

# The Current Status of Vital Tooth Whitening Techniques

CE 3



**Richard Blankenau, DDS**, was a 1966 graduate of Creighton University School of Dentistry. After 2 years of service in the Public Health Indian Health Service, he returned to Creighton University to begin a career in dental education. He held a variety of positions, including University Faculty President, Chairman of the Department of Operative Dentistry, Professor of Operative Dentistry, Associate Dean for Academic Affairs, and Chairholder of the Oscar S. Belzer Endowed Chair in Dentistry. His research interests included operative dentistry and lasers. He published more than 60 papers and lectured internationally on a variety of topics dealing with his research interests.



**Ronald E. Goldstein, DDS**, is currently Clinical Professor of Oral Rehabilitation at the Medical College of Georgia School of Dentistry, Augusta, Georgia. Dr. Goldstein is coauthor of the text *Complete Dental Bleaching*. He is cofounder and past President of the American Academy of Esthetic Dentistry and is currently the President of the International Federation of Esthetic Dentistry. In 1997, Dr. Goldstein was bestowed the Alpha Omega International Fraternity's most prestigious award for "meritorious contributions to dentistry and its allied sciences," joining past recipients Albert Einstein and Jonas Salk.



**Van B. Haywood, DMD**, is Professor in the Department of Oral Rehabilitation, School of Dentistry, Medical College of Georgia. An alumni of the Medical College of Georgia, he was in private practice for 7 years in Augusta, Georgia, and taught at the University of North Carolina School of Dentistry in Operative and Prosthodontics for 12 years before going to the Medical College of Georgia in 1993. In 1989, he coauthored the first publication on nightguard vital bleaching with Dr. Harold Heymann. In 1997, he coauthored the first article on extended treatment of tetracycline-stained teeth. He has completed further research on the NGVB technique and the topic of bleaching and esthetics.

*Tooth whitening of vital teeth continues to have a major impact on the practice of dentistry. The growing public interest in having whiter, brighter teeth is clearly evident in the advertisements from toothpaste manufacturers on "whitening" formulations of their products and by the number of individuals seeking whitening procedures from their dentists. In addition, new over-the-counter whitening products continue to emerge in a marketplace that cannot seem to get teeth white enough, bright enough, fast enough.*

*What new products and procedures have evolved over the past decade to whiten teeth? Are they better, safer, faster, and more effective now? Are dentists meeting public demand for whiter teeth and is this quest having a positive or negative impact on the practice of dentistry or the patient's dental health? I posed these questions to a group of experts on whitening procedures to get their opinions and recommendations.*

## Learning Objectives:

*After reading this article, the reader should be able to:*

- discuss trends in at-home vs in-office whitening treatments.
- describe a differential diagnosis of stained teeth before treatment.
- explain the variable depth of penetration of several different whitening systems.

## In Memoriam

A sad footnote to this article is that Dick Blankenau recently lost his battle against cancer. Although I knew Dick for only a short time, I did gain a sense that he was a dedicated, hard-working dentist, educator, and researcher who loved his work and his profession. His enthusiasm was infectious and his humble, common-sense approach to our projects together was refreshing. I will remember him with great fondness.—MJF



**Figures 1A and 1B**—Yellow discoloration usually responds well either to several in-office treatments or to at-home treatment.



**Figures 2A and 2B**—Banded discoloration may not respond as well to treatment as other types of extensive discoloration.

### Increased Demand for Teeth Whitening

Dr. Richard Blankenau saw the public demand for whiter teeth increasing both in the private patient population and at his university dental school clinic. One survey suggests that patients between the ages of 40 and 50 years inquire about whitening their teeth more often than any other dental health service.<sup>1</sup> That same survey reports that more than 90% of dentists offer an at-home whitening procedure and 50% to 60% of them offer an in-office technique. According to a recent survey by Dr. Kevin Frazier from the Medical College of Georgia and Dr. Van Haywood (unpublished data, May 1999), most dental schools are offering some form of at-home whitening and other esthetic options in their dental curriculum. Because of this increased demand, Dr. Blankenau's university (Creighton University in Omaha) has added tooth-whitening procedures to its educational curriculum. Providing whitening not only teaches the students the technical aspects of the procedure, but it also gives them experience with the psychological implications of trying to meet subjective patient expectations.

