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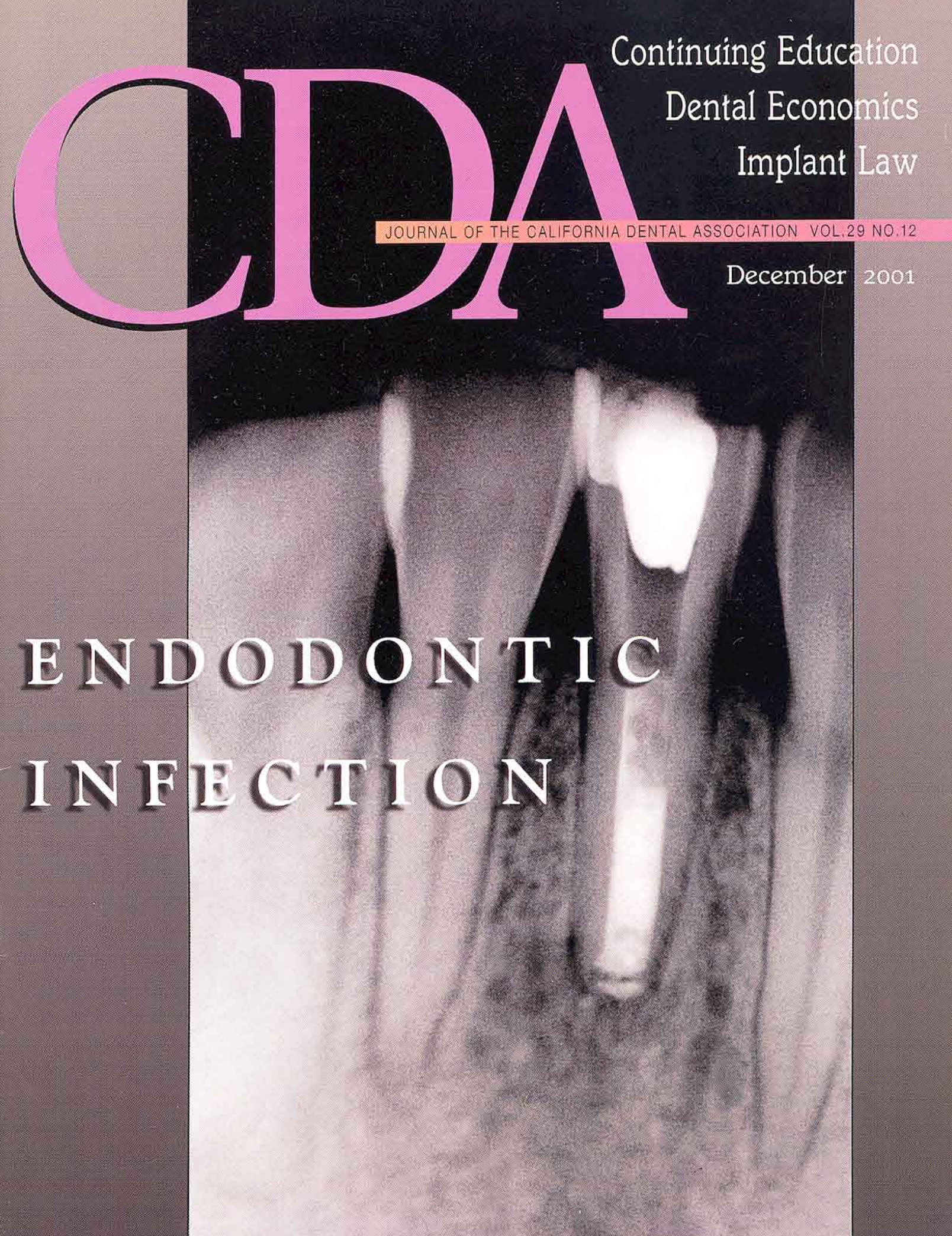

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FEATURES

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Of Professional Policy and Equity

JACK F. CONLEY, DDS

Those who have served in the leadership trenches of the California Dental Association, including service as a delegate to the American Dental Association House of Delegates, will agree on at least one important observation, which prevailed once again at the recent ADA House of Delegates session in Kansas City.

Due to the diversity in the demographics of the profession, the geography of California, and to many workforce-related factors, California is often the first district of the American Dental Association to see the need for change in organized dentistry's policies. New programs, policies, or resolution of problems are necessary to meet the changing needs of the profession and the public.

We have seen this reality as an ever-present challenge to each recent California delegation as it prepares to seek changes that are believed to be in the best interest of not only California dentists, but also the profession at large. California delegates frequently have been frustrated when delegates from other districts have remained unconvinced that a problem facing dentistry in California requires a change in ADA policy or a new program. Since CDA membership represents 18 percent of the total ADA membership, it would seem that colleagues in organized dentistry in other states might be more receptive to resolving issues that could have implications to members or potential members in their state. In our experience, that has not been the case.

Of considerable concern to this observer were some of the arguments advanced in support of maintaining the status quo at the recent House of Delegates. For example, a modification of ADA guidelines on licensure sought by the California delegation, which would have encouraged consideration of credentialing and mobility of foreign-trained graduates, failed to be approved. A major argument advanced by those opposing new language that would allow mobility of practitioners who had a clean and safe record of practice for a minimum of five years was that such a change would lower the traditional educational standards of the dental profession. The notion behind this specious or deceptive argument seemed to be that graduation from an accredited dental school (or the lack of it) in the practitioner's past was a more important evaluation criterion than a dentist's record of practice and postgraduate achievements in dentistry during his or her career.

In the fast-changing dental profession of today, after five, 10, or 20 or more years of practice, it is unlikely that the school of graduation is any longer a valid criterion for assessing a dentist's reputation or record of practice. Yet, 55 percent of the delegates defeated the California resolution that sought to modify ADA policy to favor the mobility of a qualified practitioner from California or any other state who had passed National Boards Part I and II, had passed a state or regional licensure examination, and had practiced with a good record for a minimum of five years. Denying the freedom of movement to qualified

foreign-trained graduates with a good practice record is neither equitable nor a fair standard in the United States of America today. A foreign-trained dentist now practicing in California (or Hawaii) is unable to move to another state, even though that state recognizes licensure by credential, unless one of two things occurs:

- The practitioner leaves practice and goes back for a supplementary predoctoral education program of at least two years at an accredited U.S. dental school, OR,
- A state changes their regulations to permit credentialing based upon a qualifying practice record of five years or more. (This was the modification of ADA policy under consideration at the House.)

For now, let's put the frustration that CDA delegates experienced in a strong attempt to educate other colleagues on this issue aside and look at the real impact of the ADA guidelines or policies on licensure.

ADA guidelines on licensure have traditionally placed state's rights to determine licensing standards ahead of any association policy considerations. The ADA Board of Trustees, to whom many delegates look for development of their attitudes and positions on various issues, has recognized accredited dental education as the standard for initial licensure and for licensure by credential. ADA policies allow "state boards sufficient latitude to fulfill their legal duty to determine appropriate educational qualifications of applicants for dental licensure from other jurisdictions."

Thus, even the current ADA policy that provides for licensure by credential is not enforceable in states; and the changes sought by the CDA delegation, even if they had been approved by the House, would probably not have changed the inequity previously described -- at least immediately.

The net effect of ADA policy, when it comes to licensing can be best described as an instrument useful in bringing about a change in attitude -- both within the profession and eventually within state legislatures and regulatory boards. Policies can "encourage" and "urge" change but cannot mandate it within state jurisdictions. An attitudinal change could take years in some states, as there are so few foreign-trained dentists in some locales that legislators or boards are unlikely to feel the need to make a change. At a time when unity and inclusiveness are widely discussed throughout the land, these disparities in professional and public policy are unfortunate. This is the pessimistic view.

On the positive side, the efforts of the CDA delegation this year to educate other constituencies was productive and hopefully advanced the cause. Even the House reference committee that studied the matter recommended adoption of an amended version of the CDA proposal. That was a major sign of progress.

This issue will be back. More colleagues must be educated to the need to achieve equity in licensure for all of the practicing profession. A new attitude will build within organized dentistry that will eventually convince state legislators and regulators that revised licensing guidelines are essential to providing improved access to care.

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USC Moves to Problem-Based Learning

By Janyce Hamilton

Six years after the University of Southern California's problem-based-learning pilot program was initiated, people are still saying "Huh?"

The USC School of Dentistry transitioned to the innovative problem-based-learning approach to encourage students to become engaged in their learning and develop critical thinking skills essential for success in dental practice. Traditionally, the first few years of dental school involve sitting through disconnected lectures presented in multiple courses on different themes. Lectures introduce curricular content that students are to memorize and master for subsequent application to patient care, however actual clinical application may not occur for months to years. Unfortunately, the delay from passive learning to active implementation challenges retention in even the brightest students.

In the problem-based-learning changeover, USC joins the ranks of Harvard Medical School, Harvard School of Dental Medicine and Indiana University, which make problem-based learning a significant component of their education programs. USC's Medical School is currently transitioning to the format as well.

"The traditional approach involves lectures often unrelated to one another, and few other overarching themes exist that allow the students to relate physiology to biochemistry to other disciplines," said Malcolm Snead, DDS, PhD, professor of USC School of Dentistry, Center for Craniofacial Molecular Biology. Dr. Snead is one of the faculty actively involved in problem-based-learning program development and student facilitation.

Instead of waiting until the last two years of dental school to give students real-world problems to solve, problem-based learning is done throughout all of dental school for all courses and involves no scheduled lectures. The problems serve as the vehicle for learning for all curricular content, including both the basic and clinical sciences.

During freshman year, the application of content learned through the cases is applied as the student progresses from simulator to the clinic. The student provides care and completes clinical procedures that are at his or her level of competency, such as examinations, data collection, and initial periodontal therapy. Right from the beginning, this approach to learning serves as an engaging means of learning "the basics" and how these pieces of knowledge fit into the puzzle of a case scenario. The problem cases naturally lead to the delivery of dental care, and the sequence of learning is established so that the students progress to more-complicated therapies in the later years of dental school. For example, a senior would do complicated restorative, prosthodontic, and periodontal procedures.

This problem-based-learning approach is often likened to the process that a clinician follows when working up a patient.

The typical steps of problem-based learning include:

- The facilitator provides a small group of students with a case scenario that includes a series of signs and symptoms exhibited by a patient.
- The students first establish the facts of the case and then brainstorm hypotheses in analyzing the facts, thereby determining a course of investigation. This course of investigation involves the students formulating their learning needs so they further understand the facts, their hypotheses, and the mechanisms behind the signs and symptoms. In doing so, they go to the literature and acquire the knowledge needed to understand the patient's presentation (a skill development critical for lifelong learning);
- The students meet and review the facts based on their newly amassed knowledge, revising and rejecting ideas and establishing new lines of investigation to further expand their knowledge base.
- The cycle of learning continues when the facilitator provides the group with an additional page of information about the case scenario, from which the students begin to triage their ideas, link facts, and identify new learning needs. The cycles of critical thinking, mastery of new material and application to the problem occur continually.

This process of learning integrates all the content mastered by the student and provides a high degree of relevance through the application to a patient's condition. One result of the problem-based-learning process can be summed up by the "high-fives" students sometimes give each other when they discover that they have successfully diagnosed and identified treatment for solving the patient's problem.

The problem-based-learning students begin clinical experiences in the first trimester and continue to increase the number of clinical experiences per week throughout the four years of the curriculum. Compared with students in the traditional DDS program at USC, the problem-based-learning students have more than 50 percent more clinical sessions during their four years in school. All clinical experiences occur at the student's level of clinical competency since they enter the clinic to perform a procedure once they have demonstrated preclinical competency. Early clinical experience is a valuable incentive for students and helps them to appreciate the rationale for the content of the curriculum and the application of the basic and clinical sciences they have mastered.

The problem-based-learning students meet the same set of clinical competencies as all other graduates of the school. Currently, there are 24 competencies established by the faculty that define the abilities of a new dental graduate. These competencies require both breadth and quality of clinical experience as important criteria to establish student ability. There is little difference between the criteria used to establish graduation competency for either the traditional or problem-based-learning programs.

According to Charles Shuler, DMD, PhD, associate dean of student and academic affairs, the problem-based-learning format is breeding a new crop of critical thinkers who investigate the evidence presented to them.

"Analyzing the student achievements, it has been shown that the students performed at a much higher level on standardized tests and had a much greater interest in learning," Shuler said.

Traditional naysayers resisting the changeover to problem-based learning at other dental schools claim its flaw is the potential for "gaps in knowledge" because students may not address some issues in a case. Countered Snead: "For that reason, we employ cases that overlap learning themes," which he claims results in reinforcement in detail and refined knowledge, correcting misunderstandings.

