

Quality Resource Guide

Effectiveness and Safety of Tooth Whitening Agents

Author Acknowledgements

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Educational Objectives

Following this unit of instruction, the dental team member should be able to:

1. Describe the mechanism of action of tooth whitening.
2. Discuss over-the-counter and in-office tooth whitening options and proper indications for each type.
3. Discuss the effectiveness of tooth whitening modalities.
4. Discuss the safety and proper use of tooth whitening.
5. Give appropriate recommendations to patients who seek tooth whitening treatment.

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The following commentary highlights fundamental and commonly accepted practices on the subject matter. The information is intended as a general overview and is for educational purposes only. This information does not constitute legal advice, which can only be provided by an attorney.

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Introduction

Agents capable of whitening teeth were initially discovered in the 1940s. The use of carbamide peroxide to treat dental diseases such as acute necrotizing ulcerative gingivitis (ANUG) and inflammation of the gingiva was noted to have a side effect of lightening the enamel.^{1,2} Tooth whitening products were introduced into the mainstream market in the 1980s due to an increased interest in esthetics and a desire by individuals to whiten tooth discoloration.³ Since then, the options for tooth whitening have become numerous and are available over-the-counter or through a dentist. Tooth whitening products come in numerous forms: gels, strips, rinses, gums, dentifrice, and paint-on liquids. Dental professionals play an essential role in effective and safe tooth whitening and counseling their patients on their options.

The goal of tooth whitening is to make teeth appear lighter or whiter. A tooth's color is influenced by its intrinsic color and extrinsic stains on the tooth surface.⁴ Extrinsic stains are caused by sources such as tobacco, coffee, tea, and chlorhexidine rinse. On the other hand, intrinsic color develops within the tooth structure, often due to aging, trauma, or medications.^{5,6} Tooth whitening products may help remove both intrinsic color and extrinsic stains from teeth.

This Quality Resource Guide, directed to dentists, dental hygienists, dental therapists, and all office support personnel, provides an evidence-based review of methods and materials designed to whiten teeth. In addition to providing background information about currently available products, it also examines issues patients should understand before seeking whitening treatment.

Tooth Whitening Mechanism of Action

The most common whitening mechanism of action is through a chemical mechanism. The active ingredients in most tooth-whitening products are carbamide or hydrogen peroxide.⁷ The two ingredients are similar, but each has unique properties (see **Table 1**).

Carbamide peroxide breaks down into urea and hydrogen peroxide. A 30% carbamide peroxide whitening gel equals 10% hydrogen peroxide. When applied to the teeth, hydrogen peroxide penetrates the enamel and dentin to interact with the chromophores in the tooth.^{8,9} Chromophores are colored organic or inorganic compounds within the teeth. The hydrogen peroxide in whitening agents breaks down and oxidizes the chromophores.^{7,9}

Teeth may also be whitened through the mechanical removal of extrinsic stains with abrasives. Many whitening dentifrices use both hydrogen peroxide and an abrasive to whiten teeth.¹⁰ Dental professionals can make more informed recommendations for their patients if they understand how each whitening product works (see **Table 2**).

Tooth whitening is generally a safe and effective procedure,^{11,12} but patients should have a dental exam before undertaking whitening for several reasons:

- Darkening of teeth may result from dental disease, such as caries or pulpal necrosis - tooth whitening would not be effective in lightening or treating this condition.
- Carbamide and hydrogen peroxide tooth whitening products are only effective on natural teeth – restorations, veneers, or crowns will not whiten, and the treatment may result in a negative esthetic result for the patient.¹³

Tooth Whitening Options

There are many options available to patients for whitening their teeth. Dental professionals must be knowledgeable about these options to provide their patients with appropriate recommendations. Tooth whitening options can be classified in several different ways. Over-the-counter (OTC) and in-office options will be reviewed.

Over-the-Counter (OTC)

Most OTC options for tooth whitening fall into one of four categories; dentifrices, strips, mouthrinses, or paint-on gels. The mechanisms of action and effectiveness of each category differ significantly.¹⁴ OTC products are available to patients at retailers and online. Dental professionals should educate patients about OTC tooth whitening options so they may be used safely and effectively. OTC products cost less to the patient, but have varying levels of effectiveness.

Dentifrices

The most common and accessible tooth whitening products are whitening dentifrices. Tooth-whitening dentifrices work through both mechanical and chemical methods. Dentifrices that whiten teeth through mechanical methods contain abrasive ingredients to remove extrinsic stains. Silica, calcium carbonate, dicalcium phosphate dihydrate, calcium pyrophosphate, alumina, perlite, and sodium bicarbonate are abrasive additives used in dentifrices.

