

FUTURE OF DENTISTRY



Today's Vision: Tomorrow's Reality

ADA

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American Dental Association
Health Policy Resources Center



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The Future of Dentistry report was developed by a large group of individuals, selected for participation because of their knowledge, expertise and commitment to the welfare of the dental profession and the public it serves. Throughout the preparation of this report, the creative effort was conducted with great independence. **The ideas expressed herein are not necessarily those of, nor endorsed by, the American Dental Association.**

Future of Dentistry
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ISBN: 0-910074-55-0

Printed by the American Dental Association
Cover and book design by Absolute Graphics Inc., Chicago, IL

Suggested Citation

American Dental Association. *Future of Dentistry*. Chicago: American Dental Association, Health Policy Resources Center:2001.

Message from the President of the American Dental Association

I have on occasion compared the dental profession to the great works of art, always emphasizing that it is a work in progress.

This document is a vital tool for dentistry as the profession grows and evolves in these beginning years of the 21st century. The information and recommendations in this report provide the tools we need to mold, paint and shape the strong future that all of us want for our profession and certainly for our patients.

As we take up this task, we should be mindful of the legacy developed by the actions of those who came before us. Our strong public image came not from outside forces but from dentists—all giving, sacrificing and working for the good of the public and the profession. I am convinced that the future will be determined in this same manner. Together, we can determine the wisest steps to take and then commit ourselves to the actions necessary to strengthen dental education, research, practice, access to care for the underserved, our role in governmental affairs, and other key aspects of this profession.

The future is in our hands ... and, with this document in our hands, we are ready to build that future!



Robert M. Anderton, D.D.S., J.D., LL.M.
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Foreword

Today's Vision: Tomorrow's Reality

Looking to the future and predicting what the oral health needs of our citizens will be, and how to address them, are formidable tasks. It is equally difficult to discern the problems that will confront our profession. The 2001 Future of Dentistry report attempts to create a vision of challenges that are likely to emerge in the coming years. The report is based upon reasonable evaluation and interpretation of current information and observable trends.

This project, while commissioned by the American Dental Association, is not a policy document of the organization. It has been designed to reach out to all parties interested in the betterment of health throughout the world and, more specifically, to those who are able to contribute to improving the delivery of dental care in order to achieve the optimal oral health of the public.

The many who contributed to this report—giving enormously of their time and expertise—hope that future generations will look back on it as a landmark document. It represents their commitment to excellence and an understanding that the profession and its partners must set aside parochial agendas to fulfill their social responsibility. The authors want the report to be read and believe firmly that all who do so will develop a better understanding of the issues facing the dental profession in its pursuit of excellence in serving the public.

The 2001 Future of Dentistry Report is intended to be a practical guide for the profession's next generation. It is meant to stimulate thoughts and actions that will move the dental profession forward into the new century. In order for it to have the lasting impact, the report must become a living document that can be amended and redesigned as circumstances evolve.

The report's central theme is one of global cooperation. The modern world is a much smaller place than our parents knew. Our children will live in an even smaller world. It is clear that in this complex and ever-changing world, isolation is not a viable option. This is a clarion call for dentistry's international community to come together in a coordinated effort to improve the world's oral health.

Plans for the future must take into account that advances in the diagnosis and treatment of oral disease are being made throughout the world. Sophisticated informational technology will be emerging to benefit both the public and dental professionals. Cooperative efforts will no longer require that individuals be in the same room. Instead, interaction can occur almost instantly among persons separated by continents.

However, science and technology cannot solve all problems. Political will, social responsibility and the willingness to set aside cultural differences are also necessary. The dental profession has a bright and exciting future that can be achieved only by a commitment to think creatively, eliminate barriers, and forge new alliances.

As a healing profession, we must have but one over-riding vision. All people, whatever their status, whatever their age, wherever they live, should have the right to good oral health. That is our call to action. That is our challenge. Let us rededicate ourselves to this vision and become faithful stewards of the commitment to make today's vision tomorrow's reality.



Leslie W. Seldin, D.D.S.
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Preface

Successful planning is never easy. It requires a clear-eyed assessment of the past, of what impeded progress at one point, what propelled it at another. It also requires an appreciation of an axiomatic truth: that tomorrow belongs to those who prepare for it today.

With that in mind, the dental profession has begun the process of evaluation that, given the complexity of the world in the 21st century, will ensure the most desirable future for dentistry and the public it serves.

This difficult task of dentistry's preparation for the future is heightened by its own diversity—general dentists and specialists in and out of private practice, educators and researchers, members of the Federal Dental Services, and allied dental personnel. Beyond its own borders, the profession must respond to a range of outside influences, including government and commercial interests. Satisfaction of the oral health needs of the public becomes the ultimate goal of the process.

Professional organizations have a wider responsibility than just their own memberships. They also have a responsibility to a trusting public and must be in a position to meet any new developments with confidence. Looking to the future and predicting what will confront the dental profession are formidable tasks. Dentists, as scientists, cannot purport to have visionary capabilities or to be fortunetellers. Thus, the observations and predictions contained in this document are based on measurable trends that can be extended legitimately into the years ahead.

Clearly, much must be done to guarantee the most desirable future for the profession and the public. To achieve that goal, all issues that touch dentistry must be identified and addressed. Sensitive matters cannot be brushed aside or ignored. This report identifies all areas of concern. Its authors have been committed to the belief that the duty of the profession and its partners require them to put aside any personal agendas and to focus on the future, in seeking to fulfill their responsibility to protect the viability of a respected profession and effectively serve a deserving public.

The 1983 Future of Dentistry Report

In 1983, the American Dental Association published a report on the future of dentistry that explored the state of the profession at that time and offered predictions on the challenges dentistry would likely face in the years ahead. That first report also provided a number of broad recommendations and laid the groundwork for a strategic planning process that continues to this day.

As the future became the present, many of the forecasts contained in the 1983 document proved accurate; others did not. More important than the document itself was the profession-wide self-examination it kindled. The complex act of preparing the report forced the profession to explore its mission and structure and to address difficult issues and confront them with its best wisdom.

The 2001 Future of Dentistry Report

The ADA House of Delegates recognized the value of rekindling the process begun 15 years earlier when, in 1998, it approved the blueprint for development of a new Future of Dentistry report. The charge was essentially the same this time as last: Look unflinchingly into the future; recommend actions and activities that will help the profession meet its responsibilities in the years ahead.

A task force was assigned to prepare a plan. The 1999 House of Delegates approved the plan and commissioned preparation of a new Future of Dentistry report. The Board of Trustees of the ADA appointed an Oversight Committee with members representing all corners of the dental profession. This committee, responsible for the development, structure and content of the project was charged with presenting its final report to the 2001 ADA House of Delegates.

Assessing the sheer enormity of the project before it, the committee decided to separate the task into logical parts. Panels of nationally recognized experts were recruited to explore the issues and trends in six critical areas:

- ◆ Clinical Dental Practice and Management
- ◆ Financing of and Access to Dental Services

- ◆ Dental Licensure and Regulation of Dental Professionals
- ◆ Dental Education
- ◆ Dental and Craniofacial Research
- ◆ Global Oral Health

As a first step, each panel was asked to make an honest appraisal of the prevailing environment in its assigned area. Panelists were to pinpoint trends; to separate what is known from pure speculation; and to offer reasonable, logical predictions for the future, defined as the next 5 to 15 years, depending on the area of interest. Finally, each panel was to forge recommendations aimed at helping the profession meet future challenges.

The report was written by several authors and reflects the style of those authors. During the editing process, some standardization of format was developed, but no attempt was made to develop a uniform style.

To secure input from all of dentistry's disparate communities of interest, the Oversight Committee solicited written testimony from various groups and individuals. It also held a series of three public forums (October 2000, March 2001, June 2001) where communities of interest, dental organizations and ADA constituent dental societies could share their views on the project. Drafts of the report-in-progress were distributed prior to each conference.

This final report, almost two years in the making, is meant to serve the entire dental community and the public. Thus, the insights and recommendations are directed to assist any individual or organization which seeks to ensure and protect the oral health of the public.

Acknowledgements

The Future of Dentistry report was developed by a large group of individuals, selected for participation because of their knowledge, expertise and commitment to the welfare of the dental profession and the public it serves. Throughout the preparation of this report, the creative effort was conducted with great independence. This was the intention of the House of Delegates of the American Dental Association (ADA), which commissioned the study. The demand that the report be honest, objective and unresponsive to external pressures was scrupulously observed.

This project could not have succeeded without the selfless dedication, talent, and extensive knowledge of those who participated. Deep appreciation is extended to these individuals who include members of the Oversight Committee, members of the six expert panels, staff of the ADA, outside editors, and consultants. Heartfelt thanks are also offered to the entire range of communities of interest (both dental and non-dental) that provided their wisdom and constructive comments. Their input was invaluable in improving this report.

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FUTURE OF DENTISTRY

Today's Vision: Tomorrow's Reality

Introduction



What affects the United States and its people affects the dental profession. Dentistry's future ability to promote the oral health of the nation will depend on its capacity to integrate new, better technologies into practice, to respond to changing consumer needs, to assure a sufficient supply of well-trained dental educators and dental students, to maintain a strong research focus and, all the while, to address the needs of those people who do not have easy access to dental care.

The national visibility for oral health has never been greater. This visibility is seen in recent national and state legislation, federal reports and the media. The United States Surgeon General gave national and international visibility to oral health and its relationship to general health and well being in: "Oral Health in America: A Report of the Surgeon General," published in May 2000.

The report's findings highlight oral health's relationship to general health. It provides an assessment of the status of oral health in America, how oral health is promoted and what needs to be done. The report finds, for example, that oral diseases and disorders affect health and well being throughout life. These diseases and disorders are complex, often are not self-limiting, compromise daily functions such as eating, speaking, swallowing, and school and work performance. The report notes that the mouth mirrors general health and well being, providing a diagnostic window to other, less visible parts of the body.

Changes in the nation's demographic profile, new technologies, evolving disease patterns, growing government and media influences, marketplace changes, the globalization of health care—all these and other factors affect dentistry just as they influence other parts of society.

The goal of the 2001 Future of Dentistry report is to help the dental profession cope with inevitable change, both at home and on the world stage. The findings and recommendations it contains were prepared by experts who came together in a mutual desire to improve oral health by improving oral health care. The report addresses all issues that touch the profession—no matter how sensitive they may be—and insists that all parochial views be set aside.

The report suggests actions in general terms, remanding to dentistry's leaders and organizations the task of developing and implementing specific activities. No organization can do this alone. Success will require collaboration, a will to break down barriers of isolation and pooling of resources for a common good. Such coalitions must cross all boundaries and involve groups both inside and outside the profession.

The trends and issues identified by the expert panels will not come as a surprise to most, and the recommendations will not require radical changes in direction. A roadmap to the future is presented that will benefit the profession and the public it serves. What new turns may appear as the route is traveled cannot be predicted. Most important is that the journey be undertaken and the direction traveled be determined by a dental profession which acknowledges its responsibilities and enthusiastically undertakes to reach its goals.

THE ROLE AND RESPONSIBILITIES OF THE DENTAL PROFESSION

Dentistry is part of the broad spectrum of health services that address the needs of the general population. Its mission is to guard the oral health of the public. The American Dental Association defines its role more specifically as fostering "the improvement of the health of the public" and promoting "the art and science of dentistry."

Dentistry is known and celebrated for its high ethical standards and an awareness of its social responsibilities and public trust. Whatever actions the profession takes in response to future challenges, that trust must be preserved. To do so, the profession must find ways to provide care for those in need, regardless of their financial wherewithal or the challenges they present. Most Americans receive good oral health care; some do not. Those thought of as underserved include the indigent and special needs populations.

With the free-enterprise system as its foundation, the U.S. economy has permitted dentists and allied personnel to seek and receive fair compensation for their services. Decades of economic analysis show that dentistry has fairly controlled its fee structures, ensuring that periodic increases are in line with inflation and accepted rates for professional services. Moreover, dentists provide substantial amounts of free care to the poor.

Dentistry can be proud of its accomplishments. This nation's dental health care system—encompassing education, research and development, clinical practice and more—is widely regarded as the very best in the world. It is hoped that, as the global community grows closer together, the highest standards of oral health care will be made available to the entire world population. As a guide to the decades ahead, this Future of Dentistry report is intended to help maintain those standards and to ensure continued growth and improvement for years to come.

KEY TRENDS

As a first step in forecasting dentistry's future for the next 5 to 15 years, it is helpful to examine key oral health, demographic, economic, scientific, financial and industry-specific trends.

Disease and Health Trends

The health of the nation, including oral health,

will continue to improve in the coming decades. Greater awareness of the health effects of lifestyle behaviors, such as tobacco and alcohol use, the value of physical exercise, basic hygiene and the role of diet, has contributed to a generally healthier population with increased life expectancy. Infant mortality rates in the United States, however, still lag behind those of other developed countries.

Like general health, oral health has improved dramatically in recent decades. The percentage of children and adolescents aged 5 to 17 years who have never experienced dental caries in their permanent teeth continues to increase. Likewise, adult Americans aged 18 to 34 years have less decay and fewer fillings in their permanent teeth than ever before. What's more, the percentage of people who have lost all their teeth has declined substantially in the last 30 years. In 1971-74, 45.6% of adults aged 65-74 were edentulous. In 1988-94, just 28.6% of Americans in this age group were edentulous.

Trends for other oral health conditions, such as periodontal diseases, are more difficult to track because of variations in the way these diseases have been measured. Overall oral cancer rates are declining, but certain site-specific oral cancers are actually on the rise. The incidence of tongue cancers among young males is climbing, while lip cancers are declining. The five-year survival rate for oral cancers has remained the same for the past 25 years.

There also are wide variations in oral diseases and conditions among racial and ethnic groups, between poor and more affluent populations, between males and females, young and old, generally healthier Americans and those with medical conditions and disabilities. The incidence of tooth loss, for instance, varies by race/ethnicity as well as income levels. Males are more than twice as likely as women to develop oral and pharyngeal cancers. The rate of oral cancers in African American males is 39.6% higher than in White males, and the five-year cancer survival rate for African Americans of both sexes is just 34% vs. 56% for Whites.

The aging of the population, increases in the numbers of people with disabilities, and a rapidly changing race/ethnic profile will require a dental workforce that is confident and competent to address both routine and uncommon oral problems. Dental professionals must be equipped to manage the oral health effects of comorbidities and medications, interacting more often with other health care providers, social service agencies and institutionalized patients.