The case scenarios chosen are in fact carefully selected to, at minimum, equate learning imparted through a traditional lecture, but minus the yawning, bobbing heads.

In fact, more than 20 U.S. dental schools, and several international dental schools, have contacted USC for more information on problem-based learning. According to Shuler, whose office has played a central role in the transition, several visiting faculty have sat in to observe the process and learn the teaching skills of being a problem-based-learning facilitator.

Snead said practicing dentists who have observed the problem-based-learning process say it is identical to the process they use in their practices every day.

NIDCR Gives UCSF $11 Million Grant

The University of California at San Francisco School of Dentistry has received an $11 million grant from the National Institute of Dental and Craniofaial Research to study eliminating painful, difficult, and expensive treatments for tooth decay in children as young as 1 year old. Aimed at children from environments with a high incidence of dental problems, the project aims to eventually find results that will help all young people maintain healthy teeth and mouths.

Jane A. Weintraub, DDS, MPH, Lee Hysan Professor of Oral Epidemiology and Dental Public Health, will assume additional duties as director of the new Center to Address Disparities in Children's Oral Health, based in San Francisco. The center will collaborate on a seven-year program with the San Francisco Department of Public Health and the San Ysidro Community Center, located at the Mexican border south of San Diego. An additional 12 institutions along the West Coast will participate in the work of the center.

"This is the first time that the NIDCR has funded a project so closely networked with community organizations," Weintraub said.

A California survey of children showed that 33 of every 100 children in Head Start programs had dental caries, with even higher rates among children of Asian heritage (44 of every 100) and Latino children (39 of every 100).

"The prevalence of early childhood caries is particularly high among some racial and ethnic minorities and low socioeconomic groups," Weintraub said. "The primary goals of the center are to understand, prevent, and reduce oral health disparities among young children, with a primary focus on preventing early childhood caries."

A secondary focus of the center is to understand the interactions between the oral health and medical delivery systems that an affect children's oral health, Weintraub explained.

Life Expectancy Hits New High in 2000

Life expectancy for the U.S. population reached a record high of 76.9 years in 2000 as mortality declined for several leading causes of death, according to preliminary figures from a report released by the U.S. Centers for Disease Control and Prevention.

"Americans on average are living longer than ever before, and much of this is due to the progress we've made in fighting diseases that account for a majority of deaths in the country," Health and Human Services Secretary Tommy G. Thompson said.

"But we can do even more by eating right, exercising regularly, and taking other simple steps to promote good health and prevent serious illness and disease."

The estimates are featured in a new CDC report, "Deaths: Preliminary Data for 2000," an analysis of more than 85 percent of the death certificates recorded in the United States for 2000.

JAMA Articles Available on Biological Weapons

In response to the recent concern about biological terrorism, the Journal of the American Medical Association has made the full text of articles on this subject available free to the public.

Beginning in May 1999, JAMA published a series of articles that outlined recommendations for medical and public health professionals following the use of five kinds of biological weapons against a civilian population -- smallpox, anthrax, plague, botulinum toxin, and tularemia. These articles are by the Working Group on Civilian Biodefense and can be found on the JAMA Web site (www.jama.com):

- Anthrax as a biological weapon. J Am Dent Assoc 281:1735-45, 1999.
- Smallpox as a biological weapon. J Am Dent Assoc 281:2127-37, 1999.
- Plague as a biological weapon. J Am Dent Assoc 283:2281-90, 2000.
- Botulinum toxin as a biological weapon. J Am Dent Assoc 285:1059-70, 2001.
- Tularemia as a biological weapon. J Am Dent Assoc 285:2763-73, 2001.

The report shows that age-adjusted death rates continued to fall for heart disease and cancer, the two leading causes of death in the United States, which account for more than half of all deaths in the country each year. Mortality from heart disease has declined steadily since 1950, while cancer mortality has been on the decline since 1990.

In addition, the preliminary infant mortality rate in the United States fell to its lowest level ever in 2000 -- 6.9 infant deaths per 1,000 live births, down from a rate of 7.1 in 1999.

* The report can be found online at the CDC Web site: www.cdc.gov/nchs.

New Material Can Reduce Caries

Researchers at the National Institute of Standards and Technology are developing a material using amorphous calcium phosphate that can prevents dental caries from forming.

Amorphous calcium phosphate has been shown to cause new mineral growth in cow dentition, according to Joe Antonucci, a polymer chemist at the institute. He said the new material can regenerate small areas but not large ones.

"We don't think it's going to work with a large cavity," he said, "because it only repairs small holes and isn't as strong or hard as conventional filling materials such as ceramic and glass."

But the material may be used as a liner or base for another filling material. That could help to prevent secondary caries from forming around fillings. Also, amorphous calcium phosphate may find a role in the use of orthodontics to keep caries from forming where appliances touch teeth.

Beyond dentistry, Antonucci said, the material may be useful for delicate bone repair such as facial reconstruction. "Long term," he explained, "we envision our material in tissue-engineering applications where you want to remineralize defects in bone with injectable, biodegradable, polymer-based composites."

Study Shows Fee-for-Service Preference

Patients enrolled in fee-for-service dental plans are better satisfied with their dental care than patients in capitation plans, a new report shows.

These findings are consistent with the American Dental Association's long-held policies about the advantages of private-practice-based, fee-for-service dentistry.

Although managed care had already gained prominence within the U.S. health care system by the early 1990s, increased concentration within dentistry prompted ADA to seek information about the impact it would have on dental care for patients.

Surveyed adults enrolled in capitation plans expressed less satisfaction with their plans than adults enrolled in fee-for-service plans and were less likely to give an "excellent" rating to their oral health.

Such are some of the conclusions of the ADA-funded RAND study, "Self-Reported Behavior and Attitudes of Enrollees in Capitated and Fee-for-Service Dental Benefit Plans." The 1995 ADA House of Delegates authorized the study because the implications of managed care in dentistry were largely unknown.

Dental Pulp Cells May Have Therapeutic Use

Researchers at the University of Michigan School of Dentistry, Ann Arbor, and the Karolinska Institute in Stockholm say research they are conducting on dental pulp cells may one day help improve the lives of patients with spinal cord injuries.

The research focuses on determining if dental pulp cells might have purposes other than making and maintaining teeth, said Dr. Christopher Nosrat, assistant professor at the UM School of Dentistry.

In a laboratory setting, the researchers will grow dental pulp cells and closely monitor the growth and development of nerves within those cells that eventually lead to the formation of proper nerve connections in teeth. The process of dental pulp cell innervation and spinal cord cell regeneration after injury may be similar, Nosrat said. The research seeks to determine if similar mechanisms and molecules may be involved in both processes and how these similarities could be exploited in new treatment strategies for patients with nerve injuries.

"Conceivably, it one day may be possible to extract a tooth, grow dental pulp cells, and implant those cells into a patient suffering from neuro-degenerative disease such as Parkinson's disease," Nosrat said. "While that is the ultimate goal, it still is a long way off. We need to conduct experiments over a long period of time."

Honors

Gordon L. Douglass, DDS, is the new president-elect of the American Academy of Periodontology. He maintains a full-time private periodontal practice in Sacramento and Folsom, Calif.

Michael G. Newman, DDS, has received the Fellowship Award from the American Academy of Periodontology. Newman is an adjunct professor of periodontics at the University of California at Los Angeles School of Dentistry and a private practitioner in Los Angeles.

Gary C. Armitage, DDS, MS, has received a Special Citation in recognition of outstanding contributions to the American Academy of Periodontology. Armitage is the chair of the Division of Periodontology, professor of periodontics and practitioner at the University of California at San Francisco School of Dentistry.

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Strategies to Treat Infected Root Canals

José F. Siqueira, Jr., DDS, MSc, PhD

ABSTRACT Periradicular lesions are diseases either primarily or secondarily caused by microorganisms and therefore they must be prevented or treated accordingly. If the professional is well-versed in both preventing and eliminating the root canal infection, the success rate of endodontic therapy may exceed 90 percent. The present paper discusses theoretical and practical aspects of effective antimicrobial endodontic therapy and delineates strategies to effectively control root canal infections.

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Periradicular lesions are diseases either primarily or secondarily caused by microorganisms.1-3 Microorganisms of probable pathogenic significance in endodontic infections include Porphyromonas species, Prevotella species, Fusobacterium nucleatum, species of the Streptococcus anginosus group, Bacteroides forsythus, Treponema denticola, Peptostreptococcus species, Eubacterium species, and Actinomyces species.2,4-6 In addition, enterococci, pseudomonas, yeasts, and some enteric rods may be involved in persistent or secondary root canal infections7-9 **(FIGURE 1).**

Because of the critical role played by microorganisms in the pathogenesis of periradicular lesions, endodontic therapy should be considered for the clinical management of a microbial disease. Thus, it is extremely important that clinicians understand the role of microorganisms in the pathogenesis of periradicular lesions and be aware that they are treating and/or preventing an infectious disease. Nonsurgical and surgical endodontic techniques are unique tools to treat and/or prevent root canal infections.

Antimicrobial endodontic therapy is based on the premise that periradicular diseases are infectious disorders. At a minimum, antimicrobial intracanal procedures must be able to eradicate pathogenic microorganisms effectively. As knowledge of the microorganisms implicated in the pathogenesis of periradicular diseases and of the structure of the root canal microbiota increases, clinicians will be able to incorporate more-effective

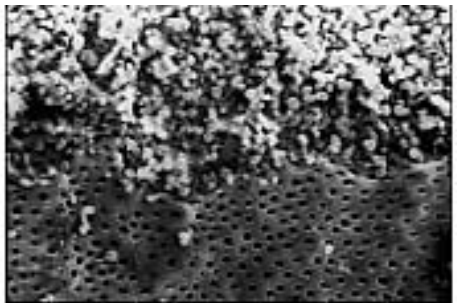

FIGURE 1. Fungi cells colonizing the dentinal walls in the middle third of the root canal (original magnification 2,100x). Although fungi are occasionally found in primary root canal infections, they have been associated with several cases of persistent infections.

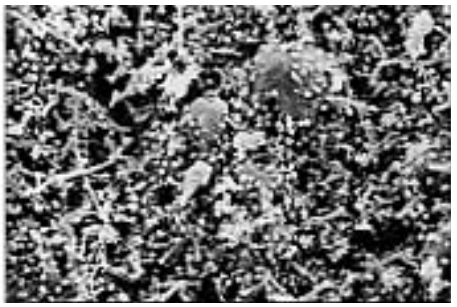

FIGURE 2. Dense mixed bacterial population colonizing the root canal walls (original magnification 3,300x).

antimicrobial strategies as part of their armamentarium for optimum treatment. To date, from a treatment point of view, root canal infections should be considered polymicrobial and treated accordingly.

This paper outlines basic and current concepts of and practical approaches to antimicrobial root canal therapy and attempts to relate current knowledge to clinical protocol.

Root Canal Infection

As are all connective tissues, the dental pulp is a sterile tissue. Contact with oral microorganisms is prevented by a barrier that consists of enamel at the crown of the tooth and cementum at the root. In certain conditions, such as caries, the pulp may come into contact with microorganisms from the oral cavity and therefore be injured and become inflamed. If pulp necrosis occurs as a consequence of injury, the pulp then loses its defense capability. As a result, microorganisms colonize the root canal system.

Most pulpal and periradicular pathoses are inflammatory diseases of microbial etiology. Microorganisms and their products play an essential role in the induction, progression, and perpetuation of such diseases.1-3 More than 150 microbial species have been isolated from infected root canals, usually in mixed infections consisting of four to seven different species and with predominance of obligate anaerobic bacteria.10

Whereas most of the endodontic microbiota remains suspended in the fluid phase of the root canal,11 dense bacterial aggregates also commonly adhere to the root canal walls, sometimes forming multilayered bacterial condensations (**Figure 2**). In addition, particularly in teeth associated with periradicular lesions, infection can propagate to dentinal tubules and anatomic variables, which are more common in the apical third of the root canal.