Dr. Ronald Goldstein agrees that public demand is partially responsible for driving the tooth-whitening marketplace, but he also sees a large push by the product manufacturers.

Manufacturers of lasers, "bleaching lights," and other in-office systems are increasing advertising to the dental community, and he sees a trend toward in-office methods in combination with at-home techniques. Some manufacturers of in-office whitening systems have suggested in their advertisements that the desired results can be obtained in just one visit. Dr. Haywood says that his experience has found this not to be the case. And Dr. Goldstein estimates that it takes approximately three to five in-office treatments to achieve reasonable results. Dr. Haywood is also concerned that these in-office laser systems are being advocated for use with no clinical science to substantiate safety and efficacy. Dr. Goldstein agrees that some advertising shows individuals with very white teeth, which he believes are more the result of the photography and printing processes than the actual whitening process. He also cautions that with the more intensive in-office treatments, rubber dam isolation and tooth desiccation can give the patient a false impression. After rehydration, the brightness fades, and he is careful to advise patients of this phenomenon.

### Over-the-Counter Products

Dr. Haywood makes a specific distinction between over-the-counter (OTC) home-



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European Patent Nos. 2,022,051; 2,041,170; 2,041,171; 2,041,172; 2,041,173; 2,041,174; and 2,041,175.

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**Figures 3A and 3B**—Example of brown fluorosis staining, which may require as long as 2 months of at-home treatment or as little as 1 week.



**Figures 4A and 4B**—Blue-gray tetracycline discoloration may require several months of at-home treatment. In-office treatment may be used to shorten overall treatment time, but the effectiveness of additional in-office treatment cannot be determined beforehand.

applied systems and dentist-prescribed home-applied systems. The latter implies that an examination and diagnosis has been made to determine the etiology of the tooth discoloration and the appropriate treatment method and protocol has been prescribed.

Despite investigative reports by ABC's "20/20" and NBC's "Dateline"<sup>2,3</sup> that found that OTC whitening products do not work very well, Dr. Haywood's dissatisfaction is that there is still a strong marketplace for these products, especially if they are priced below \$50. He believes that a significant number of people will not return a product—even if it does not perform according to the advertised claims—if it is priced below \$50.

According to Dr. Blankenau, one reason that patients may not get good results with OTC products is compliance: "They may just not be using the products properly or long enough." Without a clear understanding of what to expect in specific clinical circumstances, outcomes can easily fall short of expectations. According to Dr. Goldstein, another reason that expectations may not be met is that patients may not recognize that their teeth have discolored composite restorations or crowns that will not be affected by



**Figure 5**—Example of a tooth being treated with a dual-activated 35% hydrogen peroxide. Tissue isolation was performed with a rubber dam and ligation. After application, the whitening product was activated with a curing light.

whitening. Teeth that are nonvital or discolored from dark tetracyclinelike stains will also show poor results with OTC products.

### In-Office Whitening and Energy Sources

Dr. Goldstein has provided in-office whitening for more than 30 years and has used a variety of methods. He has a specific protocol that he follows for every patient.<sup>4</sup> The assessment is to determine the type of discoloration and if it is of primarily one color or multiple colors. If the discoloration is of a yellow type, it will usually respond well to in-office and/or at-home whitening methods. For



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**Figures 6A and 6B**—Enamel before (A) and after (B) bleaching with 10% carbamide peroxide gel. The enamel was treated 6 hours per day for 5 days.

brown discolorations, he recommends starting with an in-office treatment followed by at-home tray whitening for a few months. The blue-gray and the brown discolorations may take much longer to alter with a similar treatment plan. Multicolored or “banded” discoloration patterns are not as successfully whitened as other types of discoloration. Although the teeth may exhibit lightening, the banded areas are usually not eradicated completely. Typically, treatment for brown or dark yellow discolorations consists of 2 or 3 in-office treatments with 1 to 2 months of at-home treatment (Figures 1 through 4).