Demographic Trends

The world population increases by roughly a billion people each decade. Today, there are about 281 million people in the United States; by the year 2050, that figure is expected to reach approximately 400 million.

At the same time that America is seeing an aging of its population, it is also becoming more racially and ethnically diverse. Such demographic changes are expected to alter disease patterns as well as cultural attitudes and expectations about health care and lifestyle behaviors. As a corollary, health care delivery systems and the services they provide will also change.

Economic Trends

Like all other elements of society, the dental sector is influenced by the overall performance of the economy. The supply and demand for dental care determine the amount and types of dental services provided, as well as the geographic distribution of dentists, the average income levels of dental professionals, the financial strength of dental practices and the number of applicants to and graduates from dental schools.

The robust economy of the past two decades has greatly benefited the dental profession. Between 1970 and 1996, real gross domestic product (GDP) doubled, representing an annual real growth rate of 2.7 percent. Through most of the 1990s, unemployment, interest rates and inflation have remained low compared to earlier decades, and prices today are rising at an annual rate of slightly more than 2 percent. The last genuine economic contraction occurred in 1991, and even that downturn was brief and mild. The ensuing decade has been one of uninterrupted prosperity and steady growth.

Dental markets have adjusted to supply-side forces by reducing the number of new graduates and to demand-side forces by changing the mix of services provided in response to changing disease patterns. Overall, fee increases have been moderate, and a smaller proportion of overall economic resources have been used to provide dental care. As a result, an increasing number of Americans have access to needed treatment.

Science and Technology Trends

The rate of scientific and technological advancement has accelerated in recent years, a trend that

will continue into the next decade and beyond. Through research, dentistry has improved its understanding of the causes and sequelae of diseases and conditions and their interrelationships. The social, biological, and physical sciences have evolved and begun to merge, fostering an improved understanding of human health.

Through sophisticated biotechnology research, science is mapping the human genome and gaining knowledge of the organisms and microbes associated with such conditions as dental caries, oral candidiasis and periodontal diseases. Genetically engineered animals and foods have become a reality, and it is now possible to mimic nature by applying biomimetics to design and fabricate new drugs, tissues and organs. With these developments come critical ethical, legal and social questions that must be addressed.

Miniaturization and nanotechnology provide additional tools contributing to improved health care and communication. These technologies have tremendous potential, particularly in connection with optical laser systems and computer-assisted informatics. Information technology is revolutionizing the teaching and delivery of health care through virtual-reality systems, telemedicine and teledentistry.

The Internet makes global communications possible, increasing access to information around the world, breaking down national and other barriers and accelerating the speed of communication. Among other effects, these new technologies are improving efficiency in patient scheduling, referrals and record keeping. New technologies also are changing traditional methods of disseminating information through scientific journals, books and other documents. Increasing numbers of Americans are using the Internet to seek health information and make health care choices. The frenetic pace of this activity has an important downside: some of the materials disseminated in this way are bound to be of questionable value and accuracy.

The decades ahead will witness advances in science and technology as yet unforeseen. Dentistry will benefit from these advances and must be intimately involved in their progression.

Advancing Determinants of Health

Over the past 50 years, a growing understanding of the many factors that affect health has spawned various public health initiatives in the United States and other nations. Underlying these initiatives is the

premise that the biomedical approach to disease cannot solve all health problems.

These initiatives spring from evolving models that spotlight factors affecting human health: lifestyle choices and personal skills, social and community influences, living and working conditions, the organization and provision of health care services, socioeconomic, cultural and environmental conditions.

In the United States, the national "Healthy People" initiative has entered its third decade of emphasizing health promotion and disease prevention. Oral health objectives have been part of this effort (now referred to as "Healthy People 2010") since 1979. Those objectives include reducing the incidence of oral disease across all population groups, promoting disease prevention measures like fluorides and sealants and improving the means of delivering care.

The emphasis is on promoting health, rather than preventing disease—an approach expected to gain momentum in the years ahead. Dentistry's record of health promotion through private practice and community-based prevention programs positions it to play a leading role in future public health initiatives.

Increasing Globalization

All the trends described thus far point to one incontestable fact: health care is a global concern that breaks down national boundaries. Microbes can be transported around the world in a matter of hours. Health care information can be transmitted from one corner of the globe to another in seconds. New and useful scientific findings and technologies can arise anywhere in the world. Dentistry is a resident of that global community and a vital participant on the world stage.

Vision and Recommendations

2

To guide the development of policy recommendations, members of the Future of Dentistry project adopted the following statement of vision and guiding principles.

VISION STATEMENT:

Improved health and quality of life for all through optimal oral health.

GUIDING PRINCIPLES:

- 1. Improving the health of the public in a socially responsible and culturally competent manner is the primary goal of the dental profession and will remain dentistry's central focus.*
- 2. The profession must continue its commitment to the adoption of appropriate science-based practices so essential to the future of dentistry.*
- 3. A strong educational system is critical to the future of dentistry.*
- 4. An aggressive approach to health promotion, disease prevention, and access to appropriate care will improve oral health and quality of life.*
- 5. Closer collaboration among all health professions will contribute to achieving dentistry's primary goal of improving the health of the public.*
- 6. The dental profession must develop a global perspective and an action plan to fulfill its responsibility as part of the world community.*

The dental profession must establish a rapid, flexible and effective response system for predicted and unknown changes in health care delivery, education and research in the future. Dentistry has numerous accomplishments resulting in the improved health of the public, but more needs to be done. The answers and the challenges are at the interface of the traditional areas emphasized in this report. The dental profession should now be ready to take a leadership role for the nation's oral health, building upon the base it has established.

This chapter presents a number of recommendations intended to encourage professional organizations and other groups to support existing and new programs.

BROAD RECOMMENDATIONS

These recommendations transcend the area-specific issues and provide a guide for the coming five to 15 years.

ORAL HEALTH PARTNERSHIPS

The success of the future of the dental profession relies on its ability to be responsive and proactive in meeting the public's oral and general health needs, to effectively incorporate new technologies and knowledge into practice, and to assume a leadership role in the globalization movement.

National and international partnerships and alliances will be needed to address the many issues raised in each of the chapters. Clear and direct avenues of communication must be established. Achievable goals, and the necessary resources for their accomplishment, must be identified. These goals must embrace the objectives of each organization and group.

Broad Recommendation-1: Establish and support partnerships and alliances among dental, other health care professional, and public health organizations, as well as business and social service groups, in order to address common goals to improve oral health.

Strategy

- ◆ Establish regular forums to meet with groups representing patients and families. By listening to the needs and experiences of these groups the profession will be better positioned to identify priorities and take action on activities that will make a difference to the health of the nation and the world.
- ◆ Establish and expand mechanisms for ongoing interaction among dentists, allied dental personnel, educators, researchers, manufacturers, and third party payers. These modalities should be used to strategically position and reposition all components of dentistry based on emerging trends and opportunities. This will align them with the common goal of improving oral health.

ORAL HEALTH PROMOTION

Through office-based, home-based and commu-

nity-based efforts many of the health needs of the public are being addressed. The dental profession must continue and expand that commitment. It should maintain a constant focus on oral health promotion which will require increased resources for such efforts in the coming 5 to 15 years. All programs and efforts must include formal evaluations so that best practices can be identified and promulgated.

Broad Recommendation-2: Aggressively address the oral health needs of the public.

Strategy

- ◆ Promote and accelerate known and effective dental caries preventive measures, such as community water fluoridation and sealants.
- ◆ Undertake educational efforts aimed at the prevention of life-threatening diseases, such as oral cancer.
- ◆ Develop and implement programs targeted to special needs populations.
- ◆ Highlight the inter-relationship between oral and general health, and the role that common risk factors play in contributing to both.
- ◆ Enhance financing and reimbursement programs for oral health services, especially for low-income populations and for individuals with special needs.
- ◆ Develop and maintain databases that monitor and help predict the public's oral health needs, disease and life-style behavior patterns. Standardized and systematic population-based approaches to national and global data collection and analyses are essential to effective planning and program implementation.

RESEARCH AND EDUCATION CAPABILITIES

Dentistry's research and educational institutions are national resources that provide and improve health care and health promotion for Americans. Perpetuating these resources and ensuring their capacity to train future generations of practitioners and to provide the life-long learning opportunities

for practitioners is critical. In addition, these resources play a lead role in maintaining and catalyzing needed international collaborations in research and education.

Broad Recommendation-3: Strengthen and expand dentistry's research and education capabilities.

Strategy

◆ Augment resources for the dental research and education infrastructure, giving priority to those aspects which warrant immediate attention and resources. Funding for rapidly emerging clinical research opportunities is insufficient. Facilities need to be refurbished, replaced and modernized. New technologies, such as information technology and research equipment, need to be developed and adopted. Research and educational workforce issues need to be addressed. Collaborations among institutions should be encouraged.

◆ Enhance the visibility and prominence of dental schools at academic health centers. Dental schools are the institutions where the majority of dental research is conducted and are critical members of their academic health centers. They should become more prominent through their education, community service and research functions.

◆ Strengthen the interaction between research and education. Effective ways to accelerate the transfer of science findings into the dental curriculum should be developed and implemented.

◆ Develop new approaches to facilitate the transfer of emerging scientific knowledge into clinical practice. Oral health science and technology transfer centers could be established to promote the effective and accelerated transfer and adoption of research findings into practice.

DENTAL WORKFORCE

Having a responsive, competent and "elastic" dental workforce is key to meeting the needs of the public. The rapidly changing environment and emerging science and technology base continually place new demands on the existing and developing workforce. The numbers and types of personnel needed to address oral health improvement and

their ability to meet the needs of the public are but a few of the many issues.

The issue of local problems being best addressed and solved with local solutions should be the mindset that tempers consideration of solutions. This includes, but is not limited to, states rights issues in licensure, use of allied dental personnel, workforce, and access and financing of dental care for the underserved. Other than in the area of research where obvious limitations in resources make this impractical, this basic concept should prove to be most efficient.

Broad Recommendation-4: Ensure the development of a responsive, competent, diverse, and "elastic" workforce.

Strategy

◆ Expand efforts to recruit into and retain individuals in dental profession careers. Ideally, the dental workforce should reflect the ethnic and cultural diversity of the general population.

◆ Develop and implement methods to rapidly and effectively address the distribution and mobility of the dental workforce.

◆ Increase the availability and use of allied dental personnel, under appropriate supervision by dentists. This approach is a quick and cost-effective way to increase the "elasticity" of the dental workforce.

◆ Establish and expand efforts to recruit and maintain an adequate dental research and education workforce.

FINANCIAL RESOURCES FOR THE DENTAL PROFESSION

Adequate funding is necessary to meet the many needs facing the dental profession's ability to address the public's needs. Underserved populations are restricted from needed access and desired care as a result of inadequate funding for programs, facilities and services. In addition, the dental schools are hard pressed to find adequate funds to modernize facilities that have fallen into disrepair. There is a shortage of faculty members in the educational institutions and researchers who are so vital to the advancement of dental science.

Student debt is a genuine problem for future dentists, hampering their ability to follow their desired professional path in order to find sources to satisfy their financial needs. These and other important aspects of dentistry are dependent on few dollars made available and the competition for those funds tends to fractionate the profession.

Broad Recommendation-5: Develop strategies to address the fiscal needs of the practice, education and research sectors of dentistry to ensure their viability and vitality.

Strategy

◆ Assess the financial needs of the dental profession so that a reasoned and structured approach to optimal use of financial resources could be adopted. This would, in the end, advance the best interests of the oral health of the public.

COLLABORATION BETWEEN DENTAL PRACTICE, EDUCATION AND RESEARCH

The dental profession will face challenges that will require close collaboration between dental practitioners, educators and researchers. While interactions do occur between these groups, they have usually occurred on an ad hoc basis. In the future, it would be helpful if these interactions occurred on a continuous basis within a formal organization. The individuals participating in this effort should meet on a scheduled basis to discuss issues of common concern. The cooperation would include the development, implementation and oversight of activities that address issues that could be best solved by its collective actions.

Broad Recommendation-6: Establish a formal organization with membership consisting of the American Dental Association representing dental practice, the American Dental Education Association representing dental education, and the National Institute of Dental and Craniofacial Research and the American Association of Dental Research representing research.

Strategy

◆ Establish formal cooperative efforts to meet the resource and funding needs of those requiring oral health services and those responsible for offering these services.

COLLABORATIVE MARKETING AND PUBLIC RELATIONS

Too often important issues in dentistry are presented to the public as controversies, if not exposés. Examples would include amalgam safety, waterline quality and general anesthesia. However, the profession has developed a progressive agenda to deliver services of ever-increasing quality. This agenda should be presented to the public through the media in ways that target and captivate the interest of consumers by virtue of their importance and innovation. An example would be an oral cancer awareness campaign.

Broad Recommendation-7: Utilizing the combined resources of the dental profession and dental industry, emphasis should be placed on the development of highly targeted, collaborative marketing and public relations initiatives.

Strategy

◆ Develop a cooperative effort between various sectors of the dental profession and relevant business sectors to plan marketing and public relation initiatives. Cooperation such as this will leverage both funds and impact of these kinds of activities.

The recommendations that follow are based on the findings from the six subject areas explored.

RECOMMENDATIONS FOR CLINICAL DENTAL PRACTICE AND MANAGEMENT

DENTAL WORKFORCE

To assure that dental services are available to all who need them, it is imperative to establish the adequacy of the dental workforce. The workforce dif-

fers across the country and within specific communities. Factors that must be considered when evaluating the adequacy of the workforce in any geographic area include the socioeconomic status, race/ethnicity, disability or handicapped status, and

disease patterns of the population. Other factors that impact the capacity of the dental workforce are productivity, efficiency, extent of duties of allied personnel, new technology and techniques, and emerging research that alters the manner of diagnosis and treatment.

Continued study of dental workforce adequacy is essential. Studies should assess the number of dental care providers available to treat the public and should provide an in-depth analysis of the need for dental care as well as the demand for dental care. It should address the capabilities and duties of the various members of the dental team and establish whether alterations must be made to assure that the public can be adequately served.

The national supply of dental services will increase substantially due to enhanced dental productivity. There is potential to increase dental output through more efficient use of allied dental personnel. These factors indicate that an increase in the aggregate number of dentists may not be necessary. Nevertheless, the nation must be ready to act if circumstances change.

