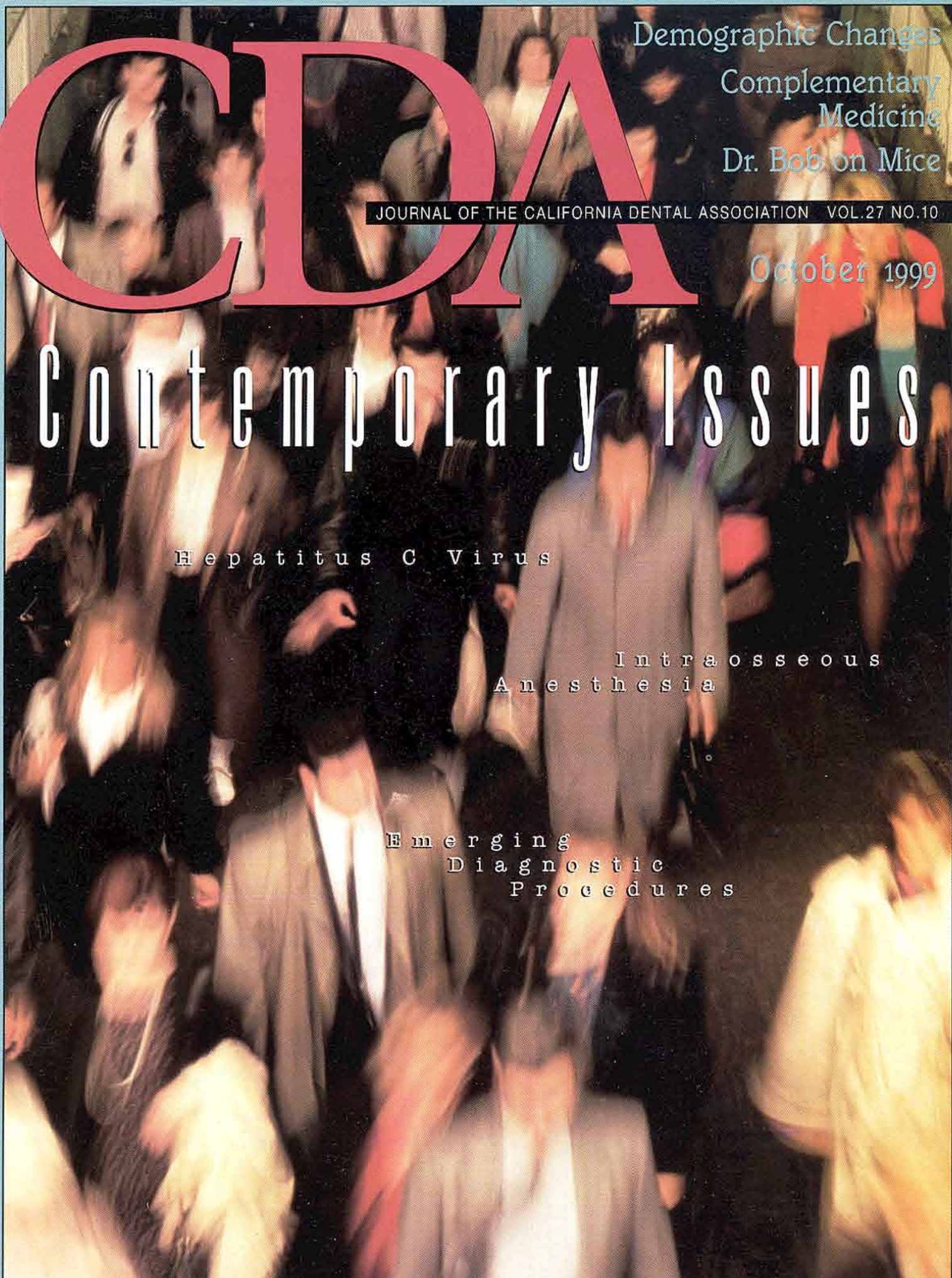

CDA

Demographic Changes

Complementary Medicine

Dr. Bob on Mice

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Contemporary Issues

Hepatitus C Virus

Intraosseous Anesthesia

Emerging Diagnostic Procedures

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DEPARTMENTS

FEATURES

CDA JOURNAL, VOL 27, Nº10

A New Era at CDA

JACK F. CONLEY, DDS

Last month, the topic here was the changing environment in which dentistry finds itself as the new millennium approaches a relatively few ticks of time from now. But what about the California Dental Association? What changes have set the association of 1999 apart from its previous editions?

Change in an organization is often difficult to measure because all but very major changes in personnel or policy are likely to occur without fanfare or recognition by the vast majority of membership. Such a major change occurred last year when Tim Comstock was hired as executive director. Most members of CDA are very familiar with that change in administration, due in part to the prolonged transition phase in CDA administrative leadership during the previous two years. The Comstock era at CDA is an example of a visible change.

Changes in volunteer leadership and the implementation and progress of programs are often more subtle and less visible to the membership at large. For example, at every annual House of Delegates, a new president is installed and a newly elected volunteer leader moves up to serve on the Executive Committee of the association. Beyond the fanfare associated with the House, it is business as usual for the association. Similar leadership transitions occur annually with new volunteers moving into service on the Board of Trustees and the various councils and committees of the association. An infusion of new ideas and new energy from this "rite of passage" is important to the growth and progress of our professional organization, although these transitions are not visible to the average member.

While each president may identify programs to be initiated during his or her tenure, they will also inherit issues of concern to the membership or new or developing programs that have previously been placed on the table by the House or Board of Trustees. For example, fluoridation was on the association legislative agenda several years ago. Since statewide fluoridation passed, the association has maintained a continuing and necessary presence to encourage and facilitate implementation of local fluoridation programs throughout the state.

An extremely significant issue to this association has been the increasing diversity of the profession in California. Given a declining market share of culturally, ethnically, and gender-diverse groups within the association membership and leadership, diversity became an important component of CDA's 1994 strategic plan. An ad hoc Diversity Steering Committee to study the issue and provide direction was appointed in 1996. This activity has been ongoing since that time, recently culminating in a report to the Board of Trustees, which described a three-year Organizational Plan for Membership and Leadership Inclusiveness (2000 through 2002) for CDA.

If queried about diversity in CDA, the majority of members would probably be of the belief that very little visible change has occurred in the past four years of committee activity. In important areas of leadership such as the Board of Trustees,

traditionally, significant change can only occur after change occurs at the component dental societies where these CDA trustees are selected. However, the steering committee report describes some notable accomplishments in each of the past four years that will facilitate the accomplishment of the goals set forth in the three-year organizational plan approved by the Board of Trustees in August.

Most important, a change toward a younger, more diverse Executive Committee has been quietly occurring and, until recently, may not have been particularly visible. Upon careful review, the changes have been remarkable. While recent boards of trustees (1996-99) have not shown a high level of diversity in their composition, they have nonetheless demonstrated (in their role of nominating committee for the association), that they have been incorporating an open and progressive attitude toward selection of a diverse association leadership corps. Unquestionably, the strategic plan and the work of the steering committee have also had some positive influence on this leadership process even though the formal organization plan has yet to commence.

When approved next month by the 1999 CDA House, the six elected, voting members of the year 2000 Executive Committee will feature ethnic minorities and the first woman to serve as a CDA officer. And, perhaps, most encouraging to the future vitality of the profession here in California is our observation that the average age of the officers in the chair positions (president, president-elect, vice president, secretary, and treasurer) is relatively low when compared to the usual age range we have seen over the years.

We have always had great respect for those who have served in the elected CDA leadership positions. The time requirement has always been demanding, and the commitment to the profession exceptional. It should also be noted here that in the past decade, we have seen the responsibilities and time requirements expand considerably for the volunteer leadership, making their contribution to their profession an even more significant sacrifice. Traditionally, the time and commitment required of volunteer leadership has limited the interested and qualified to those whose practices have matured to the point that they can afford time away for service to component dental societies, various professional organizations, and CDA. Typically, an individual will spend in excess of 15 to 20 years in service activities, not to mention balancing the responsibilities of raising a family. In the past, the majority of officer candidates were well into their mid-50s.

The year 2000 elected chair officers, with an average age of 49 years, are definitely not on the verge of retirement. Based upon their career accomplishments to date, and with their diverse backgrounds, they have the energy and insight to address some of the problems facing the younger and more diverse members, as well as those of the total membership. It promises to be a new and exciting era at CDA.

CDA JOURNAL, VOL 27, Nº10

Ancient Remedies Still Effective, Again

By David G. Jones

After long being ignored by Western medicine, ancient systems of treatment and healing again are coming of age and are being embraced by some medical institutions and practitioners. Some experts believe that dental professionals, subject to specialized kinds of stress and injury, may find benefits in the age-old therapies.

From acupuncture to yoga, these therapies date back to an ancient ideas and methods of healing developed over centuries as part of the traditional medicine of China, Japan and other Eastern countries. Records of some early techniques date back more than 2,000 years, but those techniques have not been widely embraced where Western medicine has held sway.

"We're slowly getting in touch with the value of these therapies, so we're back to the future again," says Peter L. Jacobsen, DDS, PhD. "But we're now just beginning to scientifically appreciate how this works."

Jacobsen, a member of CDA's Council on Dental Research and Developments, was to present a seminar titled "Health of the Healthcare Provider" at the association's Fall Scientific Session, held in San Francisco in August.

Sixty percent of medical schools nationwide have begun to teach students about alternative medicine practices, and hospitals are creating complementary and integrated medicine programs. Stanford University Medical Center has been in the vanguard in offering a variety of health techniques to patients since its Complementary Medicine Clinic opened in April 1998.

"The reason we were considering opening the center was there was clearly a growing demand from patients: 42 percent of Americans use some form of alternative medicine," says David Spiegel, MD, a psychiatrist and medical director of the Stanford clinic. "We also thought it would complement the regular care of our center, which devotes itself to coping with serious illness. It was a way to apply to the community at large the same level of high-tech medicine to 'high-touch' (non-traditional) medicine."

Bay area dentist Dr. Mark Abramson spends part of his time deeply involved at the Stanford clinic. He specializes in face and neck pain at his practice and teaches mindfulness meditation at Stanford to help people relax, cope with stress, and better deal with chronic pain.

"There is always stress for dental professionals in a normal smooth-running practice," Abramson says. "Just going from procedure to procedure all day long builds stress. Frustration with the staff, frustration with patients who are late and other things add more stress. As we get busy and focused on getting procedures done, we're not paying attention to our bodies, and this even affects the mental attitude we hold toward what we're doing or about to do, and that can affect quality of care."

According to Abramson, many practitioners anticipate problems and try to stay ahead of themselves.

"That puts them in a physiological stress state, and the immune system is being shut down because the body can't differentiate between what's real and what's imagined," he says. "So this meditation technique keeps you focused on the moment and helps you to respond to what's present in that moment, helping to take you away from anticipating and fighting things that aren't even happening."

G.K. Akhoshi, DDS, a general dentist practicing in San Jose for 27, took Abramson's course.

"I had an episode that a cardiologist thought might be a heart condition, and I was suffering from a lot of stress," Akhoshi says. "I thought it would be good to take the course."

Akhoshi says it confirmed the effectiveness of meditation.

"For me it was good, and I saw the positive effects on other people, too," he says. "There was a noticeable difference in my attitude and my physical and mental well-being. It's been very useful when I make it part of my everyday routine."

Dental professionals use their hand and arm muscles in intricate ways, so mindfulness can be a direct benefit there too, according to Abramson.

"We build tension in the muscles, and muscles become sore," he says. "I've learned at the end of the day to focus on my wrist, forearm, and fingers, and relax the muscles. This program teaches us to relax and recognize that pain is good because it helps us recognize where the muscles are hurting. This is important because ignoring it can be catastrophic."

Jacobsen says dental professionals tend to focus on patients' health to the exclusion of their own.

"Patients are in the office for an hour or two, but we're there for a lifetime," he says. "We often neglect our own health. Understanding and being attentive to our health is crucial for us and the longevity and quality of our practice and patient care."

The National Center for Complementary and Alternative Medicine within the National Institutes of Health conducts and supports basic and applied research and training and disseminates information on complementary and alternative medicine to practitioners and the public. Its former director, Wayne B. Jonas, MD, says that alternative medicine is here to stay.

"It is no longer an option to ignore it or treat it as something outside the normal processes of science and medicine."

For more information on the national

CDA JOURNAL, VOL 27, Nº10

center, call toll-free (888) 644-6226, or contact the center online at http://nccam.nih.gov/nccam/clearinghouse/.http://nccam.nih.gov/nccam/clearinghouse/

Demographic Makeover Comes to California

The traditional view of immigration to the United States elicits images of Irish, German, Italian and central and eastern European people hopefully working their way through the gates of Ellis Island.

California's ethnic history brings to mind a stream of Chinese who helped populate the state during its early years and helped create the country's most abundant and influential state.

But on the eve of the 21st century, a new wave that has been building for several years is ready to crest and further enhance California's diverse makeup. The demographic changes anticipated show a significant increase in the state's Hispanic and Asian populations and certainly will be reflected in the patient base of dental practices.

In 1990, California represented 12 percent of the nation's population compared with less than 10 percent in 1970. California's population has grown at roughly twice the rate of the other 49 states with much of the growth since 1990 specifically attributed to the increase in the Hispanic population. That trend is projected to continue at least through the next 50 years.