Given the importance of bacteria in the development of periradicular lesions, the eradication of the root canal infection is paramount in endodontic therapy. Studies have revealed that the success rate of the endodontic treatment is significantly increased when the endodontic infection is effectively eradicated before filling.12-14 In addition to the eradication of the root canal infection, maintenance of the aseptic chain also assumes special importance in root canal therapy. Treatment must be undertaken in a sterile environment, thereby precluding the possibility of new microorganisms entering the root canal system and establishing a secondary infection. A rubber dam must be used, and it should not leak. Efforts should also be made to effectively remove plaque and all vestiges of caries, to decontaminate the operative field, to avoid touching with fingers the parts of the sterilized endodontic instruments that will enter the root canal, and always to use sterilized or self-sterilizing irrigant solutions.10

Treating Infected Root Canals

Root canal infections possess some peculiarities that differentiate them from infections in other human sites. Once established, a root canal infection cannot be eliminated by the host defense mechanisms nor by systemic antibiotic therapy. This is explained by the fact that microorganisms present in root canal infections are in a privileged sanctuary, where the absence of a blood supply in a necrotic pulp impedes the transport of defense cells and molecules as well as systemically administrated antibiotics to the infected site. On the other hand, although host defense mechanisms and systemic antibiotics are ineffective against microorganisms within the root canal system, if microorganisms gain access to the highly vascularized periradicular tissues, they are usually effectively eliminated and thereby prevented from spreading to other sites. Due to the anatomical localization of the endodontic infection, it only can be treated through professional intervention using both chemical and mechanical procedures. Thus, the endodontic treatment involves three important steps to control of the root canal infection: the chemomechanical preparation; the intracanal medication; and the root canal obturation.10

Chemomechanical Preparation

The main root canal makes up the largest area of the root canal system. Because most of the intracanal microorganisms and their products are located in the main root canal, the chemomechanical preparation may be considered an essential step in the root canal disinfection, once significant amounts of irritants are removed during this phase.15-21 The removal of irritants from the root canal is carried out through mechanical action of instruments and the flow and backflow of the irrigant solution.15-18 In addition, antibacterial irrigants may be of significant help in eliminating bacterial cells from the root canal system.19-21

Mechanical Action

Studies in which no antibacterial irrigants were used have reported that the mechanical action of instrumentation and irrigation was effective in significantly reducing the number of bacterial cells in the root canal.17,18 However, total elimination of bacteria was not observed in most of the cases. Ingle and Zeldow22 have observed that immediately after instrumentation, using sterile water as an irrigant, 80 percent of the initially infected root canals yielded positive cultures. At the beginning of the second appointment, 48 hours later, this number increased to 95.4 percent. Byström and Sundqvist,17 using physiologic saline solution during instrumentation, found that bacteria persisted in about half of the cases despite treatment on five successive occasions. Infection persisted in those teeth with a high number of bacteria in the initial sample. Siqueira et al.18 evaluated the reduction of the bacterial population within root canals experimentally infected with E. faecalis by the mechanical action of instrumentation using hand Nitiflex files in alternate rotary motions, GT files, and Profile 0.06 taper Series 29 rotary instruments. Irrigation was performed using sterile saline solution. All the techniques and instruments tested significantly reduced the number of bacterial cells in the root canal. Instrumentation with a Nitiflex #30 was significantly more effective than GT files. There were no significant differences when comparing the effects of the Profile instrument #5 with either the GT files or the Nitiflex #30. Enlargement to a Nitiflex #40 was significantly more effective in eliminating bacteria when compared with the other techniques and instruments tested. The larger the apical preparation, the higher the percentage of bacteria eliminated from the root canal.

In clinical practice, the extent of instrumentation will depend on the root dimension, the presence of curvatures, and the type of endodontic instruments used. Hand and rotary nickel-titanium instruments can predictably enlarge curved root canals, while maintaining the original path, to sizes not routinely attainable with stainless steel files. Sufficient large preparations can incorporate more anatomic irregularities and allow the removal of a substantial amount of bacterial cells from the root canal. In addition, instrumentation with larger file sizes can also result in better irrigant exchange in the apical third of the root canal. Since larger preparations remove more bacterial cells, a higher rate of treatment success can be expected.

A higher success rate for endodontic treatment has been reported for teeth instrumented with hand NiTi files when compared with teeth prepared with hand stainless steel files.23 The authors observed that NiTi file utilization was five times more likely to achieve success than utilization of stainless-steel files.23 This probably occurred because of the greater capability of NiTi files in maintaining the original canal shape during instrumentation.

Thus, it appears that regardless of whether hand or rotary instruments are used, it is more important how much the root canal is enlarged. NiTi instruments allow the attainment of larger preparations in curved root canals with reduced risks of procedural accidents. Because of this, they should be the instruments of choice to prepare curved root canals. One should bear in mind that enlargement must be restricted up to 1 mm short of the root terminus. Although the apical foramen ideally should be cleaned, disinfected, and maintained patent, it must not be enlarged, The clinician should be aware of the risks in using large instruments at the patency length, as this procedure can result in severe periradicular injury, cause lack of an apical stop, and extrude a large amount of infected debris, which can predispose the tooth to postoperative discomfort and/or jeopardize the outcome of the endodontic therapy.[10,13,24,25]

Chemical Action

Although considerable bacterial reduction can be achieved by the mechanical action of instruments and irrigants, microorganisms are rarely completely eliminated from the root canals regardless of the instrumentation technique and file sizes employed. Remaining pathogens may survive in sufficient numbers to jeopardize the outcome of the root canal treatment.9,14,24,25 Therefore, it becomes evident that antibacterial irrigants must be used to maximize bacterial elimination from the root canal. Stewart26 and Auerbach,27 in clinical investigations, reported negative cultures in more than 70 percent of the initially infected root canals after chemomechanical preparation using antibacterial irrigants. Siqueira et al.21,28 found that irrigation with antibacterial irrigants was significantly more effective than saline solution in rendering canals free of bacteria.

During World War I, Dakin introduced the widespread use of a 0.5 percent to 0.6 percent sodium hypochlorite solution for antisepsis of open and infected wounds.29 NaOCl was recommended as an endodontic irrigant by Coolidge in 1919;30 and, in 1936, Walker introduced the use of double-strength chlorinated soda (5 percent NaOCl) solution as a root canal irrigant.31 NaOCl use as an irrigant in endodontic practice has continued worldwide, and no study has hitherto definitively shown any other substance to be more effective. NaOCl has tissue-dissolving ability and a broad-spectrum antimicrobial activity; it can rapidly kill vegetative bacteria, spore-forming bacteria, fungi, protozoa, viruses, and bacterial spores.32-35

Siqueira et al.35 compared the antibacterial activity of several irrigants against four black-pigmented anaerobic bacteria and four facultative bacteria through the agar diffusion test. The antibacterial effectiveness was ranked as follows, in decreasing order: 4 percent NaOCl; 2.5 percent NaOCl; 2 percent chlorhexidine; 0.2 percent chlorhexidine;

FIGURE 3. Tissue remnants in root canal irregularities after chemomechanical preparation using 5.25 percent NaOCl as irrigant.

FIGURE 4. Bacterial cells invading dentinal tubules (original magnification 1,900x). Efforts should be also directed toward their elimination.

EDTA; citric acid; and 0.5 percent NaOCl. These laboratory findings also confirmed that the antimicrobial effectiveness of NaOCl is directly dependent on the concentration of the solution.

In another study, Siqueira et al.28 investigated the ability of a 4 percent NaOCl solution used in different irrigation methods in eliminating E. faecalis from the root canal. Regardless of the irrigation method used, more than half of the teeth yielded negative cultures. Conversely, all specimens irrigated with saline solution yielded positive cultures. Although the mechanical effects of irrigation can significantly contribute to the elimination of root canal bacteria, this finding confirmed the need to use antimicrobial substances to maximize the root canal disinfection.

Siqueira et al.21 evaluated the in vitro intracanal bacterial reduction produced by instrumentation and irrigation with 1 percent, 2.5 percent, or 5.25 percent NaOCl or saline solution. All test solutions significantly reduced the number of bacterial cells in the root canal. There was no significant difference between the three NaOCl solutions tested. Nonetheless, all NaOCl solutions were significantly more effective than saline solution in reducing the number of bacterial cells within the root canal. This emphasized the importance of the chemical effects together with the mechanical effects in eliminating intracanal bacteria. Regular exchange and the use of large amounts of irrigant should maintain the antibacterial effectiveness of the NaOCl solution, compensating for the effects of concentration. The same observation was done by Baumgartner and Cuenin36 when evaluating the tissue-dissolving ability of NaOCl solutions.

Therefore, the use of an antimicrobial irrigant significantly contributes to the elimination of microorganisms from the root canal. NaOCl remains as the irrigant of choice in root canal therapy. Regardless of the concentration, high volumes and frequent exchange are required for optimum antimicrobial and tissue-dissolving capabilities.

Role of the Intracanal Medication

Although a considerable reduction in bacterial cell numbers within the root canal can be achieved by the chemical and mechanical effects of instrumentation and irrigation, viable bacteria can still be found in at least half of the cases.17,19-21,28 Whilst minor anatomical irregularities are usually incorporated into preparation, other areas such as isthmuses, culs-de-sac, branches, and dentinal tubules can harbor microorganisms. These areas are not commonly affected by the chemomechanical preparation because of inherent physical limitations of instruments and the short time the irrigants are present within the root canal (**FIGURE 3**).

In situ investigations have revealed that bacteria can infect dentinal tubules to an extent ranging from 10 to 300 µm37-38 (**FIGURE 4**). Bacterial cells penetrating up to approximately 200 to 300 µm are unlikely to be eliminated by chemomechanical procedures. In such areas of dentin infection, the root canal should be theoretically enlarged to a diameter approximately 0.4 to 0.6 mm larger than the initial diameter of the root canal in order to remove bacteria inside tubules. This is practically impossible to accomplish in most cases, particularly in the apical third of the root canal. In vitro studies have evaluated the capacity of irrigants in eliminating bacterial cells within tubules during varying periods.39,40 However, depths of disinfected zones in dentin have been rarely reported. It is unknown to what extent irrigants can reach antimicrobial effectiveness within dentin in in vivo conditions.

In most cases, surviving bacteria within tubules are entombed by the root canal filling and may have a drastically reduced substrate. In such anatomical regions, bacteria entombed by the root filling usually die or are prevented from gaining access to the periradicular tissues. Even interred, some bacterial species are likely to survive for relatively long periods, deriving residues of nutrients from tissue remnants and dead cells.25 If the root canal filling fails in promoting a fluid-tight seal, seepage of tissue fluids into the canal can provide substrate for bacterial growth. If growing bacteria reach a significant number and gain access to the periradicular tissues, they can perpetuate inflammation.25 Thus, one might assume that persistent dentinal infection has the potential to jeopardize the outcome of the endodontic therapy and ideally should be eradicated before filling.

Histologic studies have shown that some root canal walls remain untouched after chemomechanical preparation, regardless of the instrument type, the instrumentation technique, and the irrigant used.16,41-43 Untouched areas may contain bacteria and necrotic tissue substrate even though the root canal filling

appears to be radiographically adequate. If infected areas are not effectively isolated from the periradicular tissues by a three-dimensional seal provided by the root canal filling, microorganisms may maintain periradicular inflammation. The fact that studies have reported the occurrence of viable microbial cells in treated teeth with a persistent periradicular lesion indicates that microorganisms derive nutrition from tissue fluid, which can seep into the root canal space.9

Studies have revealed that the success rate of endodontic treatment is increased if the root canal is free from microorganisms at the time of obturation.12-14 Since microorganisms are the major etiological agents of periradicular diseases, their presence in the root canal system at the time of root canal filling jeopardizes the outcome of the treatment. Therefore, all efforts should be directed toward the thorough elimination of microorganisms.

Inherent physical limitations impede action of the instruments in areas beyond the main root canal. Irrigants remain for a short time in the root canal to eliminate microorganisms located in such areas, and the faster the instrumentation technique the lesser the time of irrigant presence within the root canal. Thus, the effects of the chemomechanical preparation are restricted to the main root canal. By remaining for a longer time in the canal than irrigants, antimicrobial intracanal medicaments have a higher probability to reach microorganisms located in areas unaffected by the chemomechanical preparation and thereby help in disinfection of the entire root canal system.

One-Visit Versus Two-Visit Treatment

One-visit endodontic treatment offers some potential advantages to both the dentist and patient. In addition to being faster and well-accepted by patients, it prevents the contamination or recontamination of the root canal system between appointments. In cases of vital pulp, treatment ideally should be finished in one session provided that the time available, operator's skills and anatomical conditions are all favorable. On the other hand, treatment in one session of necrotic pulps whether associated with a periradicular lesion or not is still a controversial issue in endodontics.

Despite anecdotal evidence supporting endodontic therapy in a single visit, two factors must be taken into account before deciding upon a one-visit treatment of teeth with necrotic pulp: the incidence of postoperative pain and the long-term outcome of the treatment. Studies have found no difference in the incidence of postoperative pain between one- and multiple-visit endodontics.44-46 As consequence, the outcome of the endodontic treatment should be the major factor taken into account when deciding the number of therapy sessions.

