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The Science and Art of Tooth Whitening

A Peer-Reviewed Publication

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Educational Objectives

This course is intended to provide the dental professional with information on tooth whitening and current treatment options. At the end of this course, the dental professional will be able to do the following:

1. Know the types of staining that occur and the reasons for their occurrence, and be able to explain the differences between extrinsic and intrinsic staining
2. Understand the mechanism by which whitening agents work, as well as their safety and efficacy profiles
3. Know the common side effects that can occur as a result of tooth whitening
4. Know options available for management of potential side effects

Abstract

Tooth whitening removes intrinsic and extrinsic staining. Many tooth-whitening options are currently available, including in-office treatments and home-use products that can be office-dispensed or purchased over the counter. Each type of treatment has its own advantages and disadvantages. Management of potential side effects such as tooth sensitivity and gingival irritation must be considered and managed if necessary. Tooth whitening is safe, effective and desired by patients in our esthetically conscious society.

Introduction

Early modern attempts at tooth whitening occurred several decades ago with the introduction of hydrogen peroxide and abrasives in oral care products. In Roman times, the ancient Gauls, as well as other peoples, used urine (which contains urea) as a mouthrinse to whiten teeth.¹ Modern tooth-whitening products include in-office and home-use whitening treatments. In addition, many dentifrices are available offering moderate extrinsic whitening benefits. Mouthrinses and dentifrices containing hydrogen peroxide are also available, albeit at low concentrations and in contact with the teeth for only a brief period of time. Tooth whitening is popular in our esthetically conscious society to treat extrinsic and intrinsic staining, and has been found to be safe and effective.^{2,3,4,5} Patients may perceive their total treatment as more successful if they receive esthetic tooth-whitening treatment in addition to other treatments, such as orthodontics, that can result in esthetic improvements.⁶ Understanding the available options is important for patient education and recommendations regarding whitening procedures. Key differentiators in determining the type and the length of treatment that will likely be required include the type and severity of the stain present on/in the teeth and the individual patient's expectations and anticipated adherence to a whitening protocol.

Tooth Whitening and Extrinsic Staining

Non-developmental extrinsic stains on the surfaces of the teeth are due to factors such as tobacco use; drinking coffee,

tea and red wine; and eating spicy foods. Regular brushing with a dentifrice containing a mild abrasive helps remove stain on a daily basis. Tooth-whitening dentifrices typically contain fine, rounded abrasives and have a relative dentin abrasivity (RDA) level that can be above the RDA of non-whitening dentifrices. Some brands of whitening toothpastes are in fact less abrasive than conventional toothpastes. Whitening dentifrices gently remove superficial stains and smooth out the microscopic defects that alter light properties at the tooth surface and can result in a darker appearance. Dentifrice containing amorphous calcium phosphate (ACP) also has a whitening effect; it fills in the microscopic surface irregularities so that, as with the removal of surface irregularities, the teeth appear whiter. Recently, a silica-containing dentifrice with blue covarine has been studied and found to reduce tooth yellowness and increase whiteness immediately after brushing with it, and to effectively remove extrinsic stain.^{7,8} In addition, the tooth-whitening agents discussed below for the removal of intrinsic stain will simultaneously remove extrinsic staining.

Table 1. Extrinsic staining and treatment

Whitening dentifrices	Stain removal with fine, round abrasives
	Smoothing of superficial enamel defects
	ACP filler of superficial defects
	Silica-containing with covarine blue (study)
Carbamide peroxide/ Hydrogen peroxide	Whitening effect; bleaching of extrinsic stains

Tooth Whitening and Intrinsic Staining

Intrinsic stains (dentin staining) may be due to systemic conditions, use of medications after the permanent teeth have erupted (e.g., minocycline) or during their development (tetracycline), childhood diseases, infection or trauma to a primary tooth while the underlying tooth is developing, trauma to a permanent tooth or natural aging changes and the accumulation of stain that has entered the teeth.^{9,10} Each of these presents differently and treatment varies with cause.