**The issue of safety is always a concern when discussing tooth whitening, especially in the presence of heat generators, such as a laser or a high-intensity light source.**

A number of new in-office whitening systems use some form of peroxide formulation “activated” with an energy source. Argon lasers, CO<sub>2</sub> lasers, plasma arc lamps, quartz halogen lamps, incandescent lamps, and infrared lamps have all been advocated, as well as hand-held heating instruments. Dr. Goldstein chooses a system based on patient sensitivity. He finds that the argon laser in combination with 35% hydrogen peroxide (QuasarBrite<sup>TM,a</sup>) produces the least postoperative sensitivity (Figure 5). (However, only StarBrite<sup>®a</sup> 35% hydrogen peroxide is ADA-approved for in-office use, although not with a light source.) Dr. Goldstein points to Pick, who has demonstrated that lasers are effective

in reducing temperature sensitivity, particularly to cold.<sup>5</sup> Dr. Goldstein feels that the argon laser may eventually be proven to be helpful in reducing sensitivity, and he encourages further research in this area. And Dr. Haywood says there is literature to support the safety of 35% hydrogen peroxide with a minor amount of heat.<sup>6,7</sup> Dr. Goldstein, however, refers to research showing that although heat produces changes (such as pulpal inflammation), these changes are reversible.<sup>7</sup> However, activating the peroxide with a CO<sub>2</sub> heat source is not an ADA-accepted technique for vital teeth.<sup>8</sup>

Dr. Blankenau took a strong position on the issue of heating hydrogen peroxide or carbamide peroxide with lasers. He felt that there was a significant body of science to suggest that it was known to be a “bad idea” before it was ever used.<sup>9-16</sup> He referred to the fact that CO<sub>2</sub> lasers had been used in the oral cavity for soft-tissue surgery for quite some time and that proper technique specifically recommends that the teeth be protected from the laser because of potential pulpal damage from heat.

### Safety and Sensitivity

The issue of safety is always a concern when discussing tooth whitening, especially in the presence of heat generators, such as a laser or a high-intensity light source. Dr. Blankenau said work he was doing in a study on extracted teeth suggested that the enamel surface hardness is reduced on teeth that are subjected to whitening procedures. However, Dr. Haywood referred to a body of papers that report the opposite.<sup>17-21</sup> He says, “The literature suggests that there is no surface or subsurface alteration in hardness from the 10% carbamide peroxide whitening products.” His work on long-term exposure to 10% carbamide peroxide did not find any apprecia-

<sup>a</sup>Spectrum Dental Inc, Culver City, CA 90232



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J. Murawski, D.M.S., et al., "Clinical Evaluation of a Combined In-Office and At-Home Bleaching Agent," JDR, Vol. 78, Abs. No. 312 (1999): 144.  
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**Figures 7A and 7B**—Before and after treatment photos showing a mild color change that may not be acceptable to some patients.

ble changes from scanning electron microscopy studies of in vitro enamel surfaces as a result of exposure to as many as 1,000 hours of carbamide peroxide.<sup>22,23</sup> Therefore, the fear that this process will eventually dissolve away the enamel surface is not supported by current research (Figures 6A and 6B).<sup>24</sup>

**T**ooth sensitivity is the most common side effect of whitening. Research on the effectiveness of using potassium nitrate to reduce tooth sensitivity is making that side effect less of an issue.

However, Dr. Haywood cautions that this information should not be extrapolated to other concentrations of carbamide peroxide. He says that most of the negative clinical reports on the use of carbamide peroxide are related to higher concentrations, in the range of 16% to 35%.<sup>25-27</sup> Dr. Haywood also has concern for the use of 50% hydrogen peroxide rather than 35% hydrogen peroxide because no significant research exists on the safety of the higher concentration of peroxide on teeth or pulps. He feels that dentists must carefully consider the downside of using even a 15% carbamide peroxide that is not ADA-approved over the 10% formulations that have been ADA-approved for six manufacturers. He further advises that dentists should not assume, just because one product is ADA-approved, all of the manufacturer's products are approved.