There is a paucity of studies comparing the success rate of the endodontic therapy performed in one or more sessions. Most of these few studies have been based on poorly defined criteria of evaluation. The most common flaws include short-term follow-up, no differentiation between pathological conditions (vital or necrotic pulps, presence of periradicular bone destruction, etc.), nonstandardized intracanal procedures, multiple operators with obvious divergent skills, retrospective evaluation, and loose criteria in determining success and failure.

Pekruhn46 published one of the largest studies on single-visit treatment results. His study used a one-year follow-up period, and the inclusion criteria was undefined. Many cases were treated in two visits. There were significantly fewer failures in the two-visit treatment group than in the one-visit treatment group, regardless of the pretreatment diagnosis.

A few studies have presented clearly defined criteria. In a very well-controlled clinical study, Sjögren et al.14 investigated the role of infection in the outcome of one-visit treatment after a follow-up period of five years. All followed-up teeth (n = 53) showed infected pulps before treatment. The irrigant solution used was 0.5 percent NaOCl. Although it is considered a weak solution, it has not been demonstrated to be clinically less effective than 5 percent NaOCl in eliminating intracanal microorganisms.19,20 Forty-four cases were successful (83 percent). Of the nine failed root canals, seven yielded positive culture before filling. Slight overfilling appeared to have no influence on the outcome because all 10 overfilled teeth were successful. The remaining 43 cases were obturated within 2 mm of the apex. These findings can be directly compared to others of the same research group.13 Success was reported for 94 percent of the infected root canals associated with periradicular lesions treated in multiple visits when the root canals were filled within 2 mm from the root apex (the same conditions of the one-visit study). Thus, a difference of 11 percent could be detected between single- and multivisit treatment.

In another well-controlled clinical study, Trope et al.47 evaluated radiographic healing of teeth with periradicular lesions treated in one or two visits. All patients were treated by the same operator. Instrumentation was standardized with 2.5 percent NaOCl used as irrigant. All teeth were obturated with lateral condensation of gutta-percha and Roth 801 sealer. In the two-visit group, root canals were medicated with calcium hydroxide for at least one week. After a one-year follow-up evaluation, the additional disinfecting action of calcium hydroxide resulted in a 10 percent increase in healing rates. This difference should be considered clinically important.47

Katebzadeh et al.48,49 radiographically and histologically compared periradicular repair after endodontic treatment of infected root canals of dogs performed in one or two sessions. They reported better results for the two-visit treatment in which calcium hydroxide was used as an intracanal disinfecting medicament for one week.

Microorganisms can survive the effects of chemomechanical preparation in 40 percent to 70 percent of the cases.17,19-21,28 Most of the surviving

microorganisms die either by the antimicrobial action of root canal filling material or by the absence of available nutrients in a filled root canal. Nonetheless, in certain cases, microorganisms can survive even in a well-filled root canal, acquiring nutrients and reaching sufficient numbers to perpetuate a periradicular lesion.

Perpetuation of a periradicular lesion caused by a persistent root canal infection will depend on (a) the access of remaining microorganisms to the periradicular tissues; (b) the ability of residual microorganisms to survive in an environment with low nutrient availability; (c) the virulence; (d) the number of the surviving microorganisms; and e) the host resistance.10

Therefore, overwhelming scientific evidence indicates that microorganisms can survive the effects of chemomechanical preparation in at least a half of the cases; and microorganisms are the major causative factors of the endodontic failure, even in well-treated cases. Because remaining microorganisms jeopardize the long-term outcome of the endodontic treatment, additional measures should be taken to predictably eradicate the root canal infection. To date, the support of an interappointment antimicrobial dressing is necessary to accomplish such an objective.

In cases of vital pulp, a single-visit treatment should be used whenever possible. This is based on the fact that the pulp is only superficially infected and the root canal is free of bacteria, provided the aseptic chain is maintained during the intracanal procedures. Therefore, there is no apparent reason not to treat vital pulps in a single visit.

On the other hand, if the pulp is necrotic and associated with a periradicular disease, there is ample evidence that the root canal system is infected. In these cases, the root canal ideally should be cleaned and shaped, an intracanal medication placed, and the canal filled in a second appointment. These procedures, as previously mentioned, are based on scientific evidence and not merely suppositions.

It is obvious that in the future, the single-visit treatment will become a suitable choice for treating infected teeth also. Ongoing research has the potential to discover measures that will enable dentists to treat infected root canals in one session predictably. However, the current treatment that offers a significantly higher success rate is accomplished in two or more sessions and, for this reason, should be the only choice for the treatment of infected root canals at this time.

Intracanal Medicaments

Since its introduction by B.W. Hermann,50 a German dentist, in 1920, calcium hydroxide has been widely used in endodontics. It is a strong alkaline substance with a pH of approximately 12.5. Currently, this chemical substance is acknowledged as one of the most important antimicrobial dressings used during endodontic therapy.

Most endodontopathogens are unable to survive in a highly alkaline environment such as that of calcium hydroxide, therefore several bacterial species commonly found in infected root canals are eliminated after a short period when in direct contact with this substance.51

The antimicrobial activity of calcium hydroxide is related to the release of hydroxyl ions in an aqueous environment. Hydroxyl ions are highly oxidant free radicals that show extreme reactivity, reacting with several biomolecules. This reactivity is high and indiscriminate, so this free radical rarely diffuses away from sites of generation. Their lethal effects on bacterial cells are probably due to the following mechanisms:

Damage to the bacterial cytoplasmic membrane. Hydroxyl ions from calcium hydroxide can induce lipid peroxidation, resulting in the destruction of phospholipids, structural components of the cellular membrane. Hydroxyl ions remove hydrogen atoms from unsaturated fatty acids, generating a free lipidic radical. This free lipidic radical reacts with oxygen, resulting in the formation of a lipidic peroxide radical, which removes another hydrogen atom from a second fatty acid, generating another lipidic peroxide. Thus, peroxides themselves act as free radicals, initiating an autocatalytic chain reaction, and resulting in further loss of unsaturated fatty acids and extensive membrane damage.52

Protein denaturation. Alkalinization provided by calcium hydroxide can induce the breakdown of ionic bonds that maintain the tertiary structure of proteins. As a consequence, the enzyme maintains its covalent structure; but the polypeptide chain is randomly unraveled in variable and irregular spatial conformation. These changes frequently result in the loss of biological activity of the enzyme and disruption of the cellular metabolism. Structural proteins may also be damaged by hydroxyl ions.

Damage to the DNA. Hydroxyl ions react with the bacterial DNA and induce the splitting of the strands. Genes are then lost.53 Consequently, DNA replication is inhibited, and the cellular activity is disarranged. Free radicals may also induce lethal mutations.

Several studies have demonstrated that calcium hydroxide exerts lethal effects on bacterial cells.51,54,55 Optimum effects were observed when the substance was in direct contact with bacteria in solution. In such conditions, the concentration of hydroxyl ions is very high, reaching incompatible levels to bacterial survival. Clinically, this direct contact is not always possible.

Although hydroxyl ions possess antibacterial effects, rather high pH values are required to destroy microorganisms. Killing of bacteria by calcium hydroxide will depend on the availability of hydroxyl ions in solution, which is higher where the paste is applied (the main root canal). Calcium hydroxide exerts antibacterial effects in the root canal as long as they retain a very high pH. If calcium

hydroxide needs to diffuse to tissues and the hydroxyl concentration is decreased as result of the action of buffering systems (bicarbonate and phosphate), acids, proteins, and carbon dioxide, its antibacterial effectiveness may be reduced or impeded.56

Bacteria inside dentinal tubules may constitute an important reservoir from which root canal infection or reinfection may occur during and after endodontic treatment. As previously mentioned, remaining microorganisms may cause a persistent infection that puts the outcome of the endodontic therapy at risk. Bacteria inside dentinal tubules are protected from the effects of host defense cells and molecules, systemically administered antibiotics, and chemomechanical preparation. Therefore, treatment strategies that are directed toward the elimination of tubule infection are necessary and must include medicaments that penetrate dentinal tubules and kill microorganisms.

After a short-term intracanal dressing with calcium hydroxide, pH levels reached in dentine may still allow the survival or growth of some microbial strains. Microorganisms vary in their pH tolerance ranges, and most human pathogens grow well within a range of 5 to 9 pH.57 Some strains of Escherichia coli, Proteus vulgaris, Enterobacter aerogenes and Pseudomonas aeruginosa can survive in pH 8 or 9.58 These bacterial species have occasionally been isolated from infected root canals, usually causing secondary infections.7 Certain bacteria, such as some enterococci, tolerate very high pH values, varying from 9 to 11. Fungi generally also exhibit a wide pH range, growing within a range of 5 to 9 pH.58 It has been demonstrated that enterococci and fungi are highly resistant to calcium hydroxide.51,59 Since these microorganisms are commonly found in cases of endodontic failure, the routine use of calcium hydroxide should be questioned.

The ability of a medicament to dissolve and diffuse in the root canal system would seem essential for its successful action. A saturated aqueous suspension of calcium hydroxide possesses a high pH, which has a great cytotoxic potential. Nevertheless, this substance owes its biocompatibility to its low water solubility and diffusibility. Because of these properties, cytotoxicity is limited to the tissue area in direct contact with calcium hydroxide. On the other hand, the low solubility and diffusibility of calcium hydroxide may make it difficult to reach a rapid and significant increase in the pH to eliminate bacteria within dentinal tubules and enclosed in anatomical variations. Likewise, the tissue buffering ability controls pH changes. Because of these factors, calcium hydroxide is a slowly working antiseptic. Prolonged exposure may allow for saturation of the dentine and tissue remnants. The long-term use of calcium hydroxide may be necessary to obtain a bacteria-free root canal system.56 However, in most instances, the routine use of an intracanal medication for a long period does not seem to be an acceptable practice in modern endodontics.

Although clinical studies have revealed that the treatment using calcium hydroxide as intracanal dressing showed higher success rates when compared with single-visit treatment, the search for more-effective medicaments or combinations should not necessarily stop. This statement is based on the following facts: Living microorganisms still remain in approximately 20 percent of the previously infected canals after one week of medication with calcium hydroxide;60-62 and some microorganisms associated with endodontic failures are intrinsically resistant to calcium hydroxide. Endodontic infections are polymicrobial, and no known medicament is effective against all the bacteria found in infected root canals. In addition, the medicament should ideally reach microorganisms located in distant areas of the root canal system in lethal concentrations. Combination of two medicaments may produce additive or synergistic effects. Recently, renewed interest has been generated regarding the association of calcium hydroxide with other antimicrobial substances, such as camphorated paramonochlorophenol (CPMC), chlorhexidine, or iodine potassium iodide (IPI). Laboratory studies have shown that these substances significantly increase the antimicrobial spectrum of calcium hydroxide.63-66

Evidence suggests that the association of calcium hydroxide with CPMC has a broader antibacterial spectrum, has a higher radius of antibacterial action, and kill bacteria faster than mixtures of calcium hydroxide with inert vehicles (water, saline, glycerin).56,63-65,67 Although CPMC has strong cytotoxic activities,68 studies have reported a favorable tissue response to calcium hydroxide/CPMC mixture.69,70 This association probably owes its biocompatibility to:

- The small concentration of released paramonochlorophenol (PMC). Calcium hydroxide plus CPMC yields calcium paramonochlorophenolate, which is a weak salt that progressively releases PMC and hydroxyl ions to the surrounding medium.71 It is well-known that a substance may have either beneficial or deleterious effects, depending on its concentration. The low release of PMC from the paste might not be sufficient to have cytotoxic effects;
- The denaturing effect of calcium hydroxide on connective tissue, which may prevent the tissue penetration of PMC, reducing its toxicity;56
- The fact that the effect on periradicular tissues is probably associated with the antimicrobial effect of the paste, which allows natural healing to occur without persistent infectious irritation. If the wound area is free of bacteria when the transitory chemical irritation occurs, there is no reason to believe that tissue repair would not take place as the initial chemical irritant decreases in intensity.56

Therefore, the use of an antimicrobial intracanal dressing can significantly contribute to the eradication of the

root canal infection. Logically, not all antimicrobial substances used as intracanal medication exert such desirable effects. Calcium hydroxide has yet to be tried by time and scientific assessment. It is not a panacea. Besides not being effective against all microorganisms present in the root canal infection, after a short exposure calcium hydroxide may not reach microorganisms located beyond the main root canal in lethal concentrations. Association of calcium hydroxide with other antimicrobial substances, such as CPMC, IPI, and chlorhexidine, has the potential to optimize the antimicrobial effectiveness of the intracanal medication.

