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Back to the Future: The Medical Management of Caries Introduction

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ABSTRACT Based on the literature, a protocol was developed involving the application of 25 percent silver nitrate directly to cavitated caries lesions, immediately followed by 5 percent sodium fluoride varnish. This protocol results in arrest of active caries lesions. This minimally invasive treatment is well-accepted by patients and reduces anxieties related to dental office visits.

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Conflict of Interest Disclosure: Steven Duffin, DDS, is owner of Shoreview Dental, LLC.

In the late 1970s, it looked like the dental profession might be close to finding the cure for caries—the world's most prevalent disease.

Initiation of community water system fluoridation programs in the 1950s plus the introduction of fluoridated toothpaste substantially cut caries rates across many demographics in America. And there was talk of a caries vaccine that would be available in 10 years or so that would essentially eliminate the disease.¹

Thirty-something years later, in many ways, things have not changed that much. Even today, there is still talk about a possible caries vaccine that would be available in 10 years. In more affluent populations within the United States, caries is a relatively minor health concern. Multiple studies show that 20 percent of

the population have 80 percent of dental caries. Those high caries rate populations are characterized by lower socioeconomic status. Contributing factors for high disease rates may be increased exposure to dietary sugars, lower dental IQ, and ineffective oral hygiene practices.²

What has changed is that we now have a much greater awareness that despite good oral health for a large proportion of Americans, there are great disparities among different populations within the United States; some continue to have a high prevalence of caries, and a correspondingly high morbidity from the disease. This is especially true for the children of some racial and ethnic minority populations, as was pointed out in the Surgeon General's report on Oral Health in America in the years 2000 and



FIGURE 1. Initial setup for subsequent application of silver nitrate and fluoride varnish.



FIGURE 2A.

FIGURE 2. Transfer of 25 percent silver nitrate from bottle to dappen dish for subsequent application using a microbrush.

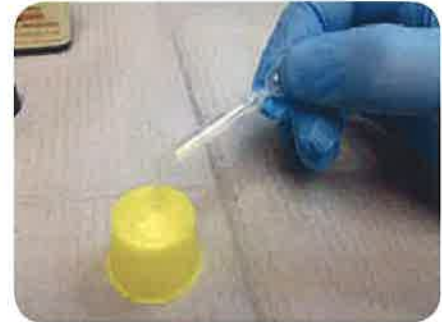


FIGURE 2B.

2012 and in a recent front-page article in the *New York Times*.^{3,5}

To try to eliminate these racial and ethnic oral health disparities, the response of the dental public health community has been logical: Do more of what has worked well for the more affluent populations. This has included increased emphasis on community water system fluoridation and use of fluoride-containing toothpaste, plus adding school-based fluoride varnish and sealant programs. Despite these laudable efforts, there is an increasing awareness that these methods are simply inadequate to provide protection for the children at highest risk—many of whom have such severe caries in the primary dentition (CIPD) that they require full-mouth restoration under general anesthesia.⁶ The belief that doing more of the same preventive measures will be successful in high-risk populations has not proven to be effective. Despite all of these public health efforts at prevention, disease rates continue to rise in these high-risk populations.⁷

In 2005, the author's clinic began treating 2,500 Medicaid patients in a locale where there had been very limited access to dental care. This location was overwhelmed with cases of children with advanced caries, many of whom needed to be scheduled right away for in-hospital restorations. Emergency calls from parents with children in dental pain seemed to be a nightly occurrence.

This frustration led to the search for a better approach to preventing and managing caries—especially for the young children—than the methodologies available at that time.

This comprehensive search was comprised of all of the literature on the microbiological etiology of caries and how it had been approached by some of the founding fathers of the modern dental profession, including W.D. Miller, G.V. Black, and Percy Howe. It was impressive that, beginning with Miller, all three had utilized the known antimicrobial compound, silver nitrate, in solution to arrest active caries.⁸ Black developed a protocol using multiple applications of silver nitrate directly to the lesion until it became hard and totally arrested.⁹ Percy Howe, first research director of the Forsyth Institute in Boston, spent much of his time treating the poor working class children of Boston in addition to conducting research projects and training dentists from all over the world. Howe was so well-known for his successful treatment of caries with silver nitrate that beginning in the 1920s many dental professionals referred to silver nitrate solution simply as “Howe’s solution.”^{10,11} In addition to these reports from the founders of modern dentistry at beginning of the 20th century, an extensive review of the more recent literature was formative in developing the silver nitrate solution followed by fluoride varnish protocol.^{2,12-21}

And then, sometime around the middle of the 20th century, the dental profession seemed to forget this history of successful management of caries using silver nitrate. Perhaps it was the increasing affluence of the country, increasing access to dental care, or decreasing acceptability of the black appearance caries develops once arrested by silver nitrate. Regardless, by the 1960s, silver nitrate was no longer being routinely used in the United States for control of caries, nor was any other antimicrobial product adopted to replace it.