Existing regional workforce imbalances may become more pronounced in the future. Given the widely varying workforce conditions among states, one overall national policy is not likely to satisfy every state's needs. Each state should address its workforce issues based on its specific circumstances.

Flexibility is a desirable strategy for workforce policy. If more dental capacity is needed, an attractive workforce option is to adjust the number of allied dental personnel. This is a cost-effective means to generate additional dental services. However, dental hygienists and dental assistants are not available in sufficient numbers in some regions of the country. Open positions for dental hygienists in dental offices are difficult to fill, sometimes remaining vacant for extended periods of time.

Clinical Practice Recommendation-1: Continued comprehensive studies should be conducted to assess the capacity of the dental workforce addressing all of the possible factors and variables that affect the ability to provide adequate services to the public. The status of the workforce should be reassessed periodically.

Clinical Practice Recommendation-2: The dental profession must continually evaluate its data requirements and collect needed data in sufficient quantity, frequency and detail to form the basis for a rational assessment of workforce requirements.

Clinical Practice Recommendation-3: Due to regional workforce imbalances, a consortium of appropriate leaders and other policymakers should be convened to develop a plan to address these issues.

Clinical Practice Recommendation-4: Individual states or regions should develop workforce plans that address their specific needs.

WORKFORCE MODEL

With the data collected from these workforce assessments, valid evaluations of the future needs of the ever-changing population will be possible. It is imperative to develop a workforce model that portrays the emerging pattern of the need for dental services. Creative methods must be developed to assure an "elastic" workforce that adjusts to the changes in a timely and effective manner.

Factors that might be considered in the model could include geographic distribution of dental health care providers, the approved duties of allied personnel and incentive programs that attract practitioners to underserved areas.

Clinical Practice Recommendation-5: Workforce models should continually be evaluated and changed, refined and strengthened, as necessary to forecast the future dental care needs and demands of the public.

WORKFORCE BALANCE AND DIVERSITY

The dental profession must develop a balanced workforce. A balanced workforce is one that is sufficient in number and educationally and culturally prepared for the many roles required to satisfy the needs of the public. The workforce must also be balanced in its capacity to address health promotion and disease prevention as well as diagnosis and treatment for the public it serves.

Today's dental workforce is not representative of the ethnic composition of the population. Furthermore, enrollment in dental schools and participation in the allied dental fields from minority populations is far below what is desirable in trying to achieve balance with the present and future ethnic distribution of the public. It is imperative that efforts be made to increase the participation of the growing minority groups into the dental profession.

Programs to address this issue should include, but

not be limited to, outreach programs in the K-12 educational environments, community outreach efforts, public education programs, mentorship associations, scholarships and other incentive programs. Alliances with organizations outside the dental profession would foster a team effort that extends to every level of the social structure.

Clinical Practice Recommendation-6: The dental profession, through collaboration among all levels of organized dentistry, governmental agencies and educational institutions, should devise a program of recruitment to encourage the youth of minority populations to enter an educational track that would lead to joining the dental workforce.

WORKFORCE MOBILITY

The social responsibility that the dental profession assumes demands that it help ensure an adequate workforce. States have traditionally retained the responsibility assuring the best interests of their citizens regarding health services. This has translated into assessing competency and deciding the standards required by health professionals to practice within the various states. This is an important principle and needs to be maintained, while continuing to meet the needs of a mobile citizenry. It is important to note also that need and demand for dental services are sometimes unsatisfied in certain geographic areas because of a scarcity of dental workforce. Improved workforce mobility would facilitate adjustments to satisfy regional requirements.

Clinical Practice Recommendation-7: The dental profession should support licensure by credentials for dentists and dental hygienists.

The increasing demand for preventive dental services requires greater use of personnel from the allied dental team. There are regional shortages of dental hygienists that increase the difficulty of fulfilling staffing needs. The lack of mobility of dental hygienists created by state licensure processes is another factor contributing to the staffing shortfall for dental hygienists. Varying levels of duties allowable in states cause discrepancies in training, ability and compensation. This, in turn, inhibits geographic mobility.

To encourage potential applicants to enter the profession, and to retain qualified hygienists, authorized duties should be commensurate in all

venues and the ability to move from one state to another should be possible. In addition, the duties allowed for dental assistants should be uniform among all states, allowing well-trained and experienced individuals to provide services in areas to which they move.

Clinical Practice Recommendation-8: Workforce studies should be undertaken to identify the optimum number and distribution of allied dental personnel.

Clinical Practice Recommendation-9: The dental profession should establish as a goal the standardization of approved duties for allied personnel within the United States.

PUBLIC AWARENESS

The public must understand the importance of oral health in order to appreciate and take advantage of the services available. Education efforts must be made to ensure that every individual is aware of the necessity of visiting a dental practitioner on a regular basis. Optimal oral health care can be achieved only by a cooperative effort of all interested parties, including the public, the government, private industry, and health care providers. Alliances should be forged to structure and fund this effort.

Clinical Practice Recommendation-10: An alliance should be formed comprised of the dental profession, organized dentistry, government health agencies and dental industry to develop and fund a "National Health Awareness Campaign" focusing on increasing the awareness of the public and policymakers of the importance of oral health.

Clinical Practice Recommendation-11: Lobbying activities should be organized that include the participation of all levels of society to convince legislators that oral health is a major part of general health and that increased funding is necessary to support efforts to achieve the goal of optimum oral health for all.

Low-income children often suffer from dental neglect and pain. This can cause decreased nutrition, inattention in school, and lost school days. Studies show a 60% decrease in dental decay in communities with fluoridated water. It is unacceptable to

spend tax dollars for dental care but neglect the obvious savings of water fluoridation.

The dental profession must make a greater effort to convince the public and policymakers about the efficacy and cost effectiveness of fluoridation. It must be shown that prevention is our greatest cost containment device. It must be illustrated that communities without fluoridated water continue to exist today, affecting our lower socioeconomic groups more severely than other groups with greater access to care and prevention. The public and policymakers must also be convinced that fluoridation will protect the entire community.

Clinical Practice Recommendation-12: The dental profession, together with all interested parties, should increase efforts to convince the public as well as local, state and national policymakers that fluoridation of water supplies is a safe and cost-effective way to protect oral health.

With over 30,000 new cases and over 7,800 deaths reported annually, oral cancer now accounts for approximately 3% of all cancer deaths in the United States, a number which exceeds that of melanoma and cervical cancer. The dental profession must make sure that every individual knows the importance of a regular oral cancer examination and is encouraged to receive one on an annual basis.

The public should be educated about the importance of oral examinations by qualified health professionals and other pertinent information, which will heighten the awareness of the risks of developing oral or pharyngeal cancer as well as the benefits of regular screening.

Clinical Practice Recommendation-13: The dental profession should conduct intensive public service information and education efforts to reduce the death rate due to oral cancer through early diagnosis.

RISK-BASED DENTAL CARE

Given the changing oral disease patterns and treatment options, future clinical practice may be expected to incorporate more diagnostic-based data into treatment plans. Research and experience suggest that each patient presents different risk factors and that patient recall and evaluation should be based on their susceptibility to various oral diseases. Scientific studies to support or deny the effectiveness of risk-based dental care, that is, treatment patterns

based on risk assessment strategies, are not available and should be developed.

Clinical Practice Recommendation-14: A comprehensive study should be undertaken to assess the efficacy of risk-based dental care.

EVIDENCE-BASED CLINICAL PRACTICE AND SCIENCE TRANSFER

Evidence-based dentistry is a concept for which health professionals have developed renewed interest. The study of the appropriate uses of this process in assisting dentists and patients to arrive at the best decisions needs renewed commitment. The potential of this approach along with possible misuses need to be understood by dental practitioners, educators, researchers, and policymakers.

The current meaning of evidence-based dentistry and its interpretation by practitioners, patients and policymakers are not the same. Confusion exists and there is a barrier to the use and application of evidence-based practice reviews. Creation and adoption of uniform diagnostic codes on which to base evidence-based therapies will help eliminate the current misapplications of evidence-based clinical practice.

Understanding the dimensions of evidence-based practice and contributing to development of the needed science and scientific study designs to enhance the knowledge-base will allow the practice of dentistry to evolve more rapidly. Enhanced understanding of, and communication regarding, evidence-based dentistry will help reduce the considerable uncertainty that currently exists regarding its definition and role in the modern practice of dentistry.

Evidence-based practice involves the incorporation of such new knowledge into practices. However evidence-based practice also involves expertise on the part of the clinician interacting with patients to determine their needs and demands. The interface and balance among the current science, practitioner competence and the patient should to be maintained.

Clinical Practice Recommendation-15: Dental practitioners, educators, researchers and policymakers should develop a common definition of evidence-based practice.

Clinical Practice Recommendation-16: The dental profession, in concert with all other interested parties, should identify ways in which to integrate science from systematic research, practitioner expertise, and patient choice to ensure the appropriate application of the latest knowledge into the delivery of care.

DIAGNOSTIC CODES

With scientific advances, methods and approaches to evaluation, diagnosis, and treatment planning will change. Likewise, implementation of preventive interventions as well as definitive therapy will evolve. Outcomes assessments can help guide the introduction and evaluation of new methods. More-over, appropriate diagnostic codes in conjunction with clinical judgment of practicing dentists and the treatment goals of patients can assist dentists and their patients in arriving at the most appropriate treatment choices.

However, outcomes assessments in dentistry are likely to remain incomplete in accuracy and scope until more broadly based diagnostic protocols are implemented. Research databases derived from clinical settings, if properly designed and implemented, will allow for more immediate understanding of efficacious clinical diagnostic and treatment applications. Scientific evidence, based on outcomes data, would broaden the base of knowledge for clinical practice, research and education.

With these tools, clinical practitioners can then employ diagnostic and therapeutic services objectively, while preserving the ability to utilize sound professional judgment. The dental profession must establish sound scientific application for outcomes, based on accurate diagnostic protocols.

Clinical Practice Recommendation-17: An appropriate system of diagnostic codes should be developed and integrated into the daily practice of dentistry.

A network of practitioners, assembled by the appropriate professional organizations and connected by electronic communication, could provide a large source of data on procedures and outcomes. Clinical practitioners, to enhance their ability to monitor clinical and procedural protocols, should be able to access unbiased and reliable information easily.

Clinical Practice Recommendation-18: The dental profession should strive to develop the leading repository of the most accurate dental diagnostic and therapeutic databases.

TECHNOLOGY TRANSFER

Clinical practitioners must apply the most appropriate technology to patient care. New diagnostic and treatment methodologies are available that would improve care, but are not swiftly implemented because of cost or concern about the ease of integration into dental practice. Lack of familiarity makes many practitioners hesitant to use new technologies.

Clinical Practice Recommendation-19: A consortium of representatives of dental practice, research, education, and the dental product industry should be established to ensure the rapid transfer of information regarding new modalities of oral health care to private practitioners.

DENTAL LABORATORY TECHNICIAN TRAINING AND PROGRAM ACCREDITATION

Prosthetic services will continue to be a large part of dental practice. Given longer life expectancy and the inevitable loss of teeth by the older population, it is imperative that the resources for providing the needed restorations are made available. Dental laboratory technicians typically fabricate the prostheses under a dentist's direction.

The dentist must remain the repository of laboratory skill and knowledge. The laboratory industry should not become the authority on laboratory procedures. Abdication of the dentist's role in the laboratory phase due to educational cost/convenience must not create a vacuum of knowledge in the profession. Dental school curriculums must maintain sufficient focus and resources to continue to prepare dentists to provide prosthodontic/restorative therapies that continue to constitute the majority of the service component of a general dental practice.

There are no national standards for dental technicians and accrediting programs are decreasing. A shortage of qualified dental technicians will create a risk situation in the areas of access and quality of care, especially for the financially disadvantaged populations.

Clinical Practice Recommendation-20: A study should be undertaken to address the adequacy of the number of dental laboratory technicians and to develop a strategy for attracting qualified individuals into that profession.

Clinical Practice Recommendation-21: The dental profession should develop strategies to maintain the dentist as a knowledgeable director of laboratory procedures to insure the safety of the patient.

RECOMMENDATIONS FOR FINANCING OF DENTAL SERVICES

EMPLOYER-BASED DENTAL BENEFITS

Major changes in employer funding of dental benefits are expected. Higher medical costs and competitive pressures will lead to more defined contribution programs, more voluntary programs, greater employee cost sharing, and optional coverage for retirees. These changes will impact the use of dental services and the mix of services. Third party payments are simply a means of helping fund dental care. They must never inappropriately influence the dentist's diagnosis and treatment recommendations.

Financing Recommendation-1: The dental benefits industry should explore a market-oriented solution to financing dental services which would include tax deferred dental/medical savings accounts and direct reimbursement plans.

Financing Recommendation-2: Financing of dental services should be structured so it will not inappropriately interfere with the professional judgment of the dentist or create unwarranted intrusion into the decisions reached jointly by dentists and patients regarding appropriate and best treatment options.

Radical changes in the health care delivery system have often left patients in positions where they feel defenseless in their attempts to receive quality care. In many cases this can be directly traced to unwarranted intrusion by third parties into the doctor/patient relationship. To remedy this situation national legislators have sought to initiate actions that would give Americans access to responsible care. Organized dentistry has been a pacesetter in the struggle to ensure that patients have the right to choose health providers within a plan; have the option of joining a point-of-service-plan outside the network; be assured of prompt care; have access to care within reasonable distances from their home; and have the ability to pursue legal action against negligent health plans.

Financing Recommendation-3: The professional dental communities must continue their support of national legislation that will protect patients from health plans that place bottom-line profit ahead of quality and access to care. Even after passage of

such legislation, the profession must remain vigilant in ensuring that the intent of the legislation is not undermined.

Financing Recommendation-4: The dental profession should develop an active campaign to educate employers and employees regarding dental benefits choices so they can become better health care consumers. This campaign should include dentists as members of the educational team.

INNOVATION IN DENTAL FINANCING ARRANGEMENTS

Patients are experiencing greater limitations, restrictions, exclusions, larger co-payments, static maximums, and administrative problems which are contributing to their growing frustration. If these factors continue and are not corrected, they will lead to growing dissatisfaction on the part of patients; some may be unwilling to continue their dental insurance plans. Changes in technology, disease patterns and demographics may stimulate development of new dental benefit programs that would have different reimbursement methods, incentives and covered benefits. These changes could impact the types of services provided. Innovative dental insurance programs should be developed to respond to these changes.

Financing Recommendation-5: The dental profession should encourage the dental benefits industry to streamline procedures, reduce administrative burden and policy limitations, and provide greater flexibility for covered individuals in their reimbursement for dental services.