Abrasive dentifrices are effective at removing extrinsic stains but do not whiten intrinsic color and, therefore, may have only a small effect on

Table 1 - Comparison of Carbamide and Hydrogen Peroxide⁸

	Carbamide Peroxide	Hydrogen Peroxide
Chemical Formula	CH ₆ N ₂ O ₃	H ₂ O ₂
Formulation	White crystalline solid	Colorless liquid
Concentration	10 - 35%	5 - 40%
Mechanism of Action	Breaks down into urea and hydrogen peroxide	Releases oxygen upon contact with the tooth

tooth whitening.¹⁵ These dentifrices should be cautiously used as highly abrasive dentifrices may cause enamel wear. In addition, they do not remove stains interproximally as efficiently as they do from facial and lingual surfaces.¹⁰ Charcoal dentifrices have become popular in the media and with consumers. Current evidence shows that charcoal dentifrices do not contribute to significant tooth whitening.^{13,16,17}

Other dentifrices contain small concentrations of hydrogen or carbamide peroxide. Generally, these dentifrices contain 0.1% to 5% hydrogen peroxide. The hydrogen peroxide in the paste is brushed onto the teeth and only has a short contact time with the teeth. Evidence shows that some whitening does occur with dentifrices that contain peroxides. However, the shade change is often very slight since the concentration of peroxide is low, and the time it contacts the teeth is minimal.^{10,15}

A final and less popular mechanism of dentifrice whitening is an optical approach. Using a blue covarine dentifrice deposits a thin layer of blue covarine pigment on the tooth. This layer modifies the visual appearance of the tooth to appear whiter but does not break down chromophores or stains.^{18,19} The evidence supporting the effectiveness of blue covarine on tooth whiteness is inconclusive. Some studies have found that it improves whiteness, particularly on teeth with a yellow color.^{20,21} Other studies have found no difference in the appearance of teeth after its use.^{18,19,22} Patients should be cautioned that they may not experience whitening effects when using blue covarine dentifrice.

Many whitening dentifrices contain both mechanical and chemical mechanisms to whiten teeth. Whitening dentifrices whiten teeth more than non-whitening dentifrices, but the results are poor compared to other forms of whitening.

Strips

Whitening strips are another popular OTC whitening option. The thin, flexible polyethylene strips contain a gel with hydrogen peroxide at varying strengths (5-14%).^{14,23} Strips are designed to be used at home, placed over the teeth, and manipulated to cover the facial and lingual surfaces. Typically, the strips are worn for 30-60 minutes per day over two weeks. Whitening strips are the most effective OTC whitening agent.^{11,14,24} Disadvantages to the strips are that they only cover a small number of teeth, they may not be adaptable to malposed teeth, and they may expose the gingiva to the whitening gel, causing irritation.²³

Mouthrinses

Whitening mouthrinses contain low concentrations of hydrogen peroxide (1.5%) and are intended to be swished by the patient.²³ Misuse of the mouthrinse can lead to gingival chemical burns or erosion.^{25,26} Whitening mouthrinses have been shown to have a poor ability to whiten teeth and should not be recommended as a treatment.^{27,28}

Table 2 - Tooth Whitening Options Summary

Product	OTC	In-Office	Mechanism of Action	Grade of Effectiveness	Other Information
Dentifrices	X		Both chemical and mechanical Mechanical if there are abrasive agents in the dentifrice Chemical if it contains hydrogen or carbamide peroxide	Small effect	Effective in tooth whitening, especially for dentifrices with peroxide compared to non-whitening dentifrices Whitening effect is small
Strips	X		Chemical Most contain hydrogen peroxide in 5-14%	Highly effective	Most effective OTC option for whitening
Rinses	X		Chemical Most contain a low percentage of hydrogen peroxide	Poor effect	Results are poor for tooth whitening, and misuse can cause other dental problems
Paint-on gels	X		Chemical	Poor effect	Results are poor for tooth whitening
Custom tray		X	Chemical	Highly effective	Dispensed in the office and used at home
In-office whitening (power whitening)		X	Chemical	Highly effective	Highly effective after one treatment, requires additional custom tray treatment to maintain

Paint-on Gels

Paint-on gels are painted onto the teeth with a brush or applicator. These products contain a liquid with carbamide or hydrogen peroxide. The whitening liquid is only in contact with the tooth for a short period after it is applied because of the action of the lips and cheeks. Because of this, the whitening results for paint-on gels are usually poor.^{23,29} The evidence to support the effectiveness of paint-on gels is low quality. The dental profession should be aware that whitening teeth with paint-on gel is not effective despite its convenience.

