dentistry are also known most accurately as which of the following?
- Computer-Aided Diagnosis (CAD)
  - Automated computer diagnosis
  - Digital profiling of similar teeth
  - Computerized database comparison using clinical examples only
25. Computer-Aided Diagnosis (CAD) databases used in dentistry contain which of the following types of information?
- Clinical images
  - Radiographs
  - Histology
  - All of the above
26. The Computer-Aided Diagnosis (CAD) system evaluates the digital bitewing radiograph. What probability is calculated according to the level of false positives programmed into the system?
- The odds ratio that the tooth is a sound tooth, is decalcified only or is carious and requires a restoration
  - The probability that the tooth needs an amalgam, a composite or a crown
  - The probability that the tooth will be retained for the life of the patient
  - The likelihood that the tooth will ever require endodontic therapy
27. Practitioners who use Computer-Aided Diagnostic (CAD) systems for diagnosis often find these systems to be which of the following?
- Very difficult to master
  - Unreliable
  - Very helpful, especially as a 'second opinion'
  - Not useful in the clinical setting
28. In the 2011 Tracy study, it was found that the Computer-Aided Diagnostic (CAD) system affected the rate at which caries were diagnosed; which of the following is true?
- Caries were diagnosed at half the unaided rate when CAD was used
  - Caries were diagnosed at approximately twice the unaided rate when CAD was used
  - The caries diagnosis rate was actually unchanged when CAD was used
  - Caries were diagnosed at four times the unaided rate when CAD was used
29. The 2011 Tracy study also evaluated the rate at which dentists could accurately diagnose a sound tooth as not having caries when using Computer-Aided Diagnostic (CAD) system; how was this rate affected when using CAD?
- There was no effect
  - There were an increased number of false negative findings
  - There were a decreased number of false negative findings
  - The effect could not be determined
30. Future improvements in caries detection include which of the following?
- Widespread adoption of the ICDAS system
  - OCT, or optical coherent tomography
  - PTR/LUM or frequency-domain laser induced infrared photothermal radiometry & modulated luminescence
  - All of the above

## Notes

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# A Review of Dental Caries Detection Technologies

Name: \_\_\_\_\_ Title: \_\_\_\_\_ Specialty: \_\_\_\_\_

Address: \_\_\_\_\_ E-mail: \_\_\_\_\_

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Requirements for successful completion of the course and to obtain dental continuing education credits: 1) Read the entire course. 2) Complete all information above. 3) Complete answer sheets in either pen or pencil. 4) Mark only one answer for each question. 5) A score of 70% on this test will earn you 2 CE credits. 6) Complete the Course Evaluation below. 7) Make check payable to PennWell Corp. For Questions Call 216.398.7822

## Educational Objectives

1. Describe the rationale for adopting the new ICDAS detection and assessment tool for dental caries
2. Discuss the major technological advances in the field of caries detection
3. Incorporate the 2012 radiographic selection criteria to more effectively utilize bitewing radiography as a diagnostic tool in caries diagnosis
4. Assess the caries detection technologies

## Course Evaluation

1. Were the individual course objectives met? Objective #1: Yes No **No** Objective #2: Yes No **No**

Please evaluate this course by responding to the following statements, using a scale of Excellent=5 to Poor=0.

- |   |       |   |   |   |     |    |
|---|-------|---|---|---|-----|----|
| 2. To what extent were the course objectives accomplished overall?                            | 5     | 4 | 3 | 2 | 1   | 0  |
| 3. Please rate your personal mastery of the course objectives.                                | 5     | 4 | 3 | 2 | 1   | 0  |
| 4. How would you rate the objectives and educational methods?                                 | 5     | 4 | 3 | 2 | 1   | 0  |
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| 6. Please rate the instructor's effectiveness.  | 5     | 4 | 3 | 2 | 1   | 0  |
| 7. Was the overall administration of the course effective?                                    | 5     | 4 | 3 | 2 | 1   | 0  |
| 8. Please rate the usefulness and clinical applicability of this course.                      | 5     | 4 | 3 | 2 | 1   | 0  |
| 9. Please rate the usefulness of the supplemental web bibliography.                           | 5     | 4 | 3 | 2 | 1   | 0  |
| 10. Do you feel that the references were adequate?  |       |   |   |   | Yes | No |
| 11. Would you participate in a similar program on a different topic?                          |       |   |   |   | Yes | No |
| 12. If any of the continuing education questions were unclear or ambiguous, please list them. | _____ |   |   |   |     |    |

13. Was there any subject matter you found confusing? Please describe.  
 \_\_\_\_\_  
 \_\_\_\_\_

14. How long did it take you to complete this course?  
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 \_\_\_\_\_  
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| 14. (A) (B) (C) (D) | 29. (A) (B) (C) (D) |
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