Dentists are reporting increasing frustration in dealing with dental benefits companies. A growing number of dentists are distancing themselves from dental insurance companies proclaiming themselves to be "insurance free." Bureaucratic and administrative problems, excessive and time consuming paperwork and telephone activity, "lost" submitted forms and radiographs, interference with treatment, fee restrictions and payment delays are among the reasons cited. It is difficult to determine how significant the "insurance free" trend will become, but it appears to be

gaining acceptability and momentum. If the dissatisfaction becomes more widespread, it will negatively impact the value of dental insurance in the future.

Financing Recommendation-6: The dental profession should commence constructive dialogue with third party carriers to develop a user-friendly attitude and more efficient administrative procedures in their dealings with providers and purchasers.

Third party carriers have been slow to respond to new techniques and options for dental treatment

with regard to including them as reimbursable procedures in their plans. This is burdensome to both practitioners and patients. Carriers need to respond quickly to changing science and technology with updated coverage that includes the more recent and efficacious diagnostic and treatment modalities.

Financing Recommendation-7: The dental benefits industry should shorten its response time for including scientifically accepted new diagnostic and treatment options as reimbursable procedures in their plans.

RECOMMENDATIONS FOR ACCESS TO CARE

The guiding vision for the dental profession is that all Americans will be able to receive the dental care they need, regardless of their financial, geographic, health status, or other special circumstances. The dental profession is eager and willing to assist in securing access for all Americans. However, providing access to dental care for all requires the cooperation of every segment of society, including policymakers, the dental profession, and the general population. Most dentists provide free or discounted care to people who otherwise could not afford it. But charity alone is not enough. We as a society—policymakers, the dental profession, community leaders and the public—must summon the political will to break down financial and other barriers that diminish access to care.

The large majority of Americans can and do access dental services, and the private delivery system provides high quality dental care for those who avail themselves of it. However, for the numerous individuals who face barriers to care, commitment must be made to develop new and innovative approaches to facilitate access.

THE DISADVANTAGED

There are two large groups of people with low incomes. One group consists of those with incomes below the federal poverty level, and their family members. In 1996, this group consisted of 38 million people, or 14% of the U.S. population. Many of this group are the long-term unemployed. The second group consists of the working poor, those who fall between 100 to 200% of the federal poverty level, and their family members. In 1996, this group consisted of 53 million people, or 20% of the population. Within both of these groups are found a dispro-

portionate number of African Americans, Hispanics, Native Americans, and recent immigrants.

LONG-TERM UNEMPLOYED

For the long-term unemployed, adequate public financing is essential but currently, in most states, non-existent. One exception is the Michigan's Healthy Kids Dental Program where funding does accommodate market level reimbursement and administration of the program is handled privately. This has resulted in improved access to care for covered children.

New programs should be developed which would address the demand for services from this segment of the population. It is essential that the reimbursement fees for these services not fall below prevailing market rates and thus, in the long term, should be indexed to assure that goal. In order to accommodate the anticipated increase in demand, these programs may have to be introduced incrementally, with initial limited resources targeted to children. Administration should be redesigned to be comparable to employer-based dental prepayments plans. Non-economic barriers to care for this population should be addressed such as cultural diversity, language, education and transportation needs.

Access Recommendation-1: Public funding should be expanded to provide resources that would cover basic dental services for the long-term unemployed. In order to assure participation by providers and improve access, dentists should be reimbursed at market rates for their services. Administration should be managed utilizing the same procedures and systems as employer-based dental prepayment plans.

THE WORKING POOR

The working poor are defined as those people who are employed in low-wage positions (i.e., 100-200% of the poverty level) in economic sectors where there is a lack of affordable private prepayment programs. Programs to address the needs of this population could include some level of financial participation by the individual employee.

Public funding could provide the individual with a stipend to subsidize the purchase of either a traditional prepayment plan or dental savings account. The federal or state governments could address the necessity to spread the risk by the creation of pools. The administration of the program could be contracted to the private sector.

This type of structure would empower the disadvantaged to make choices regarding dental care in a manner similar to the rest of the population. By bypassing the employer and going directly to the individual, the difficulties of providing employer-based prepayment for this segment of the market is avoided. Individual employee contributions could be withheld from wages.

Access Recommendation-2: New programs, subsidized in part by public funding, should be developed in which individual employees could purchase insurance plans directly from risk pools if their employers do not provide it.

THE DISADVANTAGED IN GEOGRAPHICALLY ISOLATED AREAS

Adequate availability of dental care is a problem for the poor in inner cities and rural areas. Financing care for the long-term unemployed and the working poor are essential first steps to address access. Additional efforts are needed to increase availability of care for those groups in geographically isolated areas. The dental profession should encourage dentists to provide services in these locales.

Access Recommendation-3: Effective incentives should be offered to attract dentists to underserved areas. These could include loan forgiveness, tax credits or adequate reimbursement rates.

A program similar in design to the National Health Service Corps would be beneficial in providing increased workforce to underserved areas. Eligibility

for this program should not be limited to new dental graduates. Older dentists and those in semi-retirement may provide an important pool of personnel to address this issue. Long term funding at adequate levels is essential to the success of this type of program.

Access Recommendation-4: The National Health Service Corps program should be expanded to help provide dental care in the underserved areas.

SPECIAL NEEDS POPULATIONS AND INDIVIDUALS WITH DISABILITIES

Access for special needs populations and individuals with disabilities is difficult because of the special needs of these individuals and the complex management of their care. Many of these patients are homebound, institutionalized or unable to cooperate with care in a traditional dental setting. Furthermore, health providers require special skills and educational background to effectively manage some of these individuals' health problems. Financing for the care of this group of people will require reimbursement rates at levels that will attract providers to undertake the additional training necessary to manage these patients. In addition, educational programs to train providers with the necessary specialized skills should be developed and widely implemented.

Access Recommendation-5: A publicly funded or subsidized dental program should be developed for people with disabilities, recognizing their special needs.

Access Recommendation-6: Outreach programs at the state and local levels, which might include the establishment of specialty dental clinics, should be developed to meet the needs of patients unable to receive care in traditional dental offices.

THE ELDERLY

Utilization and access among the elderly have increased resulting in much improved oral health. This trend is likely to continue. Although many of the elderly can budget for dental care without dental prepayment, others might access care to a greater degree if prepayment were available. There is evidence that employers are reducing retirement-based prepayment coverage for their former employees. The development of a market-oriented solution to

this lack of coverage, supplemented by the growing economic resources and improved oral health of the elderly, will meet many of the access needs of this population.

Access Recommendation-7: Tax-deferred dental/medical savings accounts should be established in which the balances accrue over time and can be used by the elderly as needed during their retirement.

RECOMMENDATIONS FOR LICENSURE AND REGULATION OF DENTAL PROFESSIONALS

Issues of licensure and regulation of dental practice are the responsibility of individual states. These issues also continue to be very important to dental professionals. Although the health and welfare of the public is the underlying goal of both professional licensure and regulation of dental practices, these activities can restrict the dentist's freedom to practice how and where they wish.

While progress continues to be made in reducing the impact of overly restrictive licensure regulations, standardized requirements that cut across all state boundaries are still in the formulation and discussion stage. Changing disease patterns will influence the content and design of licensure examinations. Competency and continuing education requirements will further evolve, generating continued debate about their necessity and application.

Licensing issues are not confined to the practicing dentist. Geographic imbalances in the dental workforce are creating a changing environment in the marketplace as it relates to competition among states to attract an adequate number of dental health personnel. Irrespective of many traditional barriers to freedom of movement of practitioners, many states may alter licensure requirements to ensure a more adequate dental workforce.

Possible changes in expanded functions for dental assistants and hygienists may affect licensure, regulatory, and certification requirements. Accordingly, non-dentist clinician demands for unsupervised practice raises the potential of fragmentation of care to the detriment of the quality of care received by the public.

Regulations have increasingly affected the dental health care system. Federal, state and local governments continue to promulgate regulations related to the safety of the dental office and environmental issues. Meeting the requirements of these rules has dramatically increased the overhead costs of dental care practices and could influence the choice of dental materials used in restorative dentistry. Laws, such as the Americans with Disabilities Act, do not primarily target the health professions, but have profound implications for health care delivery. Federal and state activities are likely to

increase in the near future in the area of access to care for Medicare, Medicaid, and SCHIP beneficiaries. Federal activity is also likely to occur in the area of the workplace environment. New proposals being considered could increase the cost of delivering care, thereby increasing consumer costs and, ultimately, decreasing access to oral health care.

NATIONAL BOARD EXAMINATIONS AND CONTINUING COMPETENCY

National board and regional clinical licensing examinations are anticipated to reflect more accurately the change in dental disease patterns and clinical practice patterns. Limits on resources and time will necessitate less emphasis on, or elimination of, some traditional educational themes within dental schools. The balance between development of cognitive and clinical skills will change and continue to be a source of controversy and debate. This debate will intensify as it relates to measurement of initial and continuing competency.

Licensure and Regulation Recommendation-1: National board examinations, as well as regional clinical licensing examinations, should evolve to reflect more accurately the change in dental disease patterns and clinical practice patterns.

Licensure and Regulation Recommendation-2: The dental profession should support a study to address the issues of continuing competency.

PATIENT-BASED LICENSURE EXAMINATIONS

Patient-based licensure examinations present a myriad of ethical and procedural problems. Within the past few years, several dental professional organizations have called for elimination of licensure examinations that involve delivery of care to patients. Simulation technology or post-treatment case review has been successfully incorporated into competency examinations for many other professions.

Licensure and Regulation Recommendation-3: The profession should strive for approaches aimed at evaluating the clinical competency of a dental practitioner by simulated methods or post-treatment case review.

Licensed dentists have undergone extensive education and training to prepare them to diagnose and treat oral diseases. It is essential that the primary care provider possess this broad knowledge and extensive preparation. Movements to permit the independent practice of limited areas of dentistry, such as denture and preventive services, risk fragmenting preventive, diagnostic and therapeutic roles. This fragmentation will mean that dentists' judgments will sometimes be replaced with the judgment of individuals with insufficient training to the detriment of the quality of care received by patients.

Licensure and Regulation Recommendation-4: In order to assure the quality of care for patients, the dental profession should maintain the role of dentists as the ultimate authority for the diagnosis of, treatment planning for and delivery of care for oral disease.

Currently, individuals undertaking initial competency examinations face a wide variety of requirements in various states and regions of the country. First and foremost, the standard of care for dentistry is the same for all regions of the U.S. and should be applied universally for all patients. In addition, regional differences in examinations make it difficult for individuals to prepare for the various requirements. Also, for individuals taking the examination at a location where they do not reside and/or where they did not train, it is especially difficult to find patients exhibiting the appropriate case-mix required by the examination administered at that location. In order to prepare their students for initial examinations, regional differences in examination content require dental schools to vary their curricula in ways not indicated by dental science.

Licensure and Regulation Recommendation-5: The dental profession should establish as a goal the equivalence or unity of all examining bodies.

The knowledge and clinical skills between general dentists and ADA-recognized specialists are substantially different. As dental specialists continue

their education and practice, their clinical skills become further removed from their original training as general dentists. In many areas, additional examinations are required for a specialty license. The requirement that previously licensed specialists be re-examined as a general dentist when relocating is an unnecessary burden that does not protect the public nor improve patient care. Such a requirement requires specialists to practice outside the scope of their specialty in order to retrain themselves for a general dentistry examination.

Licensure and Regulation Recommendation-6: The dental profession should encourage all licensing boards to develop guidelines and procedures that allow for the examination of educationally-qualified specialists in their respective areas of expertise without requiring concurrent examination for a general dentistry license.

The dental profession has supported the freedom of movement of dentists within the U.S. This is an important principal of personal and professional freedom. More importantly, without such potential mobility, addressing regional and local workforce imbalances are more difficult.

Licensure and Regulation Recommendation-7: The dental profession should intensify efforts to achieving licensure by credentials in all states.

In recent years regulatory activity has had a profound effect on the manner in which dentistry is practiced. Whereas some of this regulatory activity has been appropriate and welcome, much of it has been justly criticized as being insufficiently substantiated by scientific data. Any regulations pertaining to dental practice must be based on valid scientific principles. Regulations will only be beneficial if they add safety and value to the services provided and if compliance does not require unreasonable burden. The dental profession must remain a leader in developing and influencing legislative and regulatory activity affecting dentistry.

Licensure and Regulation Recommendation-8: The profession must continue to be vigilant and proactive in identifying and researching potential hazards that might impact the safety of patients, the dental workforce, and the environment.

Licensure and Regulation Recommendation-9: The dental profession must remain proactive in advocating scientifically valid solutions to identified hazards.

Licensure and Regulation Recommendation-10: The ADA's Division of Government Affairs and Constituent Dental Societies must remain vigilant and vigorous in ensuring that the voice of dentistry is heeded in regulatory discussions.

RECOMMENDATIONS FOR DENTAL EDUCATION

Education is expected to undergo dramatic changes in the next 15 years. The cost of dental education, probably the highest of all the major academic offerings, threatens to price dentistry out of the education marketplace.

Greater integration of the dental school into the surrounding academic community will help to sustain support but will not prevent cash-starved health science centers from looking at their dental schools as a potential financial resource for its medical programs.

All of this is taking place at a time when expansion of oral and craniofacial science, changes in disease patterns, advances in dental materials, coupled with technologic advances are competing with the traditional elements of dental education for curriculum time. Compounding these issues is the recent reduction in dental school applicants, the lack of progress in increasing the diversity of dental school students and faculties, and an inadequate pool of qualified faculty members.

Reduced government support and increased regulatory requirements have contributed to the escalating educational cost. This eliminates large segments of the college population from considering dental school as a career. This is even more evident among certain minority groups who are enrolling in other career programs with shorter training periods and higher rates of return. A continuation of this trend promises to negatively impact attempts to increase the diversity of the dental workforce. Upon graduation, large educational debt may be a factor in career choice, forcing many of these young practitioners to place undue emphasis on monetary priorities during the formative phase of their careers. For some, this means forgoing a career in dental education.

FINANCIAL SUPPORT FOR HIGH QUALITY DENTAL EDUCATION

The provision of quality dental service for all Americans must be considered a national goal. Critical to obtaining that goal is the education of a high-quality, diverse cadre of dental practitioners.

Education Recommendation-1: The provision of sustained federal/state funding to support dental student training, either in the form of scholarships or direct unrestricted block grants, should be a high priority issue.

