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C O V E R S T O R Y

IN OPALESSENCED OTHER
TOOTH WHITENING GEL

Use of tray-applied 10 percent carbamide peroxide gels for improving oral health in patients with special-care needs

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One of the most frustrating aspects of treating patients with special-care needs is coping with a general inability to maintain acceptable levels of oral hygiene. This is a universal problem that all dental practitioners have encountered in many

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kinds of special patient groups. Many times the dentist puts great effort into achieving an optimal

restorative result, only to see it fail in a relatively short time owing to the patient's inability to remove food debris and plaque from the teeth and gingiva. In addition, special-care patients may experience increased rates of plaque accumulation or be at increased risk of experiencing oral disease because of xerostomia, medications' side effects or a compromised immune system.

Poor oral health occurs in many groups of special-care patients for a variety of reasons. A number of factors contribute to this problem: impaired manual dexterity and physical challenges (such as in Parkinson disease,¹ stroke² and advanced age³); mental challenges resulting in an inability to cooperate with caregivers (such as in Alzheimer disease⁴ or psychiatric disorders^{5,6}); drug-induced, radiation-

Background. Plaque accumulation and resulting caries or periodontal disease is a frequent problem in patients with special-care needs. Tray-applied 10 percent carbamide peroxide (CP) is a tooth-bleaching agent that has positive effects on plaque, gingival health and caries.

Methods. The authors review the antibacterial properties of CP and the effects of CP on saliva, plaque, caries and gingival health. They also review tray fabrication options and techniques, application methods, safety and side effects. Finally, they address the challenges involved in and research needed regarding use of tray-applied CP materials in special-care patients.

Results. In their literature review and clinical experience, the authors found 10 percent CP delivered in a custom-fitted tray to be an effective treatment for caries in patients with compromised oral hygiene. Plaque suppression and caries control result from a CP-induced increase in salivary and plaque pH caused by CP's urea component, and from possible antimicrobial action via physical debridement and the direct chemical effect of hydrogen peroxide.

Conclusions. Tray-applied 10 percent CP may hold great promise for improving the oral health of many special-care patients, including elderly patients, patients with cancer and patients with dry mouth. Further research is needed to verify the potential benefits, specifics of treatment times and protocols and most cost-effective products for use in various patient groups.

Clinical Implications. Application of 10 percent CP in a custom-fitted tray may reduce caries by elevating the pH above the level at which the caries process can occur, in addition to debriding the teeth and improving gingival health.

Key Words. Carbamide peroxide; caries control; urea; peroxides; dental plaque; tooth bleaching.

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researched CP formulation. It decomposes into 6.5 percent urea and 3.5 percent hydrogen peroxide.²⁰ The urea further breaks down to ammonia and carbon dioxide via bacterial urease activity. Peroxide breaks down to water and oxygen via catalase and peroxidase enzymes. Carboxy polymethylene polymer (Carbopol, Lubrizol, Wickliffe, Ohio) is added to many commercial bleaching preparations because it increases the viscosity of the gel, increases contact time and slows the release of oxygen from CP.²¹ Adding carboxy polymethylene polymer to CP preparations extends the maximal oxygen release time from less than one hour to as long as 10 hours.²²

The antibacterial properties of CP are well documented. Bacterial growth is notably inhibited under peroxide stress²³ via hydroxyl radicals' reacting with bacterial membrane lipids and DNA, thus causing bacterial cell death. This has been demonstrated with both hydrogen peroxide-based and CP-based bleaching agents; in one investigation, increasing the size of the zone of inhibition of bacterial growth tended to relate to increasing hydrogen peroxide concentrations of the bleaching agents tested.²⁰

Others have demonstrated, by means of testing the zone of inhibition, that three 10 percent CP bleaching agents had a greater antibacterial effect than that of chlorhexidine.²⁴ In addition, in another study, artificially demineralized fissures (simulating carious lesions) inoculated with lactobacillus and then treated with 10 percent CP gel for two hours showed no subsequent growth of lactobacillus when plated. The authors of this study concluded that 10 percent CP penetrated the carious fissures and killed the lactobacillus.²⁵

Other researchers have shown that 10 percent CP inhibited growth of *Streptococcus mutans* and lactobacillus in vitro and reduced levels of salivary lactobacillus in vivo.²⁶