The state Department of Finance projects that in just 10 years, Caucasian and Hispanic populations in the state will be 46 percent and 36 percent, respectively. Conservative projections show a decline in Caucasian and Black populations, while the projected total growth will be attributed to the increase of Hispanics. The department projects that in 2040, one in two Californians will be Hispanic.

Those changes will mean a lot to dentistry.

Depending on the city or town of practice, the patient base of most dental offices will mirror demographic trends. A similar trend is noted when statistics from California's dental schools are examined.

The number of graduates from California dental schools in 1965 totaled 257. Although the schools were not tracing race, gender and ethnicity figures at the time, it is known that there were two female graduates and one Asian graduate that year.

The 1999 dental school classes are 48 percent Asian and 37 percent female. California's senior dental students are the most diverse in the country. And the number of Caucasian students is steadily declining, only 44 percent of the 1999 class, mirroring the projected decrease in the general population of the state.

The needs of these new dental dentists are not the same as they have been in the past. Different cultures have different views on all aspects of life, including dentistry. According to Russell Webb, DDS, chairman of the CDA ad hoc Diversity Committee, "I assumed that with the type and location of my practice (Upland, Calif.), the demographic shift wouldn't really be an issue. However, I recently hired an associate who happens to be a 30-year-old Asian male. It has been a challenge for me as a 54-year-old Caucasian male to see the practice and the needs from his standpoint."

"As an association, and as colleagues, we need to understand these differences and embrace the changes. If we don't, the new dentists will join other groups who do understand them, or they form their own groups. This loss of numbers will eventually reduce the programs CDA provide because of the loss in dues income. Eventually we will have a second-rate organization. We need to know what these new dentists need to succeed, and possibly change our approach to these new demographics, in order to remain an effective, well-represented and viable organization."

Sources: California Department of Finance, Population research unit, 1990 U.S. Census, California dental school alumni statistics.

The National Center for Complementary and Alternative Medicine recommends doing the following before getting involved in any alternative therapy:

- Get objective information about the therapy.
- Ask about the training and expertise of the person administering the treatment.
- Consider the costs, because many health plans won't cover treatment.
- Discuss all treatments with your primary care provider.
- Be open-minded, but don't accept every treatment at face value.

Smiling Swimmers Lament

Frequent swimmers may be at risk for developing yellowish-brown or dark brown stains on their teeth, according to the Academy of General Dentistry.

Those who swim more than six hours a week continually expose their teeth to chemically treated water. Pool water contains chemical additives such as anti-microbials, which give the water a higher pH than saliva. As a result, salivary proteins break down quickly and form organic deposits on swimmers' teeth.

CDA JOURNAL, VOL 27, Nº10

The hard, brown deposits, known as "swimmers' calculus," appear most frequently on the front teeth. Incidence of brown tartar is as high as 58 percent in children who swim regularly in elementary through high school.

Brushing more often and more carefully hasn't been proven to help. However, swimmers'calculus can normally be removed by a professional dental cleaning. Dentists should encourage those who swim competitively to visit the office for regular cleanings.

Get To Know the Locals

Dentists and dental groups looking to add some muscle to their marketing efforts should focus on developing relationships with local businesses, according to a survey conducted by Lew and Associations, Cerritos, Calif.

The company polled more than 100 benefits managers of small business in Southern California and found that 80 percent of them would like to learn more about specific dental services available to their employees.

"Typically, we find that only 10 to 20 percent of most employers (100 employees and above) are receptive to learning more about medical providers in their area," says Henry Lew, president of the company. "This was our first assignment for dentistry, and we were surprised that there was such positive feedback from employers. This data underscores our position that employers are constantly being presented with medical provider resources but very little in dentistry."

Dentists with multiple offices and large dental groups should add direct employer marketing to their arsenal of business development activities, Lew says. He added that dentists could ask to participate in employer health fairs, conduct employer screenings and provide

Lessons From the Geese

By Gary Henson

While some practitioners and their staff know how to work in sync with each other, many others don't. Working at cross-purposes rather than as a cohesive unit wastes energy, time and money. In that regard, a gaggle of geese can teach us a lot.

Lesson 1: As each bird flaps its wings, it creates uplift for the bird following. By flying in a "V" formation, the whole flock adds 71 percent greater flying range than if each bird flew alone.

So what? People who share a common direction and sense of community can get where they are going quicker and easier because they are traveling on the thrust of one another.

For the practitioner: If dental office players don't have clear goals and specific means of achieving them, the lack of vision will pull the team down. If the staff does not buy into the common purpose or is hostile to it, those individuals will drag the group down even further.

Lesson 2: Whenever a goose falls out of formation, it suddenly feels the drag resistance of flying alone and quickly gets back into formation to take advantage of the lifting power of the bird immediately in front.

So what? If we have as much sense as a goose, we will stay in formation with those who are headed where we want to go and will be willing to accept their help as well as offer ours.

For the practitioner: Use a methodology that looks at the strengths and weaknesses of procedures, not people. By doing so, one can fine-tune or revamp the system, which will help everyone do their job better. "How can I help you do your job?" could be a mantra.

Lesson 3: When the lead goose gets tired, it rotates back into formation and another goose flies at the point position.

So What? It pays to take turns doing the hard tasks and sharing leadership. With people, as with geese, we depend on each other.

For the practitioner: Individuals often are a problem, but blaming the person rarely solves the issue. Before criticizing the person, see if there is a problem with the system that could be fixed. If we address the system, we may not need to question the person.

Lesson 4: If the geese in formation honk from behind to be supportive, they will be empowered to lead. The united staff functions as a much more powerful team than as isolated individuals.

So what? We need to be sure our honking from behind is encouraging.

For the practitioner: If everyone learns to be supportive, they will be empowered to lead. The united staff functions as a much more powerful team than as isolated individuals.

Gary B. Henson is a profession coach and owner of Advanced Business Consulting in Sacramento, Calif.

CDA JOURNAL, VOL 27, Nº10

free seminars about oral health. In return, the dentist can distribute group information, educational materials, and educate employees about their office locations, services and insurance programs.

"Many dental groups rely only on word of mouth or direct advertising to drive their new patient business development activities," Lew says. "For those looking for sustainable growth, make sure you don't overlook your business community."

UCSF Receives $1 Million Endowment

The University of California, San Francisco, School of Dentistry recently was given a $1 million endowment from the Bernard Osher Foundation in an extension of the Osher Scholars Program.

The dual purpose of the Osher Scholars Program is to assist students with tuition costs to reduce the amount of debt that they would otherwise accrue by the time of graduation and to place a visible emphasis on the community services aspects of a professional health career.

"The Osher Scholars Program addresses a pressing need among those training in the health professions," says Charles Bertolami, DDS, DMedSc, dean of the UCSF School of Dentistry. "Many of our students want careers in community service and education, but the burden of debt significantly diminishes career options upon graduation."

Honors

David Chambers, PhD, has been appointed to the 1999 Board of Examiners for the Malcolm Baldrige National Quality Award. Chambers is the associate dean for academic affairs at the University of the Pacific School of Dentistry. (photo)

Donald W. Lippincott, DDS, has received ADA's Certificate of Recognition for Volunteer Service in a Foreign Country from the Council on ADA Sessions and International Programs.

Thomas Schiff, DMD, has received fellowship to the International Association of Dentomaxillofacial Radiology. Schiff is chair of oral and maxillofacial radiology and emergency services and director of clinical research at UOP School of Dentistry. (photo)

Guillermo C. Vicuna, DDS, has received a special citation for his significant contributions to advancing the oral health of the public and the profession of dentistry. Vicuna is co-founder of the Su Salud Disease Prevention Center.

Baldwin Marchack, DDS, has been elected to the Executive Council of the American Prosthodontic Society.

Web Watch: Special Interest Organizations

Pages of interest to dentistry.

http://www.howard.edu/collegealliedhealth/ndamain.htm

The home page for the National Dental Association.

http://www.hdassoc.org/

The page for the Hispanic Dental Association.

http://www.womendentists.org/

Home page for the American Association of Women Dentists.

http://www.persianet.com/idac/

Web site for the Iranian Dental Association of California.

http://www.ao.org/

The site for the Alpha Omega Dental Fraternity.

A listing here does not constitute endorsement by the California Dental Association. As is the case with all web sites, content is subject to frequent change.

CDA JOURNAL, VOL 27, Nº10

Hepatitis C Virus: Emergence of a Silent Pathogen

JOHN A. MOLINARI, PHD

ABSTRACT Hepatitis C is a relatively common bloodborne disease with risk considerations for health professionals, parenteral drug users, and other at-risk people. Medical and dental professionals have had to familiarize themselves with the rapidly emerging information about this form of hepatitis in order to treat infected patients and protect themselves, their co-workers and others from exposure. This article summarizes the current status of scientific and clinical evidence with regard to hepatitis C.

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Hepatitis C is a relatively common bloodborne disease with risk considerations for health professionals, parenteral drug users, and other at-risk people. Medical and dental professionals have had to familiarize themselves with the rapidly emerging information about this form of hepatitis in order to treat infected patients and protect themselves, their co-workers and others from exposure. This article summarizes the current status of scientific and clinical evidence with regard to hepatitis C.

Health care infectious-disease concerns about viral hepatitis prior to 1989 primarily focused on hepatitis B and its etiologic agent, hepatitis B virus (HBV). The documented occupational risks for HBV had been well-studied and described during the previous two decades with regard to viral characterization, transmission mechanisms, carrier risks following infection, infection control precautions designed to minimize viral cross-infection, and the effectiveness of an HBV component vaccine to stimulate protective host immunity. Viral hepatitis challenges continue to be defined; and, during the past 10 years, the following scenario has subsequently become a reality for a number of blood transfusion recipients, health care professionals, and others:

Results of serologic tests performed on a person either after an accidental needlestick while drawing blood or treating patients or following a blood transfusion received in the mid-1980s were negative for hepatitis B virus (HBV) and human immunodeficiency virus (HIV) infection. However, 10 to 15 years

CDA JOURNAL, VOL 27, Nº10

TABLE 1

Comparison of Major Microbiological and Clinical Features of Hepatitis Viruses

Principal author of study	Type of study	Anesthetic used	% Effective anesthesia	Onset	Duration	Lip numbness	Pain IO procedure	Side effects	Post-op complications
Leonard MS[5]	Clinical extractions	1.8 ml 2% lidocaine 1:100,000 epinephrine	88%	10-12 seconds	All extractions were completed in 15 minutes or less	No	A "few patients" reported pain	N/R	N/R
Replogle K[6]	Experimental, used pulp tester**	1.8 ml 2% lidocaine 1:100,000 epinephrine 1.8 ml 3% mepivacaine	74% 45%	N/R	N/R	N/R	N/R	Significant increase in heart rate with 2% lidocaine with 1:100,000 epinephrine, no increase in heart rate with 3% mepivacaine	N/R
Goggins R[7]	Experimental, used pulp tester*	1.8 ml 2% lidocaine 1:100,000 epinephrine	75% mand. first molars. 93% max. first molars. 90% max. lat. incisors 78% mand. lat. incisors.	Immediate	Steady decline over 60 minutes	58% with IO injection of mand. first molar	0-15% moderate pain	78% increase in heart rate	2-15% moderate to severe pain. 4% soreness, swelling. 4% teeth "felt high."
Replogle K[8]	Experimental, used pump tester*	1.8ml 2% lidocaine 1:100,000 epinephrine 3% mepivacaine	74% 45%	Rapid	20 min. — 62% 30 min. — 52% 45 min. — 29% 20 min. — 24% 30 min. —17% 40 min. — 7%	76% with 2% lidocaine 1:100,000 epinephrine 50% 3% mepivacaine	2-7% moderate pain. 0-2% severe pain.	N/R	2-10% moderate pain. 5% swelling, purulence. 13% teeth "felt high."

NR - not reported in study

* Anesthesia was considered successful when there was no subjective response to the maximum output of the pulp tester (80 reading - Analytic Technology pulp tester).

after the accident or transfusion, the person noticed that he or she frequently became easily fatigued, was unexpectedly losing weight, and appeared to be manifesting multiple nonspecific symptoms of liver dysfunction. After consultation with a physician and having additional blood tests performed, the person received an unexpected diagnosis. The person was found to be chronically infected with hepatitis C virus. Furthermore, as a result of detailed questioning about known risk factors, it was determined that the most probable source of viral infection was the exposure to blood many years before.

Since the discovery of hepatitis C virus in 1988,[1] variations of the above story have frequently been repeated; and hepatitis C is now regarded as a relatively common bloodborne disease with risk considerations for health professionals, parenteral drug users, and other at-risk people.

The amount of information published in the scientific and clinical literature is extensive; and knowledge continues to evolve in areas such as characterization and genetic mapping of the HCV virion, epidemiologic features of disease, modes of viral transmission, progression of acute and chronic infections, serologic diagnostic assays, risk factors, treatment approaches for HCV-infected patients, and infection control measures for health care facilities and patients' homes. Medical and dental professionals alike have had to familiarize themselves with the rapidly emerging information about hepatitis C in order to treat infected patients and protect themselves, their co-workers, and other patients from exposure. The following discussion summarizes the status of scientific and clinical evidence by using

representative questions asked by health care workers.

Was disease associated with hepatitis C virus recognized before discovery of the agent, and how does this microorganism compare with other known hepatitis viruses?