Education Recommendation-2: Creative financing and partnership with various communities of interest should be developed to increase the diversity of the dental workforce.

Education Recommendation-3: Programs should be developed to educate dental students and young graduates in debt and financial management.

Government leaders have suggested that reductions in federal and state support of educational institutions, such as dental schools, should be made up by the private sector including corporations, faith-based organizations, foundations and individuals. In this regard, dentists have proven to be charitable individuals by virtue of providing large amounts of free care to the poor. However, they generally have not focused their charitable giving on their dental educational institutions. Since corporations and foundations frequently assess alumni support as a measure of the worthiness of the institution, an increase in support by dentists for their alma mater would likely be highly leveraged. Such support would make the dental educational system less dependent on tuition and clinic income, and would likely lead to the graduation of dentists in less debt, as well as the development of a dental educational system which is in greater resonance with the issues that confront clinicians in private practice.

Education Recommendation-4: Dentists should be encouraged to provide significantly increased financial support for their educational institutions. They should also suggest to grateful patients as well as to other philanthropic individuals among their friends, that they consider a gift to the local dental school.

COST REDUCTION

Non-tuition revenue sources for the education industry have been pushed to limits. Thus, additional costs must be absorbed by tuition increases that add to high student debt. State contributions to health education centers are often controlled by medical administrations that, with their own budget pressures, are becoming increasingly reluctant to share their declining funds. To address the potential of reduced or insufficient funding, dental schools should seek ways to provide education at reduced cost without compromising quality.

Education Recommendation-5: Dental schools should explore regionalization in dental education in which dental schools collaborate to reduce costs and enhance quality in dental education. Dental schools should examine the cost effectiveness of sharing teaching faculty through electronic distance learning.

Innovative techniques, such as placing curriculum on a DVD, clinical simulation, and virtual reality warrant further evaluation as means of reducing instructional costs.

Education Recommendation-6: Dental educators should seek to use new technology and scientific advances which have the potential to reduce the cost of instruction.

OFF-SITE CLINICS

Maintaining a fixed clinical site, owned and operated by the dental school, is exceedingly costly. The medical model of sending students to hospitals and clinics for third and fourth year training experiences has resulted in significant cost reductions relative to corresponding dental school-based training. Off-site training opportunities for dental students that are educationally sound and provide access to care for the underserved should be encouraged.

Attempts to increase the dental school's clinical income through establishment or expansion of clinic activities outside of the school's primary location could put the school in direct competition with its practicing community. When dental schools have established clinics staffed by clinical faculty in affluent neighborhoods, the local professional response has not been supportive.

Education Recommendation-7: Any plans for a dental school to expand its clinical activities outside the school's primary location should be discussed with local practitioners, alumni and local components of organized dentistry.

Education Recommendation-8: Research should be conducted on the cost effectiveness of off-site training opportunities.

CULTURAL COMPETENCY

The dental profession should reflect the diversity of the population and have the cultural understanding and skills needed to provide services to a growing and diverse patient population. Dental schools have a responsibility to recruit and retain under-represented minority students and faculty and for training students to be culturally competent in dealing with various populations.

Education Recommendation-9: Dental schools should develop programs in which students, residents and faculty provide care for members of the underserved populations in community clinics and practices.

Education Recommendation-10: Dental education curriculum should include training in cultural competency, as well as the necessary knowledge and skills to deal with diverse populations.

CURRICULUM DEVELOPMENT

The explosive growth in dental knowledge will challenge dental educators to provide programs that enable the new graduate to deliver quality dental care to the public within the traditional curriculum length. The dental education curriculum should become more relevant to the practice of modern dentistry. Areas which should receive greater emphasis include: special needs populations; applied pharmacology, including pain management; business management; esthetic dental techniques; implant prosthodontic therapy; and increased knowledge of systemic disease. This would better prepare dentists to treat patients with complex medical problems. The skills necessary to evaluate the safety, efficacy, and cost effectiveness of new treatments also should become an integral part of the curriculum.

Education Recommendation-11: Dental schools should undertake a comprehensive evaluation of undergraduate curricula to assure that the appropriate and modern scientific and clinical content is included.

Education Recommendation-12: Dental researchers (especially clinical researchers) should become more integrated in the foundation of curriculum and, when possible, in clinical activities.

Education Recommendation-13: The education community should enhance undergraduate exposure to the ethics of dental practice while also providing cultural competency that provides information and training on delivering care to all segments of the population.

INTEGRATING ORAL HEALTH EDUCATION INTO OTHER HEALTH CURRICULUM

Oral health is an integral part of total health. A closer collaboration between dentistry and the other health care disciplines is imperative to assure that the public is best served.

All health care professions should convene to discuss how best to incorporate oral health content into their curricula and practices. To do this, the dental profession should be prepared to consider those aspects of the respective health care professions that could be incorporated into dental education and practice. This effort will require the cooperation of health teaching institutions and universities.

Education Recommendation-14: A formal dialogue among all health care professions should be established to develop a plan for greater cooperation and integration of knowledge in medical and dental predoctoral education, hospital settings, continuing education programs, and research facilities.

Education Recommendation-15: An inter-disciplinary structure between dental and medical schools should be established to promote close cooperation between health teaching institutions and universities.

CLINICAL TRAINING OPPORTUNITIES

The practice of dentistry has become increasingly complex. New clinical and technologic information competes for time in the overcrowded dental curriculums with traditional clinical skills. While there is gen-

eral consensus that an additional year of education and clinical training would enhance the ability of tomorrow's dentists to treat patients with complex needs, the cost associated with additional clinical training, coupled with its subsequent impact on student debt, has put a damper on its adoption. Developing sufficient numbers of programs that allow all students to participate would further enhance the students' clinical and diagnostic abilities. Postgraduate Year One (PGY-1) students could receive their initial licensure following graduation from dental school.

Education Recommendation-16: When economically and logistically feasible, a PGY-1 year should be a requirement for all dental graduates.

Education Recommendation-17: In order to make PGY-1 economically feasible, the dental profession should develop lobbying efforts directed to increasing the funding support for additional General Practice Residency and Advanced Education in General Dentistry programs. This funding should be sufficient to offer all future dental graduates the opportunity for further clinical training.

FACULTY DEVELOPMENT

The growing number of faculty vacancies, especially in the clinical specialty areas, appears to be related to the significant disparity in income available through the private dental practice and that associated with faculty positions. The many full-time vacancies for faculty, reported to number between 300 and 400, could make it difficult to maintain high dental education accreditation standards. The long term ramifications of a continuing problem in this area include reduction in new knowledge and techniques, diminished quality of teaching and care, and greater dependence on dental graduates from non-accredited schools.

Using distance learning combined with structured hands-on training, a significant number of practitioners could be trained as faculty clinicians within a short period of time.

Education Recommendation-18: The dental profession should design and implement a formal education program to train existing dental practitioners to become members of the dental faculty.

Education Recommendation-19: The dental profession should develop educational tracks with special degrees or certification for students interested in research, education, or public health futures. Specialized curricula should be developed to train these individuals for work in those areas.

Education Recommendation-20: The dental profession should seek actions to extend debt forgiveness programs to dental graduates who are willing to make a commitment to academic dentistry.

Insufficient numbers of specialty-trained faculty could lead to a shortage of specialists in the distant future. Affordable, high quality, postdoctoral training opportunities for the development of dental specialists are essential to the viability of the profession. All components of the dental care system are dependent on the training of sufficient number of specialized clinicians, practitioner consultants, dental researchers and educators.

Education Recommendation-21: Federal programs that underwrite research and specialty training need to be enhanced with sufficient funds allocated to dental applicants.

Education Recommendation-22: Specialty organizations should be encouraged to continue efforts dedicated to funding teaching scholarships and fellowships.

Education Recommendation-23: Dental educators should be encouraged to test alternative, less faculty-dependent models for educating dental students.

CENTERS FOR RESEARCH EXCELLENCE

Dental schools must be supportive of the development of new knowledge and its incorporation into practice. The success of the future of dentistry depends upon the dental schools' expansion of scholarly activities. The conduct of and resources for these activities will increasingly rely on multi-disciplinary and multi-institutional collaborations. Competition for scarce research dollars, which can enhance faculty productivity and offset portions of educational salary commitments, is expected to increase. It is unlikely that all dental schools will be able to successfully compete for the funds necessary to develop and maintain a sophisticated research

program. The mission of these research mega-centers would focus on developing the research capabilities of faculty members of a research consortium. Both on-site and off-site research involvement would be offered.

Education Recommendation-24: The dental profession should support the establishment of centers for research excellence that provide research training and opportunities for organized research for dental faculty within a defined geographic area.

MAINTENANCE AND ENHANCEMENT OF EDUCATIONAL FACILITIES

Many of dental education's physical facilities require major renovation. Many students are not using state-of-the-art equipment. With schools unable to set aside funds for deferred maintenance, the financial resources needed to purchase new technologies to enhance student learning are unavailable.

Education Recommendation-25: The dental profession should develop lobbying efforts directed towards the development of new assistance programs for the improvement of the physical facilities of dental schools.

ALLIED DENTAL PERSONNEL TRAINING

Training opportunities for some members of the dental team are not sufficient. There are shortages of all dental allied personnel. If the dental team is to function in the most efficient manner, a sufficient number of competent team members should be available. In addition, dental practitioners need to provide a stimulating work environment with sufficient reward systems to acknowledge performance excellence by dental team members. Continuing education opportunities, supported financially by dental practices, may provide the incentives for existing team members to stay in practice.

Education Recommendation-26: Well-funded, innovative recruitment programs to identify and enroll quality candidates for dental hygiene, dental assisting, and laboratory technology education should be developed.

Education Recommendation-27: The development of additional training programs for allied dental personnel, which employ both traditional and innovative educational programs, needs to be encouraged. This could be accomplished through the combined efforts of national, state, and local dental societies, working with various allied communities of interest.

Education Recommendation-28: Credit against educational debt should be sought for dental team members who work with dentists in designated underserved locales.

Education Recommendation-29: Continuing education programs, designed to provide upward mobility for dental team members, need to be developed and offered.

CONTINUING EDUCATION OPPORTUNITIES

Opportunities for high quality, relevant, continuing education appear to be one of the top-ranked issues among practitioners. The change in disease patterns and case mix necessitate that high quality, hands-on programs are offered to these individuals. Reasonable cost and flexibility of offerings need to be basic tenets of any system. Suitable reward systems are important for continuing education participants. Whenever possible, rewards should be integrated with continuing competency initiatives.

Education Recommendation-30: The dental profession should continue its efforts to ensure quality control, educational counseling, and appropriate recognition for achievement.

RECOMMENDATIONS FOR DENTAL AND CRANIOFACIAL RESEARCH

The dental profession and the public have contributed to and benefited from many advances in understanding the causes, progression, diagnosis, prevention and management of dental diseases and conditions. Public health issues, changing demographics and diseases, science and technology will continue to drive research opportunities.

Dentistry will benefit from a range of studies including: (1) biomaterials and tissue engineering; (2) chemotherapeutic preventive agents and therapies; (3) the relationship between oral and systemic conditions; and (4) gene therapy, gene therapeutics and pharmacogenomics. Behavioral intervention studies, to optimize lifestyle behaviors leading to enhanced oral health, will also be important. With the changing demographics there is a need also to study the complex diseases and conditions of the elderly and special needs populations and to continue to investigate interventions to reduce and eliminate health disparities and improve quality of life. In addition, the development of better and new animal models for oral diseases and conditions, the design and conduct of well-controlled clinical trials, and the availability of sufficient resources to support research will be needed. Continued research on the fundamental mechanisms of oral disease and on the promotion of oral health will continue to drive change in dental practice, education, and perhaps change the entire role of dentistry in the health care system.

OVERALL FUNDING OF RESEARCH

Maintenance of the visibility, funding and support of dental research is critical to the profession's science base. Although there are many funding streams, federal support is critical to basic research, clinical and epidemiologic studies and health services research. Currently the proportion of federal funds for biomedical and behavioral oral health research remains below that of the proportion of dental expenditures as a percent of total health expenditures.

Research Recommendation-1: Professional organizations, and patient advocate groups should form a coalition to support the long-term maintenance of National Institute of Dental and Craniofacial Research (NIDCR) as a separate institute within the National Institutes of Health (NIH).

OPPORTUNITIES FOR RESEARCH

The mapping of the human genome creates exciting opportunities for dentistry, medicine, and humankind. This resource will allow us to build upon the areas with which dentistry has experience such as, anthropology, evolution theory, and forensics. It will permit the profession to advance scientific knowledge in biometrics, tissue engineering,

risk assessment, and diagnostics. The dental profession should take the lead in encouraging research, training researchers and developing new knowledge using the human genome.

Research Recommendation-2: The dental profession should be an active member of the National Health Profession Coalition for the Human Genome.

Research on pathogenesis, prevention, etiology, diagnosis, and treatment is necessary for all oral diseases. Future research will form an improved definition of genetic, environmental and microbial risk factors for oral disease that will lead to development of a profile for patients at risk for advanced disease.

Research Recommendation-3: Additional studies should be undertaken to develop new approaches to the non-invasive diagnosis and genetic assessments of patients at risk for caries, periodontal diseases, oral cancer, craniofacial anomalies and other oral conditions. Clearly accepted criteria for the diagnosis of oral diseases should be developed.

TREATMENT PARADIGMS

A major opportunity for the profession rests in the increasing number of techniques to manage oral diseases through non-surgical approaches. The challenge is in achieving the appropriate balance between surgical and chemotherapeutic management of oral diseases. This balance will ultimately be determined by the most efficacious interventions that emerge from research. Examples include positive findings from studies of the treatment of early dental caries lesions with chemotherapeutic agents containing antimicrobials, fluorides and/or sealants, thus eliminating or limiting the need for restorative care. Also, several new drugs recently approved by the Food and Drug Administration (FDA) for management of periodontal diseases could alter treatments that have traditionally relied on surgery, mechanical therapy and plaque control.

Research Recommendation-4: Controlled clinical trials must be conducted to assure the safety, efficacy and appropriateness of new and emerging approaches to the treatment of oral diseases.

CHANGING POPULATIONS

While the rapidly changing demographics of the population is unquestioned, the effect of these changes on oral diseases and health is not well understood. The questions that need to be addressed include: How long patients will maintain their teeth? Will they experience more, less or different oral diseases? What are the interactions of oral diseases with other conditions? And what are the effects of these issues on dental service requirements? Predisposing factors and demographic trends known today can be used to predict the possible future incidence, prevalence and sequelae of diseases and conditions and their impact on health care delivery, education and research.