Whitening options available over-the-counter are numerous and are generally less expensive than approaches available in-office. Strips are the most effective OTC whitening option. Other OTC options produce minimal whitening results.

In-Office

Whitening can also be done in the office or with products distributed in the dental office. There are many available brands of whitening available to dental offices. In-office options are more costly, with in-office procedures being the most expensive. Custom tray and in-office (power) whitening are the most common in-office whitening procedures. A complete exam should be done prior to initiating whitening treatment. A prophylaxis prior to whitening is not required but will assist in extrinsic stain removal and is part of an overall treatment plan for oral health.

Custom Tray Whitening

Custom tray whitening is done by fabricating a custom tray for the patient and dispensing whitening gel for use at home. The fabrication of custom trays begins with an impression or digital scan of the patient's teeth, which is used to create a model of the dentition. The tray is made on the model with soft ethylene-vinyl acetate (EVA) and trimmed at the gingival margin to create scalloped edges that do not cover the gingiva.^{2,32} Some dental professionals create a reservoir space on the facial aspect of the tray when fabricating trays. Reservoir spaces have not been shown to increase the whitening in multiple studies.³⁰⁻³⁴ This step is not necessary for tray fabrication.

Hydrogen or carbamide peroxide gels in various concentrations can be used in custom trays. Hydrogen peroxide whitening gels break down faster and release most of the whitening ability within 30-60 minutes. It may be a good choice for patients who cannot wear a custom tray for an extended period. Carbamide peroxide breaks down slower, releases 50% of the whitening ability in the first two hours, and can be active for up to eight hours.³⁵ Carbamide peroxide may be a good choice for patients who plan to wear their custom trays overnight. Custom tray whitening is most successful when used with a 10% carbamide peroxide gel over several weeks or months of treatment.^{2,3,36} It is important to discuss the patient's expectations and desire for use to make the correct gel recommendation.

In-Office Whitening

Whitening can also be done in the office. This type of whitening uses high concentrations of hydrogen peroxide (25% and higher) and requires isolation of the gingival tissue. In-office whitening treatments offer a more immediate whitening effect, with results appearing after 30-60 minutes, and require less compliance from the patient.³⁷⁻³⁹ An in-office whitening treatment also requires custom tray whitening as a follow-up to maintain the achieved whiteness.³⁷ In-office treatments are also associated with higher rates of sensitivity.

Some in-office whitening systems include a light to activate the whitening gel. Research has shown that there is no difference in results for whitening systems that use a light versus those that do not use a light.³⁹⁻⁴¹

A common occurrence with in-office whitening is the rebound effect. The rebound effect is when there is a regression in whitening after the initial whitening procedure. This regression happens because tooth whitening causes dehydration of the tooth which makes the tooth appear whiter.^{36,37} Use of a custom tray whitening procedure after in-office whitening is suggested to maintain whiteness. The rebound effect should be discussed with patients when educating them about the in-office procedure.

In-office options for tooth whitening are highly effective and can be tailored to the patient's needs. Completing an exam and providing patient education are essential for successful tooth whitening treatment.

Safety

Tooth whitening treatments are safe if used according to instructions. The most common side effects are tooth sensitivity and gingival irritation.^{36,42} These can be managed during the tooth whitening process. To reduce tooth sensitivity, patients can use dentifrices or treatments containing potassium nitrate or sodium fluoride before, during, and after whitening treatment. This approach is efficacious and does not limit the success of whitening treatments.⁴³ Lower concentrations of peroxide have also been shown to reduce sensitivity.⁴⁴ However, sensitivity is a common side effect of whitening treatment, and patients should be advised that it may occur and can last up to 6 months after the whitening procedure.⁴⁵

Gingival irritation is the second most common side effect of tooth whitening. When whitening gels come in contact with the gingiva, they can cause inflammation, primarily when high concentrations of peroxide are used. In order to reduce the chance of gingival inflammation custom trays should be fabricated so the gel does not come in contact with the gingiva, and in-office whitening procedures must properly isolate the gingiva. OTC products are not customized and may result in more exposure to the gingiva.⁴²

Concerns have been raised about the carcinogenic potential of peroxide used for tooth whitening. There is no evidence that those who use peroxide-based whitening are at a greater risk of oral cancer.^{12,46,47}

If used according to instructions, tooth whitening is a safe dental treatment.