Table 2. Types of intrinsic staining

Medication use during development of permanent teeth
Medication use following eruption of permanent teeth
Trauma to primary or permanent teeth
Abscess in primary tooth affecting underlying permanent tooth
Accumulation of stain permeating the teeth
Aging changes
Fluorosis/enamel defects

Traumatized Permanent Teeth

Teeth with a history of trauma and endodontic staining can gradually darken. One treatment option for darkened teeth is veneers (in mild cases) or crowns. A less invasive option for teeth that have been endodontically treated is to bleach the tooth using external bleaching, an internal “walking bleach” method, or a combination of the two. When using an internal bleaching method, the gutta percha is removed to the level of the bone past the CEJ and a leakfree coronal seal for the root canal placed. It has been reported that a high concentration of hydrogen peroxide that leaks into the gutta percha can lead to cervical resorption.¹¹ It is recommended that a glass ionomer cement be used and not a composite resin. There is concern that a bonded resin restoration will be difficult to control during placement and that resin will block and seal the dentin tubules and limit the peroxide’s action during the bleaching process. Internal bleaching may use hydrogen peroxide or sodium perborate that is retained in the chamber between visits. Custom-designed in-office 35% hydrogen peroxide whitener specifically designed for the “walking bleach” method is available (Opalescence Endo, Ultradent). Internal bleaching has resulted in success rates of up to 90%.^{11, 12, 13} An alternative is simultaneously bleaching using a standard 10% carbamide peroxide whitening agent externally in a tray and syringed into the open chamber in the tooth.¹⁴ A significant lightening of nonvital teeth has been found using an in-office whitening agent in endodontically-treated teeth, followed by use of externally applied at-home 10% carbamide peroxide.¹⁵

Figure 1. Nonvital “walking bleach” technique
Before



After



Trauma/Infection of a Primary Tooth

Infection in, or trauma to, a primary tooth, as well as childhood diseases such as measles, can result in the appearance of a white or mottled area on the permanent tooth. Some success has been achieved with these using a microabrasion/etching technique.

Tetracycline Staining

Tetracycline staining can result in greyish or yellow staining of the permanent dentition, either throughout the tooth or presenting as a band of discoloration, typically although not always in the gingival third of the teeth. Tetracycline stain is the most resistant to tooth whitening and typically requires the longest whitening treatment.¹⁶ Effective treatment over a period of one to six months has been reported with use of 10%–20% concentrations of carbamide peroxide. Ninety months post-treatment, whitening of tetracycline-stained teeth was found to be retained and stable.^{17,18} One study found that high concentrations of enzymes – specifically peroxidase and lactoperoxidase – increased the rate of whitening when used with carbamide peroxide.¹⁹

Figure 2. Tetracycline staining



Fluorosis/Enamel Surface Defects

Selective abrasion/microabrasion of superficial enamel defects combined with in-office or home-use whitening agents has also been found to be effective for the esthetic treatment of superficial enamel defects and dental fluorosis.^{20,21}

Figure 3. Fluorosis



Aging

Gradual yellowing of the teeth occurs during adulthood as a natural aging process and due to penetration through the

enamel of staining agents such as tobacco and red wine. In geriatric patients, an increased yellowing or greying of the teeth can be observed. This is partially due to internal changes and partially due to surface morphology changes. As the patient ages, the incisal edges wear and become less translucent, the enamel thins, and the dentin thickens, also resulting in a more yellow and a more dense appearance. The severity of such intrinsic staining varies. Staining can be successfully treated with in-office and/or at-home tooth-whitening agents.