Research Recommendation-5: Federal agencies, the insurance industry, private foundations and the dental profession should establish partnerships to fund the development of systems that can model future oral diseases or conditions in the context of rapidly changing demographics, increased co-morbidities associated with aging, and enhanced understanding of complex oral diseases.

USE OF BIOMATERIALS

Many dental services involve reparative and replacement therapies using biomaterials to replace diseased tissue and to restore function. Until we reach a state where all diseases can be actively prevented, the need for improved rehabilitative therapies remains. Ideally these materials and appliances should be compatible with the host, and they should be durable, long-lasting, functional and esthetic. The interrelationship between biomaterials and bioappliances with host tissues and immune response warrants continued study. An example of this issue is the long-term host acceptance of implants. These therapies must demonstrate predictable longevity with minimum iatrogenic effects. A specific emphasis should be placed on applying emerging approaches derived from biomimetics, nanotechnology and other investigations to the restoration of oral, dental and craniofacial tissues.

Research Recommendation-6: The research community should establish as a goal the refinement and improvement of biomaterials and bioappliances with the aim of increasing their efficacy and longevity and minimizing their iatrogenic effects.

The future of oral health care and product development will require a closer relationship among engineering, materials sciences, biology and genetics. This is witnessed by the development of guided tissue regeneration and the emergence of oral-based diagnostic tests, among others. To foster the necessary research and the ultimate adoption of research findings, a closer relationship is needed between science and clinical disciplines that could address the unique aspects of oral diseases and conditions. In addition, the profession must be prepared to understand the emerging science disciplines and to apply new diagnostic and therapeutic approaches effectively and appropriately to patient care and community health.

Research Recommendation-7: The scope of clinical research should be expanded to incorporate tissue engineering and biomimetic approaches.

DISEASE-SPECIFIC EXAMPLES

Dental Caries

Dental caries, although a preventable disease, continues to be a highly prevalent disease. Caries is declining overall but remains a problem for millions of citizens. New thinking is needed in the community and public health dental sectors to address the major caries problems that occur in underserved populations.

Research Recommendation-8: Health promotion activities should be undertaken to educate the public of the continued presence of dental caries and the need to engage in preventive and diagnostic regimens to assure optimum oral health.

Links Between Oral and Systemic Disease

The mouth has been called the mirror of the body, reflecting signs and symptoms of health and disease. Recent research reveals findings that relate oral infections to systemic conditions. Specifically, emerging evidence indicates that chronic oral infections such as periodontal diseases may contribute to the risk for preterm birth, diabetes, stroke and cardiovascular disease.

Research Recommendation-9: If it is demonstrated that oral infections are related to one or more systemic diseases, coalitions within the health professions should encourage national and international clinical trials to establish optimal dental treatment protocols.

Research Recommendation-10: If clinical trials confirm the existence of links between oral and systemic diseases, health promotion activities will need to be targeted to high-risk groups.

Oral Cancer

In 2000, an estimated 30,200 Americans developed oral and pharyngeal cancers and 7,800 died from these cancers. Tongue cancer incidence and mortality are increasing, especially among young White males. Oral cancer in young adults appears to be associated with the risk factor of tobacco smoking, drinking alcohol and low consumption of fruits and vegetables. In addition, the incidence and mortality from various oral cancers are related to ethnicity and gender. African American males have a 20% higher incidence rate of oral and pharyngeal cancers than White males and their mortality rate is twice as high.

Research Recommendation-11: The research community should establish as a priority goal the identification of patients at risk for oral cancers.

RESEARCH WORKFORCE

There are insufficient numbers of appropriately trained individuals in dental research to conduct the planned agenda. This is especially true in clinical research, on which there is less emphasis in federal training programs. The allure of lucrative private practice seems to draw students away from considering these career avenues. Loan forgiveness at the national, state or dental school level in exchange for teaching may help students to enter careers in research. The profession should monitor the need for researchers and the number of training positions necessary in order to assure that adequate numbers of qualified researchers are available. Without an adequate research workforce, the opportunities for advancement in scientific knowledge will be severely diminished.

Research Recommendation-12: The dental profession should educate legislators about the need for economic support for individuals who wish to follow a career track into research.

Research Recommendation-13: Professional organizations should develop mechanisms to provide financial support for research projects and/or training for dental school faculty in their fields of interest.

Research Recommendation-14: Together with non-profit organizations and industry, the dental profession should consider creating and supporting fellowship programs for research.

FUNDING FOR CLINICAL RESEARCH AND FOR RESEARCH FACILITIES

The opportunities and needs for dental clinical research, specifically clinical and community trials, are extensive. Basic sciences continue to contribute to a rapidly expanding knowledge base that is ripe for clinical research and development. Severe limitations in the funding for dental clinical research; however, diminish opportunities to enhance oral health services and care through patient-oriented research. There is a serious need to increase the resources to perform clinical research and science transfer so that new findings make their way from the scientist, to the clinician, for the ultimate benefit of the patient. Federal and private policymakers understand these opportunities exist. The contributions of clinical research to improved oral health of the public must be clearly described to policymakers and other communities of interest.

Research Recommendation-15: The dental profession, in concert with federal agencies and the private sector, should work for enhanced resources for clinical research.

Research Recommendation-16: Building upon the ADA's Research Agenda for the Practicing Dentist, the dental profession should convene a clinical research consortium to develop and oversee the implementation of this agenda.

CENTERS FOR RESEARCH EXCELLENCE

Centers for research excellence that can provide research training and opportunities for dental faculty need to be established. The mission of these research mega-centers would focus on developing the research capabilities of faculty members.

Research Recommendation-17: The dental profession should support the development of oral health research centers of excellence that would facilitate collaborative and clinical research.

RESEARCH FACILITIES

Many research facilities have not been modernized for decades. As a result, some investigators are using less than state-of-the-art equipment. Without the necessary technological infrastructure to conduct complex and cutting-edge investigations, the research personnel will be unable to provide the critical advancements that will lead to the improvement of dental care and the oral health of the public.

Research Recommendation-18: To improve the research capabilities of dental schools, funding programs for enhancement and modernization of their facilities should be developed and promoted.

SCIENCE AND TECHNOLOGY TRANSFER

The rapidly expanding knowledge base requires the practicing dental profession and dental students to be fully informed and prepared to use technologies emerging from basic science. The timely transfer of research findings into dental practice is a priority. The creation of centers that would aid in providing state-of-the-science information to practitioners and dental allied personnel is desirable. This could be accomplished by the development of regionally placed "Oral Health Technology Centers." Dental societies, dental schools, dental public health organizations and representatives of the private sector are in a unique position to create such regionally placed centers.

Research Recommendation-19: A plan to ensure the effective and accelerated transfer of research findings and new technology into practice and into the dental curriculum should be established.

The promotion of oral health is everyone's responsibility. Many individuals and organizations are not aware of the current potential for these activities and what roles they must play to realize these prospects. Creating an effective science transfer system will be necessary if dentistry is to be in the forefront of health promotion. The increased understanding of the etiology, pathogenesis and management of dental, oral and craniofacial diseases and conditions clearly emphasizes the need to involve all members of the health professions, the public, and policymakers. In order to make further gains in the oral health of the public,

all health care disciplines must discuss how best to incorporate oral health content into their curricula, practices and policy. Similarly, dialogue must take place regarding those aspects of the respective health care professions that in turn should be incorporated into dental education and practice.

Research Recommendation-20: The dental profession should take the lead in convening all members of the health care community in developing a plan to incorporate appropriate oral and systemic health care concepts into the respective curricula.

RECOMMENDATIONS FOR GLOBAL ORAL HEALTH

Global oral health practices and concepts thematically address research, education, health care delivery, product development, approval and distribution, and health promotion. Distance no longer is an impediment to collaborations. Language also is becoming less of a barrier.

As dentistry acts locally, its future demands that it must think and act globally. The future of dentistry will favor a philosophy that joins dentistry in the United States with the global dental community. This approach will encompass the training and education of dentists and allied dental personnel, systems of dental health care delivery, and a movement toward best practices for clinical practice, teaching and research.

INTERNATIONAL COLLABORATION

As globalization advances rapidly in this new century, crosscutting issues emerge that demand a worldwide collaborative approach to solving health problems. The leadership of the American dental profession is essential to establish and reinforce the importance and relevance of oral health to total health. Dentistry must be fully involved in international organizations and activities for research, education and clinical practice. This involvement requires a commitment to learning from other countries and cultures and creates a mandate for leadership with sensitivity.

Global Health Recommendation-1: The American dental profession should be an active partner and leader in the global environment.

The United States will benefit from dentistry's global involvement. As the demographics of this country continue to change and reflect multiple cultures from around the world, answers to many of the disease management, disease prevention and health promotion questions will be found through collaborations with other countries.

Global Health Recommendation-2: International collaborative networks should be established to facilitate funding and implementing of research, education and practice-related activities.

Positioning oral health as a fundamental priority along with other health issues throughout the world is a challenge that must be undertaken. The World Health Organization (WHO) is critical to providing central guidance for efforts in the developing world as well as for information sharing and partnerships across countries of every socioeconomic group.

Global Health Recommendation-3: The American dental profession should work to restore and perpetuate the presence and effectiveness of oral health programs at the WHO.

PROMOTING DISEASE PREVENTION THROUGH INFORMATION SHARING

Success in preventing and controlling oral disease in the United States is dependent upon an ability to share knowledge and expertise with others around the world. Also, there is a unique opportunity to promote health on a global scale by addressing those risk factors that have a direct effect on oral as well as general health. When countries work together, each may be able to realize greater benefits for the health of their citizens.

Global Health Recommendation-4: The dental profession should emphasize the importance of addressing global oral health and general health issues to its members and to other health professions.

Dentistry must play an active role in promoting health through active participation in controlling the global spread of risk factors such as tobacco use, and diet fads among others. This will require den-

tistry to be part of multi-national initiatives and to be involved with the public and their representatives.

Global Health Recommendation-5: National and global health policies, particularly those promoting primary preventive strategies, should be developed.

The experiences and programs of each country provide the basis for global resources that can be used to improve the practice of dentistry, facilitate research, and monitor disease. Each country has unique approaches to care delivery, payment systems, education, and intervention strategies that affect oral and general health and lessons can be learned from each other.

Microbial infections can rapidly be spread around the world. Emerging and re-emerging infections and conditions, such as dental caries, oral manifestations of HIV infection and oral cancers, mandate the need for surveillance as well as ways in which to address emerging problems. Monitoring the determinants of oral diseases, and of oral health and disease status on a global level, is critical for the assessment of the effectiveness of delivery systems, service provision and for directing research and education programs. By monitoring and studying infections and conditions worldwide, the United States will be better prepared to manage these infections and conditions domestically.

Global Health Recommendation-6: The international dental profession should work to establish and maintain a strong global data bank that would capture information which helps to prevent the spread of diseases and promote the best clinical practices.

INTERNATIONAL WORKFORCE

Having a dental workforce prepared for international collaborations in each country also is critical to global health. These collaborations require individuals who can effectively address emerging issues and support the movement toward best practices and health promotion. All aspects of dentistry must be addressed—research, education and practice. Fortunately, technologies are now available for efficient communication and timely transfer and storage of information and data. An investment in the training of personnel who could work with global resources and databases is needed.

Global Health Recommendation-7: The international dental community should ensure that there are sufficient individuals trained in epidemiology, dental informatics, and health services research.

In order to strengthen linkages among all investigators so that future collaborative research initiatives will be facilitated, it is desirable to provide training for researchers and educators from various countries. In addition, it will be necessary to broaden the education of U.S. scientists to prepare them for the challenges of conducting international collaborative science.

Global Health Recommendation-8: The international dental community should foster the development of exchange programs and fellowships to ensure that basic principles of ethics, competencies, and sensitivity to cultural differences are maintained.

Global Health Recommendation-9: The international dental community should foster research training for investigators from developing countries.

GLOBALIZATION OF DENTAL PRODUCTS

Access to the Internet is rapidly affecting the distribution of and access to dental products by the dental manufacturer, the dental distributor, the dental laboratory, and the dentist. Many manufacturers who have sold through distributors are now creating websites and are selling products to dentists and laboratories through the Internet. With the globalization of the production and distribution of dental products comes the need to assure that these products are safe, efficacious and comply with appropriate safety records and regulations. It is important that the global dental community work together to see that the identification process of products is very clear and in compliance with local laws and regulations.

Global Health Recommendation-10: International standards for dental products and equipment should be fostered.

Global Health Recommendation-11: The international dental community should support the emerging development of standards for dental education and clinical practice.

INTERNATIONAL HEALTH PROMOTION AND EDUCATION

The global dental profession presently provides considerable international volunteer patient care. These activities should provide educational benefits for local practitioners, a process critical to sustain the health of the involved community. An important benefit of strengthening the educational component of volunteer efforts is that it will enhance the perception of the importance of oral health among the general populations of those countries.

Global Health Recommendation-12: The global dental community should foster the expansion of international volunteer activities to include educational components for local practitioners and populations.

Clinical Dental Practice and Management

3

CHAPTER OVERVIEW

The goal of the dental profession is to maximize the oral health of all individuals. Achievement of this goal will require the combined efforts of dental education, dental research, dental practice, industry, government, and the public.

For purposes of this discussion, clinical practice includes, but is not limited to, those oral health services provided by dentists in the dental office and those community-based programs such as community water fluoridation, oral cancer screening and sealant programs.

Clinical care is influenced by the demographics of the population, patterns of dental disease, and the expectations of both patients and providers. Demographically, the United States population is growing older, and more ethnically and culturally diverse. There is increased recognition of the impact of the role of race, culture, beliefs and behavior on health outcomes. This growing awareness may lead to a paradigm shift from a medical model of oral health care based on disease to a health model based on health promotion.

Changes underway in the clinical practice of dentistry will make improved oral health for all Americans a real possibility in the next two decades. To help make that possibility a reality, this chapter examines the following issues and discusses their likely impact on clinical practice and practice management.

This chapter discusses six major areas:

- ◆ Trends, disease patterns and use of dental services;
- ◆ New concepts in patient-based diagnosis, treatment planning and disease management;
- ◆ Market force issues affecting demand;
- ◆ Technological advances affecting the dental workplace;
- ◆ The dental workforce, including its composition and the role of allied health personnel; and,
- ◆ The organization of dental practices.