Role of the Root Canal Obturation

Most endodontic sealers show antimicrobial activity before setting, but most of them also lose this ability after setting. Because antimicrobial activity of most sealers is not pronounced and is usually ephemeral,72-74 it is highly unlikely that sealers will be of significant assistance in killing microorganisms that survived the effects of the chemomechanical preparation and the intracanal medicament (if used).

In reality, cleaned and shaped root canals must be three-dimensionally filled, eliminating the empty space, which has the potential to be infected or reinfected. In addition, by creating a fluid-tight apical, lateral, and coronal seal, root canal fillings may confine residual irritants within the root canal system, impeding their egress to the periradicular tissues. A fluid-tight seal of the root canal system also prevents both the coronal recontamination by saliva and the seeping of periradicular tissue fluids into the root canal, denying nutrient supply to remaining microorganisms. Therefore, the critical function of the root canal obturation is preventive, essentially acting as a barrier to infection or reinfection of both the root canal system and the periradicular tissues.

The root canal system often possesses a complex anatomy, including fins, culs-de-sac, isthmi, ramifications, and other irregularities. It has been claimed that many of these areas are difficult to fill using conventional techniques, such as the lateral condensation technique. Thermoplasticized gutta-percha techniques have been advocated for root canal obturation as they can provide a more homogenous mass of obturation and a better filling of root canal intricacies when compared with the traditional lateral condensation technique.75,76 Theoretically, such properties might favor the attainment of an impervious coronal and apical seal of the root canal system.

Nonetheless, numerous studies have shown that neither contemporary root canal obturation techniques nor available filling materials can provide an impervious seal to leakage.77-80 To date, no well-controlled clinical study has demonstrated that thermoplasticized gutta-percha techniques provide more favorable treatment outcomes than traditional lateral condensation technique. Further, one should bear in mind that apparently moving gutta-percha or sealer or both into all anatomic variations does not necessarily mean that the root canal system was appropriately cleaned, disinfected, and sealed.

Antibiotics

The purpose of antibiotic therapy is to aid the host defenses in controlling and eliminating microorganisms that have temporarily overwhelmed the host defense mechanisms.81 The most important decision in antibiotic therapy is not so much which antibiotic should be employed but whether antibiotics should be used at all.

The vast majority of infections of endodontic origin can be treated without antibiotics. Due to the absence of blood circulation within a necrotic and infected pulp, antibiotics cannot reach and eliminate microorganisms present in the root canal system. Thus, the source of infection is unaffected by systemic antibiotic therapy. On the other hand, antibiotics can help impede the spread of the infection and the development of secondary infections in compromised patients. Therefore, antibiotic therapy can be a valuable adjunct for the management of some cases of endodontic infection. The rare occasions in which antibiotics are indicated in endodontics include:

- Acute periradicular abscesses associated with systemic involvement, such as fever, malaise, and lymphadenopathy;
- Spreading infections resulting in cellulitis, progressive diffuse swelling and/or unexplained trismus (**Figure 5**);
- Acute periradicular abscesses (even with localized swelling) in medically compromised patients who are at increased risk of a secondary infection at a distant site following a bacteremia;
- Prophylaxis for medically compromised patients during routine endodontic therapy;
- Some cases of persistent exudation not resolved after revision of intracanal procedures; and
- Replantation of avulsed teeth.
- Acute periradicular abscesses in healthy patients without systemic involvement and characterized by localized swelling do not require antibiotic therapy.

Patients under antibiotic therapy must be monitored daily. The best practical guide for determining the duration of antibiotic therapy is clinical improvement of the patient. When clinical evidence indicates that the infection is certain to resolve or is resolved, antibiotics should be administrated for no longer than one or two additional days.

Antibiotic treatment of infections of endodontic origins is initiated based on the knowledge of the most likely pathogens. Amoxicillin, a broad-spectrum semisynthetic penicillin, is the antibiotic of first choice for such infections. Most of the root canal microbiota is susceptible to amoxicillin.82 In patients allergic to penicillins or in cases resistant to amoxicillin therapy, clindamycin is indicated. The risk/benefit ratio should be always considered before administration of systemic antibiotic therapy.

FIGURE 5. Spreading root canal infection resulting in cellulitis. Systemic antibiotic therapy is indicated in cases such as this (courtesy of Dr. Henrique Martins).

FIGURE 6A. Preoperataive

FIGURE 6B. Follow-up radiograph after seven months showing repair of the lesion and stopping of the root resorption process.

FIGURE 6A AND 6B. Treatment in two sessions of a tooth associated with periradicular lesion and showing apical root resorption. A. Preoperative, and B. follow-up radiograph after seven months showing repair of the lesion and stopping of the root resorption process.

FIGURE 7A. Preoperataive

FIGURE 7B. Follow-up radiograph showing bone repair of the lesion.

FIGURE 7A AND 7B. Treatment in two sessions of a tooth associated with extensive periradicular bone destruction. A. Preoperative, and B. follow-up radiograph showing bone repair of the lesion (courtesy of Dr. Luis Paulo Mussi).

Laser Irradiation of Infected Root Canals

A laser that transforms light of various frequencies into a chromatic radiation in the visible, infrared, and ultraviolet regions with all the waves in phase capable of mobilizing immense heat and power when focused at close range.83 Many kinds of laser devices have been used in dentistry. Among potential applications in endodontics, lasers have been tested for efficacy in disinfecting root canals. All lasers have an antimicrobial effect at high power that varies with the type of laser. The Nd-YAG laser has been studied the most because its laser energy and laser fiber can be easily controlled. Although promising results have been reported in vitro,84,85 root canal disinfection can be problematical in narrow curved canals and because of the possible thermal injury to periodontal tissues. In addition, laser devices are still relatively costly. Future research will help to define optimal laser parameters for safe and effective disinfection of root canals.

Clinical Protocol Based on an Antimicrobial Strategy

Diligent antimicrobial therapy should focus upon employing well-tolerated antimicrobial agents exhibiting effectiveness against the most prevalent microorganisms involved in primary and persistent root canal infections. Moreover, the antimicrobial endodontic therapy should be able to eliminate microorganisms present not only in the main root canal, but also in all variations of the root canal system. The following protocol to routinely treat infected root canals is based on both scientific evidence and clinical experience (Figures 6 and 7):

1. The tooth to be treated must be free of plaque and calculus.

2. Preparation of the access cavity can be initiated before the application of a rubber dam but cannot be concluded until after its placement. All carious tissue must be removed.

3. After rubber dam placement, the operative field must be cleaned with hydrogen peroxide and disinfected with iodine solution, chlorhexidine, or sodium hypochlorite solution.

4. After completion of access preparations, the pulp chamber must be copiously irrigated with a 2.5 percent NaOCl solution.

5. Chemomechanical preparation should be performed using a crown-down technique, with hand and/or rotary instruments and at least 1 to 2 ml of 2.5 percent NaOCl after each file size. NiTi instruments should be used in curved root canals. The root canal should be enlarged to 1 mm short of the apex. Overinstrumentation is undesirable as it can predispose the tooth to both postoperative symptomatology and treatment failure. However, the 1 mm apical segment ideally should be cleaned and maintained free of debris by using small size patency files.

6. After smear layer removal, the root canal is medicated with a calcium hydroxide/CPMC/glycerin paste. The paste is prepared on a glass slab, using equal proportions of CPMC and glycerin (1:1, v:v). The two liquids are mixed and then calcium hydroxide is slowly added until a creamy consistency is reached. The paste ideally is applied in the canal using lentulo spirals.

7. The tooth is radiographed to check the proper placement of the intracanal medication, and a temporarily coronal material is applied.

8. In the second appointment, three to seven days later, the paste is removed using files under copious irrigation with 2.5 percent NaOCl and the root canal obturated.

Outline of Strategies to Treat Root Canal Infections

1. Periradicular lesions are diseases of infectious origin and therefore must be prevented or treated accordingly;

2. Maintenance of the aseptic chain is as important as disinfection of the root canal for the outcome of root canal therapy. In other words, from a microbiological point of view, what one removes from the root canal is as important as what one places into it.

3. Root canal therapy in vital pulp cases ideally should be concluded in a single visit.

4. It is essential to disrupt the microbial communities within root canals by mechanical means (root canal instrumentation) with sodium hypochlorite irrigation.

5. Antimicrobial dressings are valuable adjuncts to predictably eliminate microorganisms from the root canal system. The smear layer should be removed to facilitate diffusion of the medicaments into dentinal tubules.

6. Two-visit endodontic treatment using calcium hydroxide dressing results in a higher success rate than a single-visit treatment. The success rate of treatment may even be increased if an intracanal medicament or a combination of medicaments (such as calcium hydroxide plus CPMC) with a broader antimicrobial spectrum and a higher radius of action is used.

7. Root canal obturation assumes a special relevance in perpetuating the status of root canal disinfection obtained after both chemomechanical preparation and intracanal medication.

8. Antibiotics are never a substitute for either drainage procedures or proper endodontic therapy. Thus, antibiotics are not used to treat root canal infections, but mainly to prevent their spreading. Clinicians should be aware of the risk/benefit ratio before indicating systemic antibiotic therapy.

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Favorable Dental Economics Could Belie Coming Crisis

H. Barry Waldman, BA, DDS, MPH, PhD

ABSTRACT In the 1990s, the general economy, as well as the economics of dental practice, were favorable. Should there be a future period of economic downturn, three factors could be cause for economic concern: the wide ranges in spending for dental services in different parts of the country, the reliance on out-of-pocket spending for dental care, and the minimal level government contribution for these services.

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The "bullish" stock market of the 1990s fueled employment, optimism, and consumption of just about everything from homes to jewelry and, yes, even dental care. The combination of decreasing numbers of dental school graduates, an increasing resident population, and increased coverage of dental services by private health insurance arrangements (private insurance covered 48 percent of dental expenses in the 1990s, compared to 28 percent in the 1980s1) ensured favorable prospects for most dental practices. But the stock market debacles in the second half of 2000 may portend difficult times for the dental profession as underlying limitations in the substructure of dental economics are exposed and potential patients reconsider expensive elective procedures.

The Health Care Financing Administration recently reported that in 1998, $53.8 billion was spent for dental services in the United States.2 This is but the latest in a long list of favorable financial accounts during the past 30 years that recorded current dollar and constant dollar (removing the effects of inflation) increases in expenditures at the national level for dental care. However, these positive overall economic reports do not reflect uniform developments throughout the country and mask potential economic weaknesses in the economics of dental practice. For example:

- Spending for dental care represents a progressively smaller percent of the overall spending for health services;
- Out-of-pocket spending continues to

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represent a greater share of dental expenditures than spending for many other health services;
- Contrary to developments in other health service sectors, government spending for dental services continues to represent an exceptionally limited component of overall dental expenditures; and
- In some states, there have been decreases in constant dollar expenditures for dental services.1,2

A series of recent tabular reports from the Health Care Financing Administration provides historic and projection data that can be used to develop an awareness of the vulnerability of the economics of dental practice at a time of potential contraction of the general national economy.

Spending Changes for Health Care Services

Spending for personal health services from 1970 to 2000 is projected to increase from $63.8 billion to more than $1.1 trillion (in terms of constant dollars, an increase from approximately $197 billion to $440 billion3). During the past three decades, advances in health care services, the evolution of third-party systems, and changes in delivery arrangements have dramatically altered the pattern of expenditures for health services. For example, the hospital-care share of spending decreased from almost 44 percent to 34 percent of all personal health care spending. By contrast, prescription drug spending increased from 8.6 percent to 12.6 percent of health care expenditures. During the same period, while spending for dental care increased from $4.7 billion to a projected $60 billion in 2000, the dental-expenditure share of personal health spending will decrease from 7.3 percent of 4.5 percent (**Table 1**).

Spending for Dental Services

Although dental expenditures increased almost 1,200 percent during the past three decades, in terms of constant dollars, spending actually increased by 90 percent, but with limited increases during the final years of the 1990s. Similarly, per capita expenditures for dental care increased 800 percent from $22 to $199 during the past 30 years. In terms of constant dollars, per capita dental expenditures increased 50 percent. Expenditure projections through 2008 forecast dental care spending at $93 billion (4.8 percent of overall personal health services) and a $307 per capita rate (Tables 1 and 2).

Distribution of Dental Spending

But dental care expenditures are "felt" to greater extent by the patient than other major health services. By the end of the 1990s, out-of-pocket spending represented less than 20 percent of all personal health services: 3 percent of hospital care, 15 percent of physician services, but 47 percent of dental services.

Private health insurance covered approximately one-third of all personal health services, including almost one-third of hospital care, and almost one-half of physician and dental services.2 In addition, a major component of health care services is covered by federal, state, and local government agencies, including 44 percent of all personal health services, 61 percent of hospital care, 32 percent of physician services, but less than 5 percent of dental services (**Table 3**).