The Chemistry of Tooth-Whitening Agents

Tooth-whitening treatments typically contain either carbamide peroxide or hydrogen peroxide. Agents containing enzymatic whiteners have also been introduced. Ultimately, carbamide and hydrogen peroxide work in the same manner. Carbamide peroxide breaks down into hydrogen peroxide and urea intraorally, and the hydrogen peroxide is responsible for the whitening effect. Ten percent carbamide peroxide would break down to 3% hydrogen peroxide and 7% urea. It is understood that the hydrogen peroxide works by diffusion through the enamel and oxidation, breaking bonds in the stain molecules. This results in the stain molecules becoming invisible to the eye, not in their removal from the teeth. Surfactants contained in the whitening agent also help to lift and remove surface extrinsic stains. In-office and home-use treatments have the same chemical mechanism of action; the main difference is the concentration of whitening agent used. In-office treatments are mostly hydrogen-peroxide-based, typically in the 25%–38% concentration range, and take one hour or less, while home-use products are typically 10%–16% and up to 35% carbamide peroxide. Home-use, low-level hydrogen peroxide whiteners are also available. The speed of whitening is in general related to the concentration and duration of treatment.²² Tooth-whitening treatments for maintenance of the whitening effect can be provided to counteract recurrence of staining over time.

In-office Treatments

In-office treatments typically use a higher concentration of hydrogen peroxide for a more rapid effect, and can achieve substantial whitening in 30 to 60 minutes. Some in-office treatments utilize a whitening light, with the objective of speeding up the whitening process. The use of a light is controversial, with some studies finding that it increases the effectiveness and speed of the procedure and other studies finding that it has no visible effect.^{23,24,25} Based upon the evidence to date use of light enhancement may be optional. Laser tooth whitening has also been studied for speed and efficacy and found to be effective.²⁶ Some concern has been raised regarding increases in intrapulpal temperature and increased tooth sensitivity with the use of lights and lasers for enhanced in-office bleaching.^{27,28} Light-assisted tooth whitening may also increase the risk of microleakage.²⁹ In-office, high-concentration whitening systems usually require the use of a rubber dam – or isolation dam – to protect the gin-

givae during whitening. Poor attention to placement of the rubber dam or isolation material can result in gingival irritation, burning and sloughing. In-office or office-dispensed whitening treatments ensure that the patient is provided with whitening for which he or she is a suitable candidate, and that the treatment is supervised (provided the patient returns for reevaluation). It also provides an opportunity to help prevent and treat transient sensitivity that can be associated with whitening treatments. Even though the research is not definitive on the use of light enhanced bleaching, the patient expects its use. If the light is not used, the patient will wonder if he or she is getting the proper care. Many look upon light enhanced bleaching as being important for patient satisfaction and marketing.

Table 3. Treatment options

In-office	High concentration; up to 38% hydrogen peroxide
	High concentration; up to 35% hydrogen peroxide with light or laser
	Laser
Home-use	
Office-dispensed	Custom tray plus up to 35% carbamide peroxide
	Standard tray plus up to 35% carbamide peroxide
	Disposable, single-use tray plus carbamide peroxide
Over-the-counter	Standard tray plus carbamide peroxide
	Strips with carbamide peroxide
	Paint-on whitening agent

Home-use Treatments

Home-use whitening treatments contain carbamide peroxide or hydrogen peroxide at a lower concentration than in-office whitening treatments. The results achieved are equal to those obtained with in-office treatments, although they take longer to achieve.^{30,31} Office-dispensed whitening agents are available that use custom-fabricated trays, standard trays or preloaded disposable trays.

Custom-fabricated trays are usually made with a thermoplastic material and are vacu-formed. These are molded over a model of the patient's dentition, with or without a spacer between the model and the tray. Using a spacer creates a reservoir for the whitening agent and results in less gel leakage from the tray during use. The tray is trimmed such that it covers the teeth for maximum contact of the whitening agent without impinging on the gingivae, and is either scalloped to mimic the gingival form or covers the gingivae. The comfort and success of these trays depends on a good impression and the fabrication technique. Advantages of custom trays are the intimate fit to the patient's arch and the limited amount