Early case investigations of post-transfusion hepatitis in the 1950s suggested a possible infectious etiology for the condition. This finding led to the practice of screening potential blood donors for blood or liver abnormalities in an effort to reduce the incidence of post-transfusion hepatitis.[2-4] Later discoveries of hepatitis A virus (HAV) and hepatitis B virus as organisms responsible for two forms of viral hepatitis were facilitated by major scientific advances in serology and tissue culture technologies and provided the tools for further viral investigations.[5-9] As more cases of hepatitis A and hepatitis B were diagnosed in the 1970s, clinicians noted that sera from a number of patients presenting with hepatitis signs and symptoms were negative for HAV and HBV immunological markers. Subsequent reports described another form of post-transfusion and percutaneous injury hepatitis that could not be attributed to any microorganism. Since diagnosis of this condition was based on abnormal liver function and the exclusion of positive markers for known hepatitis viruses, the term non-A, non-B (NANB) hepatitis was introduced.[10-15] Efforts to discover other microbial etiologies continue, and at least six viral agents have been found that cause the majority of cases of viral hepatitis (**Table 1**). Of these, HCV has emerged as an occupational concern for health care workers because of the risk of bloodborne transmission and the significant potential for chronic infection.

What are the major characteristics of HCV?

TABLE 2
Features of Hepatitis C

Principal author of study	Type of study	Anesthetic used	% Effective anesthesia	Onset	Duration	Pain IO procedure	Side effects	Post-op complications
Dunbar D[9]	Experimental pulp tester* mandibular posterior teeth asymptomatic	1.8 ml 2% lidocaine 1:100,000 epinephrine	100% immediate. 90% 60 minutes or longer.	Immediate	95% for 30 minutes. 90% at least 60 minutes.	2-12% mild-moderate pain	80% increased heart rate	2% pain 3% swelling 10% teeth "felt high"
Reisman D[10]	Clinical mandibular posterior teeth - Dx irreversible pulpitis-endo treatment	1.8 ml 2% lidocaine 1:100,000 epinephrine IAN block. 1.8 ml 3% mepivacaine supplemental	80% 1st supplemental -increased to 98% with 2nd supplemental	Waited three minutes before starting treatment	N/R but duration sufficient to complete endodontic procedure	9% moderate-severe pain performation. 27% moderate pain. 6% severe pain injection.	No increase in heart rate with 3% mepivacaine	N/R
Nusstein J[11]	Clinical mandibular posterior teeth-Dx irreversible pulpitis-endo treatment	1.8 ml 2% lidocaine 1:100,000 epinephrine	88% success with supplemental intraosseous injection	N/R	Sufficient time to complete endodontic procedure	8% moderate to severe pain perforation. 4% severe pain injection.	46% increased heart rate	N/R
Parante SA[12]	Clinical - DX irreversible pulpitis-endo treatment	0.45-0.90 ml 2% lidocaine 1:100,000 epinephrine	89% success used 0.45 to 0.90 ml anesthetic for supplemental 4/33 teeth needed a 2nd IO injection	Immediate	Sufficient time to complete endodontic procedure	N/R	Advised to caution patients-increased heart rate with IO injection	1/37 patients reported mild post-operative discomfort

N/R - not reported in study.

* Anesthesia was considered successful when there was no subjective response to the maximum output of the pulp tester (80 reading - Analytic Technology pulp tester)

HCV is a single-stranded RNA virus classified in the Flaviviridae family; it was isolated and cloned using recombinant DNA technology.[1] Worldwide, six distinct HCV genotypes have been characterized. In the United States, approximately 70 percent of the individuals with chronic HCV infection have been shown to harbor genotype 1. More recent studies investigating viral structures from clinical isolates have shown that there is also an extensive diversity in HCV genomes. Thus, different HCV strains, termed "quasispecies," can have substantial variations in genome sequencing, with resultant high rates of virion amino acid variability.[16-17] This heterogeneity occurs as result of viral RNA mutations that occur during viral replication. It is thought that the consequence of this genetic diversity in clinical infections is to allow the virus to escape protective host immune responses, with the most common result being a high rate of chronic infection18 (**Table 2**).

How is HCV transmitted, and what is the status of serologic testing?

HCV infection most commonly occurs following parenteral exposure to contaminated blood or blood products. Statistics collected during the the 1970s and '80s indicated that parenteral NANB hepatitis was responsible for nearly 90 percent of the reported U.S. transfusion-associated hepatitis cases.[19-20] In recent years, however, less than 5 percent of the reported cases have been traced to blood transfusions. The highest rates of HCV infection have been demonstrated in groups with large or

repeated percutaneous exposures, such as parenteral drug users and patients with hemophilia.[21-22] Health care workers who have frequent contact with blood and personal contact with others who may be infected within households, have also been documented with an increased incidence for hepatitis C compared to the general population.[23] Sexual transmission[24-25] and perinatal passage from HCV-infected mothers to their offspring[26-27] can occur, although neither of these routes is thought to be an efficient mode of viral exposure. **Table 2** lists groups described by the Centers for Disease Control and Prevention as being at increased risk for HCV infection.

Recombinant nucleic acid techniques were used to successfully clone the HCV genome. As a result, a sensitive serologic assay for anti-HCV immunoglobulins was developed. This first-generation radioimmunoassay was able to detect antibodies against viral c100-3 antigen.[1] Anti-HCV is found to develop in virtually all people infected with the virus and is associated with current or past HCV infection. It is important to note that the detection of anti-HCV in a person's serum does not indicate whether the person has had hepatitis C and is immune or has become chronically infected (i.e., still capable of transmitting the virus). Anti-HCV can persist in blood for years but may become undetectable spontaneously or following regimens of antiviral interferon.[18,22,28-30] Although not absolute in being able to detect all HCV infections and eliminating the potential for false positive results, subsequent second- and third-generation assays have increased the sensitivity and specificity of tests (**Table 3**). Since techniques aimed at growing HCV in vitro are not yet available, detection of viral RNA in a person suspected of hepatitis C is currently used as a direct viral marker.[31]

TABLE 3

HCV Serological Assays
Third generation anti-HCV immunoassays detect anti-HCV in more than 95 percent infected patients.
Remaining Problems:
1. They do not detect anti-HCV in all people.
2. They do not distinguish acute, chronic, or resolved HCV infections.
3. They may be prolonged period between acute HCV onset and seroconversion.
4. They have a high false-positive incidence in low-risk populations.
From: alter MJ, Mast EE, et al, *Hepatitis C. Infect Dis Clin N Am* 12:13-26, 1998

What is the course of infection with HCV?

Manifestations of HCV infection can be variable, exhibiting patterns similar to those observed for other hepatitis viruses. Briefly, affected persons may develop asymptomatic infections and appear healthy with normal liver function and no pathological sequelae, or they may develop acute and/or chronic disease manifestations. HCV infection often induces less hepatic inflammatory reactions than do hepatitis A or B, thereby manifesting milder symptoms. The most characteristic feature of acute hepatitis C is a fluctuating alanine aminotransferase pattern.[22] The range of asymptomatic patients with acute hepatitis C is 60 percent to 70 percent, with 20 percent to 30 percent becoming jaundiced, and the remaining 10 percent to 20 percent manifesting only fatigue, anorexia, and abdominal pain.[32] Since appearance of anti-HCV in a person's serum may not occur for weeks to months after viral infection, patients can continue to be infectious for extended intervals prior to onset of symptoms and diagnosis.

Although HCV is similar to HBV infection in certain aspects, a major difference can be found between the carrier rate incidence for the two. While hepatitis B has a 5 percent to 10 percent chronic carrier risk of longer than six months, approximately 85 percent of individuals infected with HCV can become carriers, with persistent or occasional viremia.[33-35] This form of persistent HCV infection increases later risks for hepatic failure and hepatocellular carcinoma. Individuals with certain immune-compromised conditions have also been found to have higher hepatitis C morbidity. Such individuals include people who are HIV-infected or who are preparing to undergo kidney or liver transplantation. Transmission in these cases is most probably due to frequent parenteral exposure to HCV via blood transfusion or intravenous drug use. High-risk sexual activity may also be a factor.[36]

What are the occupational risks for health care workers for bloodborne hepatitis C?

In a similar manner as historically demonstrated for hepatitis B, accidental percutaneous injuries from contaminated sharps represent the major hepatitis C occupational risks for health care workers. Occupational risks for NANB hepatitis were described even before there was a description of HCV.[12,37-38] Later, occupational risk investigations published after the virus was cloned further documented instances of HCV transmission to health care workers after bloodborne percutaneous accidents.[39-45] Syringe needles contaminated with patient blood were involved in most clinical reports.

Few transmission studies have been performed investigating HCV risks in dental professionals. Klein and his colleagues reported a higher incidence of

TABLE 4

Potential Transmission Risks to Health Care Workers*

Pathogen	Concentration mL Serum Plasma	Tranmission Rate (%) Postneedlestick Injury
Hapatitis B virus	1000-100,000,000	6.0-30.0
Hepatitis C virus	10-1,000,000	2.7-6.0
Human immunodeficiency virus	10-1,000	0.31

*Relationship between viral load and potential rate of transmission

Adapted from: Lanphear BP, Trends and patterns in the transmission of bloodborne pathogens to health care workers. Epidemiol Rev 16:43\37, 1994.

anti-HCV in a sample group of New York City area dentists (1.75 percent) compared with blood donor controls (0.14 percent). In one portion of the study, an observed higher incidence of anti-HCV markers in the sera of participant oral surgeons (9.3 percent) led to the suggestion that greater occupational risks occurred with increased exposure to blood.[40] Later data have not completely substantiated the earlier findings.[46-48] In fact, a recent review suggested that the prevalence of HCV among dentists, surgeons, and hospital-based health care workers is similar to the 1 percent to 2 percent figure reported for the general population.[49]

Based on this type of information, it appears that HCV is more difficult for health care workers to contract occupationally than HBV, yet HCV is a far more infectious bloodborne pathogen than HIV. **Table 4** compares viral concentrations of HBV, HCV, and HIV in blood and calculates infection risks following worst-case scenario needlestick accidents.[50] HCV is present in concentrations ranging from a few virions to 100,000 or more particles per milliliter of infected blood. This range falls far below that typically found in sera from HBV-infected persons. This information should serve as reinforcement for the routine use of universal bloodborne precautions aimed at preventing HBV transmission in clinical settings. Those same precautions are appropriate for HCV infection control. Unfortunately, even though HCV is less transmissible than HBV, a person who is infected with HCV appears to have a greater chance of developing chronic hepatitis C and only a low chance of recovering with immunity. Despite apparent lower health care worker and patient risks from sharps, however, HCV infection carries with it the increased possibility of chronic liver disease. The progression from persistent viral infection to either hepatic cirrhosis in about 25 percent of infected persons or hepatocellular carcinoma in others present real challenges to infection control for health care providers.

As part of an effort to prevent occupational transmission of HCV infection, the CDC published prescribed guidelines for follow-up procedures subsequent to accidental health care worker exposures to blood.[51] These procedures include:

- Baseline testing for anti-HCV immunoglobulins for both the person exposed and the source individual, with periodic follow-up testing for the exposed person;
- Confirmation of any positive serologic tests;
- Lack of proven effectiveness of prophylactic antisera; and
- Continued health care worker education about HCV risks and prevention measures. These guidelines were expanded in a more detailed 1998 CDC series of recommendations targeting prevention and infection control issues.[52]

What therapeutic approaches are being used to treat people who are chronic carriers of hepatitis C?

Antiviral chemotherapy with interferon has generally been recommended for individuals with chronic hepatitis C who are at the greatest risk for disease progression to cirrhosis.[53-54] The Food and Drug Administration approved a recombinant form of this antiviral agent for treatment of chronic hepatitis C in 1991.[55] Additional investigations attempted to further refine therapeutic dosages and time intervals for drug administration. For more detailed information, the reader is referred to the 1997 National Institutes of Health consensus statement.[53] In recent years, combining of chemotherapeutic agents has shown promising results. A combination of interferon and ribavirin is now FDA-approved for treatment of chronic hepatitis C patients who have relapsed following interferon regimens.[52] Test groups of patients who received this drug combination showed a substantial increase in success rates (40 percent to 50 percent) compared with those receiving interferon alone (15 percent to 25 percent).[52,56-57]

Patients are counseled prior to initiation of therapy, since both of these agents can cause mild to severe adverse effects. For example, interferon therapy has a number of potentially serious adverse effects associated with prolonged subcutaneous injection protocols, with the most common being flu-like symptoms in 60 percent to 80 percent of the trial recipients. Fortunately, evidence indicates that the side effects are in part dose-related and reversible after interferon therapy is stopped.[58-59] A serious problem associated with ribavirin use is the possible induction of hemolytic anemia, which can be life-threatening for some patients.[53]

TABLE 5

Hepatitis C and HCV Summary
■ Formerly non-A, non-B hepatitis (NANBH)
■ Major transmission ¾ bloodborne
■ Very high carrier rate compared to HBV
■ Health care worker occupational risks lower than documented HBV risks
■ Most serious risk ¾ percutaneous injury
■ No protective anti-HCV found yet
■ No HCV vaccine available
■ Nosocomial infection risk for health care workers and patients reported

Summary

Hepatitis C was formerly called parenterally transmitted non-A, non-B (NANB) hepatitis. This infectious disease has epidemiological characteristics similar to hepatitis B, with infection from contaminated blood appearing to be a primary source of the virus. Although at one time, NANB hepatitis was responsible for 80 percent to 90 percent of the transfusion-associated hepatitis cases in the United States, injection drug abuse has become the major documented risk factor for HCV infection. Health care workers and their patients face hazards for HCV infection primarily through needlestick and other contaminated sharps accidents, although the risks are much lower than those historically documented for HBV infection. Current universal bloodborne precautions for infection control appear to be effective against occupational cross-infection in patient care settings. A summary of these and other important features is presented in **Table 5**. There are pressing issues that still need to be explored, however, including provision of routine anti-HCV testing of health care workers after possible exposure, improvements in chemotherapeutic treatment regimens, and management of health care workers who develop chronic hepatitis C following occupational exposures.