It is projected that in 2000, more than $28 billion will be spent out of pocket for dental services ($99 per capita out-of-pocket spending out of a total $211 per capita dental expenditure) (**Table 4**).

Spending for Health Care at the State Level

Total health care as a percent of state gross product: In 1997, total personal health care represented 11.9 percent of the national gross product, with some wide variations among regions and states.
- Total spending for health services as a percent of state gross product ranged from 10.3 percent for the Rocky Mountain and Far West Regions, to 13.1 percent in the Southwest Region. The greatest difference within a single region was reported between Wyoming (7.5 percent) and Montana (14 percent).
- The variations at the state level ranged from less than 10 percent in Alaska, Delaware, District of Columbia, Nevada, and Wyoming, to 16.1 percent in Nevada and 17.5 percent in West Virginia (**Table 5**).

Per capita dental care spending: In 1998, the use of the national average per capita expenditure datum for dental services ($199 per person) masked the wide range of spending in the various regions and states. For example:
- Per capita spending for dental care ranged from $164 in the Southwest Region to $253 in the Far West Region.
- The variations at the state level ranged from $115 in Mississippi and $122 in West Virginia to $288 in the District of Columbia and $302 in Washington (**Table 5**).

But despite increases in per capita spending for dental services from 1990 to 1998, constant dollar per capita spending:
- Decreased in the Mideast Region;
- Decreased in Connecticut, Hawaii, Iowa, New Jersey, New York, Pennsylvania, Rhode Island, and Wyoming;

Remained unchanged in California (**Table 5**).

In 1998 (a year of favorable economics, decreasing rates of unemployment and rising stock markets), spending for dental care represented 5.2 percent of total health expenditures, with a range from 3.1 percent in West Virginia, to more than 8 percent in Oregon and Washington. But during the 1990s:
- 15 states reported decreases in the proportion of total health care expenditures that was spent for dental care; and
- Kentucky, Mississippi, West Virginia, and the District of Columbia reported that the proportion of total health care expenditures spent for dental care was between 3.1 percent and 3.6 percent (**Table 5**).

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Summary

Even in the "high flying" 1990s, there were indications that there should be some concern regarding the infrastructure of dental economics.

Previous Reviews

There have been reports (for the 1990s) in the *Journal of the California Dental Association* regarding national dental economics.4,5 Results from studies by the Internal Revenue Service, the Health Care Financing Administration, the Bureau of the Census, and the American Dental Association emphasized the favorable combination of:

- Improving general economics;
- An annual decline in the 1990s of more than 1,500 dental school graduates (since the greatest number of graduates in 1983);
- Increase per capita expenditures for dental services; and
- Increases in gross practice receipts and practitioner net income.

Commentary

The continued positive direction of dental economics in this new decade is dependent upon the ability and willingness of individuals (and their employers) to finance 95 percent of dental costs (a combination of out-of-pocket spending and private insurance). By contrast, out-of-pocket spending and private insurance accounts for 53 percent of overall personal health care spending, 35 percent of hospital services and 65 percent of physician care.1 But all this probably is of limited concern -- as long as the economy hums along in continual expansion.

Almost all government support for dental services is within the boundaries of the Medicaid program ($8 of $9 per capita government spending for dental care in 2000 [**Table 4**]). Unlike the Medicare program, which sets no income limitations, the Medicaid program guidelines in each state enforce maximum income eligibility standards. Thus, for the most part, the "safety-net" support provided by this federal-state program is not available for the "near poor" and lower income families. In addition,

- The extent and type of Medicaid dental services for adults are elective options; and
- Limited numbers of dental practitioners are willing to participate in the Medicaid program as a result of inadequate reimbursement schedules, administrative red tape, and appointment no-show rates.

The absence of government support for dental care is complicated further by employment and benefit practices carried out in the 1990s. Great numbers of workers were added to part-time and full-time "lower end" service positions, which traditionally offer limited fringe benefits. Many of these new workers recently had left the welfare rolls as a result of the 1990s welfare legislation eligibility limitations and work requirements, and/or were underemployed minority group members.

Table 1. Personal Health Care: Selected Years 1970-2008[1]

	1970	1980	1990	1997	2000*	2008*
	(In billions)					
Total	$63.8	$217.0	$614.7	$969.0	$1,150.9	$1,925.2
Hospital care	28.0	102.7	256.4	371.1	424.0	659.5
Physician services	13.6	45.2	146.3	217.6	258.7	416.1
Dental services	**4.7**	**13.3**	**31.6**	**50.6**	**60.2**	**93.1**
Prescription drugs	5.5	12.0	37.7	78.9	112.1	243.4
Nursing home care	4.2	17.6	50.9	82.8	94.1	150.7
	(Percent distribution)					
Total	100%	100%	100%	100%	100%	100%
Hospital care	43.8	47.8	41.7	38.2	36.8	34.2
Physician services	21.3	20.8	23.8	22.4	22.4	21.6
Dental services	**7.3**	**6.1**	**5.1**	**5.2**	**4.5**	**4.8**
Prescription drugs	8.6	5.5	6.1	8.1	9.7	12.6
Nursing home care	6.5	8.1	8.2	8.4	8.1	7.8

* Projected

Table 2. Current and Constant Dollar Dental Expenditures: Selected Years 1970-2008 [1-3]

	Total (in billions)			Per capita	
	Current	CPI	Constant	Current	Constant
1970	$4.7	39.2	$11.9	$22	$56
1980	13.3	78.9	16.8	57	72
1990	31.6	155.8	20.2	121	77
1997	50.6	226.6	22.3	182	80
1998	53.8	236.2	22.7	199	84
2000*	60.2			211	
2008*	93.1			307	

* Projected

As the labor market tightened in the final years of the 1990s, in some instances health benefit packages were added as incentives -- but with increasing employee contributions.

Now consider the impact of an economic downturn -- unemployment, pessimism, decreased consumption of just about everything from homes to jewelry and, yes, even dental care. The lack of a government safety net as well as limited industry interest in expansive health benefits, could become significant factors in the continued economic health of dental practices.

No doubt, the extended 1990s period of financial "irrational exuberance," combined with the downturn in the numbers of dental graduates (resulting in fewer numbers of young practitioners to replace the projected number of dentists leaving practice6) led the profession to fiscal complacency.

Given the histories of Medicaid dentistry and Medicare HMOs (e.g., as of January 1, hundreds of thousands of senior citizens were dropped from their rolls because of claimed inadequacy of capitation rates), the dental profession may (should?) be concerned with further government intrusion into the economics of dental practice. If this is the case, then increased efforts are essential for the profession to work closely with employers and unions to ensure continued and ever increased insurance coverage for dental services during all economic periods.

As reluctant as we may be for increased third-party involvement, we must consider support for innovative programs that place dental care on a par with other health services. At the same time, however, we must support efforts to increase public awareness of the extreme limitations of third-party support for dental services. Guidelines that the profession might adopt include dentistry within the Medicare program,7 increased action to provide dental services to people with mental retardation and developmental and other disabilities who increasingly reside in our communities,8 and focused lobbying on the shortcomings of managed care programs that seek to limit spending for dental services -- particularly now that the media is increasingly exploring their deficiencies.9,10

Or are we willing to continue to be lulled into complacency despite, the stock market performance in 2000 (and 2001):

- The worst annual performance of the Nasdaq Stock Market.
- The Standard & Poor's index's greatest loss since 1977.
- The Dow Jones Industrial Average's greatest percent loss since 1981.11

And, headlines that tell us: "Cuts in health benefits squeeze retirees' nest eggs"?12

Table 3. Distribution of Expenditures for Selected Personal Health Services: Selected Years 1970-2008 [1]

	Out-of-pocket			Total government spending		
	1970	**1997**	**2008***	**1970**	**1997**	**2008***
Total	39.0%	19.4%	18.5%	35.3%	44.6%	44.1%
Hospital care	9.0	3.3	3.2	55.4	61.6	58.8
Physician services	42.2	15.7	15.6	22.5	32.2	34.4
Dental services	**90.8**	**47.1**	**46.5**	**4.6**	**4.5**	**4.4**

** Projected*

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Table 4. Dental Expenditures by Source of Funds: Selected Calendar Year 1970-2008[1]

Year	Total	Total Private	Out-of-Pocket	Private Health Ins.	Total Public	Medicaid *
			(In billions)			
1970	$4.7	$4.5	$4.2	$0.2	$0.2	$0.2
1980	13.3	12.7	8.8	3.8	0.7	0.5
1990	31.6	30.6	15.4	15.1	0.9	0.8
1997	50.6	48.4	23.9	24.3	2.3	2.0
Projected 2000	60.2	57.5	28.4	28.8	2.7	2.2
2005	79.3	75.8	36.9	38.5	3.5	2.8
2008	93.1	89.0	43.3	45.3	4.1	3.2
			(Percent distribution)			
1970	100%	95.4%	90.8%	4.5%	4.6%	3.5%
1977	100	95.5	47.1	47.9	4.5	3.9
Projected 2000	100	95.6	47.2	47.9	4.4	3.6
2008	100	95.6	46.5	48.7	4.4	3.5
			(Per capita expenditures)			
1970	$22	$21	$20	$1	$1	$1
1997	182	174	86	87	8	7
Projected 2000	211	202	99	101	9	8
2008	307	293	142	149	14	11

***Subset of public funds**

Table 5. Spending for Dental and Total Health Services by Region and State: 1990, 1997, 1998 [2]

	Total health care as % of state gross prod.	Current dollar dental expend. per person		Constant dollar dental expend. per person		Percent dental expend. as % of total health care	
	1997	1990	1998	1990	1998	1990	1998
United States	**11.9%**	**$126**	**$199**	**$80**	**$84**	**5.1%**	**5.2%**
New England Region	**12.4**	**154**	**240**	**98**	**101**	**5.3**	**5.2**
Connecticut	10.8	194	273	124	115	6.3	5.8
Maine	15.1	106	187	68	79	4.9	4.6
Massachusetts	12.9	150	239	96	101	4.7	4.8
New Hampshire	11.4	139	238	89	100	6.0	6.1
Rhode Island	14.9	145	219	93	92	5.3	4.8
Vermont	12.7	125	215	79	91	6.0	6.3
Mideast Region	**12.3**	**139**	**205**	**89**	**86**	**4.9**	**4.6**
Delaware	9.2	122	208	78	88	4.7	4.9
Dist. Columbia	8.0	165	288	105	121	2.8	3.5
Maryland	12.1	130	203	83	85	5.3	5.3
New Jersey	10.7	162	236	103	100	6.2	5.8
New York	12.4	138	203	88	85	4.6	4.3
Pennsylvania	14.4	127	186	81	78	4.6	4.3
Great Lakes Region	**12.1**	**120**	**192**	**77**	**81**	**5.0**	**5.1**
Illinois	10.7	120	189	77	80	5.0	5.1
Indiana	12.5	98	173	62	71	4.2	4.8
Michigan	12.6	143	218	91	92	6.0	6.0
Ohio	12.7	109	176	69	74	4.4	4.6
Wisconsin	12.7	126	208	80	88	5.4	5.4
Plains Region	**12.6**	**111**	**182**	**71**	**77**	**4.6**	**4.7**
Iowa	11.8	98	168	62	58	4.5	4.7
Kansas	12.4	109	184	69	77	4.8	5.1
Minnesota	12.6	143	222	91	93	5.5	5.1
Missouri	13.0	100	161	64	68	4.0	4.1
Nebraska	11.7	100	164	64	69	4.5	4.4
North Dakota	16.1	98	172	62	72	3.8	4.0
South Dakota	13.1	96	163	61	69	4.4	4.2
Southeast Region	**13.1**	**103**	**170**	**66**	**71**	**4.4**	**4.6**
Alabama	15.1	91	149	58	63	4.0	4.0
Arkansas	13.7	87	154	55	65	4.1	4.6
Florida	14.9	129	198	82	83	4.7	4.9
Georgia	11.3	115	180	73	76	4.9	5.0
Kentucky	13.6	76	134	48	56	3.5	3.6
Louisiana	12.8	84	160	59	67	3.5	4.2
Mississippi	14.5	67	115	43	48	3.6	3.5
North Carolina	11.7	99	175	63	74	4.8	4.8
South Carolina	13.3	91	154	58	65	4.7	4.4
Tennessee	14.4	102	170	65	71	4.1	4.1
Virginia	10.0	115	187	73	79	5.4	5.7
West Virginia	17.5	71	122	45	51	3.3	3.1

Southwest Region	**11.1**	**100**	**164**	**64**	**69**	**4.5**	**4.8**
Arizona	11.4	121	185	77	78	5.2	5.8
New Mexico	11.2	92	154	59	65	4.7	5.0
Oklahoma	13.6	95	150	60	63	4.7	4.5
Texas	10.7	97	162	62	68	4.4	4.7
Rocky Mountain Region	**10.3%**	**$133**	**$217**	**$85**	**$91**	**6.4%**	**6.9%**
Colorado	10.1	147	237	94	100	6.3	6.8
Idaho	11.0	122	205	78	86	7.3	7.4
Montana	14.0	103	171	66	72	4.9	5.3
Utah	10.1	133	219	85	92	7.1	7.7
Wyoming	7.5	108	158	69	66	6.1	5.4
Far West Region	**10.3**	**165**	**253**	**105**	**107**	**6.7**	**7.4**
Alaska	8.7	171	276	109	116	7.0	7.3
California	10.2	162	244	103	103	6.5	7.2
Hawaii	11.7	175	238	112	100	7.1	6.1
Nevada	9.0	138	223	88	94	6.0	6.9
Oregon	10.4	163	274	104	116	7.4	8.3
Washington	10.6	187	302	120	127	8.1	8.9

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Dental Implant Jurisprudence: Avoiding the Legal Failures

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ABSTRACT The law measures the quality of dentistry by the "standard of care" as defined by the courts. The ultimate judges of the facts in a malpractice suit are usually juries made up mostly of lay people. Ignorance of the legal requirements for dentistry, and specifically dental implants, unnecessarily exposes today's dental health care provider to such suits. However, with a reasonable understanding of the legal issues and requirements surrounding the standard of care, a dentist may avoid becoming embroiled in a malpractice claim.