of gel that can leak out. Disadvantages include the laboratory/fabrication process, the need for the patient to dose the whitening agent correctly into the tray and the increased cost associated with fabrication of the tray. Standard whitening trays avoid the need for custom fabrication, thereby reducing cost and removing technique sensitivity as a factor. They are available in standard sizes and shapes only. The third option is disposable single-use trays. In addition to having no need for a laboratory process or technique-sensitive process, and being cost-effective, they are flexible, available in several sizes and easy to insert. Disposable whitening trays are available in several sizes. Single-use trays are convenient, preclude the need for tray cleaning or storing, tray loss by the patient is not a factor and they reduce the risk of cross-contamination. Preloaded disposable trays are already dosed with the whitening agent, removing the need for the patient to dispense the agent into the tray.

Figure 4. Home-use whitening products



Home-use, over-the-counter (OTC) whitening agents include whitening systems in trays, as strips and as paint-on whitening agents that do not require use of either trays or strips. One very important aspect of OTC whitening products is that the patient does not have a diagnosis for his or her tooth discoloration. Discoloration due to endodontic staining, caries, tetracycline staining or moderate fluorosis is not amenable to OTC whitening treatments. A disadvantage of whitening strips is that they typically extend over the six anterior teeth. Since they only partially cover the arch, only those teeth in contact with the strip will have the potential for whitening. Strips have been demonstrated to be effective in whitening.³² Strip whitening systems should not be used for patients with anterior teeth that are misaligned because

the strip needs to be in contact with the teeth. Home-use whiteners are effective to varying degrees, and depend on adherence to the instructions for use. However, it is difficult to monitor patients while these are working, and to prevent potential problems from arising. Their unsupervised selection and purchase can result in inappropriate use, with poor results or an increased risk of sequelae such as sensitivity. In addition, since these products are over-the-counter, the individual user may or may not have had an oral examination prior to using the whitener, or have received any required pretreatment (such as restoration of carious lesions). OTC agents offer whitening at a lower cost, and can be useful if used as recommended after consultation with a dentist and as a maintenance tooth whitener.

Bleaching Relapse

Bleaching relapse has been reported. With in-office bleaching, Clinical Research Associates reported relapse of 41% at 1 year.³³ For tray bleaching Haywood reports 26% at 18 months.³⁴ Bleaching can be maintained through the use of whitening toothpastes and bleaching toothpastes with yearly touch-up bleaching using a peroxide bleaching agent in the patient's custom fitted tray.

Potential Side Effects

Gingival irritation and tooth sensitivity can occur with the use of whitening treatments. Studies show that higher concentrations of carbamide peroxide (or hydrogen peroxide) are associated with an increased incidence of gingival irritation and tooth sensitivity.³⁵ It is important to note that patients should not start a whitening regimen if they have preexisting gingival irritations or gingivitis, but should wait until these have resolved. If a patient does experience gingival irritation, burning or sloughing during whitening, he or she should discontinue whitening until the problem has resolved. The tray, amount of whitening agent and other factors should be discussed with the patient and a determination made on whether to resume or modify treatment.

Tooth sensitivity is the most common side effect associated with tooth whitening.³⁶ It is believed that this is associated with dehydration,³⁷ though the removal of the smear layer and dentinal plugs by hydrogen peroxide may also play a role – this would result in fluid flow in the dentinal tubules in response to stimuli such as hot or cold foods and drinks (Brännström's Theory). With respect to in-office power bleaching, it has been observed that use of a diode laser rather than a light results in reduced tooth sensitivity and gingival irritation.³⁸ Tooth sensitivity with in-office whitening is patient and product dependent.