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Infectious Disease and Infection Control Time Line

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Clinicians and students in health professional programs commonly want to know how far science has progressed in the control of infectious diseases. The following time line was developed to allow the reader to obtain a better appreciation for the historical progression of control of microbial disease, from early disease investigations and attempted solutions, to later issues, challenges, and strategies. The central theme is the recognition and application of scientific principles and data in the development of effective infection control practices.

The time line arbitrarily begins with one of the historical milestones linking microorganisms to infectious disease etiology. Emphasis has been placed on more recent events and publications in order to include primarily information that is of use to today's patient care providers.

Infectious Disease and Control Time Line

1546

First reports of disease transmission by contagion (i.e., minute bodies capable of self-multiplication).

1790s

Introduction of smallpox vaccination by Dr. Edward Jenner as effective preventive method against disease epidemics.

1843

Application of epidemiology principles to demonstrate infectious nature of puerperal fever.

- Demonstration of transmission from physicians and nurses.
- 1860s
- Introduction of antisepsis in prevention of cross-infection.
- Importance of hand hygiene demonstrated.

- Introduction of antiseptic technique for surgical procedures.
- Introduction of chemical agents (carbolic acid) for antisepsis, disinfection, and sterilization use.

1890

Introduction of rubber gloves for use during hospital surgeries.

1929

Penicillin first isolated by Sir Arthur Fleming from Penicillium notatum. Initial observations showed that the antibiotic was bactericidal against Staphylococcus aureus.

1940/1941

First patients administered penicillin G against infections caused by streptococci and staphylococci.

1940s

Growing number of reports of adaptive penicillin resistance in strains of Staphylococcus aureus. Primary mechanism of drug resistance found to be bacterial synthesis of penicillinases, enzymes that inactivate penicillin by cleavage of the drug's beta-lactam ring.

1941

Commercial production of penicillin G accomplished. This antibiotic was available for general use in the United States by the end of the 1940s.

1949

First occupational case of serum hepatitis (later termed hepatitis B) reported in a health care worker. Infection developed following needlestick exposure to contaminated blood.

1952

Earliest American Dental Association infection control guidelines published in Accepted Dental Remedies. Guidelines related to use of chemical agents for disinfection and emphasized precleaning and heat sterilization of instruments.

1963

First published description of microbial contamination of dental unit waterlines. High levels of microbial contamination were isolated in water samples taken from handpiece and syringe lines.

1965

Description of hepatitis B surface antigen by Blumberg and colleagues.

- Led to characterization of hepatitis B virus (HBV) and development of sensitive serologic tests for detection of blood markers following infection.

1970

Occupational Safety and Health Administration (OSHA) created by Congress.

1970s

Twenty-seven percent of oral surgeons and 13.6 percent of general dentists show serologic evidence of prior infection with HBV compared to 2 percent to 5 percent of general public.

Reports of clusters of HBV transmission from health care workers to patients.

Through mid-1980s, 20 clusters involving 300 patients were reported; nine clusters involved dentists/oral surgeons.

1973

Congress passes Rehabilitation Act of 1973.

1976

Outbreak of pneumonia (subsequently called Legionnaires' disease) at Philadelphia hotel during American Legion convention. A total of 221 cases were reported, including 34 fatalities.

1977

Isolation of Legionella pneumophilia accomplished from lung tissue of patients in Philadelphia.

1978

ADA report on infection control for dental offices published in Journal of the American Dental Association.

- Suggested procedures for reducing microbial contamination, cross-infection, and cross-infection.
- Included recommendation: "All instruments, burs, mirrors, bands, and other devices used in intraoral treatment should be routinely sterilized."
- Included initial consideration of waterline contamination along with possible solutions.

1981

First reports of Acquired Immunodeficiency Syndrome (AIDS) cases:

June – Unusual occurrence of five cases of Pneumocystis carinii pneumonia in previously healthy male homosexuals in Los Angeles.

July – Aggressive Kaposi's sarcoma seen in 26 young males in New York and California.

1982

First hepatitis B vaccine (Heptavax-B) becomes commercially available.

Centers for Disease Control (CDC) releases occupational infection control guidelines for health care workers: Recommendations include use of gloves, gowns, and extraordinary steps to avoid injury.

1983

CDC isolation guidelines include recommendations for dental health care workers: 1) wear gloves, mask, and protective eyewear; and 2) sterilize instruments.

Health care worker unions petition OSHA for an emergency standard to make employers pay for HBV vaccine. The request was denied. OSHA begins rule-making process for a standard on bloodborne disease transmission in health care settings.

1983/1984

Human immunodeficiency virus (HIV) identified.

- Found to be a retrovirus.
- Initially called by different names: In the United States -- human T-lymphotropic virus type III (HTLV-III); In France -- lymphadenopathy-associated virus (LAV).

1984

First case reported of occupational HIV infection of health care worker. Transmission occurred via accidental needlestick from an HIV-infected patient to a nurse in Africa.

Last reported outbreak of hepatitis B transmission in a dental care setting, from an HBV-infected oral surgeon to four patients (New Hampshire).

1985

First HIV antibody test for screening blood donors is licensed for commercial use. Blood donation centers initiate screening of all donated blood.

First generation enzyme immunoassay allows for better investigation of HIV surveillance, detection, and assessment of risks to health care workers.

Reported data suggest more HIV infections than reported AIDS cases.

1986

CDC publishes first comprehensive dental infection control guidelines. The central recommendation was a shift from selective precautions to routine use of universal infection control precautions.

1987

CDC reinforces universal precautions as basis for infection control. Agency emphasizes that blood, saliva, and gingival fluid in dentistry should be considered infectious. Also, universal precaution recommendations for HIV- and HBV-infected health care workers are made.

No further reports of HBV transmission from dentists to patients reported; still cases reported for viral infection from physicians to patients.

Sterilization of handpieces arises as an infection control issue for dentistry.

Dental unit waterlines identified as a source of postoperative wound infections in two cancer patients.

1989

Hepatitis C virus (HCV) identified.

- First form of Non-A, Non-B (NANB) hepatitis identified.
- HCV believed to be major cause of hepatitis associated with blood transfusions.

Hepatitis E virus identified.

- Cause of enterically transmitted NANB hepatitis.
- Transmission primarily related to contaminated water supplies.
- Multiple, large hepatitis E outbreaks reported in developing countries.
- Number of reported U.S. AIDS cases passes 100,000.

1990

First case report of HIV transmission from a health care worker to a patient (HIV-infected Florida dentist).

Americans with Disabilities Act passed, with implementation to occur in phases.

First generation anti-HCV serologic blood test developed.

Reports of multiple drug-resistant Mycobacterium tuberculosis continue to increase.

1991

FDA sends "Dear Colleague" letter to dentists concerning handpiece sterilization.

Continued reports of infected patients in case of HIV transmission involving Florida dentist.

FDA publishes initial recommendations for people with latex hypersensitivity following more than 1,100 submitted reports of latex allergies with 15 deaths attributed to natural rubber latex barium enema tips.

CDC releases HBV-/HIV-infected health care workers guidelines.

- Adherence to universal precautions.
- HIV transmitted much less readily than HBV.
- Recommendations for establishment of review panels in health care facilities.

OSHA Bloodborne Pathogen Standard becomes U.S. law.

Reports of occupational dental injuries demonstrate downward trend from 12 per year to three to four per year.

1992

CDC publishes report on second 100,000 U.S. AIDS cases.

- First 100,000 cases occurred during an eight-year period.
- Second 100,000 cases reported during two-year interval.
- Trends for second 100,000 cases reflect increasing proportion of people with AIDS who had heterosexual exposure to people at risk for HIV infection.

- One AIDS death reported every 15 minutes.

CDC publishes report titled "Management of Persons Exposed to Multidrug-Resistant Tuberculosis." Included were suggestions for evaluating and managing people exposed to patients with strains of Mycobacterium tuberculosis that exhibit resistance to isoniazid and rifampin.

Women surpass intravenous drug users in frequency of new AIDS cases.

OSHA petitioned by health care unions for workplace standard on tuberculosis control.

HBV incidence reported down to 9 percent in general dentists and 20 percent in oral surgeons.

1993

CDC publishes updated dental infection control guidelines.

- Tuberculosis precautions included.
- Recommendations for dental unit waterline infection control precautions.

Large waterborne outbreak of cryptosporidiosis reported in Milwaukee as a result of problems with municipal water treatment processes.

- Estimated 403,000 people infected.
- Immune-compromised people at greatest risk for life-threatening illness.

CDC reports 55 percent decrease in rate of HBV infection.

1994

CDC finalizes tuberculosis infection control guidelines. Occupational risks for dental health care workers generally considered to be low in most practice settings.

Pediatric AIDS study reports benefits of prenatal AZT use; decrease from 25.5 percent to 8.3 percent perinatal risk.

1995

Public Health Service reports AIDS incidence growing faster among women than men:

- Women account for 22 percent of new AIDS cases and 22 percent of total AIDS cases.
- HIV continues as leading cause of death in males ages 25 to 44.

ADA publishes statement on dental unit waterlines: suggestion of microbial target level for year 2000.

CDC reports AZT reduces HIV infection risk by 79 percent in health care workers when used as postexposure prophylaxis.

1995/1996

HIV protease inhibitors receive FDA approval.

1996

Hepatitis G virus identified.

Virus may be transfusion-transmissible.

Global distribution.

Thought to be present in U.S. volunteer blood donor population.

ADA Council on Scientific Affairs and Council on Dental Practice publish latest infection control recommendations for the dental office and the dental laboratory.

As of June, 51 health care workers documented with HIV infection resulting from occupational exposure, with 108 additional possible occupational infections.

- No dental health care workers documented with occupational HIV infection.

FDA licenses HIV home test kits.

- First saliva test for HIV.
- HIV antigen test for screening blood donations.

CDC revises HIV postexposure prophylaxis to include use of reverse transcriptase inhibitors and protease inhibitors in either mono or combination therapy.

Viral load testing becomes routine HIV evaluation.

President signs Safe Drinking Water Act ($7.6 billion) to improve U.S. water processing systems and water quality.

FDA publishes latex policy statement "requirement for manufacturers" in product labeling.

- Hypoallergenic label deemed inappropriate and misleading.

1997

French Health Ministry issues findings of epidemiological investigation concerning HIV-infected orthopedic surgeon who transmitted HIV to patient during surgery.

First cases of vancomycin-resistant Staphylococcus aureus infection in humans.

- First case reported in Japan, followed soon after by two U.S. cases.

As of June, 52 health care workers documented with HIV infection resulting from occupational exposure, with 114 additional possible occupational infections.

Still no dental workers with documented occupational HIV infection.

In September, CDC publishes notice of draft guidelines for infection control in health care personnel to update and replace 1983 recommendations.

Broad recommendations for reducing transmission of infections from patients to health care workers and from health care workers to patients, including immunizations, isolation precautions, exposure management, and work restrictions.

Recommendation made for anti-hepatitis B surface antigen postvaccination testing in health care workers who receive hepatitis B vaccine.

National Institute for Occupational Safety and Health research agenda targets health care worker latex allergy problems. Research direction investigating latex exposures and allergic reactions in health care industry.

CDC reports 1996 AIDS data, which show first decline in U.S. AIDS deaths and AIDS opportunistic infections.

1998

Public Health Service reports continued decline in reported U.S. cases of tuberculosis for 1997 (19,855 cases, 7.4 cases per 100,000 population).

FDA-mandated latex regulations for manufacturers become effective.

CDC publishes recommendations for prevention and control of HCV infection and HCV-related chronic disease.

U.S. Appeals Court for the First District rules there is no direct threat in providing dental care to an HIV-positive woman.

1999

As of Dec. 31, 1998, 54 health care workers documented with HIV infection resulting from occupational exposure, with 134 additional possible occupational infections.

To date, no dental workers with documented occupational HIV infection.

OSHA pushes for new legislation to reduce needlesticks among health care workers.

Ten states have passed legislation, and 10 states have pending legislation in this area.

Conclusion

Although the time line has been set up to be representative of many areas, it most certainly has omitted events or reports some readers consider important. If any readers have information they believe should be included, please send them to the address below. The present time line can then be made more inclusive and useful to treatment care providers and health professional students alike.

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Oral Medicine: Advances in Diagnostic Procedures

Carol Anne Murdoch-Kinch, DDS, Ph.D.

ABSTRACT In the latter part of the 20th century, the computer and molecular biology have facilitated great scientific progress in medicine and dentistry. In dentistry, emerging clinical methods based in molecular biology and digital technology have the potential to improve the early diagnosis of dental caries, periodontal disease, and oral cancer. In addition, saliva shows potential as a convenient substitute for blood in diagnostic testing for systemic and oral diseases. DNA chip technology, a new system that combines these two technologies, has potential diagnostic value in dentistry as well as medicine. For each of the three common oral disease processes, emerging diagnostic procedures are discussed, with an emphasis on their potential utility for the practicing dentist of the 21 century.