If 10% carbamide peroxide is the most appropriate material to use for at-home bleaching, are all brands basically the same? According to Dr. Haywood, the pH, flavorings, and other components differ. Some are very

viscous, whereas others are more water-soluble. Double-blind clinical trials demonstrate differences in effectiveness as well as differences in sensitivity.<sup>28-37</sup> Some patients even exhibited sensitivity with controls that did not contain carbamide peroxide, which suggests the sensitivity may have been related to the other components in the product being evaluated.<sup>38</sup>

According to Dr. Haywood, there is not sufficient science to claim that high-energy light sources or lasers are safe to use for bleaching techniques. Dr. Goldstein cautions that if 35% hydrogen peroxide is used, local anesthesia should not be administered because any leakage of the rubber dam may result in a significant tissue burn that will not be noticed by the patient.<sup>39</sup> This method of whitening with 35% hydrogen peroxide should not be used on young children because their developing pulp chambers may be large. According to Dr. Haywood, at-home procedures are more appropriate for young patients. And although these materials have low toxicity, he feels it would be prudent to avoid their use during pregnancy.

Tooth sensitivity is the most common side effect of whitening. Research on the effectiveness of using potassium nitrate to reduce tooth sensitivity is making that side effect less of an issue. There are three commercially available 5% potassium nitrate products from DenMat<sup>b</sup>, Ultradent<sup>c</sup>, and Discus Dental<sup>d</sup>, that can be used within the whitening tray. In addition, desensitizing toothpastes have the same ingredient and can be used to decrease sensitivity, but they may cause some tissue irritation from other components in the toothpaste. Jerome and others described using Sensodyne<sup>®e</sup> toothpaste in a whitening tray to reduce postoperative sensitivity from periodontal surgery.<sup>40-43</sup>

<sup>b</sup> Den-Mat, Santa Maria, CA 93456

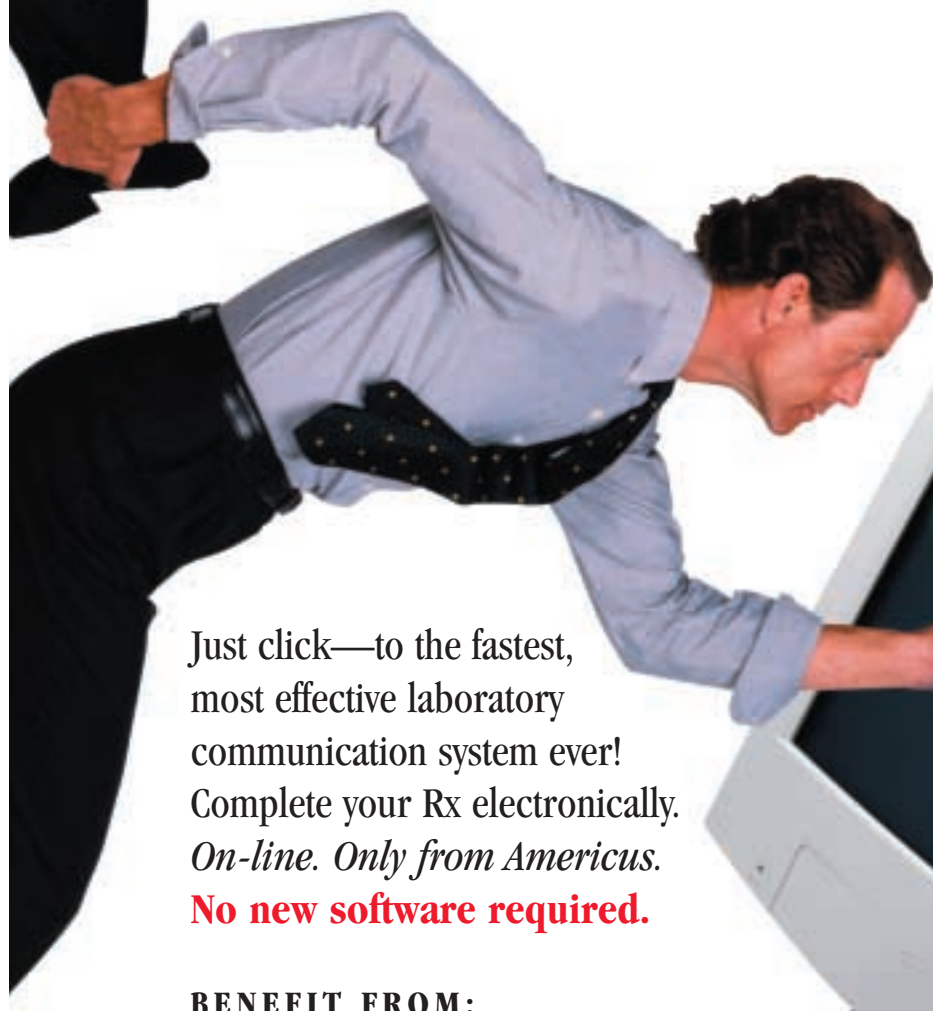
<sup>c</sup> Ultradent Products, Inc, South Jordan, UT 84095

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**Figures 8A and 8B**—Before and after treatment photographs showing a dramatic color change.