Methods: Back to the Future — Adopting G.V. Black's Protocol in 2005

After a thorough review of the literature, Black's protocol of multiple applications of silver nitrate to control caries was implemented at the clinic. His experience and observations suggested that silver nitrate would be a safe and effective alternative to surgical restorations for the extensive lesions seen on a daily basis at this location.⁹ The question of possible silver nitrate toxicity has been well-addressed in four publications.^{10,22-24} In the quantities recommended by this protocol, toxicity from silver nitrate is not considered to be a concern. However, the possibility of an allergy to silver nitrate or silver ion compounds is a known contraindication and should be a consideration during the informed consent process.

After acquiring a bottle of 25 percent silver nitrate (25 percent silver nitrate and 75 percent purified water) from Henry Schein, Inc., (Gordon Laboratories) informed consent was obtained and a tiny amount was carefully applied directly on the child's caries lesions with a microbrush. When the child returned the following week, the lesions were dark and hard, and on subsequent visits it appeared that the active caries had been fully arrested.

Encouraged by this first success, use of this procedure was continued on other patients with active cavitated caries. Over time, this protocol was refined

to be more effective. Empirically, it appeared that applying fluoride varnish over the area treated with silver nitrate would have the multiple benefits of (a) preventing any contact of the silver nitrate with the soft tissue; (b) providing a protective layer to keep the silver nitrate from being washed away by saliva; plus (c) adding the benefits of fluoride.

The setup (FIGURE 1) and execution of this protocol could hardly be simpler. Before implementing this protocol, a tooth-by-tooth evaluation should be conducted to determine whether a sufficient layer of dentin remains between the carious cavitation and the pulp. Tools to assist in this

assessment include radiographs, presence or absence of symptoms in the tooth, color or surface texture of the lesion, and dimensions of the lesion. There should be a minimum of 1 mm of healthy dentin between the advancing front of the lesion and the pulp, which can be observed via radiographs. Do not apply if there are any signs of pulpitis or draining fistula, visual signs of pulp in the lesion (pink color), or if the cavitations are large enough that they likely border the pulp. Doing so prevents the silver nitrate from reaching tooth pulp in sufficient quantity to be painful and theoretically induce pulpitis. Following of this protocol has never resulted in pulpitis at the clinic.

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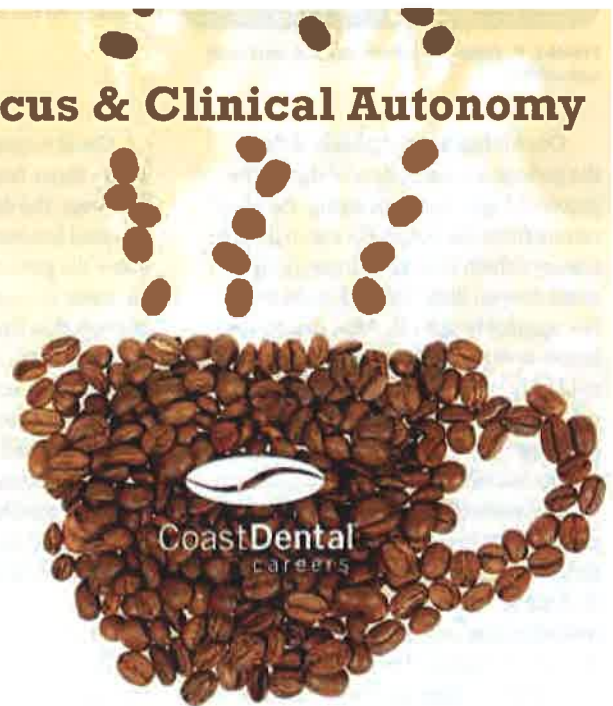
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FIGURE 3. Silver nitrate application, using a microbrush, to cavitated lesion.



FIGURE 4. Application of 5 percent sodium fluoride varnish over silver nitrate in cavitated lesion



FIGURE 5. "Little black scar" as a result of silver nitrate application to cavitated lesion.



FIGURE 6. Appearance of tooth after addition of tooth colored filling.



FIGURE 7. Radiograph demonstrating presence of secondary dentin after silver nitrate followed by fluoride varnish protocol.



FIGURE 8. Root cavity after silver nitrate/fluoride varnish treatment.