CARBAMIDE PEROXIDE'S EFFECT ON SALIVA, PLAQUE, CARIES AND GINGIVAL HEALTH

Ammonia resulting from CP degradation plays a significant role in modifying salivary and plaque pH. In the 1960s, investigators demonstrated that application of urea solutions to plaque resulted in an initial rapid rise in pH followed by a slow fall.²⁷ The increase in plaque pH was related to

urea concentration. More recently, 10 percent CP applied via the wearing of a custom tray resulted in a significantly increased salivary pH after five minutes of wear even though the CP products tested had an acidic pH (4.8 to 5.2).²⁸ Salivary pH remained elevated above baseline for the two hours of tray wear for the test period. The buffering effect of CP in custom trays extends to plaque pH; measurements of plaque pH during two hours of CP application by means of custom tray showed that mean final plaque pH was significantly higher than baseline plaque pH levels.²⁹ These results confirm the buffering effect of urea on saliva, because saliva's normal urea concentration has a significant role in elevating plaque pH and in negating the drop in plaque pH after sugar challenge.³⁰ Because the critical pH at which

Elevation of salivary pH by carbamide peroxide also allays fears that acidic bleaching agents may cause enamel erosion.

enamel and dentin begin to dissolve is 5.2 to 5.7 and 6.0 to 6.5, respectively,³¹ and the above-noted studies demonstrate elevation of plaque and salivary pH significantly above these levels, this presumably results in a lower rate of caries. Elevation of salivary pH by CP also allays fears that acidic bleaching agents may cause enamel erosion. It is important to note that

bleaching agents that contain hydrogen peroxide but not CP do not have these pH-elevating effects, because it is the urea released from CP that causes elevation of plaque and salivary pH. Thus, hydrogen peroxide-based agents would not necessarily have the same cariostatic benefits as demonstrated by CP-based agents.

These observations regarding urea, salivary pH and caries rates are apparent in a segment of the special-care population; investigators in a study involving children and adolescents with chronic renal failure (CRF) observed that these participants had a salivary urea concentration higher than that of normal healthy control participants or those who had undergone successful renal transplantation. Salivary urea levels strongly correlated with plaque pH, and the investigators proposed that elevated plaque pH in the participants with CRF accounted for lowered caries frequency.³² A similar study demonstrated a lower caries rate among a group of children with CRF, which the authors attributed to inhibited growth of *S. mutans* related to significantly greater mean salivary urea levels and salivary buffering capacity in the children with CRF.³³ These two



are all that is needed to fabricate the tray. Occasionally, thermoplastic trays may not be long enough to cover the molars completely. However, research has shown that 10 percent CP is effective as a bleaching agent well beyond the borders of the tray.³⁹ Additionally, the elevation of pH in the saliva may be enough to have an effect on caries activity.

■ Deliver the trays, providing detailed instructions for use to the patient or caregiver. The patient can wear the tray empty for one or two nights to enable him or her to adjust to it. When the patient is ready to use the tray, the caregiver or patient should place one drop of 10 percent CP solution in each tooth impression in the tray. Bleaching materials are ideal because their high viscosity maximizes contact time and minimizes leakage from the tray, and they can be worn and are effective for overnight application or for daytime use of a minimum of two hours. However, they can be cost prohibitive for long-term use. Over-the-counter (OTC) products (such as Gly-Oxide, Glaxo-SmithKline Consumer Healthcare, Pittsburgh, and CVS Antiseptic Oral Cleanser, CVS Caremark, Woonsocket, R.I.) are much more affordable but lack carboxy polymethylene polymer thickening agent and thus are not maintained in the tray as long as are dentist-provided bleaching agents. OTC products can be worn in the tray for a minimum of one hour. Whichever material is selected, direct the patient or caregiver to use only the amount that will cover the tooth surface without excessive leakage from the tray. Have the patient or caregiver demonstrate use before dismissal.

■ The tray is removed most easily by grasping it between finger and thumb at the most posterior aspect, gradually pulling it away from the teeth from one side to the other. Once removed, the tray should be rinsed with body-temperature running water or scrubbed gently with a soft toothbrush to remove all remaining bleaching material. Clinical experience and long-term bleaching studies involving recall visits have shown that CP application can be continued indefinitely as a way to suppress plaque formation and control caries in patients who have difficulty maintaining acceptable levels of oral hygiene.^{40,41} Researchers have suggested that a 30-second rinse with chlorhexidine followed by

overnight tray application of 10 percent CP may be an effective antimicrobial strategy, because CP kills lactobacilli⁴² and chlorhexidine kills *S. mutans*.⁴³ Another benefit of alternating CP and chlorhexidine is that CP can reduce or eliminate the black staining often associated with chlorhexidine use.⁴⁴

Some patients may not allow the making of impressions or the fabrication of thermoplastic trays. Although application time will not be as long as with tray application, there may be some benefit to application of CP by means of a conventional soft toothbrush, a foam brush (Toothette Oral Swabs, Sage Products, Cary, Ill.), or finger to teeth and gingiva (perhaps in the latter case by means of a textured finger toothbrush/gingival massager intended for infants). We noted earlier the documented improvements in gingival health and reduced plaque levels associated with manual application of 10 percent CP.