Neutral fluoride also can be used in the tray to reduce sensitivity. Dr. Goldstein adds, “Patients who have severe microcracks and large pulps may be especially sensitive.”

Before initiating any bleaching treatment, screening radiographs are taken to ensure that no periapical pathology is present and restorations are identified and charted. The most important elements are that a preoperative photograph is taken and one of the six ADA-approved 10% carbamide peroxide-containing products is used.

### Tooth Whitening and Restorative Procedures

The problem with all esthetic procedures is that the personal, subjective elements cannot always be accurately predicted because esthetic desire may change over time. Often, patients express a desire to have teeth so white that there is little chance of reaching their objective with in-office or at-home whitening alone. For those individuals, it may be more appropriate to initiate a restorative procedure (porcelain veneers or crowns).

Because porcelain veneers are thin and somewhat translucent, the underlying tooth color can “bleed through,” which lowers the value of the restoration. Trying to mask dark stains and still maintain some translucency can result in a significantly lower value than expected. Also, as teeth age and become darker, the darker color can be transmitted through the surface of the porcelain veneer. All of our experts have observed some surprising results with the in-office and at-home whitening used in conjunction with restorative techniques. They say it is difficult to predict with accuracy when the procedure will work exceptionally well and when it may only provide a moderate change. Therefore, they often will try some form of whitening of underlying tooth structure before initiating restorative efforts. In addition, Dr. Haywood’s research demonstrates that teeth with porce-

lain veneers can be successfully lightened in color with at-home carbamide peroxide whitening.<sup>44,45</sup> This is because the peroxide travels through the enamel and dentin, all the way to the pulp.<sup>46-48</sup> Therefore, the lingual surface allows the peroxide access to the internal aspect even though the facial aspects of the teeth are covered with porcelain.

### Patient Expectations

There will always be some patients who even the most experienced dentist cannot please. They present a challenge because their expectations are difficult to “pin down.” Dr. Blankenau believed that the “unhappy patient syndrome” can be avoided by knowing what they want in advance, but this may not be possible because often they do not know themselves. Some of these individuals present to our offices specifically for elective esthetic changes. If they have no track record in the office, patient management issues are unknown.

Dr. Goldstein is a staunch advocate of computer imaging, which allows esthetic changes to be simulated and viewed by the patient before treatment is initiated. He has determined three patient types and their reactions to imaging.<sup>49</sup> The first type can visualize the simulated image as a representation of their final results and are pleased with the simulated changes. The second type is not pleased with the simulated image or is very judgmental about it, which suggests that because their expectations are somewhat unrealistic, they may be difficult to please with the actual treatment. The third type cannot visualize how the image relates to their appearance. These individuals may represent the most difficult challenge because they cannot describe what they want and if they can, may not be able to recognize when it is achieved. Some patients also change their minds about what they view as successful treatment and have difficulty seeing a positive



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result, even if the dentist and staff can easily see it.

Dr. Haywood refers to a tooth color relationship that beauty consultants look for: if the brightness of the teeth is similar to the sclera (whites) of the eyes, then the value of the teeth is considered pleasing.<sup>50</sup> He agrees that this is subjective and patients need some visual guides to assist them in communicating their desires and expectations. For example, a photographic guide could assist dentists with this difficult issue. Patients would be able to rate their expectations by using a series of photographs to target their specific desires for the appearance of the finished results.

