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.
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. 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 Van Haywood (unpublished data, May 1999), most dental schools are offering some form of at-home whitening and other esthetic options in their dental curriculum.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-
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" 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 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. 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
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).

### 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.

A number of new in-office whitening systems use some form of peroxide formulation “activated” with an energy source. Argon lasers, CO₂ 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™) produces the least postoperative sensitivity (Figure 5). (However, only StarBrite® 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. 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. Dr. Goldstein, however, refers to research showing that although heat produces changes (such as pulpal inflammation), these changes are reversible. However, activating the peroxide with a CO₂ heat source is not an ADA-accepted technique for vital teeth.

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. He referred to the fact that CO₂ 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.
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. Therefore, the fear that this process will eventually dissolve away the enamel surface is not supported by current research (Figures 6A and 6B). Double-blind clinical trials demonstrate differences in effectiveness as well as differences in sensitivity. 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.

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. 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, Ultradent, and Discus Dental, 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 toothpaste in a whitening tray to reduce postoperative sensitivity from periodontal surgery.

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%. 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.
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 porcelain veneers can be successfully lightened in color with at-home carbamide peroxide whitening. \(^{44,45}\) This is because the peroxide travels through the enamel and dentin, all the way to the pulp. \(^{46-48}\) 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. \(^{49}\) 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
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.\textsuperscript{50} 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.

There 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)

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 \textsuperscript{12}CO\textsubscript{2} 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-
approved products places the dentist in a strong position for having practiced well within or above the standard of care.—MJF

References