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SAFETY AND SIDE EFFECTS OF CARBAMIDE PEROXIDE

Daily application of 10 percent CP does not cause soft-tissue damage⁴⁵ and generally is accepted as safe, even considering that a certain amount of peroxide will be ingested as part of the procedure.^{46,47}

Extended periods of CP use for lightening of tetracycline-stained teeth have been studied and shown to be effective and safe.^{40,41} Whitening of tooth structure is an obvious consequence of CP use, and because restorations do not change color with bleaching, color discrepancies between tooth and restoration may occur. This may necessitate restoration replacement if the mismatch is unacceptable to patient or guardian.⁴² However, restoration replacement may be an acceptable risk considering the alternative of increased caries and potential tooth loss if this preventive aid is not used.

Another side effect, tooth sensitivity, may occur with CP application. Use of a soft tray material minimizes sensitivity resulting from orthodontic tooth movement or physical soft-tissue irritation. Sensitivity usually is minor and can be managed by prebrushing with potassium nitrate toothpaste (ProNamel, GlaxoSmithKline Consumer Healthcare) two weeks before CP application begins, brushing with the paste between periods of tray use, skipping a day or two of CP application after an episode of sensitivity, or using the paste or dentist-dispensed potassium nitrate gel (such as

UltraEZ, Ultradent Products, and Relief ACP Oral Care Gel, Discus Dental) in the tray for 10 to 30 minutes. Many CP formulations now include potassium nitrate to reduce the incidence of sensitivity.⁴⁶ Finally, CP use may result in an increased rate of calculus deposition, because calculus formation is more likely to occur at higher plaque pH levels.⁴⁹

FUTURE RESEARCH OPPORTUNITIES

Our recommendations for use of CP as a plaque suppression and caries-control agent are based on empirical clinical observations, bleaching studies, in vitro studies and only a few studies involving patients with special-care needs. To our knowledge, there are no recent clinical trials of the use of CP as a plaque suppression agent in a population of special-care patients. This type of study would be an obvious starting point for clinical investigation. Other potential areas of research include the following:

- the development of a more viscous preparation, available either OTC or from a dentist, that maintains tray and tooth contact longer than currently available fluid agents and that is cost effective;
- investigation as to whether daily application is required to achieve plaque suppression (it is possible that an initial period of daily wear to clean the teeth and raise the pH, followed by maintenance wear—for example, every other day or every third day—would be just as effective as daily wear);
- determination whether CP-facilitated plaque suppression and caries control would be applicable to special situations, such as in patients with a low platelet count to reduce gingival inflammation, and whether tray wear would cause minimal trauma and not stimulate bleeding as brushing and flossing might;
- comparison of a CP protocol with fluoride tray use in patients who have xerostomia both during and after radiation therapy.

Opportunities abound for clinical research in the special-care population. This research may involve protocol, dosage, frequency, duration and long-term outcomes.

CONCLUSIONS

The safety and effectiveness of tooth bleaching by means of application of 10 percent CP via a custom tray are documented thoroughly. An additional effect of such application is the suppression of plaque and control of caries. Plaque suppression

and caries control is a result of a CP-induced increase in salivary and plaque pH and possible antimicrobial action via physical debridement and direct chemical effect of hydrogen peroxide. The net result is a potential improvement in gingival health and reduction in caries activity. The application method requires little manual dexterity, which is an asset when considering patients with special needs. It still does require, however, the patient's or caregiver's compliance with the regimen and the patient's tolerance of impressions and tray wear. Many special-needs patients who otherwise cannot maintain acceptable levels of oral hygiene would fit into this category.

Much research remains to be completed to prove conclusively that this method is effective in the special-care population and to facilitate the development of cost-effective products for daily use. There is great potential, however, for this to be a simple and effective method of assisting special-needs patients in maintaining the best oral health possible. Although using this method of plaque suppression in the special-needs population will pose challenges, the application of creativity and resourcefulness displayed by most successful practitioners in this field has the potential for great benefits in improving the overall oral health of our patients. ■

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