Once it has been established that the patient is a viable candidate for the protocol, begin by transferring the silver nitrate from the bottle, via micro pipette (Henry Schein item No. 2013051), to a small dappen dish (Henry Schein item No. 294487) (FIGURE 2). After drying the lesion, apply a single drop of approximately 17 μ l of 25 percent silver nitrate solution using a microbrush (Henry Schein item No. 1078831) to upward of eight caries lesions (FIGURE 3). Immediately cover with a 5 percent sodium fluoride varnish preparation; fluoride varnish used by the clinic was manufactured by Centrix (FIGURE 4). After all the caries lesions have been treated in this way, apply 5 percent sodium fluoride varnish to the rest of the child's teeth. Repeat silver nitrate solution and 5 percent sodium fluoride varnish application to all carious lesions at two, four, eight, and 12 weeks. Evaluate the state of caries arrest at each time interval. Discussion about restorative options with patient and/or parents is done at week 12.

Great success was observed in arresting active caries from this combination therapy. However, the dark appearance of the arrested lesions (FIGURE 5) was of concern to some the parents because the unfavorable cosmetic appearance. It was explained to parents that the silver nitrate kills all cavity causing bacteria, but in doing so it leaves a "little black scar" on the tooth, and that after four to six weeks, it is possible to place a tooth-colored filling without the need for local anesthesia (FIGURE 6). This explanation has been readily accepted by patients and parents, and the cosmetic concern is much less of an issue now.

Results

By the end of 2011, the clinic had treated more than 5,000 children with the silver nitrate followed by fluoride varnish protocol over the previous five years. Overall, these findings suggest that this protocol has achieved complete arrest of active caries in almost all the teeth for which it was used. This

clinical impression has been reinforced in situations where radiographs were taken of the treated teeth after completion of the protocol. There is clear evidence of new secondary dentin formation at the base of the lesion (FIGURE 7). The formation of secondary dentin following arrest of the lesion may explain why restorations can be subsequently placed without the need for local anesthesia. When a restoration is chosen, a full discussion about the advantages and disadvantages of the restorative materials glass ionomer, composite, and amalgam is held with the patient. Currently, the clinic has an assignment of approximately 2,500 Medicaid patients, of whom 80 percent are children. The first three years were spent working through the backlog of children with extensive, deep cavitations. At that time, the practice experienced an annual average of 20 full-mouth restorations under general anesthesia.