1. CLINICAL DENTAL PRACTICE AND MANAGEMENT TODAY

The dental profession's success in reducing caries, periodontitis, and tooth loss has dramatically improved the oral health status of the United States population. Tooth loss can be categorized by extent—complete loss of teeth (or complete edentulism) and partial loss of teeth, ranging from one to many (partial edentulism). Many factors have contributed to this improvement in the nation's oral health including the widespread use of fluoride, an increase in preventive services, and more clinical time dedicated to the prevention and treatment of oral diseases.

Despite these advances, demand for dental services is at an all-time high. Higher income and educational levels and increased access to dental insurance have resulted in increased care and changing expectations among both dental professionals and patients. In 1996, 65% of persons two years of age and older visited a dentist (U.S. Department of Health and Human Services [USDHHS], 2000a).

DENTAL DISEASE PATTERNS AND USE OF DENTAL SERVICES

Clinical dental care is influenced largely by the demographics of the population, patterns of dental disease, and the expectations of both patients and providers. The population is growing. Demographically, it is becoming older and more culturally diverse. The average American has fewer caries and is retaining more teeth into old age. As measured by DMFS (decayed, missing, and filled surfaces) the decline in caries was 64% from 1971-1974 to 1988-1994 (USDHHS, 2000b; and Miller et al, 1987). According to *Healthy People 2010*, 25% of children have 80% of pediatric dental caries.

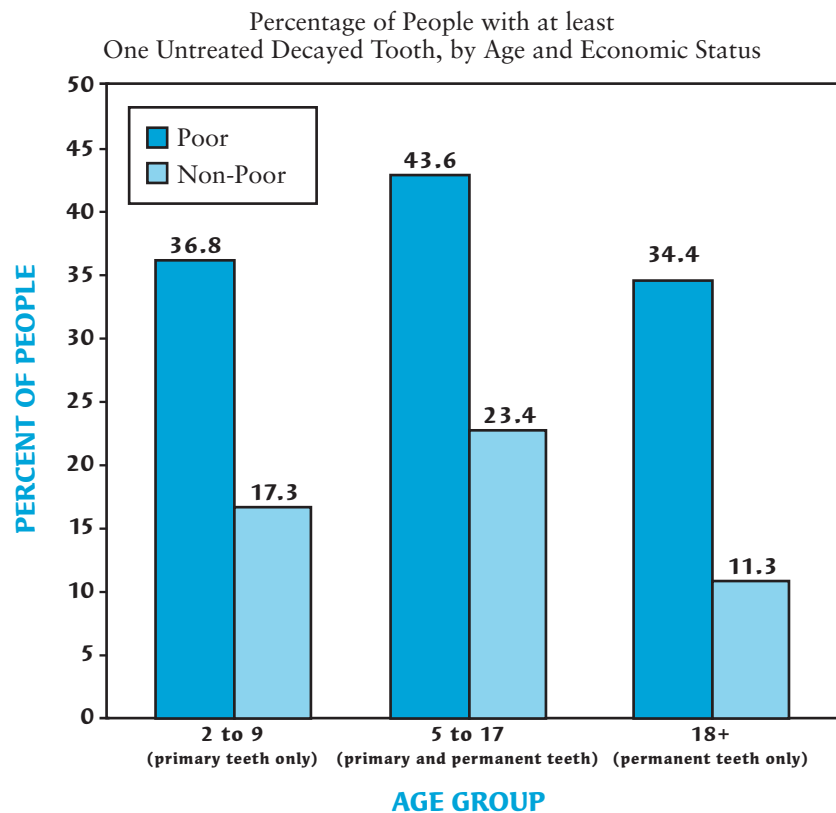
However, poor people continue to experience more caries than non-poor people and they are less likely to receive treatment (USDHHS, 2000b). See Figure 3.1. Epidemiological evidence demon-

strates that dental disease rates and dental needs are highest in low-income and special needs populations.

Oral Health Status and Trends

The proportion of untreated dental caries in school children has been declining overall, but has increased among children six to eight years old. The average number of DMFS (decayed missing filled surfaces) per child among children 6-18 years old was 1.9 in 1991, down from 4.4 in 1974. By age 17, only 16% of children are caries free in their permanent dentition. However, 85% of 14 year-olds do not have dental sealants (USDHHS, 2000a). As shown in Table 3.1, complete edentulism is decreasing for all ages, with a corresponding increase in ratio of partial edentulism versus complete edentulism (Miller et al, 1987).

FIGURE 3.1



Source: USDHHS, 2000b.

TABLE 3.1

Percentage of People who are Edentulous, by Age Group

Age Group	1971-1974	1988-1994
35-44	9%	3%
45-54	16	9
55-64	33	20
65-74	46	29

Source: USDHHS, 2000a.

Dental caries is the single most common chronic childhood disease—five times more common than asthma and seven times more common than hayfever (USDHHS, 2000b). Caries, periodontal diseases, and the management of other conditions, such as wear of hard tissue, oral infections, oral cancer, developmental disorders, intentional and unintentional injuries, chronic and disabling conditions such as temporomandibular disorders, craniofacial pain, Sjögren's syndrome, and systemic diseases, present difficult treatment and prevention issues (USDHHS, 2000b). The treatment of older people is particularly complex. Dental therapies are frequently intricate, and the elderly also have chronic medical conditions, which complicate patient management.

The prevalence of root caries, strongly age-dependent, is increasing. Among adults 60-64 years old, 54% had at least one decayed or filled root surface; among adults 18-19 years old 7% had at least one decayed or filled root surface.

According to the Third National Health and Nutrition Examination Survey (NHANES III), 23% of dentate adults 30-90 years old had significant gingival recession, 35% had periodontitis, and 50% had sulcular bleeding upon probing (Miller et al, 1987; Albander et al, 1999; Albander and Kingman, 1999; and Kingman et al, 1988). Ninety-two percent of all persons, regardless of age, had calculus. Signs of gingivitis and periodontitis were more prevalent in males than females, and more prevalent in certain racial and ethnic groups.

As the United States population ages and a larger percentage of older Americans retain some or all of their teeth, the need for preventive, restorative, arrestive, prosthodontic services, and regenerative periodontal services will continue to increase. Thus, the clinical practice of dentistry faces challenges from many directions. It must address the needs of those whose care has lagged behind that of the gen-

eral population. At the same time, it must address the increasingly complex demands of its more fortunate patients and its aging patients.

In addition, new research suggests the possibility of linkages between oral diseases and systemic disease. This and other research findings could lead to an increased relationship between oral health and overall health. For some

patients, a shift is occurring from need-based dentistry—that is, care directed at alleviation of pain, caries control, management of periodontitis, and replacement of teeth—to desire-based dentistry. The latter is characterized by services which may be viewed as elective and addresses improvements in self-esteem and quality of life. Dentistry must effectively integrate the new technologies and clinical advances into dental practice for all people.

Reports on changes in the use of selected dental services reflect an increase in the frequency of diagnostic and preventive services, with a concomitant decrease in frequency of restorative and other invasive procedures. For example, from 1980 to 1995 the percent change in use of various procedures were (Eklund et al, 1997; and Eklund, 1999):

- ◆ Prophylaxes increased by 20% in newborn to five-year-olds and 30% in people aged 65 and older.
- ◆ Oral exams increased by 29% in newborn to five-year-olds and 75% in people aged 65 and older.
- ◆ Periodontal services increased by 89% in 25- to 34-year-olds and 586% in people aged 65 and older.
- ◆ Amalgam and resin restorations decreased by 45% in newborn to five-year-olds, and 21% in people aged 65 and older.
- ◆ Simple extractions decreased by 40% in newborn to five-year-olds, and 43% in people aged 65 and older.
- ◆ Use of complete dentures decreased by 75% in 35- to 44-year-olds and 50% in people over 65 years of age. No data are available on complete dentures supported by implants.

- ◆ Endodontic procedures decreased for individuals through age 64. Due to the increase in retention of teeth in older adults, endodontic procedures increased by 56% for people over 65 years of age.
- ◆ The absolute number of edentulous patients increased despite the decrease in the percentage of the population that was completely edentulous.

Market Forces Affecting Demand

THIRD PARTY COVERAGE

Private Coverage

Dentistry is an approximately \$60 billion industry. Individuals pay about 48% (\$28 billion) of dental expenditures out of their pockets directly to dentists. Another 48% of dental expenditures is reimbursed by employer-sponsored insurance (Health Care Financing Administration [HCFA]). Together these two sources of payment account for approximately 96% of all dental expenditures. About 160 million Americans do not have private dental insurance. (Also see Chapter 4, Financing of and Access to Dental Services.)

With dental expenditures increasing at a more rapid rate than expenditures for most other goods and services, employers are seeking ways to hold down the increasing dental premiums. This may result in more cost sharing by enrollees, reduction in dental benefits, and more negotiated discounts on services.

There is a relatively strong demand for dental services. Capitated managed care plans are not likely to become a significant factor in the dental marketplace. Given the relative tightness of supply, dentists are more likely to maintain busy patient schedules without participating in capitated managed care plans (Bailit, 1999).

As an inflation-adjusted benefit, there has been a steady decrease in the constant dollar value of dental insurance. A strong economy contributes significantly to the demand for dental services. This discussion assumes that the economy will continue to be strong. Should the economy weaken, the demand for dental services is likely to also weaken.

Evidence that dental disease is linked to morbidity and even mortality could recast the significance of dental insurance from a discretionary to a required benefit. Additionally, pressure to expand dental benefits under Medicare may come from the "baby boomer" generation as it moves into retirement (Niessen, 1984). Members of this group have had

access to dental services throughout their lifetime.

Publicly Funded Third Party Payment Programs

Government funding of dental care for low-income populations is decreasing. Medicaid, the primary funding vehicle for low-income, medically compromised, physically challenged, and nursing home populations, is under-funded. Less than 1% of Medicaid funds are spent on dental services compared to approximately 5% of the total United States health care dollar spent on dental services (HCFA). State coverage of Medicaid dental services for adults is discretionary, with many states providing coverage for emergency services only.

Given the high administrative overhead involved in treating Medicaid recipients, low levels of patient compliance, and the reimbursement rates that are often less than half of market value, many dentists do not participate in Medicaid.

COMMUNITY-BASED ORAL DISEASE PREVENTION PROGRAMS

Dental professionals traditionally have played a leadership role in the implementation of community-based preventive programs. Community-based prevention programs, such as community water fluoridation, sealant programs, or oral cancer screening will continue to play an important role in improving the public's oral health. Fluoridation, for example, benefits more than 150,000,000 Americans, and is the most cost-effective means to prevent dental caries.

The dental profession will continue to support community-based preventive programs, such as water fluoridation. This support will be needed to strengthen local, state and federal public health capacity to track disease patterns, develop policy, and assure that people are linked with appropriate education, preventive, and clinical services.

Future research and technology may result in new community-based preventive programs that help prevent caries, periodontal diseases and other oral diseases and conditions. (See Chapter 7, Dental and Craniofacial Research.) Implementing these programs will require efforts by dental professionals, perhaps working with other health professionals, such as school nurses to prevent sports injuries and child care workers to prevent early childhood caries.

THE DENTAL WORKFORCE

Numbers of Practicing Dentists

The American Dental Association (ADA) Future of Dentistry report of 1983 predicted two changes in the composition of the nation's dental workforce. First, that report anticipated that declining first-year enrollments in dental schools would result in fewer graduates beginning in 1983. Second, it anticipated that the total number of practicing dentists would increase throughout the remainder of the century—despite the declining number of graduating dental students. Both of

these changes have occurred (ADA, 1983).

The number of dental school graduates declined from a high of 5,756 in 1982 to a low of 3,778 in 1993, a decrease of 34%. Since 1993, graduates increased steadily to 4,041 in 1999 (ADA, *Surveys of Predoctoral Dental Education*). The decline of graduates during the 1980s slowed the rate of growth of practitioners. As shown in Table 3.2, the number of professionally active dentists and private practitioners increased during the 1990s. However, their growth rates were slightly less than the growth in the United States population. As a result, dentist-to-population ratios started declining around 1995 and

TABLE 3.2

Census Counts and Projections of U.S. Resident Population, Professionally Active Dentists, Active Private Practitioners, Professionally Active Dentists and Active Private Practitioners per 100,000 U.S. Resident Population, 1976-2020

Year	U.S. Resident Population (in thousands)	Professionally Active Dentists	Active Private Practitioners	Professionally Active Dentists Per 100,000 U.S. Resident Population	Active Private Practitioners Per 100,000 U.S. Resident Population
1976	217,563	110,276	100,051	50.7	46.0
1978	222,095	117,044	106,672	52.7	48.0
1982	231,664	126,985	116,208	54.8	50.2
1987	242,289	137,817	126,357	56.9	52.2
1991	251,802	150,762	138,094	59.9	54.8
1992	254,933	152,925	140,349	60.0	55.1
1993	258,103	155,087	142,603	60.1	55.3
1994	261,312	157,228	144,581	60.2	55.3
1995	264,561	158,641	146,089	60.0	55.2
1996	267,850	160,388	147,247	59.9	55.0
1997	271,180	160,781	147,778	59.3	54.5
1998	274,552	163,291	151,309	59.5	55.1
1999	277,966	164,664	152,151	59.2	54.7
2000	281,422	166,049*	153,431*	59.0	54.5
2005	294,108	170,476*	160,318*	58.0	54.5
2010	306,524	173,942*	163,328*	56.7	53.3
2015	319,205	177,076*	166,088*	55.5	52.0
2020	332,145	179,930*	168,528*	54.2	50.7

* Preliminary estimates for 2000, 2005, 2010, and 2020.

Source: ADA, 2001b; and U.S. Department of Commerce, Bureau of the Census, 1990 and 2000 Census.

have continued to decrease (ADA, 2001b). Overall, there has been a 0.91% decline in the ratios.