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In the latter part of the 20th century, both computer science and molecular biology have facilitated great scientific progress in medicine and dentistry. In dentistry, emerging technologies based in molecular biology and digital technology have the potential to improve the early diagnosis of dental caries, periodontal disease, and oral cancer. In dental caries, for example, the dental explorer and bitewing radiograph have always been integral to the caries examination. Soon, they may be replaced by electrical conductivity methods and quantitative laser fluorescence measurements. The scientific principles behind these methods are made clinically relevant through the use of digital technology. Also, the concept of risk assessment in oral diagnosis and treatment planning may have a greater chance of becoming a practical reality in private dental practice, if computer algorithms can be applied to clinical data to quickly and accurately calculate risk. Measurements of disease indicators such as cytokines or DNA analysis may be included in such risk assessments in the future, thus combining digital and molecular technologies. Similarly, digital subtraction radiography in periodontal disease and computer-aided cytology in oral cancer represent new diagnostic procedures that dentists of the 21st century can be expected to use to benefit their patients through early diagnosis and disease intervention. These and other selected diagnostic procedures will be discussed.

Saliva is a potential source of material for diagnostic testing in both systemic disease and oral disease. With new

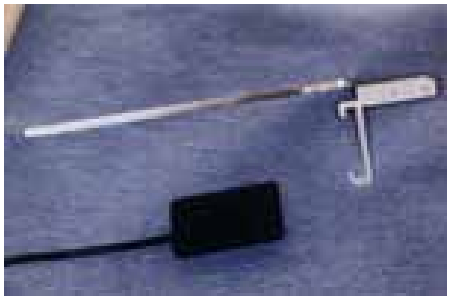

Figure 1. The charge-coupled-device sensor for the digital radiography is attached to the computer by a cable. The sensor fits into the film holder for a parallel projection periapical image.

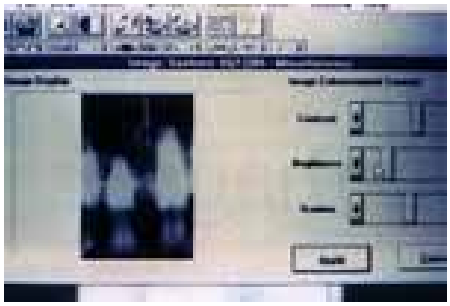

Figure 2. A view of the display screen using a currently available digital radiography software program shows the image enhancement options available. Most commercially available software packages include these options (Photo courtesy of Dr. James Geist)

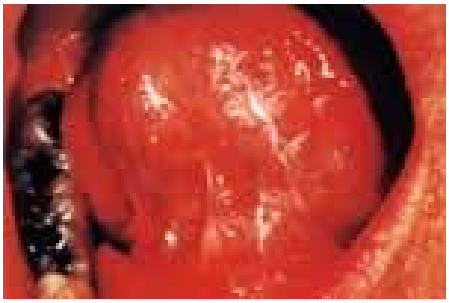

Figure 3. This leukoplakia located on the ventral surface of the tongue and anterior floor of the mouth is the type of clinically suspicious lesion that might initially be assessed using the oral brush biopsy technique

interest in the link between oral and systemic health[1] and recent success using saliva-based molecular diagnostics, it is possible that saliva sampling may become part of the routine examination and assessment of dental patients. In addition to the biologically active proteins and exogenous substances such as drugs that can be found, saliva is also a source of the patient's DNA. The imminent completion of the Human Genome Project and its progress to date suggest that DNA analysis may become important in risk assessment, disease prevention, and health promotion efforts of all health professionals.[2] Therefore, this paper will conclude with a brief description of micro-array or "DNA chip" technology. This emerging technology represents the combination of the "state-of the art" of both digital and molecular biology techniques and shows promise as a diagnostic aid in medicine and dentistry in the very near future.

The aim of this paper is to:

- Give an overview of recent progress in oral diagnosis in those diseases most relevant to practicing dentists, and
- Serve as an introduction to the diagnostic procedures that are expected to become part of dental practice in the next century.

Dental Caries

By the time the earliest signs of caries are detectable, the disease is already well-established.[3] Dentists cannot detect the onset of caries. In most Western countries, caries prevalence has declined, although there are certainly portions of the population that demonstrate high caries rates. Caries is harder to detect in populations with low caries prevalence, because lesions are smaller and progress slower. Fluoride may be partially responsible for the declining prevalence and also the difficulty in detecting lesions. Research has shown that caries can be arrested and noncavitated lesions that are confined to the enamel can remineralize. To take advantage of the potential for remineralization, the caries must be detected at an early stage so that aggressive medical treatment can be used at the right time. In addition, dentists need to be able to monitor lesions for small changes indicative of progression or remineralization.[3]

It takes more time to diagnose early lesions because they are harder to detect and the dentist is more likely to detect lesions in those patients at greatest risk of developing caries. If dentists are to successfully remineralize early lesions in their patients, they must first detect those early lesions. Caries risk assessment must be performed to identify those patients for whom additional diagnostic procedures may be indicated. There are several excellent reviews of risk assessment in dentistry.[4-6]

Methods of detection are different for different types of caries.[3] The pattern of caries has changed. Occlusal surfaces are proportionately affected more often than smooth surface or approximal surfaces; therefore, recent attention has focused on the early detection of occlusal surface caries. However, methods of detection of approximal, smooth surface, and root caries will also be discussed: direct digital radiography, quantitative light (laser) fluorescence, electrical conductivity measurements, and microbial testing.

Direct Digital Radiography

Wenzel7 recently reviewed the use of digital radiography for caries diagnosis. There are two types of digital radiography image systems:

1. Charge-coupled-device-based (**Figure 1**), and
2. Storage-phosphor-based.

In the charge-coupled-device system, a cable connects the sensor to the computer, and the image is displayed on the monitor (**Figure 2**). In the storage-phosphor system, the reusable image plate is exposed to X radiation to create a latent image. The plate is exposed to a laser scanner to obtain the stored information. The advantages of digital radiography over conventional film-based radiography are:

- The image can be manipulated to change contrast and density according to the diagnostic task.
- One can avoid the potential errors associated with chemical processing.
- Radiation dose to acquire a diagnostic image can be lowered to 50 percent or

less of that needed for conventional film-based radiography. This increases x- ray tube life.
- It takes less time to acquire an image.
- Image storage and communication is easier with digital networking.[5]

Based on the results of the studies she reviewed, Wenzel concluded that digital radiography appears to be at least as accurate as current dental films for the detection of caries. However, currently radiography is of no value for the detection of occlusal caries confined to the enamel. Also, for all radiographic methods, predictive values for the detection of approximal enamel lesions are poor. Radiographic methods are better for the detection of approximal dentinal lesions.[7]

Most digital radiography systems offer image enhancement software as part of a package (**Figure 2**). Wenzel and colleagues[8] showed that contrast-enhanced digitized films and charge-coupled-device-based images tended to perform better than unenhanced images within the same systems. Other studies have not shown any improvement with task-dependent algorithms for the diagnosis of occlusal and approximal surface caries.[7]

Subtraction radiography is a type of digital radiography that uses computer software to display an image representing the difference between two images of the same object. With storage-phosphor digital radiography, it is possible to enhance small changes in density to facilitate their detection. Storage-phosphor images were found to be better than film for the detection of artificial recurrent caries, and false-positive scores were reduced.[9] However, more studies exploring image enhancement and its effects on diagnosis are needed.[7]

One area that holds some promise is computer-aided diagnosis.[7,10] On average, newer systems have been shown to perform as well as or better than human observers. However, before computer-aided diagnosis can be recommended for clinical use, its accuracy must be confirmed to be higher than that of trained observers. The suboptimal specificity and sensitivity of current receptors and film-based images limit the potential of computer-aided diagnosis since the data used to make the diagnosis is inadequate.[7]

Digital radiography use is more widespread in clinical practice in Europe but is increasing in the United States. There have been few published clinical studies using digital radiography for caries diagnosis. Therefore, many of the theoretical advantages of digital radiography over conventional film-based images have not yet been confirmed in clinical studies. Also, the economic benefits of such technology for the patient, the dentist, and society need to be determined[7].

Quantitative Laser or Light Fluorescence

Quantitative laser or light fluorescence takes advantage of the natural luminescence exhibited by tooth tissue exposed to light at a wavelength of 488μm. The two emerging methods for early caries detection that appear to hold the most promise for clinical practice are electrochemical impedance spectroscopy and quantitative laser (light) fluorescence.[3] With quantitative light fluorescence a broad beam of diffuse monochromatic light within the blue-green region (wavelength of 488μm) is produced by an argon laser source and applied to a tooth. This induces luminescence of the tooth. The natural fluorescence of enamel is in the yellow-green range and is observed through a high pass filter to exclude tooth-scattered blue laser light. Areas of demineralization appear as dark spots. In the quantitative method, the fluorescent light is detected by the instrument through the handpiece that delivers the light, and its intensity is quantified using a computer. The quantitative light fluorescence method has been validated; mineral loss was strongly correlated with a relative loss of fluorescence radiance. In one study, quantitative laser fluorescence allowed investigators to follow weekly changes in enamel during a five-week period.[3,11]

Recently, a small portable quantitative light fluorescence device suitable for intraoral use was described.[12] It uses a regular light source (quantitative light fluorescence method). It has been shown to sensitively and reproducibly quantify enamel lesions to a depth of 400 μm.[12] This light-induced fluorescence method is the only one that has been tested clinically.[11] Orthodontic patients at risk of developing buccal surface caries were studied for such changes. The results suggested that quantitative light fluorescence is appropriate for the in vivo monitoring of mineral changes in incipient enamel lesions. The investigators concluded that it may be useful for the evaluation of preventive measures in caries-susceptible individuals.[11]

DIAGNO-Dent is a similar instrument currently under validation and testing. It is commercially available in Canada (DIAGNODent; KaVo, Ontario, Canada).[3] Its intended use is the quantification of caries on occlusal and smooth surfaces. A laser diode light source (similar to a laser pointer) produces light of a different wavelength than that produced by a fluorescing tooth and is delivered to the tooth by a fiber-optic handpiece. This fluorescent light is reflected back through the handpiece, where it is translated into an acoustic signal; and the

wavelength is evaluated by the control unit, which displays a digital representation of the wavelength detected. Changes in wavelength are reportedly associated with the changes in mineralization of the enamel.

Electrical Conduction Methods

Recently, Angmar-Mansson[3] described this technique that was introduced to dentistry in 1951. Its underlying principle is that the reduced mineral content of carious enamel increases its electrical conductivity, and this can be detected. The probe tip is placed in the occlusal fissure, and conductivity through the dental pulp to a handheld ground lead is measured. Studies have been done using the Vanguard and Cariesmeter L, devices no longer being manufactured. A newer instrument called the Electronic Caries Monitor (LODE Diagnostics, Groningen, Netherlands) is currently available. Studies on the two earlier models showed that electrical conductivity methods were superior to visual inspection, fiber-optic transillumination, and radiography for occlusal caries diagnosis. The recent revival of interest in fixed frequency electrical devices arises from their promise of the detection of occlusal lesions (which are proportionately more affected) and possibly approximal lesions.[3]

Electrical conductivity measurements can aid the detection of fissure caries in recently erupted molar teeth.[3] Electrical conductivity measurements can be used to determine the probability that a sealant or a restoration is required within 18 to 24 months after eruption. However, because of the low specificity, electronic conductivity methods should not be used when one is deciding whether to treat a lesion operatively. Low specificity increases the chance of false-positive results and the likelihood of unnecessary invasive treatment. Therefore, electrical conductivity methods may be better used to detect early lesions and monitor lesion progression or arrest in sites where noninvasive intervention is indicated.11 These lesions are often overlooked in conventional visual and radiographic examination.[3]

Alternating Current Impedance Spectroscopy Technique

Alternating Current Impedance Spectroscopy Technique (ACIST) characterizes the electrical properties of a tooth and lesion to monitor and quantify change. If one applies an alternating current to a tooth bathed in saliva, an ionic current flow will be generated that will have a mean value of zero and will not polarize the electrolyte solution. Electrical impedance measurements reflect not only resistance but also other factors that hinder the flow of current. Ion motion is measured when electrical impedance spectroscopy is used to characterize dental hard tissues that have pores of ionic dimensions. These electrical impedance spectroscopy measurements reflect the current size of the pores. In carious hard dental tissues, the pores are larger than in sound tissue. This method was tested in a clinical study on root caries.[14] It was concluded that repeated measurements over time could show whether the pores are getting bigger or smaller and subsequently whether caries is progressing or reversing.[14]

Greater resistance (impedance) measurements were found with small pore size, but there was overlap between experimental groups. Further testing should done to refine and validate this technique as a potential aid to diagnosis and monitoring of the caries process over time.[14]

Microbial Testing

Recent reviews of the utility of microbial tests (e.g., S. mutans, Lactobacillus sp. counts) to diagnose and predict caries activity have concluded that the tests have use as an adjunct to other methods of diagnosis in individual patients. They are probably most useful when measured initially to establish a baseline value for the patient, then measured periodically to detect change associated with an increased risk for caries. There are limitations to the accuracy of these tests that may not be correctable, even with further research, because of the inherent biology of these organisms and their relationships with the individual host.[15]