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"After many years on the bench, having presided over numerous jury trials, I have come to the conclusion that the process is not so much about the search for the truth as it is a civil method of resolving differences between people."
— Honorable Roy Norman, retired judge of the California Superior Court.

Trying to understanding the American legal system can be similar to trying to decipher a foreign language: Its esoteric rules often defy the ordinary logic of most dental practitioners. The law mea ures the quality of dentistry by the "standard of care" as defined by the courts, not by textbooks or journals. While the judges and attorneys determine the nature of the evidence presented, the ultimate judges of the facts are usually juries made up mostly of lay people with little or no health care training. Ignorance of the legal requirements for dentistry, and specifically dental implants, unnecessarily exposes today's dental health care provider to malpractice suits that are very costly to defend, both financially and emotionally. In dental malpractice lawsuits, dentists will be confronted with a legal system in which there are seldom any true winners. In addition, many suits result in costly investigations by the California Board of Dental Examiners and/or first party insurance carriers. However, with a reasonable acceptance of the reality of the law of dentistry, an understanding of the legal issues and requirements surrounding the standard of care, and implementation of a modest risk-management program, a dentist may avoid becoming embroiled in a malpractice claim and all the distress that it entails.

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No Longer Just an Option

In just two decades, this author, in the representation of dentists, has seen dental implants evolve from being considered cutting edge or even experimental by some dentists testifying as expert witnesses, to their current status as a well-accepted alternative to traditional fixed or removable restorations.1-5 In fact, the turnaround has been so complete that in the past two years, the author and some of his colleagues have represented dentists being sued for failure to recommend implants; and some insurance carriers have considered adding implants to their lists of covered benefits. Nearly every oral surgery and periodontology text published since 1995 contains some discussion of dental implants. The author has observed that attorneys representing accident victims have embraced implants because they have been accepted by trial judges as a recoverable expense necessitated by an injured party's loss-of-teeth injuries. To appreciate the legal implications, and indeed the law's requirements for dental implants, one must first appreciate the nature of the judicial system as it affects dentists.

Nature of the Legal System

The American judicial system encountered and utilized by the general public comprises three basic components: juries, attorneys, and judges. They operate under a system of laws that determine how the results of health (including dental) care delivery will be evaluated in cases involving claims of malpractice. Those laws (known as statutes or codes) are written by either the legislatures or courts of appeal (and are known as case or common law).

In our system, most often the jury, not the judge, determines issues of fact or, in plain terms, whom and/or what evidence to believe. The right to trial by jury can be waived by both sides. If that occurs, a judge would evaluate the evidence instead. In forming the jury, members of the local community are called at random from sources such as the county voter registration records, to serve on a jury.6 Initially, the judge questions jury candidates.7 They may be excused by the trial judge from serving as members of the jury for reasons such as having personal hardship, admitting to a strong bias toward one party or one side of the case, or acknowledging strong preferences for or against a particular issue before they hear any of the facts.8 After those jurors are excused, the attorneys representing the parties are allowed to question remaining prospective jurors.9

Uncovering jury biases that might favor one side or the other is the requisite skill and, indeed, art of the good trial lawyer, the second component of the legal system. After questioning, the trial attorneys for each side are allowed to reject and excuse up to six prospective jury members without stating any particular reason. Naturally, a seasoned trial attorney will use the limited number of challenges afforded him or her to excuse prospective members that might have leanings toward the opposing side and may tend to be persuasive with the other members.10 Generally, the members of the jury who make the final selection, and who will hear the evidence, are of average education, possess little or no health care training, and have not expressed any strong biases or opinions. Therefore, a dentist sued for malpractice will not be judged by a group of dentists or other health care professionals, rather by the lay public.

Attorneys are also the component of the judicial system most responsible for finding and then shaping the evidence that will be presented to the jury. Through a process known as discovery, the attorneys may interrogate witnesses with written questions known as interrogatories11 and verbal questions in a process called a deposition.12 They then hire experts to explain the dental and medical evidence, terms, and standards to the jury.13 Cross-examination of the opposing experts and their evidence is often the determining factor in the outcome of a suit. Indeed, this author has encountered and opposed several dentists who have gone to law school and opened up law practices specializing in suing dentists. They have first-hand knowledge of the issues surrounding dental implants.

The third component of the judicial system is the judge, who determines issues of law and applies the facts as determined by the jury.14-16 However, the judge is also the one who ultimately determines what evidence offered by the attorneys will or will not be admissible and heard by the jury, based upon his or her interpretation of the laws of evidence.17

The laws of California do not set forth the specific details of how dentistry is to be performed, rather without specifically defining that standard they charge that the dental care provider must meet or exceed the standard of care. The law is best summarized in the discussion given the jury to help them understand the "standard of care." The jury is told that a dentist, performing professional services for a patient, owes that patient the following duties of care:

"1. The duty to have that degree of learning and skill ordinarily possessed by reputable dentists, practicing in the same or a similar locality and under similar circumstances;

"2. The duty to use the care and skill ordinarily exercised in like cases by reputable members of the profession practicing in the same or a similar locality under similar circumstances; and

"3. The duty to use reasonable diligence and his best judgment in the exercise of skill and the application of learning. A failure to perform any one of these duties is negligence."18-21

Another way to describe the standard of care is to determine what would be reasonable and prudent conduct under the same or similar circumstances. It is not necessarily what is taught in dental schools or described in dental textbooks. Rather, it is what an expert witness will state is their belief as to the "standard of care," and then it is for the jury to decide

Case Example

In a recent case defended by this author, a patient came to a general dentist for replacement of a broken anterior tooth, No. 9, due to chronic decay and a failing root canal treatment. The doctor, in practice for about 18 years, recommended extraction and replacement with a three-unit bridge, based in part of the patient's dental plan, which provided for 80 percent coverage for anterior prosthodontics to replace missing teeth. There was no discussion about implants, as the doctor would have referred most patients out, and then only in cases where there were severe denture-retention problems.

The patient agreed to the treatment and teeth Nos. 8 and 10 were prepared for crowns. No. 10 had an old lingual composite, and it appeared the preparation was close to the pulp. The patient had the temporary bridge fall out twice and had it recemented each time. However, at the time of the try-in, the preparation did not seat; and the teeth had to be reprepared to be more parallel. New impressions were taken and the bridge seated. After cementation, the patient complained of sensitivity. It was determined that No. 10 had pulpal involvement. The doctor recommended a root canal treatment, which he subsequently performed. During the process, part of a file broke off in the apex, and he was unable to retrieve it. In the process, he ended up pushing part of the file out of the apex. The patient was advised and told the area would be watched, but no record of such was put in the chart. Three months later, the patient developed severe pain and called another dentist who sent her to an endodontist who recommended and performed apical surgery to seal off the root tip. About that same time, the patient contacted an attorney and subsequently learned that she could have had an implant and avoided any need for treatment of tooth No. 10. Suit was filed and subsequently settled in part because of the problem with the root canal treatment and for failure to advise of the alternative of dental implants.

which expert's opinion is most credible.

The same applies for specialists, and the jury is told by the judge that:

"It is the duty of a [dentist] who holds himself out as a specialist in a particular field of [dental], surgical or other healing science, to have the knowledge and skill ordinarily possessed, and to use the care and skill ordinarily used, by reputable specialists practicing in the same field and in the same or a similar locality and under similar circumstances. A failure to fulfill such duty is negligence."22,23

The jury generally comprises lay individuals, who are told they must rely on expert testimony and not their own knowledge of the science involved when determining whom to believe.

"You must determine the standard of professional learning, skill and care required of the defendant only from the opinions of the dentists who have testified as expert witnesses as to such standard.

"You should consider each such opinion and should weigh the qualifications of the witness and the reasons given for his opinion. Give each opinion the weight to which you deem it entitled.

"You must resolve any conflict in the testimony of the witnesses by weighing each of the opinions expressed against the others, taking into consideration the reasons given for the opinion, the facts relied upon by the witness, and the relative credibility, special knowledge, skill, experience, training and education of the witness."24,25

With regards to experts, the jurors are told that:

"A witness who has special knowledge, skill, experience, training or education in a particular subject has testified to certain opinions. Any such witness is referred to as an expert witness. In determining what weight to give any such opinion, you should consider the qualifications and believability of the witness, the facts or materials upon which each opinion is based, and the reasons for each opinion.

"An opinion is only as good as the facts and reasons on which it is based. If you find that any such fact has not been proved, or has been disproved, you must consider that in determining the value of the opinion. Likewise, you must consider the strengths and weaknesses of the reasons on which it is based.

"You are not bound by an opinion. Give each opinion the weight you find it deserves.

However, you may not arbitrarily or unreasonably disregard the dental opinion testimony in this case."26-29

In the final analysis, the question of whether malpractice has been committed is resolved by a battle of the experts and their individual credibility before a jury rather than some consensus of the sciences at issue.

When dental implants were first used, this author noted that plaintiffs' attorneys encountered little difficulty finding experts who would state that the care rendered was substandard because the devices were unproven or experimental. Today, it is quite the opposite. This author has found that it is nearly impossible to find any credible expert to challenge the concept that implants are an acceptable form of dental care and therefore the modern practitioner cannot escape giving them some consideration.

Evidence Standard

In a civil case the amount of proof (evidence) required by law that a plaintiff must present against a defendant is much lower than in a criminal case. As a result of the press and other media reporting criminal cases, it is not uncommon for a dentist to mistakenly believe that in order to lose a case there must be evidence "beyond a reasonable doubt." Instead, the jury is told that they need only find that the evidence in favor of the plaintiff is just more than 50 percent, or what is called "a preponderance of the evidence."

"Preponderance of the evidence" means evidence that has more convincing force than that opposed to it. If the evidence is so evenly balanced that you are unable to say that the evidence on either side of an issue preponderates, your finding on that issue must be against the party who had the burden of proving it."30,31

This author has noted that judges in California often allow lawyers to tell the jury that the evidence rule means that they must find for the plaintiff even with the slightest tipping of the otherwise evenly balanced scales of justice, even if there is as much as 49 percent of evidence to the contrary of the plaintiff's case. Once the jury finds that the preponderance is met, the plaintiff is entitled to their full measure of damages, not a reduction based upon the amount of evidence.32,33 Therefore good records become even more important evidence for the defense to use in tilting the scales toward the side of the doctor.

The New Standard of Care

The wealth of dental literature supports implants as a well-established form of long-term dental restoration, as reliable as bridges and preferable to removable appliances.1-5 The law holds that experts may rely on well-established and authoritative literature on the subject to support their opinions.34 In doing so, those experts have contributed to a change in the law by way of a modification of the duty of informed consent to include informed refusal.

Informed Consent

A dentist has a duty to obtain the informed consent of a patient before providing or declining to provide treatment. Informed consent is a process of education and communication that enhances the doctor-patient relationship and prepares the patient for the potential of a less-than-ideal outcome. With the exception of the application of general anesthesia, the law in California does not specifically require documentation of the consent process, only that it occur prior to treatment. The jury is told:

"It is the duty of the [dentist] to disclose to the patient all material information to enable the patient to make an informed decision regarding the proposed operation or treatment.