Preventing Sensitivity During Tooth Whitening

Tooth sensitivity during bleaching has been the highest reported adverse reaction. In clinical research studies, tooth sensitivity during bleaching either with at-home tray delivery

or in-office procedures has been reported in 18%-78% of patients.^{39,40,41} The sensitivity due to tooth bleaching in clinical observations suggest that it is transient with no long term effects.⁴² Some clinicians believed that this transient sensitivity was due to gingival recession. It has been shown that gingival recession is not a factor in the occurrence of tooth hypersensitivity when bleaching.⁴³ There was no significant difference in reported sensitivity while bleaching based upon the presence or absence of gingival recession. Use of a lower concentration of carbamide/hydrogen peroxide can help reduce or prevent sensitivity,⁴⁴ as may less frequent application (for instance, once versus twice daily, or every other day) and/or shorter applications. These options, however, result in slower tooth whitening and may therefore be unacceptable to some patients. Potassium nitrate and fluorides have been used as stand-alone agents, together and combined into whitening agents to reduce sensitivity. The use of fluoride may also result in increased microhardness and remineralization.

Use of Potassium Nitrate

Potassium nitrate in whitening agents works as it does in desensitizing dentifrices, i.e., by blocking the nerve transmission to the brain following stimulus of the dentinal flow and thereby preventing pain. Stand-alone 5% potassium nitrate gel and 1,000 ppm sodium fluoride has been used successfully in trays for 10 minutes before or up to 30 minutes before and after whitening to reduce sensitivity.⁴⁵ A desensitizer formulated for use during whitening treatments, containing 3% potassium nitrate and 0.11% wt. sodium fluoride (UltraEZ, Ultradent), has been found to effectively reduce sensitivity when used in the regimen. Tooth sensitivity was experienced for at least one day in 41% of the group using the desensitizer, compared to a significantly higher 78% of the group using a placebo.⁴⁶ Whitening formulations that incorporate potassium nitrate and fluoride have been found to effectively reduce sensitivity (Opalescence PF, Ultradent; NiteWhite ACP, Discus Dental).⁴⁷

Figure 5. Whitening products containing desensitizers

Potassium nitrate, fluoride

ACP



Use of Fluoride

High-level fluorides used as stand-alone treatments help prevent and reduce sensitivity during whitening. Neutral sodium fluoride varnish (5% sodium fluoride) reduces sensi-

tivity. A dentifrice of 5,000 ppm (1.1%) prescription-level sodium fluoride has also been used and has been reported to be effective. Use of 1.23% sodium fluoride gel in a tray after each whitening treatment can reduce the intensity of tooth sensitivity without affecting the effectiveness of whitening using 16% carbamide peroxide.⁴⁸ Stand-alone, syringe-delivery fluoride for use during whitening treatment is available (Flor-Opal, Ultradent), as well as office-dispensed carbamide peroxide with fluoride (NUPRO White Gold, Dentsply).

Fluoride in bleaching agents has been investigated for its influence on enamel surface properties. In vitro studies have found that enamel microhardness is significantly reduced during whitening treatments. It should be noted that the use of human rather than artificial saliva in in vitro testing reduces the risk of reduction in enamel microhardness.⁴⁹ One study found that 10% carbamide peroxide resulted in a microhardness comparable to that of unbleached samples when used in situ, and higher than that of samples bleached in vitro. Surface morphology changes and calcium loss were also higher in vitro. The investigators concluded that saliva may prevent demineralization by a whitening gel.⁵⁰ Nonetheless, there is concern regarding the potential for whitening treatment to result in diminished enamel microhardness or demineralization.⁵¹ The use of high-level fluoride varnish in whitened samples has been found to result in remineralization.⁵² Fluoride incorporated into 10% carbamide peroxide whitening agents has been found to result in less demineralization and to inhibit reductions in microhardness while having no influence on whitening, and to accelerate remineralization and recovery of enamel microhardness.^{53,54,55,56,57} Calcium peroxide and carbamide peroxide in combination have been found to recalcify incipient lesions and increase surface microhardness while simultaneously whitening teeth.⁵⁸

Use of Amorphous Calcium Phosphate

Amorphous calcium phosphate (ACP) may play a role in preventing tooth sensitivity. The addition of ACP into peroxide bleaching gels has been shown to decrease reported patient sensitivity.^{59,60}