**T**here will always be some patients who present a challenge because their expectations are difficult to “pin down.”

Photographs should play a role in baseline records whenever elective esthetic changes are contemplated (Figures 7 and 8). After the treatment is complete, the patient's baseline conditions are lost. Unless baseline photographs are part of the patient records, there is no way to substantiate that a positive change has taken place. Drs. Haywood and Goldstein concur that when litigation is initiated by a patient after receiving esthetic restorative dentistry, it is much easier for the dentist to make a strong case if baseline, preoperative color photographs are available. Unfortunately, the need for baseline color images is not yet a standard of care, and it is rarely a part of undergraduate dental training. (*see Photographic Imaging for Esthetic Restorative Dentistry, this issue*)

### The Negative Impact of Whitening

Although a desire for teeth whitening brings many patients in to see their dentists who otherwise may not seek treatment, it also has some negative impact. The most obvious is that it is changing our standards for tooth shades and making it difficult to set any consistent shade objectives. Dr. Goldstein says it has created a false and misleading impression of what natural teeth look like. He says many people want the “porcelain toilet bowl” shade and the apparent computer-enhanced shades that they see in magazines, which are not rep-

resentative of actual colors found in natural, unaltered teeth. According to Dr. Goldstein, “the days when a B1 Vita shade was a very nice bright shade may be gone.” This will certainly impact the entire arena of restorative material shading, making it more difficult to match composite resins and porcelain restorations to the “new” tooth shades. Some of these products (for both composite and porcelain) are now available in “bleaching shades.”

Dr. Haywood notes that some of the “fringe patient complaints” that used to be commonplace in “TMJ patients” are beginning to emerge in the whitening patients. Therefore, if the inevitable complaint about a dentist's whitening treatment is going to occur, it will be more defensible if the dentist used ADA-accepted products that by definition have good science to back them up. According to Dr. Haywood, it is prudent that the dentist obtain an informed consent before bleaching treatment is initiated.<sup>51</sup>

### Conclusion

In the United States, whitening techniques have become mainstream services in many dental practices. One of the side benefits from the increased public interest in whitening is the motivation of some patients to seek dental care for the first time in many years. The innocuous nature of tooth whitening procedures may be perceived as nonthreatening even to phobic dental patients. This provides an ideal opportunity to educate these patients about good oral health and preventive care.

Research substantiates the safety and efficacy of six 10% carbamide peroxide formulations and one 35% hydrogen peroxide formulation, allowing them to earn ADA approval. Other more concentrated formulations are available that do not have ADA approval. New techniques are being advocated using a whitening agent and an energy source to promote “activation.” The energy sources vary from quartz halogen lights or plasma arc lamps to argon and CO<sub>2</sub> lasers. Currently, however, these new techniques lack the science to make definitive statements regarding safety and efficacy. Experts suggest that dentists take appropriate preoperative records, including color photographs and informed consent. If a patient is dissatisfied with treatment or develops an unexpected result or complication, the preoperative photograph(s) and the use of ADA-



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## Tooth Whitening: State of the Art 2000

### A Symposium on Current Issues in Tooth Whitening

**Date:** Sunday, November 14, 1999

**Time:** Registration 7:30 a.m.  
Lecture 8:00 a.m. to 5:15 p.m.

**Tuition:** DDS \$140 AUX \$90

**Location:** Loma Linda University  
Coleman Pavilion

**Credit:** This provider is authorized to confer 8 units of California continuing dental education credit.

#### OBJECTIVES:

To present current, validated information for practicing dentists on:

1. How tooth whitening works
2. The effectiveness of different whitening techniques
3. The safety of whitening agents

At the conclusion of this course, the participant should understand:

- How long has tooth whitening been available?
- Who are candidates for vital tooth whitening?
- What whitening methods and agents are available?
- Which whitening methods are safe and effective?
- What are the oral and systemic risks of tooth whitening?
- How long the whitening effect lasts?
- How to whiten dark stained teeth.
- How long can I whiten teeth?
- What effect does whitening have on hard and soft tissue?
- Is there an advantage to using "light" activated whitening agents?
- Is laser and high output light whitening more effective than tray whitening?
- What is the best method to whiten fluorosis staining?
- What are the chemical mechanisms in tooth whitening?
- How long does carbamide peroxide stay activated in whitening trays?
- What tray design is most effective?

- What ADA approval means.
- Is it important to use an ADA approved whitening product?