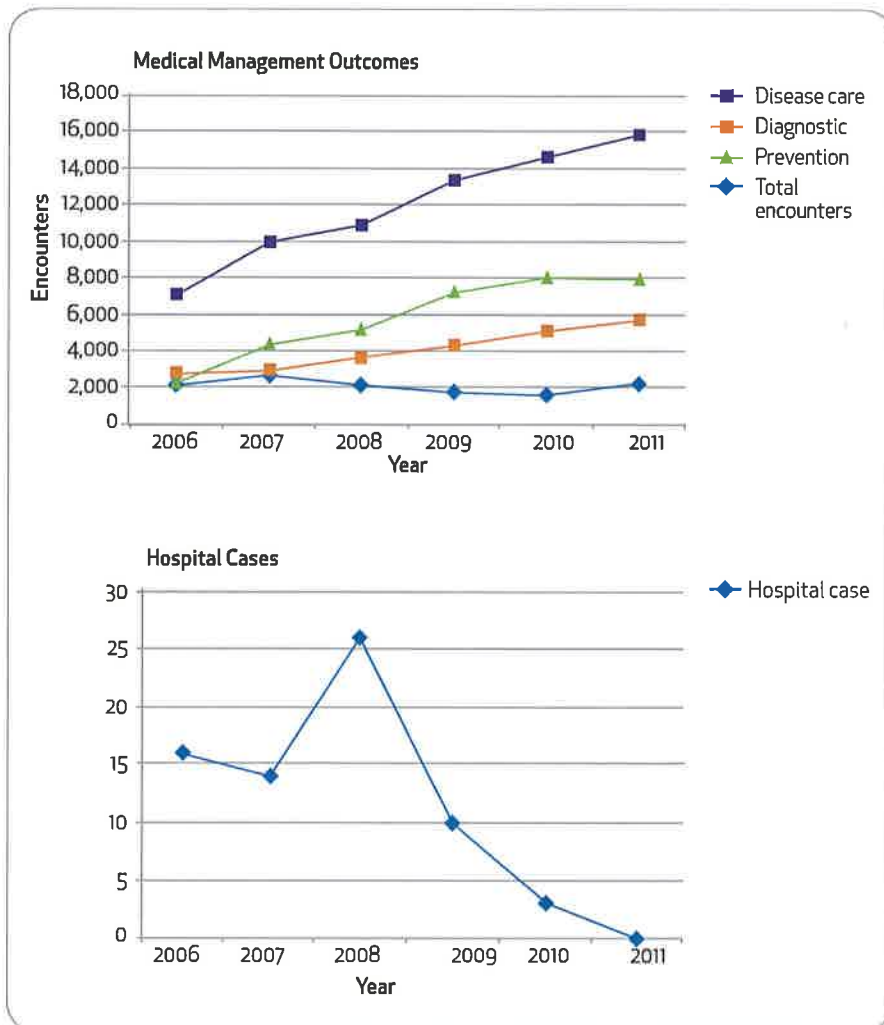


FIGURE 9. Medical management outcomes and hospital cases.

Since then, with increasing use of the silver nitrate followed by fluoride varnish protocol, each year fewer children have required operating room treatment. By 2011, zero children required in-hospital restorations. No significant adverse effects were observed while using this protocol. To try to confirm the apparent effectiveness of this treatment protocol, an outcome analysis of children in the caries management program was conducted. This analysis was difficult to perform because the protocol was implemented as clinical practice rather than research. In addition, the clinics

dental software was not designed to keep track of lesions that become arrested and do not need a restoration.

To maintain randomization, this analysis involved selecting every 10th chart from the clinic's patient records, from A to Z, and selecting children who had received the caries arrest protocol. This resulted in a sample of 106 children between 2-12 years of age; they had a minimum of 1 and mean of 5.2 follow-up visits within 30 months after the initial treatment. In these children, 578 caries lesions were identified at the date of initial examination. Upon review,

only seven of the 578 treated teeth subsequently required extraction due to continuing pathology. The clinic had continued to follow the status of the treated teeth in these children and found that for this random sample, 98 percent of the lesions remained arrested for up to four years after treatment.

Even though no outcome data has been obtained for the adults and senior citizens in this practice, it is the dentist's clinical impression that they are getting the same magnitude of benefit as the children. This is particularly important because these patients frequently use multiple medications leading to a high prevalence of xerostomia and increased rates of root caries. When older patients are assessed, many of whom are in long-term care facilities, and they are told that their root cavities can be treated with medicine that removes the need for immediate restorations, they are very agreeable to this plan (FIGURE 8).

Discussion

The clinic offers a comprehensive, family-based caries prevention program that is focused on primary prevention through good diet and hygiene and regular dental checkups.²⁵ However, when a patient presents with cavitated lesions, whether child or adult, after explaining the procedure and obtaining written consent, the silver nitrate followed by fluoride varnish protocol is used to prevent extension of the disease. The patient response has been extremely gratifying. There is a dramatic decrease of apprehension many of the patients feel due to their previous experiences of having restorations done while they were in pain from active lesions. It is often observed that other family members, including young children, watch the treatment so they too will be less apprehensive about future dental clinic visits.

The overall effect of using this medical management approach, when the primary prevention measures have not been successful, has substantially affected the nature of the practice. Although the clinic still has the same number of patients enrolled for services, there are now far more visits for prevention and diagnostic purposes than for restorations. **FIGURE 9** shows the breakdown by purpose of visit for adults and children between 2006 and 2011 and the number of hospital cases.

Summary

When primary prevention measures have not been successful, use of 25 percent silver nitrate followed by 5 percent sodium fluoride varnish results in arrest of advancing caries lesions. The elimination of active disease creates an improved environment for the placement of restorations. Since this protocol involves multiple patient visits, it provides the opportunity to more effectively treat the primary infection and better convey prevention messaging such as oral hygiene instruction and dietary counseling. These atraumatic patient encounters reduce their overall anxieties associated with dental care visits.

A tooth-by-tooth evaluation would be conducted to determine whether a sufficient layer of dentin remains between the carious cavitation and the pulp. There should be a minimum of 1 mm of healthy dentin between the advancing front of the lesion and the pulp, which can be observed via radiographs. Do not apply if there are any signs of pulpitis or draining fistula, visual signs of pulp in the lesion (pink color), or if the cavitations are large enough that they likely border the pulp. Doing so prevents the silver nitrate from reaching tooth pulp in sufficient quantity to be painful and theoretically induce pulpitis.

This protocol introduces a new technology to reduce the incidence of disease burden in children and adults with the highest need. Implementation of this protocol into the public health infrastructure could drastically reduce the need for treatment of extensive dental restorations under general anesthesia. While findings utilizing this protocol have been very positive, there exists research opportunities to better understand the mechanisms behind this highly effective treatment. ■■■■

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