Table 4. Potential side effects and treatment options

Tooth sensitivity	Adjust frequency and duration of whitening
	Fluoride and/or potassium nitrate as stand-alone desensitizer
	Fluoride incorporated into whitening agent
	Fluoride and potassium nitrate in whitening agent
	Amorphous calcium phosphate in whitening agent
Gingival irritation	Temporarily cease treatment until resolves
Decreased microhardness	Stand-alone fluoride
	Fluoride incorporated into whitening agent

Staining Susceptibility

There has also been concern that bleached enamel may be more susceptible to staining following treatment than before treatment. One study concluded that red wine staining susceptibility and uptake increased following 35% hydrogen peroxide bleaching, and another found increased enamel permeability following use of 35% hydrogen peroxide, regardless of whether light- or laser-activated tooth-whitening was provided.^{61,62} Another study, however, used quantitative light-induced fluorescence and found that bleached enamel was not at increased risk for staining.⁶³

The Role of the Hygienist

The dental hygienist is in an ideal position to advise patients on tooth whitening and care during hygiene appointments. Treatment options can be discussed with the patient such that patients are aware and pre-educated on what tooth whitening could do for them, before they see the dentist. Some patients will find rapid in-office whitening most acceptable, while other patients may prefer home-use products that are slower but less expensive, or else use of strips. These are all areas that the dental hygienist can explore with the patient, so that the dentist can immediately discuss the proposed treatment with the patient. It is often the expanded-function dental hygienist who will take the impression and make the trays for the patient if a fabricated tray is needed, and who will discuss the treatment regimen and follow-up with the patient. Furthermore, if desensitization or fluoride is required, the dental hygienist would provide this therapy. The dentist and dental hygienist can thus work together as a coordinated team, preparing the patient prior to tooth whitening and monitoring the patient during treatment.

Case Studies

Case Study: At-home Whitening

A thirty-five year old woman presented for tooth whitening. She had tried an OTC strip system and had tooth sensitivity, and had been disappointed with the results. The diagnosis was tooth yellowing due to her habit of iced tea ingestion (Figure 6). Impressions were made and casts poured with a fast setting dental stone (QuickStone, Whip Mix) so that bleaching trays could be fabricated during the same visit. The casts were trimmed to a horseshoe design with no palate or tongue space and the land area completely removed. This extreme cast trim allows for close fitting of the bleaching tray during the vacuum forming process. As recommended by the manufacturer, a light cured spacer was placed on the facial surfaces of the teeth to be bleached. A soft, vinyl bleaching tray was fabricated using a vacuum forming machine (UltraVac, Ultradent). The bleaching trays were trimmed with a scalloped design following the heights of the free gingival margin (Figure 8). For this case and based upon the patient's past history of sensitivity while bleaching, a 15% carbamide peroxide with fluoride and potassium nitrate for desensitizing during bleaching was used (Opalescence PF).

The bleaching kit was dispensed and the use of the bleaching trays and filling of the bleaching trays was demonstrated to the patient. The patient was instructed to wear the bleaching trays at night for 2 weeks. After two weeks the patient returned and was pleased with the result (Figure 8).

Figure 6. Preoperative



Figure 7. Vacuum formed tray



Figure 8. Postoperative result



Case Study: In-office Whitening

Some patients do not want the responsibility of using a tray for two weeks. For these patients in-office whitening is the perfect solution. In recent years, for maximum whitening, manufacturers have recommended one visit in-office and one week tray whitening. A patient presented for in-office whitening (Figure 9). Her past history was that she had received whitening trays but never followed through with at-home treatment. Still desiring tooth whitening, a one-visit, one-hour whitening appointment was set up. For the treatment visit, her teeth were cleaned and the gingival tissues of the teeth to be whitened were protected with the placement of a resin-based light cured barrier (OpalDam, Ultradent). A 38% hydrogen peroxide with potassium nitrate and fluoride, chemically activated whitening gel was selected