*Introduction - "Why Tooth Whitening"*  
James R. Dunn, DDS

*History and Overview of Current Status of Tooth Whitening*  
Van Haywood, DDS

*The ADA and Tooth Whitening*  
Chakwan Siew, PhD

*Degradation of Gel in Tray Whitening*  
Bruce Matis, DDS

*Present and Future Technologies of Tooth Whitening*  
Abdul Gaffar, PhD

*Tooth Whitening Agents - An Update on Safety*  
Yiming Li, DDS, MSD, PhD

*Long-term Tooth Whitening and Dark Stains*  
Ralph Leonard, DDS

*Tooth Whitening Methods - Which is Best?*  
Rella Christensen, PhD

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# Quiz 3

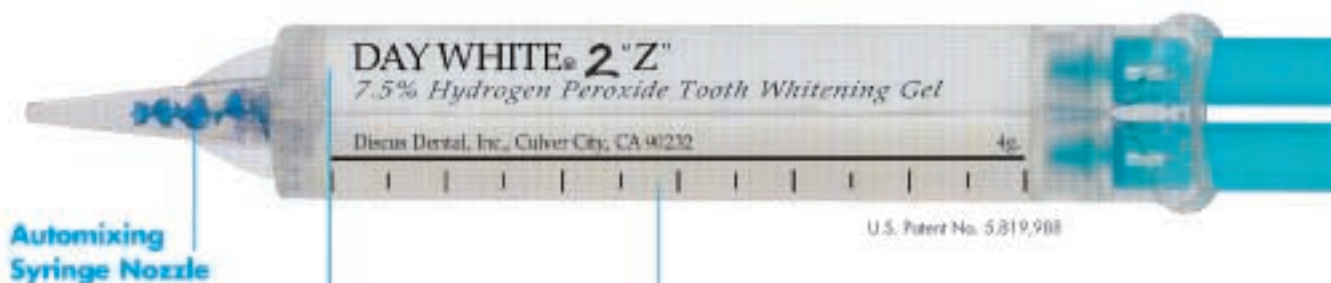
This article provides 1 hour of CE credit from Dental Learning Systems, Co., Inc., in association with the University of Southern California School of Dentistry and the University of Pennsylvania School of Dental Medicine. Record your answers on the enclosed answer sheet or submit them on a separate sheet of paper.

1. **The reason patients may not get the best results with OTC whitening products is:**
  - a. poor compliance with using the products.
  - b. patients may not recognize restorations.
  - c. nonvital and dark tetracycline stains show poor results.
  - d. all of the above
2. **What type of discoloration responds well to both in-office and at-home whitening?**
  - a. yellow
  - b. brown
  - c. gray
  - d. red
3. **The least successful type of discoloration to whiten is:**
  - a. multicolored or "banded."
  - b. light brown
  - c. dark yellow
  - d. pinkish red
4. **"Activated" peroxide formulations need an energy source, such as:**
  - a. argon lasers.
  - b. plasma arc lamps.
  - c. incandescent lamps.
  - d. all of the above
5. **Most negative clinical reports using carbamide peroxide are related to a concentration range of:**
  - a. 5% to 10%.
  - b. 16% to 35%.
  - c. 45% to 55%.
  - d. only hydrogen peroxide has negative clinical reports
6. **The most common side effect of whitening is:**
  - a. periodontal inflammation.
  - b. periodontal bleaching.
  - c. tooth sensitivity.
  - d. loss of taste sensation.
7. **The problem with all esthetic procedures is:**
  - a. they use too much chair time.
  - b. the personal, subjective elements cannot be predicted.
  - c. convincing the patient that it is needed.
  - d. justifying the cost.
8. **Porcelain veneers can be successfully whitened with carbamide peroxide because:**
  - a. porcelain is porous.
  - b. it flows between the porcelain and the tooth via the bonding agent.
  - c. the lingual surface allows the peroxide access.
  - d. there is a chemical reaction between the porcelain and the carbamide peroxide.
9. **After treatment is complete, the patient's baseline condition is lost unless:**
  - a. bitewing x-rays were included.
  - b. an informed consent was completed before treatment.
  - c. post-treatment shades are recorded.
  - d. baseline photographs were taken before treatment.
10. **Dentists can protect themselves from dissatisfied patients by:**
  - a. including color photographs in the record.
  - b. having patients sign an informed consent.
  - c. using ADA-approved products.
  - d. all of the above

*Please see tester form between pages 804 and 805.*



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