Effectiveness

Evidence shows that whitening strips are the most effective OTC tooth whitening product.^{11,24} All in-office options are effective in whitening teeth.

Whitening treatment may take longer depending on several factors. Patients with yellowing teeth have better whitening results than those with blue/gray discoloration. Blue/gray teeth can be whitened, but the treatment may take longer. Patients with intrinsic stains such as tetracycline staining may also require a longer (two to six months) tooth whitening treatment time to get the desired result. Some intrinsic discoloration may not respond to whitening treatment and clear expectations should be communicated to the patient and included in the consent form. Teeth with white spots may also appear whiter with whitening treatments, especially early on in treatment.³⁶ Tooth whitening should be delayed for 3 to 6 months after orthodontic brackets are removed and orthodontic bonding should

be done 2-3 weeks after in-office whitening procedures.^{48–50}

Whitening may also fade after the initial treatment. This is called a rebound effect. It is essential to educate patients that this is likely to occur and is normal. Even with rebound effects, patients can expect their whitening treatment to last one to three years, depending on personal and dietary habits.^{36,51}

In addition to completing an exam and providing proper education to the patient, dental professionals should document the shade of the teeth through photographs and a shade guide before whitening treatment begins. Further documentation of shade should continue through the treatment and during subsequent recalls.

Summary

There are multiple options for patients who seek out tooth whitening treatment. Before beginning whitening treatment, patients should have a dental exam completed to identify dental disease or other issues that could affect the treatment. There are numerous OTC options, and patients should be educated on the expected results and side effects of each. The most effective OTC option is strips. In-office treatments are effective at tooth whitening and allow dental professionals to provide correct instructions for use and monitor the whitening progress. The most common side effects of tooth whitening are tooth sensitivity and gingival irritation. Dental professionals should provide evidence-based information and recommendations to patients interested in whitening treatment. Documentation including photos and shade identification should be made before and after tooth whitening treatment. Setting clear expectations of tooth whitening outcomes is vital to successful treatment.

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POST-TEST

Internet Users: This page is intended to assist you in fast and accurate testing when completing the “Online Exam.” We suggest reviewing the questions and then circling your answers on this page prior to completing the online exam.

(1.0 CE Credit Contact Hour) Please circle the correct answer. 70% equals passing grade.

- 1. The primary goal of tooth whitening?**
 - a. To strengthen tooth enamel
 - b. To remove all intrinsic stains
 - c. To achieve a whiter appearance of the teeth
 - d. To prevent extrinsic staining
- 2. Which of the following is NOT a common extrinsic stain-causing agent:**
 - a. Chlorhexidine
 - b. Coffee
 - c. Aging
 - d. Tea
- 3. What is the active ingredient in the majority of tooth-whitening products?**
 - a. Sodium bicarbonate
 - b. Peroxide
 - c. Calcium carbonate
 - d. Silica
- 4. How does hydrogen peroxide in tooth-whitening agents work to whiten teeth:**
 - a. By mechanically removing extrinsic stains
 - b. By depositing a blue covarine pigment on the tooth
 - c. By creating a physical barrier on the tooth surface
 - d. By breaking down and oxidizing chromophores
- 5. Whitening of teeth requires:**
 - a. A high percentage of whitening solution
 - b. Contact with the tooth surface only
 - c. Contact with the tooth surface and time
 - d. Rinsing with mouthrinses
- 6. What is the primary advantage of in-office whitening treatment over OTC options?**
 - a. fewer side effects
 - b. more affordable
 - c. less tooth sensitivity
 - d. faster
- 7. Which side effect is commonly associated with tooth whitening treatments?**
 - a. Tooth sensitivity
 - b. Caries
 - c. Gingival recession
 - d. Enamel wear
- 8. How long can the results of tooth whitening typically last?**
 - a. One to three months
 - b. One to three years
 - c. Indefinitely
 - d. One week
- 9. Which type of stain is typically more challenging to whiten?**
 - a. Intrinsic
 - b. Extrinsic
 - c. Yellow
 - d. Tobacco
- 10. Which option would be best for patients who can only tolerate wearing a custom tray for an hour daily?**
 - a. Carbamide peroxide gel in a tray
 - b. Hydrogen peroxide gel in a tray
 - c. In-office power whitening treatment
 - d. OTC Paint-on whitening gel