(Opalescence Xtra Boost PF, Ultradent). No light is needed for whitening with this, and its distinct red color aids in proper placement and allows for visualization of its complete removal after rinsing. Also, unlike premixed high concentration in-office bleaching gels, the syringe-to-syringe mixing guarantees chemical stability and full strength for each office visit use. Once mixed the whitening gel was applied to the teeth, agitating the gel with a brush for 5 minutes on the teeth (Figure 10). After 10-15 minutes the gel was removed by placing the high velocity suction tip and sucking the gel from the teeth. With the gel removed, the teeth were rinsed with an air-water spray. The teeth were dried and the whitening gel was reapplied 3 times. For some patients this treatment can be repeated three to five days later. The bleach should be refrigerated between visits. After in-office whitening the patient was pleased with the result (Figure 11).

Figure 9. Preoperative



Figure 10. Gel application to teeth



Figure 11. Postoperative result



Summary

Tooth whitening is valued by patients as a desirable esthetic treatment. Many treatment options are available for tooth whitening. It is important that the patient understand these options and be educated on the best treatment for his or her situation. Tooth whitening has proven to be safe and effective. The most common side effect is transient tooth sensitivity during the whitening process. With the introduction of whitening agents containing fluoride and/or potassium nitrate, tooth sensitivity has become more manageable.

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Author Profile

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is professor and director of operative dentistry at the University of Maryland Dental School in the Departments of Endodontics, Prosthodontics, and Operative Dentistry. He has lectured nationally and internationally on techniques and a selection of dental materials in clinical use and aesthetic restorative dentistry. He is a fellow in the Academy of Dental Materials and the Academy of General Dentistry, a member of the American Dental Association, the Academy of Operative Dentistry, and the International Association of Dental Research. He is on the editorial board of numerous publications. He is a consultant and clinical evaluator to more than 15 dental manufacturers. Dr. Strassler has published more than 400 articles in the field of restorative dentistry and innovations in dental practice, and he has coauthored seven chapters in texts. He has presented more than 425 programs, including most of the major programs throughout the United States, Canada, and Europe. Dr. Strassler has a general practice in Baltimore, Maryland, that is limited to restorative dentistry and aesthetics.