"Material information is information which the [dentist] knows or should know would be regarded as significant by a reasonable person in the patient's position when deciding to accept or reject a recommended medical procedure. To be material, a fact must also be one which is not commonly appreciated.

"There is no duty to make disclosure of risks when the patient requests that he not be so informed or where the procedure is simple and the danger remote and commonly understood to be remote.

"Likewise, there is no duty to discuss minor risks inherent in common procedures when such procedures very seldom result in serious ill effects.

"However, when a procedure inherently involves a known risk of death or serious bodily harm, it is the [dentist's] duty to disclose to the patient the possibility of such outcome and to explain in lay terms the complications that might possibly occur. The [dentist] must also disclose such additional information as would be called for by the standard of skill and care required of the defendant under the same or similar circumstances.

"A [dentist] has no duty of disclosure beyond that called for by the standard of skill and care required of the defendant under circumstances when he relied upon facts which would demonstrate to a reasonable person that the disclosure would so seriously upset the patient that the patient would not have been able to rationally weigh the risks of refusing to undergo the recommended treatment.

"Even though the patient has consented to a proposed treatment or operation, the failure of the [dentist] to inform the patient as stated in this instruction before obtaining such consent is negligence."35,36

In such a case, the doctor can be liable for a complication, not due to a failure of skill or technique, but merely because the patient was not informed of the potential risks, including such a complication, before consenting. Therefore documentation becomes a way of proving the consent process took place and that the patient consented to treatment with a reasonable appreciation of the risks, benefits, and alternatives.

Informed Refusal

The emergence and growth of managed care in the medical and dental communities has resulted in significant expansion of the laws of informed consent to include the doctrine of informed refusal in all cases, regardless of the method of payment. Put simply, the doctor has an obligation to advise the patient of the ideal treatment plan, not just the ones the patient can afford and to advise of the risks and benefits of the alternatives or those plans. Further, if a patient chooses the less expensive, but alternative, treatment plan, the comparative risks must be explained and the discussion should be documented. Today, a doctor can be liable for problems experienced by a patient who either was not told of a potential alternative treatment or was not told the risks of refusing a recommended treatment.37 The courts have held that:

"The [doctor] who complies without protest, with the limitations imposed by a third party payor [or that of the patient's own finances], when his medical judgment dictates otherwise, cannot avoid his ultimate responsibility for his patient's care. He cannot point to the health care payor [or patient finances] as the liability scapegoat when the consequences of his own determinative medical decisions go sour." In other words, the patient must be educated as to the superior alternatives, even if they are more expensive and/or not covered by insurance.

Implants and Informed Refusal

In the past, when a patient lost a tooth due to either trauma or decay, the traditional replacement was a three-unit bridge.1-5 This required preparing the two abutment teeth with the risk of injury to the root canals, followed by placement of the bridge. Home care then required the use of a floss-threading device, and there was the issue of bone atrophy in the area of the missing tooth. Insurance carriers would pay for crown/bridge replacement every five to 10 years. Each replacement carried the risk of breakage of the remaining tooth structure and root canal damage.38,39

Today, for about the same price, a patient can have a dental implant with minimal risk to adjacent teeth, and potential bone preservation with improved hygiene.37,40 However, few, if any, insurance carriers cover such treatment, and most patients will elect to have only the insurance-covered benefit or the cheapest care. In addition, this author, in defending several dental malpractice cases, has encountered many doctors who are either not comfortable or familiar enough with implants to discuss them with their patients.41 However, as noted above, the law does not allow the doctor to avoid the discussion of implants for those reasons and will make the practitioner liable for failure to conduct an informed-consent discussion that includes the alternatives to treatment in addition to the risks of treatment.

Where appropriate, implants must be offered to the patient, and if the patient declines and chooses a more traditional restoration, the doctor must obtain and document informed refusal, just as one would document informed consent. In doing so, the practitioner becomes entitled to some of the protections under the law. For example, a jury is told:

"A patient has a duty to follow all reasonable and proper advice and instructions regarding care, activities and treatment given by such patient's doctor.

A doctor is not liable for any injury resulting solely from the negligent failure of the patient to follow such advice and instructions."42-44

Referral Duties

A dental practitioner, if unable or unwilling to provide dental implant services, such as either implant restoration or surgery, must nevertheless consider making a referral to other dentists who can provide such treatment and discuss the risks and benefits, if implants are a reasonable alternative to traditional treatment. The jury is told:

"It is the duty of a [dentist] who is a general practitioner to [refer a patient to a specialist] [recommend the assistance of a specialist] if under the circumstances a reasonably careful and skillful general practitioner would do so.

If the [dentist] fails to fulfill that duty and undertakes or continues to perform professional services without the aid of a specialist, it is the further duty of the physician to have the knowledge and skill ordinarily possessed and exercise the care and skill ordinarily used by reputable specialists in the same field and in the same or a similar locality and under similar circumstances. A failure to fulfill any such duty is negligence."45-47

Based upon the law as cited above, the modern practitioner cannot avoid at least mentioning to the appropriate patients the potential for restoration with dental implants and either treatment planning them, making a referral, or obtaining informed refusal if the patient declines treatment.

Documentation

Several studies, including those sponsored by the Harvard Medical School Risk Management Foundation, have found that patients can suffer from genuine amnesia regarding pretreatment discussions, including informed consent.48 The conclusion was to get the evidence of informed consent, and now informed refusal, in writing. Technology in the form of computers, word processor programs, and e-mail have made consent forms so easy to obtain and use, that in the eyes of many "experts" they have become the standard of care. However, the consent form is not a practical or legal substitute for the discussion that should take place between the doctor and the patient. That duty cannot be delegated to a form, a movie, an audiotape, or even to staff that are not licensed to perform the treatment at issue.

In 25 years of defending dentists, this author has observed that patients seldom prevail in claims of lack of informed consent where the record of the consent discussion is well-documented and a signed, dated, and witnessed consent form utilized.49,50 Failure to have such documentation exposes the doctor to a jury system where compliance with the consent process between the practitioner and the patient will be judged by lay people.

Team Strengths

Recently this author has seen a rise in claims involving implant failures that actually represent a breakdown in the communications between dental practitioners. Those problems could have been easily overcome by the establishment of a dental implant team concept and improved communications, with more clearly defined roles and reasonable documentation.

The ideal dental implant team involves the implant surgeon, the restorative dentist, and the soft tissue and implant manager. The team can be three offices and three doctors or one office with one doctor. However the following recommendations apply to all such combinations.

First, roles must be identified. In malpractice litigation it is this author's experience that it is typical for the patient, via their attorney, to blame everyone involved for the failure of treatment and then demand each doctor or office to define their roles. The goal is to get the defendants to point fingers at each other -- the classic divide-and-conquer strategy. Because the team members may not see each other as team players or they

have not clearly defined their respective roles, getting them to blame one another is too often not that difficult, according to the experience of this author.

Good risk management for dental implants suggests that in an ideal setting, implant teams be formed and in place before implant patients are consulted. The general practitioner must recognize his or her boundaries of experience and be prepared to consider referral to a specialist or dentist with more experience and training if the case is beyond that experience. It has been this author's experience that one of the first inquiries by an attorney representing a patient in a malpractice claim is to question and require evidence of the defendant's experience with the problems presented by the patient at the initial consultation.

Informed consent should be a process that starts with a consensus of the implant team and results in obtaining a reasonable and well-documented consent via patient education during consultation.51 The team members should share documentation of the informed consent process used by each member. In that way, the patient will experience consistency in the discussions with various team members.

Prevention is also documenting the treatment plan through a pretreatment letter sent to the patient and copied to each team member. The letter should, based upon the hundreds of cases defended by this author, state the recommendations of the team for treatment, such as implants, the potential alternative treatments, the roles of each member, and the risks of treatment and of the alternatives as well as an agreed-upon treatment schedule, costs and funding considerations, and the obligations of the patient. After treatment, the patient should be sent a post-treatment letter regarding long-term management and again identifying each team member's roles and their expectations of the patient.

The team system also prevents a recently seen issue brought up in cases defended by this author in which implants have been placed without first consulting the restorative doctor who may have had other plans for reconstruction or minimal implant experience and therefore has a limited comfort zone or experience to deal with postsurgical issues. In such cases, the patient readily finds adversaries, rather than team members who should have been advocates.

Conclusion

Today, dental implants have matured to the level of having become a standard of care alternative to traditional fixed prosthodontics. Attorneys, and thus the courts, will evaluate claims of malpractice by examining the pretreatment alternatives and potential referrals given to patients before treatment is initiated. Documentation therefore becomes essential, including a record of informed refusal as well as informed consent, as to the risks, benefits and alternatives to any treatment.

The prudent practitioner can no longer allow presumed patient finances to dictate the nature of the treatment plans offered. Rather, implants must be offered as another accepted alternative for replacement of dentition. Failure to consider these obligations and to document the patient's selection and reasons therefore creates vulnerability to claims of a violation of the "standards of care."

However, with a reasonable pretreatment planning and documentation, the careful dental care provider can avoid such claims, expand the alternatives offered to patients, and enjoy the best benefit of all -- not having to retain the services of malpractice defense attorney.

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Caries Prevention That's the Bees Knees

Robert E. Horseman, DDS

I know we promised not to report on any more mice/rat-intensive research unless it involved the introduction of the ultimate mouse trap. Intervention on behalf of the beleaguered mouse population by the SPCA, the ACLU and other alphabet-heavy entities has made news coming from mousedom scarce anyway. It is a common misconception that rats are merely mice that work out, an idea that mice have eagerly promulgated, insisting to scientists that rats are far better to experiment on than themselves. We don't care; kittens are cuter than cats, it's the same difference.

But suddenly, mice and rats are back in the news, and not only that, but they have formed an unlikely alliance with bees. Normally, rodents and bees have little or no business with each other, social or otherwise. It was the pairing of birds and bees, serving as a parental introduction to pre-adolescent sexual curiosity, that was once popular. Modern children, with access to more specific information, have largely discounted what was patently an obscure relationship between these two disparate species.

It was with some astonishment, then, that we have discovered a phenomenon simultaneously occurring in New York and Brazil involving rats and bees. The fact that this particular research may soon involve humans in such a way as to directly affect the lives of dentists is what causes stringers reporting to the Los Angeles Times to cry out "Stop the presses!" The Times obliged, headlining a 2-inch column on Page A22 with this eye-popping phrase: "Bee Substance Possible Fighter of Tooth Decay."

Alert observers noted long lines of impatient rats queued up outside the University of Rochester in New York and, in some mysterious ESP way that rats have, also outside the State University of Campinas in Brazil. Apparently researchers at these institutions leaked the fact that they had stumbled upon another one of those serendipitous discoveries that scientists are always tripping over, like chocolate is better for zits than Clearasil.

This time it involves a material called "propolis," a common substance bees have had about the hive forever, assigning it no more importance that we would to, say, duct tape or spackle.

Lacking readily available supplies of propolis at neighborhood Home Depot stores, bees cleverly make their own by collecting secretions from trees and other plants, chewing them up and mixing them with beeswax. The beeswax can be purchased in convenient blocks at any supermarket or Pep Boys outlet. Bees use this stuff as cement to hold the hive together. It's their version of Krazy Glue, without which those little hexagonal segments of beehives would fall apart, turning happy,

contently humming honeybees into killer bees with an attitude.

The rodents, though their grapevine, learned that researchers discovered that propolis cut the cavity rate in rats 60 percent, thus the migration to Rochester and Brazil. "Yes!" exulted the rats; this being the first decent thing researchers had offered them in decades. "We want in on this!" You wouldn't think that rats would be all that concerned with their oral health, what with their antidiscrimination crusades and trying to get better package deals in Hollywood scream movies.

We daresay that dentists, burdened with the pressure of providing perfect smiles for their patients, are somewhat unconcerned with the DMF rate in rodents. This shortsighted attitude must be disheartening to rats and mice. They are not asking whether they are to get this propolis stuff incorporated in cheeseballs, have it with I.V. drips or get it painted on their teeth. All they know is that propolis virtually halts the activity of a key enzyme that forms dental plaque.

As usual, when scientists have had their way with the mice and rats, if the results don't disclose an unacceptable ratio of fatalities to successes, humans are the next beneficiaries. In the meantime, if you have an apiarist of your acquaintance, you might, sotto voce, hit him up for some propolis to augment your own war on plaque. You wouldn't want the rats to get wind of it, forming picket lines outside your house and brandishing poorly lettered little signs stating, "PROPOLIS NOW!" and "SPECIEISM!"