Verdenschocht and colleagues assessed developments in caries diagnosis and their relationship to treatment decisions.[16] In the past when caries prevalence was higher, visual inspection and radiographic examination were probably adequate to diagnose caries requiring operative treatment. Now, with caries prevalence declining, these methods are no longer appropriate for all patients. For most patients in Western countries, caries detection is focused on finding small lesions. Verdenshocht and colleagues performed a meta-analysis on diagnostic tests of occlusal caries. They concluded that visual inspection performed the worst and electrical conductivity methods the best. Their meta-analysis for approximal caries showed that radiography was superior to fiber-optic transillumination. When histologic lesion depth or mineral loss was used for validation of the diagnostic method, the results were:

- For approximal lesions, quantitative fiber-optic transillumination had the highest correlation with lesion depth.
- For occlusal surfaces, visual inspection

using a scoring system based on translucency and breakdown of enamel on air drying had the highest correlation with histology. This was followed by electrical conductivity methods.[15]

Verdenschocht and colleagues pointed out a study that illustrated that clinicians may improve their performance by training in using a detailed scoring system and taking the time to dry the field and conduct a thorough exam.[15] Quantitative methods had the highest correlation with lesion depth and have more potential to monitor small changes over time.[15]

Because caries is a chronic, slowly progressive disease, its effects are not detected until years after its onset. Early detection of signs of caries in a young patient is time-consuming . It would be most productive to concentrate on finding early signs of caries in patients who have a high caries risk. The assessment of a patient's caries risk should be the result of an intellectual process involving all information pertinent to the etiology of caries(e.g., diet, saliva flow, cariogenic microbes). Verdenschocht and colleagues showed that caries-related factors (dfms, DFMT, caries in first molars) performed best in predicting future caries onset. Multiple caries prediction tests (e.g., combinations of a mutans test, lactobacilli, saliva flow test, and plaque test) performed worse than existing caries as a predictor.[15] Caries risk assessment has been reviewed elsewhere.[5]

Periodontal Disease

According to the Consensus Report for the 1996 World Workshop on Periodontics,[17] it remains unclear as to how small changes in measurements from radiography and periodontal probing relate to the progression of periodontal disease over the long term. Digital subtraction radiography can provide an objective method to improve detection of bone changes too small to be seen by eye or by conventional interpretation of sequential radiographs.[17] Controlled force periodontal probes have been found to underestimate probing depth compared to measurements taken with manual probes. The validity of the measurements of the controlled force probes is not known, and they cannot be recommended for clinical practice except for convenience. More research is needed to establish the validity of the measurements.[17]

Microbial Tests

The application of microbial diagnosis in periodontics is limited because of the inability of the tests to identify specific diseases or to predict disease progression. However, there is well-demonstrated validity for repeated microbial testing of patients who continue to experience disease progression in spite of excellent compliance and quality of periodontal care. It might also be indicated in high risk medically compromised patients where the dentist suspects that there is an unusual bacterial superinfection, or in the patient with early-onset periodontitis where Actinobacillus actinomycetemcomitans may be present. One can use the tests to demonstrate that this organism has been eradicated for successful treatment. These examples need to be proven in controlled clinical studies.[15]

Biochemical Markers

Although there is evidence that some biochemical markers in gingival crevicular fluid correlate to clinical parameters, there is a wide range of activity that can be seen in patients with differing levels of health or disease. Therefore, there are no specific biochemical profiles that characterize specific periodontal disease. Some gingival crevicular fluid markers such as Prostaglandin E^2, or interleukins IL-1A and IL-1B,[18] may hold promise in regard to prediction of future disease progression or stability; but they have not been proved to be valid. More research is needed on effects of such tests on periodontal treatment planning before they can be recommended for routine clinical use.[17]

Genetic Markers for Prediction of Periodontal Risk

The Periodontal Susceptibility Test is a commercially available test that is used to identify carriers of specific genetic polymorphisms for Interleukins IL-1A and IL-1B in the presymptomatic testing of patients. This test was recently reviewed.[19,20] IL-1A and IL-1B are cytokines involved in the host response to bacterial challenge. Investigators have calculated the increased odds of developing severe periodontitis if certain genetic variants are present. Risk is defined as the probability of an adverse event occurring. The relationship between genotype and periodontal disease risk was examined by Kornman and colleagues.[20] They found that patients who were nonsmokers and genotype-positive for a specific variant had a six to eight times greater chance of developing severe periodontitis than those who did not have that genotype. Smoking negated the effect of the periodontal disease-susceptible genotype. Limitations of the study prevented the authors from calculating absolute risk, which is the data needed to provide valuable predictive information. Prospective studies need to look at absolute risk: How many genotype-positive individuals develop periodontitis?[19,20]

Other possible genetic factors influencing the risk for periodontitis include Immunoglobulin G subclass 2 (IgG2) and its receptors, PMN chemotaxis (chemotactic agent receptors and intracellular signaling mechanisms), and PGE2 responses to bacterial lipopolysaccharide.[21] All of these have a genetic component. However, because periodontitis is a multifactorial disease, environmental factors such as the presence of periodontopathic plaque must also be considered. Even if genetic factors are found to be predictive, there will always be the problem of false-positive and false-negative results because of incomplete penetrance and variable expressivity of genotypes. Ethical issues regarding when to test and what to do with the information are other concerns. For example, should this information be made available to insurance companies or family members? Is there any benefit to the patient in knowing his or her genotype, or is it a purely academic exercise? Patients must be provided with adequate and scientifically sound information regarding such tests in order to make appropriate decisions.[19]

It is likely that genotyping combined with assessment of other risk factors may be a strong predictor of periodontal disease. Genotyping is not a diagnosis but a risk assessment, similar to elevated serum cholesterol levels and the associated risk of cardiovascular disease. In the future, presymptomatic testing for periodontitis may become commonplace and molecular biomarkers may be incorporated into risk assessment. This could also lead to new treatment strategies. Because much needs to be understood about the implications of these tests, more research is needed before recommending them for daily periodontal practice.[17]

Oral Cancer

Recent developments in the early diagnosis of oral cancer have been reviewed by Epstein and Scully.[22] The present discussion will be limited to the use of toluidine blue as an aid to clinical examination in the early detection of oral malignancy, oral exfoliative cytology, and the use of DNA markers in the histopathologic diagnosis and prognosis of oral squamous cell carcinoma.

Toluidine Blue

Several studies have shown that toluidine blue vital staining of suspicious oral epithelial lesions can help in the detection of oral squamous cell carcinoma, in high-risk populations,[23-24] including patients with a history of a previous oral cancer[25] or a positive history of tobacco and/or alcohol use[23] and advanced age. Toluidine blue is used as a 1 percent or 2 percent oral rinse or application provided as a weak acid solution in water and is available in a ready-to-use kit (OraScan; Zila Industries, Phoenix, Ariz.). The kit consists of flavored solutions containing 1 percent toluidine blue as the staining rinse, and 1 percent acetic acid for use as both pre- and post-rinses. Toluidine blue is a basic metachromatic stain that has affinity for the perinuclear cisternae of DNA and RNA. Because cancer cells contain more DNA and RNA than normal epithelium, toluidine blue delineates areas of malignancy. Although most epithelial surfaces stain after an initial application with toluidine blue, only positive areas retain stain after rinsing with acetic acid.[25]

There has been some concern about the potential carcinogenicity of toluidine blue. Both positive and negative results have been reported using toluidine blue in the Ames bacterial mutagenicity test.[2] However, animal studies suggest that toluidine blue itself is not carcinogenic, nor does it act as a co-carcinogen or promoter when given to an animal with a known carcinogen.[27] The meta-analysis of Rosenberg and Cretin[28] showed the effectiveness of toluidine blue in the identification of oral squamous cell carcinoma of the tongue. Sensitivity in the published data ranged from 93.5 percent to 97.8 percent, and the specificity ranged from 73.3 percent to 92.9 percent. Other studies have shown similar results.[23,25,29] False-positive cases have been reported. Therefore, a return visit after 14 days is recommended for repeat of the procedure. Many of the cases of false-positives were inflamed or ulcerated lesions. Regardless of the interpretation of the staining results, if a lesion is clinically suspicious or if the patient is considered a poor risk for follow-up, biopsy should not be delayed.[22]

Toluidine blue has been shown to be effective for the identification of malignancy. It has not been shown to be effective in the identification of dysplastic or premalignant lesions.[24] Toluidine blue is therefore recommended to be used as an adjunct to clinical examination in high-risk patients, especially those with a previous history of oral cancer.[24] For the general dental practice, toluidine blue can be used to aid in the decision to refer a patient to a specialist for management of a suspected malignancy.[22]

Exfoliative Cytology

Scrapings of keratinized white lesions are of limited diagnostic value because they contain only superficial cells, with many false-negative results. Many carcinomas in situ in the oral cavity are red atrophic lesions, so cytology may be of some use in those cases. Cytologic smears of those lesions may show morphologic abnormalities in squamous cells diagnostic of cancer.[22,30] The technique involves the use of an oral

biopsy brush (Oral Scan Laboratories Inc.; Suffern, N.Y.) that has been designed to obtain a complete transepithelial biopsy with minimal discomfort to the patient (Figures 3-5).

The diagnostic potential of cytology may be maximized by applying new molecular biological techniques and/or computer-aided diagnosis software[31] (**Figure 6**). For example, in one study, cytologic smears of clinically normal epithelium were obtained from patients with carcinoma of the tongue and from normal controls. The cells from the cancer patients had more than a three-fold increased expression of cytokeratin 19. Cytokeratin 19 may be a diagnostic marker to monitor patients undergoing preventive chemotherapy.[32] Proliferating cell nuclear antigen (PCNA) is a nuclear protein synthesized during cell replication that may serve as a marker of cell division in premalignant and malignant lesions since expression of PCNA has been shown to correlate with grade of dysplasia. This and other markers may be detectable in cells obtained from cytologic smears. The cytologic smear procedure is less invasive and faster than surgical biopsy. The diagnostic utility of exfoliative cytology and the testing for DNA markers or protein expression deserves further investigation.[22]

DNA Markers in Histopathology

Advances in molecular biology may provide more objective criteria for histopathologic diagnosis and information about the behavior and prognosis of specific tumor types. Included in these techniques are monoclonal antibodies; immunofluorescent procedures; and DNA, antigen and antibody studies. Certain cell-surface markers such as blood group antigens, histocompatibility group antigens, and squamous cell antigens have been identified and require further study. Oncogenes and tumor suppressor genes are currently receiving a lot of attention as potential markers.[22]

Carcinogenesis is a multistep process that involves a number of aberrant genetic events. Cancer is characterized by an accumulation of genetic mutations that allow for further genetic mutation.[33] These mutations lead to increased cell replication and altered behavior. The p53 protein is responsible for maintenance of genomic integrity. It is a tumor suppressor. If a cell has a mutation, p53 arrests the cell cycle in G1(first gap phase) to prevent replication of damaged DNA and allow time for DNA repair prior to replication and chromosomal segregation.[34] Mutations in the p53 tumor suppressor gene are commonly seen in oral squamous cell carcinoma, and mutations in p53 have been associated with the use of tobacco products. In one study, p53 was detected by immunocytochemistry in 71 percent of squamous cell carcinomas and 56 percent of clinically normal mucosa in patients with head and neck carcinomas, but was absent in the control group and in heavy smokers without oral mucosal changes.[35]

In a more recent study, oral mucosal cells obtained by oral exfoliative cytology were examined in patients with oral squamous cell carcinomas and from healthy controls. The polymerase chain reaction was used to amplify the DNA obtained from these cells and restriction fragment length polymorphism analysis was performed on the DNA obtained in this way. With polymerase chain reaction, small samples of cells are adequate for analysis, unlike conventional techniques such as Southern Blot analysis. Loss of heterozygosity of tumor suppressor genes and loss of chromosomes are cytogenetic signs of malignancy. This study showed that 66 percent of oral cancers demonstrated loss of the p53 gene heterozygosity in one site and 50 percent showed loss of heterozygosity at another one. Huang and colleagues concluded that inactivation of p53 is involved in the development or progression of oral carcinogenesis. The oral exfoliative cytology technique used with polymerase chain reaction and restriction fragment length polymorphism analysis was simple and rapid and may be useful for preliminary screening of suspicious oral lesions. Additional analysis of genetic change in oral cancer may lead to a better understanding of pathogenesis.[36]

Polymerase chain reaction and restriction fragment length polymorphism analysis was also used in another study looking at microsatellite markers, which are short repetitive sequences of DNA, in oral squamous cell carcinomas in adults younger than 40.[37] Studies that have assessed other potential markers in oropharyngeal carcinoma disclosed their potential diagnostic and prognostic value: TGF-α, EGFR, c-erbB-2/neu and PCNA.[33]

In summary, oral cancer detection may be improved through the use of computer-aided oral exfoliative cytology using a transepithelial sampling technique and toluidine blue for high-risk patients. Oral cancer diagnosis, prognosis, and treatment may be improved through the study and use of genetic markers identified both through immunohistochemistry techniques and polymerase chain reaction and other molecular biology procedures.