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Questions

- The ancient Gauls used _____ to whiten their teeth.
 - hydrogen peroxide
 - sea water
 - urine
 - none of the above
- Patients may perceive their total treatment as more successful if they receive esthetic tooth-whitening treatments in addition to other treatment.
 - True
 - False
- A key differentiator in determining the type and the length of treatment for whitening is _____.
 - the type and severity of staining
 - the individual patient's expectations
 - the patient's anticipated adherence to the whitening protocol
 - all of the above
- Extrinsic staining can be caused by _____.
 - tobacco use
 - drinking coffee, tea or wine
 - eating spicy foods
 - all of the above
- Extrinsic stain can be removed by _____.
 - whitening dentifrices containing fine, rounded abrasives
 - dentifrice containing amorphous calcium phosphate
 - whitening agents containing hydrogen peroxide or carbamide peroxide
 - all of the above
- Intrinsic stains can be due to _____.
 - medication use before or after permanent teeth erupted
 - trauma to a primary or permanent tooth
 - natural aging changes
 - all of the above
- Discolored root canal-treated teeth can only be treated by veneers or crowns.
 - True
 - False
- Whitening dentifrices can successfully whiten _____.
 - all stained teeth
 - tetracycline-stained teeth
 - teeth with mild fluorosis or similar mottled areas
 - none of the above
- Tetracycline stain is resistant to whitening and always requires an extended whitening treatment of at least one year.
 - True
 - False
- High concentrations of peroxidase or lactoperoxidase have been found to increase the rate of whitening when used with carbamide peroxide.
 - True
 - False
- The gradual yellowing appearance of teeth during adulthood _____.
 - occurs as a natural aging process
 - is due to penetration through the enamel of staining agents
 - is partially due to internal changes and surface morphology changes
 - all of the above
- Tooth-whitening treatments typically contain _____.
 - hydrogen peroxide
 - carbamide peroxide
 - enzymes
 - a and b
- Hydrogen peroxide breaks down to carbamide peroxide and urea.
 - True
 - False
- Tooth-whitening treatments work by _____.
 - diffusing through the enamel
 - breaking bonds in the stain molecules
 - helping to lift and remove extrinsic surface stains
 - all of the above
- In-office whitening agents containing up to 38% hydrogen peroxide are available.
 - True
 - False
- Home-use whitening agents always contain less than 10% carbamide peroxide.
 - True
 - False
- The speed of whitening is generally related to _____.
 - the concentration of the peroxide
 - the duration of treatment
 - the outside temperature
 - a and b
- Patients can expect use of a light during in-office whitening.
 - True
 - False
- In-office or office-dispensed whitening treatments _____.
 - ensure that the patient is being provided with whitening for which he/she is a suitable candidate
 - enable supervision of whitening treatment
 - provide an opportunity to help prevent and treat transient sensitivity if this occurs
 - all of the above
- Home-use whitening treatments take longer to achieve the same results as in-office treatments.
 - True
 - False
- Home-use and OTC whitening treatments are available using _____.
 - trays
 - strips
 - paint-on liquids
 - all of the above
- An advantage of a custom tray is _____.
 - the intimate fit to the patient's arch
 - the ability to limit gel leakage
 - the cost
 - a and b
- An advantage of a single-use, pre-loaded whitening tray is that _____.
 - no laboratory procedure is required
 - the amount of gel in the tray is standardized
 - there is reduced risk of cross-contamination
 - all of the above
- A side effect that may occur during whitening treatment is _____.
 - tooth sensitivity
 - gingival irritation
 - a reduction in microhardness
 - all of the above
- Tooth sensitivity during tooth whitening _____.
 - is transient
 - is the most common side effect
 - can be reduced using a lower percentage of hydrogen or carbamide peroxide
 - all of the above
- Potassium nitrate and fluorides have been used as stand-alone agents, together, and combined into whitening agents to reduce sensitivity associated with whitening treatment.
 - True
 - False
- Fluoride incorporated into the gel for whitening treatments has been found to result in _____.
 - less demineralization
 - inhibition of microhardness reduction
 - accelerated remineralization
 - all of the above
- Calcium peroxide and carbamide peroxide in combination have been found to recalcify incipient lesions and increase surface microhardness, while simultaneously whitening teeth.
 - True
 - False
- There are conflicting results on whether bleached enamel is more susceptible to staining.
 - True
 - False
- The dentist and dental hygienist can work together as a coordinated team, preparing the patient prior to tooth whitening and during the patient's tooth-whitening treatment.
 - True
 - False

The Science and Art of Tooth Whitening

Name: _____ Title: _____ Specialty: _____

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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 4 CE credits. 6) Complete the Course Evaluation below. 7) Make check payable to PennWell Corp.

Educational Objectives

1. Know the types of staining that occur and the reasons for their occurrence, and be able to explain the differences between extrinsic and intrinsic staining
2. Understand the mechanism by which whitening agents work, as well as their safety and efficacy profiles
3. Know the common side effects that can occur as a result of tooth whitening
4. Know options available for management of potential side effects

Course Evaluation

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

- | | | |
|-----------------------------------------------------------------------------------------------|----------------------|----------------------|
| 1. Were the individual course objectives met? | Objective #1: Yes No | Objective #3: Yes No |
| | Objective #2: Yes No | Objective #4: Yes No |
| 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 | |
| 5. How do you rate the author's grasp of the topic? | 5 4 3 2 1 0 | |
| 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. Do you feel that the references were adequate? | Yes No | |
| 9. Would you participate in a similar program on a different topic? | Yes No | |
| 10. If any of the continuing education questions were unclear or ambiguous, please list them. | | |

11. Was there any subject matter you found confusing? Please describe.
- _____
- _____
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12. What additional continuing dental education topics would you like to see?
- _____
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