Saliva and Molecular Diagnostic Methods

Saliva is used to test for drugs, such as alcohol. Salivary cotinine levels are used to monitor compliance in tobacco cessation. Salivary estradiol levels are used to indicate

preterm labor in high-risk women, and salivary cortisol levels are considered to be at least as good a measure of adrenal cortical function as serum cortisol.[38,39] Viral infections such HIV[40,41] and influenza can be detected in saliva.[39]

Detection of tumor biomarkers secreted in saliva could be used to diagnose cancer recurrence.[42,43] For example, c-erbB-2 protein expression in breast tumor tissue correlates to levels in saliva. Preliminary results indicate that c-erbB-2 protein expression in saliva may be useful for measuring patient response to chemotherapy and/or surgical treatment for breast cancer.[42]

Salivary HIV tests are currently being used.[40,41] Compared to venipuncture, saliva collection is noninvasive; and there is potentially less risk of disease transmission to the health care worker. The sampling techniques are probably also more acceptable to the patient.[40] In the past, saliva HIV tests were inadequate because they were not sensitive enough to detect low levels of immunoglobulin; but they have improved. Wisnom and colleagues40 recently compared two commercially available salivary HIV antibody tests and serum tests for the same patients from either a high- or low-risk group. Reactive tests were confirmed using Western Blot analysis. Their results indicated that the serum and saliva tests were 99.8 percent and 100 percent specific, respectively; and both were 100 percent sensitive. Although the two systems are not currently available in the United States, they have great potential for future applications.[40]

There is tremendous potential for saliva sampling to be used instead of serum for assessment of systemic disease. The Human Genome Project is expected to have the entire human genome mapped by the year 2003.[2] This project may provide DNA markers that may singly or in combination provide some indication of risk of various systemic and oral diseases. It is possible that many of these markers could be detected in exfoliated cells from saliva. Saliva testing could become a routine part of the dental and medical office visit.[38,39]

Figure 4. The specially designed brush for intraoral exfoliative cytology allows for a transepithelial sampling of the lesional tissue with minimal discomfort to the patient.

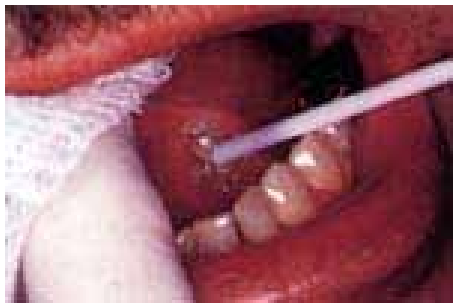

Figure 5. The brush is gently rotated along the lesion to sample as much of it as possible. There is minimal discomfort to the patient so local anesthesia is usually not indicated (Photo courtesy of Dr. Drore Eisen).

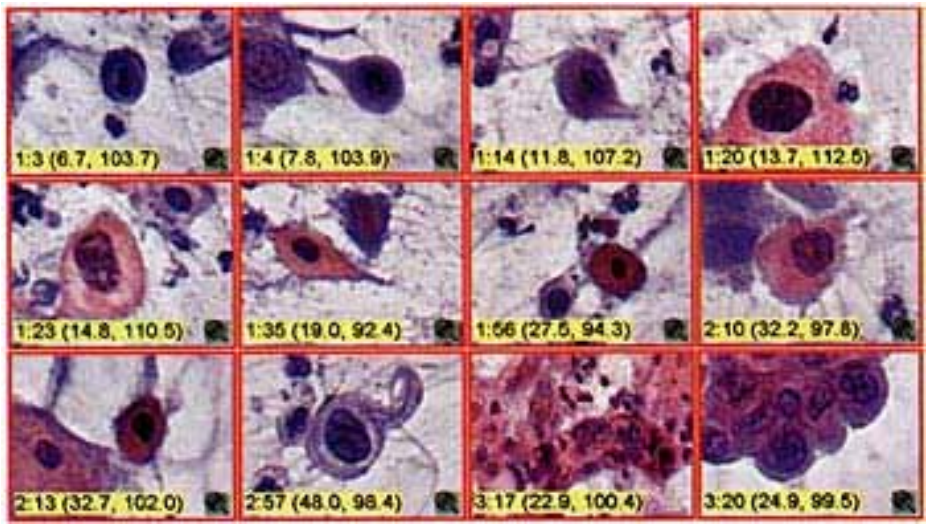

Figure 6. Conventional cytologic smears may contain as many as 3,000 cells. Computer-aided cytology diagnostic systems help the cytopathologist by identifying groups of abnormal cells and displaying them in individual frames so that they are more easily and thoroughly assessed (Photo courtesy of Dr. Drore Eisen)

The DNA Chip

The new DNA chip has the potential to provide fast analysis of the entire genome of a particular individual. The DNA chip combines the state of the art of both silicon chip technology and molecular biology. Photolithographic techniques are used to generate miniaturized arrays of densely packed oligonucleotide probes. These probe arrays can be applied to parallel DNA hybridization analysis to directly yield sequence information.[44] The chip is scanned by a laser and read by a computer. This technology has demonstrated speed and accuracy in detecting mutations in even large genes such as that for cystic fibrosis,[45] and BRCA 1 (a breast cancer gene).[46]

It is conceivable that in the future a patient's DNA could be sampled from exfoliated cells in saliva, or from a lesion via the brush biopsy technique, and then that DNA analyzed using oligonucleotide

arrays (DNA chip technology). The information obtained regarding genetic polymorphisms or mutations in key genes such as p53 or interleukin 1 could be applied to the diagnosis of a suspicious lesion (p53 or cytokeratin 19) or reveal an underlying susceptibility to a disease such as oral squamous cell carcinoma (p53) or early onset periodontitis (interleukin1). DNA chip technology represents the union of digital and molecular technology and exemplifies the type of technology that may some day revolutionize oral diagnosis and oral medicine.

Conclusions

Advances in diagnostic procedures improve the chances of earlier detection of dental caries, periodontal disease and oral cancer. Risk assessment is an integral component of the diagnostic process, both from the standpoint that advanced testing should be reserved for those most at risk and because some of the "diagnostic tests" are actually risk assessment tools. Molecular diagnostics and computer-aided diagnosis increase the potential of oral exfoliative cytology and histopathologic examination. Saliva has tremendous potential as a source of biologic molecules to serve as indicators of past history of disease, current disease, and future risk of disease. It has the potential to replace serum in many analyses.

The common theme behind all these advances is that early detection and diagnosis of disease may be facilitated by the application of digital and molecular technologies. Dentists of the near future can be expected to be able to effectively prevent disease and promote health through these improved diagnostic techniques. In order for this to occur, dental schools need to prepare the dentists of the 21st century with the skills needed to assess new technologies and rationally implement into dental practice those that are scientifically sound.

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Intraosseous Anesthesia: A Review

Ronald Brown, DDS, MS

ABSTRACT The recent introduction of intraosseous injection devices has renewed interest in the modality of local anesthesia. Three devices currently available are the Stabident System, the Hypo Brand Intraosseous Needle, and the Cyberjet System. The Stabident System is the most popular and the only one for which published research is available. Primary intraosseous anesthesia is 45 percent to 93 percent effective but of short duration. Supplemental intraosseous anesthesia is 80 percent to 90 percent effective and provides profound anesthesia of long duration (60 minutes or longer). It is used when a prior conventional infiltration or nerve block is inadequate.

During use of an anesthetic solution with a vasoconstrictor for intraosseous anesthesia, 46 percent to 100 percent of patients reported an increase in heart rate. There was a 2 percent to 27 percent incidence of moderate and sometimes severe pain during the intraosseous procedure. Postoperative complications occurred in 2 percent to 15 percent of patients and lasted one to 14 days.

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Intraosseous anesthesia involves the injection of anesthetic solution directly into cancellous bone to produce anesthesia of the neighboring soft tissue, bone, and teeth.

Historically, due to the lack of a standardized armamentarium, great ingenuity was needed to administer intraosseous anesthesia. Magnus,[1] seeking an alternative to the inferior alveolar nerve block, used a standard 27 gauge needle to both penetrate the cortical plate and inject anesthetic directly into bone. He found this method successful for deciduous molars and adult mandibular incisors and bicuspids. Bourke[2] used a No. 4 beutelrock drill in a straight handpiece to penetrate the cortical plate. He then injected anesthetic with a 3/4 inch, 26 gauge needle placed in the hole made by the drill. He used this method for both maxillary and mandibular teeth. Lilienthal[3] used a No. 4 root canal reamer in a straight handpiece to drill into bone and then injected anesthetic with an extra short needle. Pearce[4] used intraosseous anesthesia for the endodontic treatment of mandibular molars when conventional block anesthesia was not totally effective. He penetrated the cortex into cancellous bone with a No. 3 beutelrock drill mounted in a slow-speed contra-angle handpiece. He then used a 30 gauge needle cut 1/2 inch from the hub to inject anesthetic solution.

Regardless of these early efforts, intraosseous anesthesia was seldom used in the past. Recently, however, intraosseous injection systems have become available, and there is renewed interest in this method of administering local anesthetic.

Figure 1. The Stabident System.

Figure 2. The site of injection for the Stabident System is usually distal to the tooth to be anesthetized at a point 2 mm below the intersection of a horizontal line through the gingival margins of the adjacent teeth and vertical line through the center for the interproximal papilla.

Figure 3. The Hypo Brand Intraosseous Needle.

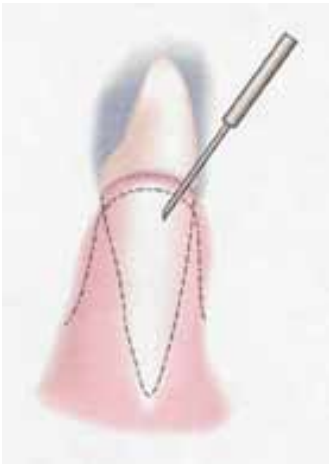

Figure 4a. The site of injection for the Hypo Brand Intraosseous Needle is the base of the interproximal papilla at the mesial of the tooth to be anesthetized.

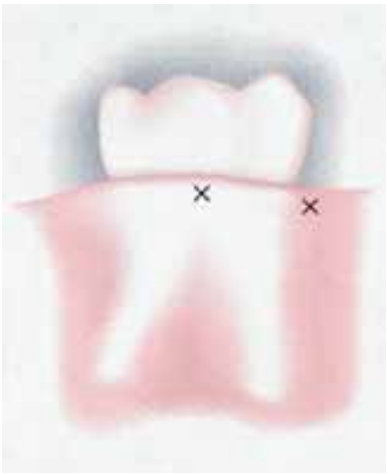

Figure 4b. Using the Hypo Brand Intraosseous Needle for mandibular molars requires two injections, one at the base of the mesial interproximal papilla and a second at the crest of bone between the mesial and distal roots.

Figure 4c. A second method of using the Hypo Brand Intraosseous Needle is to inject within 2 to 3 mm of the root apex on either the mesial or distal side.

Figure 5. The Cyberjet Intraosseous System.

Figure 6. The angle of penetration for the Cyberjet System is 30 to 40 degrees from the long axis of the tooth.

Intraosseous Injection Devices

There are currently three commercial devices for the intraosseous injection. The most widely used is the Stabident System (Fairfax, Dental, Inc., Miami, Fla.). This system consists of a perforator and an injection needle. The perforator is 0.9 mm in length and has a diameter of 0.43 mm. It is driven by a slow-speed contra-angle handpiece. The injection needle is also 0.9 mm in length but has a slightly smaller diameter of 0.40 mm. The injection needle attaches to a standard dental anesthetic syringe (**Figure 1**).

The site of injection for the Stabident System is a point 2 mm below the intersection of a horizontal line through the gingival margins of the adjacent teeth and a vertical line through the center of the interproximal papilla (**Figure 2**). If this site is in alveolar mucosa, it is moved up to attached gingiva. The area is first anesthetized with a few drops of anesthetic. Then the rotary perforator, held perpendicular to the cortical plate, is pushed through the gingiva and activated in short bursts with slow speed until a feeling of "give" is felt or until two to five seconds have elapsed. Next, the syringe is held in a "pen-grip" fashion and the needle inserted through the perforation into cancellous bone. The anesthetic is injected slowly over the course of one to two minutes. For posterior injections, the needle is bent 45 degree at the hub to facilitate placement. If back pressure is felt during injection, the needle is rotated one quarter turn and reinjection attempted. If this is not successful, the needle is removed and checked for blockage. If not blocked, the site is reperforated with a new perforator and the injection completed.

A second device is the Hypo Brand Intraosseous Needle (MPL Technologies, Inc., Franklin Park, Ill.) which is a 30 gauge needle, 1/8 inch long. It is reinforced with a plastic sheath that allows direct injection into interproximal bone. The needle is stabilized with a stainless steel sheath that retracts into the needle body and prevents the needle from bending or breaking during perforation. The Hypo Brand Intraosseous Needle allows for a single-step procedure for both perforation and injection (**Figure 3**). The site of injection for this system is the base of the interproximal papilla at the mesial of the tooth to be anesthetized. Mandibular molars require a second injection at the crest of bone between the mesial and distal roots. After the placement of topical anesthetic, the needle is placed against the tissue and angled apically. Injection of anesthetic is started as soon as the point of the needle is below the surface.

Pressure is increased on the syringe (not the plunger) with a slight turning motion until the cortical plate is penetrated. The injection is then completed. A second method is to inject within 2 to 3 mm of the root apex. This latter technique is useful in the maxillary anterior and premolar regions where the cortical bone is usually thin. It is recommended that only 0.5 ml of anesthetic be injected at each site. This provides 15 to 20 minutes of operative anesthesia (**Figure 4**).

The newest device is the Cyberjet System (Cyberdent Inc., Novato, Calif.). This system consists of a special air-driven handpiece, a disposable 27 gauge needle that also acts as a drill, and a disposable plastic transfuser that conducts the anesthetic from a standard dental anesthetic carpule.

The handpiece is operated by foot control. Perforation and injection are carried out in a single step by moving a clutch button on the handpiece (**Figure 5**). The site of perforation is the center of the base of the interproximal papilla for maxillary teeth and 2 mm below this point for mandibular teeth. Topical anesthetic is applied for a few minutes. The needle is placed at the selected penetration site and angled at 30 to 40 degrees from the long axis of the tooth (**Figure 6**). The clutch button is moved toward the motor drive to disengage rotation and a few drops of anesthetic are injected by stepping on the foot pedal. The clutch is then released and the foot pedal is pressed down completely until perforation is felt. The clutch is again pulled back and the remaining anesthetic injected. The rate of injection depends on the amount of pressure on the foot pedal. The needle is removed from the perforation site by starting rotation and withdrawing rapidly.

Review of Recent Studies

Several recent studies have investigated the administration of intraosseous anesthesia as either a primary injection technique (**Table 1**)[5-8] or a supplemental injection technique (**Table 2**).[9-12]

Primary intraosseous anesthesia is the use of the intraosseous injection instead of a conventional anesthetic technique. Supplemental intraosseous anesthesia is the use of the intraosseous injection in addition to a conventional injection technique.

The studies cited in **Table 1** and **Table 2** all used the Stabident System. There are no published reports evaluating the Hypo Brand Intraosseous Needle or the Cyberjet System.

Primary Intraosseous Anesthesia

The effectiveness of primary intraosseous anesthesia varies from 90 percent for maxillary molars to 75 percent for mandibular molars when 1.8 ml of 2 percent lidocaine with 1:100,000

CDA JOURNAL, VOL 27, Nº10

TABLE 1
Primary Intraosseous Anesthesia

Principal author of study	Type of study	Anesthetic used	% Effective anesthesia	Onset	Duration	Lip numbness	Pain IO procedure	Side effects	Post-op complications
Leonard MS[5]	Clinical extractions	1.8 ml 2% lidocaine 1:100,000 epinephrine	88%	10-12 seconds	All extractions were completed in 15 minutes or less	No	A "few patients" reported pain	N/R	N/R
Replogle K[6]	Experimental, used pulp tester**	1.8 ml 2% lidocaine 1:100,000 epinephrine 1.8 ml 3% mepivacaine	74% 45%	N/R	N/R	N/R	N/R	Significant increase in heart rate with 2% lidocaine with 1:100,000 epinephrine, no increase in heart rate with 3% mepivacaine	N/R
Goggins R[7]	Experimental, used pulp tester*	1.8 ml 2% lidocaine 1:100,000 epinephrine	75% mand. first molars. 93% max. first molars. 90% max. lat. incisors 78% mand. lat. incisors.	Immediate	Steady decline over 60 minutes	58% with IO injection of mand. first molar	0-15% moderate pain	78% increase in heart rate	2-15% moderate to severe pain. 4% soreness, swelling. 4% teeth "felt high."
Replogle K[8]	Experimental, used pump tester*	1.8ml 2% lidocaine 1:100,000 epinephrine 3% mepivacaine 45%	74%	Rapid	20 min. — 62% 30 min. — 52% 45 min. — 29% 20 min. — 24% 30 min. —17% 40 min. — 7%	76% with 2% lidocaine 1:100,000 epinephrine 50% 3% mepivacaine	2-7% moderate pain. 0-2% severe pain.	N/R	2-10% moderate pain. 5% swelling, purulence. 13% teeth "felt high."

NR - not reported in study

* Anesthesia was considered successful when there was no subjective response to the maximum output of the pulp tester (80 reading - Analytic Technology pulp tester).

epinephrine is used as the anesthetic. The onset of anesthesia is immediate but the duration decreases rapidly. When using 3 percent mepivacaine (without vasoconstrictor), both the effectiveness and duration are further decreased. The area of anesthesia is limited with the primary intraosseous injection; but, when used in the posterior mandible, lip numbness is reported to occur in 50 percent to 76 percent of the cases (**Table 1**). Goggins and colleagues,[7] however, reported that most subjects said the lip numbness was not as profound as after an inferior alveolar nerve block. Tongue and cheek numbness do not occur with primary intraosseous anesthesia.[5]

Supplemental Intraosseous Anesthesia

Supplemental intraosseous anesthesia is used when pain persists following a "clinically successful" conventional injection. When using an anesthetic with a vasoconstrictor such as 2 percent lidocaine with 1:100,000 epinephrine, the effectiveness is about 90 percent and the duration at least 60 minutes. Using anesthetics without a vasoconstrictor such as 3 percent mepivacaine, the effectiveness is about 80 percent, even in teeth diagnosed with irreversible pulpitis. It increases to 98 percent with a second intraosseous injection. The onset of anesthesia is immediate. The volume of anesthetic solution needed for supplemental intraosseous anesthesia varied from 0.45 ml to 3.6 ml (**Table 2**).

In some of the studies included in this review,[6-9] a lack of response to the maximum output of the Analytic Technology pulp tester (Analytic Technology Corp., Redmond, Wash.) was used to indicate pulpal anesthesia. However, this test was not reliable in teeth with a diagnosis of irreversible

TABLE 2
Supplemental Intraosseous Anesthesia

Principal author of study	Type of study	Anesthetic used	% Effective anesthesia	Onset	Duration	Pain IO procedure	Side effects	Post-op complications
Dunbar D[9]	Experimental pulp tester* mandibular posterior teeth asymptomatic	1.8 ml 2% lidocaine 1:100,000 epinephrine	100% immediate. 90% 60 minutes or longer.	Immediate	95% for 30 minutes. 90% at least 60 minutes.	2-12% mild-moderate pain	80% increased heart rate	2% pain 3% swelling 10% teeth "felt high"
Reisman D[10]	Clinical mandibular posterior teeth - Dx irreversible pulpitis-endo treatment	1.8 ml 2% lidocaine 1:100,000 epinephrine IAN block. 1.8 ml 3% mepivacaine supplemental	80% 1st supplemental -increased to 98% with 2nd supplemental	Waited three minutes before starting treatment	N/R but duration sufficient to complete endodontic procedure	9% moderate-severe pain performation. 27% moderate pain. 6% severe pain injection.	No increase in heart rate with 3% mepivacaine	N/R
Nusstein J[11]	Clinical mandibular posterior teeth-Dx irreversible pulpitis-endo treatment	1.8 ml 2% lidocaine 1:100,000 epinephrine	88% success with supplemental intraosseous injection	N/R	Sufficient time to complete endodontic procedure	8% moderate to severe pain perforation. 4% severe pain injection.	46% increased heart rate	N/R
Parante SA[12]	Clinical - DX irreversible pulpitis-endo treatment	0.45-0.90 ml 2% lidocaine 1:100,000 epinephrine	89% success used 0.45 to 0.90 ml anesthetic for supplemental 4/33 teeth needed a 2nd IO injection	Immediate	Sufficient time to complete endodontic procedure	N/R	Advised to caution patients-increased heart rate with IO injection	1/37 patients reported mild post-operative discomfort

N/R - not reported in study.

* Anesthesia was considered successful when there was no subjective response to the maximum output of the pulp tester (80 reading - Analytic Technology pulp tester)

pulpitis,10,11 and some teeth that tested negative required supplemental injections. Similar findings were reported by Dreven and colleagues.[13] They found that "no response" to the maximum output of the electric pulp tester was 100 percent accurate in evaluating pulpal analgesia in asymptomatic teeth but only 73 percent accurate when the teeth were diagnosed with irreversible pulpitis.

Side Effects and Limitations

Intraosseous anesthesia is accompanied by a number of side effects. An immediate increase in heart rate that lasts for two to three minutes occurs in 46 percent to 80 percent of patients when using 2 percent lidocaine with 1:100,000 epinephrine (Tables 1 and 2). Guglielmo and colleagues[14] reported increased heart rate identical to 2 percent lidocaine with 1:000,000 epinephrine when using 2 percent mepivacaine with 1:20,000 levonordefrin for supplemental intraosseous anesthesia. Lillienthal[15] stated that increased heart rate occurred in 100 percent of patients after a primary intraosseous injection of 1.8 ml 4 percent prilocaine with 1:200,000 epinephrine. In those studies where 3 percent mepivacaine (without vasoconstrictor) was used for intraosseous anesthesia, there was no increase in heart rate (Tables 1 and 2).

In most studies, there was a 2 percent to 15 percent incidence of moderate to severe pain during perforation, needle insertion, or injection of the anesthetic solution. However, Reisman and colleagues10 reported that 27 percent had moderate pain and 6 percent severe pain during injection. There was a 2 percent to 15 percent incidence of postoperative pain at the intraosseous injection site that was gone in a few days and a 4 percent to

5 percent incidence of swelling, bruising, or purulence that healed in less than two weeks. Four percent to 13 percent of the subjects reported that the teeth "felt high" for a few days after the intraosseous injection (Tables 1 and 2). There were some instances in which perforators broke during use, but they were easily removed with a hemostat.[7,8]

Contraindications to the intraosseous injection include severe periodontal disease, a narrow zone of attached gingiva, and close proximity of the teeth.[7,8] Also, there may be some areas where it is not possible to administer a successful intraosseous injection due to thick or dense bone or lack of anesthetic distribution due to constricted cancellous bone.[9]

Replogle and colleagues[16] have recommended that in patients whose medical condition, drug therapies, or epinephrine sensitivity suggest caution in administering epinephrine-containing solutions, 3 percent mepivacaine is an acceptable alternative for intraosseous injections.

Conclusions

The revival of intraosseous anesthesia is a significant addition to dental anesthetic techniques. Primary intraosseous anesthesia is useful for short procedures where it is desirable to minimize the feeling of numbness and the ballooning of tissue. The most valuable intraosseous technique, however, is the supplemental injection, which provides profound anesthesia and sufficient duration for most dental procedures and is particularly useful for those situations that are refractory to conventional anesthetic techniques.

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Of Mice and Men

Robert E. Horseman, DDS

"Wee, sleekit, cowrin', tim'rous beastie," apostrophized Robert Burns in his paean to a mouse, "O what a panic's in thy breastie!"

Well, I'll tell you what panic is in its breastie; it's those scientists and researchers hard at it again to replicate the Spanish Inquisition in today's mousedom.

Since 1995, when Athena Neurosciences -- a small biotech company now part of Elan Pharmaceuticals of Dublin, Calif. -- first achieved scientific renown with the development of the transgenic mouse for the study of Alzheimer's, every mouse with its paws on the pulse of current events has felt polarized to attract catastrophe. Nobody knows exactly what a transgenic mouse is, but from the mouse's viewpoint, any benefits accruing to the title are illusory.

What has the wind up in mouse support groups is the Elan company's latest discovery in Alzheimer research. Alzheimer's, characterized by progressive dementia and incapacitation, affects 4 million Americans and costs the nation $100 billion a year according to the July 8, 1999, *New York Times*. The man whose face I shave each morning and who now bears more than a passing resemblance to Geppetto, Pinocchio's father, was discomfited to learn that the longer people live, the more likely they are to develop symptoms of the disease. Without straining too much, I imagine I detect the swish of Father Time's scythe in the anteroom.

Too intricate to warrant recapitulating in detail what the Elan bonanza is, the gist of the discovery with the meringue sluiced off is that researchers genetically altered mice so they developed the plaque-like deposits commonly found in the brains of Alzheimer's patients. The mice were told that they were entered in some Special Olympics for maze solving, otherwise they would have called in sick.

Through some labyrinthine steps, researchers developed a vaccine that, injected into the mice, eradicated the plaques, improved the condition of damaged neurons and reduced inflammation in surrounding tissue. When the White Coats vaccinated young healthy mice, the mice grew up without developing the plaques at all. It was an occasion for infusions of expensive champagne and dollops of imported caviar, provided it could be successfully run past the accounting department.

These mice were almost as euphoric as Dr. Steven DeKosky, head of the Alzheimer's disease research center at the University of Pittsburgh, who exulted, "The biggest issue is the use of immunization. It's very clever to have tried that."

Agreed. We would never have thought of it ourselves.

While all involved are busy expatiating on the significance of this discovery, it remains to be seen if the compound (a synthetic form of the beta-amyloid peptide) will produce the same effects in people.

As Gertrude Stein once sagely remarked, "A mouse is a mouse is a mouse, but only an ignatz equates it with a hominoid and never the twain shall meet." Her medication was changed shortly thereafter, but the essence of her wisdom is still valid; it is impossible to accurately assess memory loss or cognitive ability in mice. In other words, a mouse in its normal state is hard to differentiate from an Alzheimer's mouse, not that there's anything wrong with that.

The mice of my acquaintance lead a very circumscribed life. Outside of having noses in a constant state of agitation, their days are spent beyond the reach of the Internal Revenue Service and nuclear fission, on some seventh astral plane, exclusively devoted to eating, sleeping and pooping. Their response to the encomiums resulting from Elan's research is a plea to just continue in the same vein. Spokesmen for the mice wish it known, however, that they, individually and as a genus, are sick and tired of all this experimentation without representation. A couple of months ago it was the implanting of tooth buds in their kidneys; who knows what Homeric sacrifices they'll be called upon to perform next.

Despite all the expository flapdoodle issued to justify the use of mice as experimental animals, the mice feel they were cozened into their predicament and they have offered a substitute list of candidates they feel better suited for the purposes of experiments. These include members of certain cults who believe the world will terminate in January and intransigent residents on Death Row who have been enjoying Lucullan viands at the public trough for more than 10 years.

Additionally, the mice believe that any scientist who sufficiently believes in the transcendent importance of what he's doing should be willing to volunteer for the experiment himself, even if he risks going down like a poled ox. There's a certain poetic justice there – Bobby Burns would have liked it.