Women Dentists

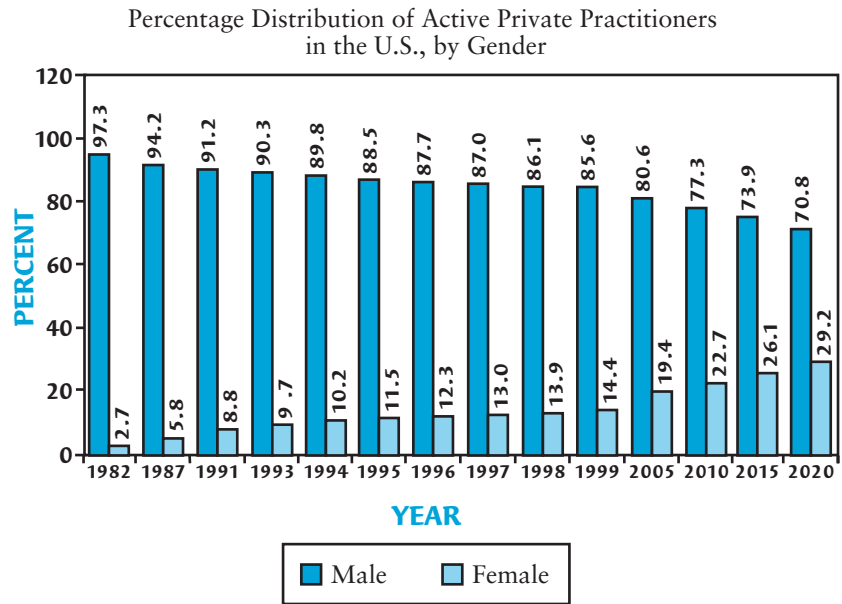
Since the mid 1970s, women have entered dental schools, and subsequently dental practice, in increasing numbers. The expansion of the number of women in dentistry has been one of the major dental workforce trends during the last quarter of the last century and will continue during the initial decades of this century. Such a fundamental demographic shift raises questions regarding the effect of that shift on workforce requirements. This section will describe similarities and differences between male and female dentists in practice characteristics that could potentially have an impact on workforce requirements.

According to the ADA census of dentists, *Distribution of Dentists*, the total number of active private practitioners¹ in the United States increased from 116,208 in 1982 to 152,151 in 1999, a 30.9% increase. The number of female active private practitioners increased from 3,029 to 21,960 during this same period, an increase of 625%. Figure 3.2 shows the percent distribution of active private practitioners in the United States by gender. In the early 1970s, there were very few women dentists. By 1982, female dentists comprised 2.7% of the dentist workforce; by 1999 they comprised 14.4%.

The increase in the female dentists resulted from an increase in female dental school graduates during the same period. Between 1982 and 1999, female dental graduates increased 72.6%, from 838 to

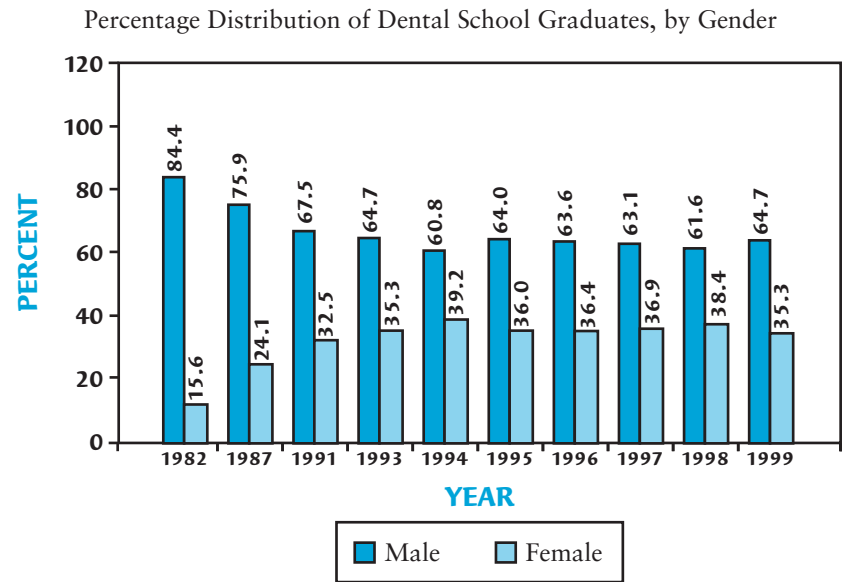
1,446, while the overall number of graduates decreased by 23.8% (from 5,371 to 4,095). The percent distribution of graduates by gender is depicted in Figure 3.3. By 1982, women comprised

FIGURE 3.2



Source: ADA, *Distribution of Dentists*; and ADA, 2001b.

FIGURE 3.3



Source: ADA, *Surveys of Predoctoral Dental Education*.

¹ Active private practitioners are defined as dentists whose primary and/or secondary occupation is private practice (full- or part-time).

15.6% of total dental graduates; their percentage increased to 39.2% in 1994. Since then, the percent distribution of female graduates leveled off, fluctuating from year-to-year in the high thirty percent range (ADA, *Surveys of Predoctoral Dental Education*).

Even if the trend in percent of female graduates has stabilized, the number and percent of females practicing dentistry will continue to increase. The ADA's *Dental Workforce Model* forecasts that 29.2% of active private practitioners will be female by 2020.

Part-Time Practice

Among male private practitioners, the percentage that worked part-time (defined here as spending less than 30 hours per week in the office) increased from 10.2% in 1987 to 14.7% in 1999. Among females, the increase was from 26.3% to 29.9% (see Table 3.3). Overall, the percentage of those working part-time has increased for both sexes. Although the percentage distribution of part-time dentists is higher among females in all three years, in 1987 it was 2.6 times that of their male counterparts – by 1999, it was only two times as high (ADA, 1989; 2001a).

Further analysis of part-time trends by gender and age revealed that among the youngest dentists, those less than 40 years of age, both males and females exhibited increases in part-time hours. The percentage distribution of part-time female dentists has consistently been 5 to 6 times that of their male counterparts during the three survey years (ADA, 1989; 1997; 2001a). Intuitively, higher part-time distribution among females less than 40 years of age can be related to childbearing and/or child-rearing responsibilities. But it can also be related to the age distribution of female dentists within the age category of "less than 40 years old." Within this age category, female dentists tend to be younger and, therefore, involved in the starting and establishing their practices. These processes that can account for the higher part-time distribution.

Among those 40-59 years of age, the percentage part-time practice for both women and men increased slightly between 1987 and 1994 and has been almost stable between 1994 and 1999. For this age cohort, the percentage distribution of part-time female dentists has been about 3 times that of male dentists (ADA, 1989; 1997; 2001a).

About 40-46% of male dentists 60 years of age or older have consistently been part-time practitioners between 1987 and 1999 (ADA, 1989; 1997; 2001a). There were too few female dentists in this age category to report the percentage working part-time. However, there have been shifts in the age distribution of women dentists during this period. Between 1987 and 1999, the female dentist population has aged (e.g., in 1987, 81.4% were less than 40 years of age compared to 46.6% in 1999). Therefore, it is likely that this shift in age distribution has resulted in a convergence of the percent of older male and female dentists working part-time.

TABLE 3.3

Percentage Distribution of Part-Time Active Private Practitioners, by Gender and Age Group

	1987	1994	1999
Male	10.2%	13.6%	14.7%
Less than 40 years old	4.6	4.9	5.6
40 to 59 years old	8.1	8.7	8.7
60 years of age or older	40.5	42.1	46.2
Female	26.3	29.8	29.9
Less than 40 years old	25.4	29.6	31.3
40 to 59 years old	27.7	29.0	28.6
60 years of age or older	N/A*	N/A*	N/A*

* The number of respondents was too low to report data.
Source: ADA, 1989, 1997, 2001a.

As indicated in the section on dentists' productivity, there is no significant difference between productivity of men and women dentists on an hourly basis (Beazoglou et al, 2001). Also, full-time women dentists work as many hours as full-time male dentists. The same is true for part-time men and women dentists. Thus, the major impact of women

on the workforce is that a larger percentage currently practices part-time. As shown in Table 3.3 about 30% of women dentists and 15% of male dentists indicate they work part-time (ADA, 1989; 1997; 2001a). Currently, 14.4% of the dentist workforce is female. A rough approximation of the impact of women on workforce output is the percentage difference in men and women dentists who practice part-time (15%) multiplied by the percent of women in the dentist workforce. This calculates to about a 2% reduction in total dental output. Even in 2020, the impact of women dentists on output will be comparatively small. Then, 29.2% percent of the dentist workforce is predicted to be women. If the current gender difference in part-time practice persists, then in 2020, the impact of women on total output will be less than a 5% reduction.

Specialty Training

The ratio of general dentists to dental specialists has remained stable at 4:1 for many years, but evidence suggests that this ratio may decrease to 3:1 early in the 21st century. While the number of dental school graduates has declined, the number of graduates of specialty training programs remained steady at 1,200. Ultimately, this trend will shift the percentage of specialists to one-third of practicing dentists.

Dental Workforce Diversity

By the year 2020 the United States population is expected to grow to 332,145,221. The rate of growth is expected to be 10% per decade from 1990 to 2020. During this period it is anticipated that 55% of the growth in the United States population will be due to immigrants and their descendants. Growth will be greatest among Hispanics and African Americans (Murdock and Hogue, 1998).

Since 1990, however, there has been a 23% decline in dental school enrollment of Hispanics, African Americans, and Native American students (Valachovic, 2000). Asian/Pacific Islanders represented 24.5% of first year enrollees in 1998. Consequently, at the very time the United States population is becoming increasingly diverse, the future supply of dentists is becoming less representative of the population it will serve.

Productivity of Dentists

The supply of dental care services is frequently associated with the number of providers licensed to practice in an area. An additional refinement for workforce calculations is the dentist-to-population ratio. The ratio relates the number of dentists to the size of the population. However, the dentist-to-population ratio is a crude determinant of the dental workforce needs of a community, especially when making comparisons over time. The ratio implicitly holds constant many factors that affect both the population's need and desire for dental care as well as dentists' ability to produce those services.

One of the factors that the dentist-to-population ratio holds constant is dentists' productivity (i.e., the amount of dental output, measured as real gross billings per hour). Improved productivity means that fewer dentists can produce the same amount of dental services compared to previous years. Ignoring productivity changes is likely to lead to serious miscalculations for workforce policy.

In their recent study, Beazoglou, Heffley and Bailit, showed that total dental output (total production of dental services) of the dental delivery system tripled between 1960 and 1998, growing at an annual rate of 2.95% (see Table 3.4). Change in dental output results from an increase in the number of dentists or from improved productivity per dentist. Over the entire period, the contributions to the increase in dental output from increases in the number of dentists and in dentists' productivity (i.e., the amount of dental output, measured as real gross billings per hour) were almost equal: the number of dentists increased 1.85 times, and dentists' productivity increased 1.64 times.

It is useful to divide the period from 1960 to 1998 into three different periods, based on changes in productivity and the number of dentists (see Table 3.4). During the period from 1960 to 1974, dental output grew much faster than the population: 5.01% compared to 1.18% annually. The reason for the leap in dental output was the rapid rise in productivity per dentist, which grew at 3.95% annually. Growth in the number of dentists was actually less than the growth in population.

During the second period, from 1974 to 1991, dental output continued to expand more rapidly than the United States population but the difference was much smaller, 1.84% compared to 0.96% annually. All of the increase in dental output came from an increase in the number of dentists, which

rose at about 2.0% annually. Dentists' productivity actually declined by 0.13% annually because the over-abundance of dentists compared to demand for dental care made it difficult for dentists to stay busy.

During the period from 1991 to 1998, dental output continued to grow more quickly than the population. However, the growth in dentists' productivity had recovered from its stagnant period during the 1980s to expand at 1.05% annually. Its contribution to output was equal to that of the increase in the number of dentists.

Thus, there are two ways to increase dental services: one through increases in the number of dentists and the other through increases in existing dentists' productivity. The two methods are related. If an over-abundance of dentists compared to demand occurs, productivity is retarded, slowing the increase in dental output. As the dental market tightens, dentists stay busy and productivity is enhanced. Improvements in technology

indicate, given the existing number of allied personnel (across all general practitioner dental practices), the effect on dentist output if the number of allied personnel were to be changed – assuming all other factors remain constant.

Several factors contribute to changes in dentists' productivity (Beazoglou et al, 2001). Table 3.5 shows the percentage increase in dental output per hour from a 10% change in each of these factors separately, holding the other factors constant. For example, a 10% increase in dentist hours would increase dental output by 2.92% while an increase of 10% in dental hygienist hours would increase output by the almost equal amount of 2.74%. If more than one factor is changed their contributions are additive. Thus, 10% increases in both dental hygienists and dental assistants hours would increase dental output by 4.02%. These productivity enhancements can be realized by increasing the staff hours of these personnel. Moreover, these increases can be realized with the current scope of duties for these personnel, as they exist in the various states.

Increasing the number of dentists' hours by producing more dentists may not be the most cost-effective way to increase productivity and subsequently dental services. Interestingly, once other factors are held constant, neither gender nor age is a significant factor in productivity. Female dentists are just as productive as male dentists. Also, older and younger dentists can produce at the same rate.

TABLE 3.4

Annual Growth Rates in the U.S. Population, Dental Output, and Output per Dentist, 1960-1998

	1960-98	1960-74	1974-91	1991-98
U.S. Population	1.02%	1.18%	0.96%	0.98%
Dental Output	2.95	5.01	1.84	1.80
Output per Dentist	1.31	3.95	-0.13	1.05

Source: Beazoglou et al, 2001.

enhance productivity, but the full impact of technical change will also be affected by market conditions.

Appropriate use of staff and office space can enhance dentists' productivity (Beazoglou et al, 2001). The type of analysis described next will discuss these issues. This analysis is different from the previous discussion of dentists' productivity per hour. It is like a recipe for efficient production of dental services given the various factors (such as number of staff, staff hours, office space, etc.) that contribute to changes in dentists' productivity. However, the analysis does not indicate which factor is more important in a fundamental sense. Of course, the inputs of dentists are critical because dental services cannot be produced without dentists. Although this productivity analysis does not measure the productive effect of expanded duties for allied dental personnel, it is valuable because it does

National Dental Workforce Projections

To develop a national dental workforce policy, one must understand the productive capacity of the dental workforce. One dental workforce objective could be to keep the productive capacity of the dental workforce constant in relation to the United States population in 2020 compared to 2000.

In 2000:

- ◆ United States population was 281,421,906;
- ◆ Active private practitioners numbered 153,431; and,
- ◆ Dentists-per-100,000-population ratio was 54.5.

TABLE 3.5

Percent Change in Dental Output
Associated with a 10 Percent Increase in an Input

Dentist Hours	2.92%
Hygienist Hours	2.74
Dental Assistant Hours	1.28
Other Staff Hours	1.69
Office Space	1.77
Gender (male=1)	1.14*
Dentist's Age	-0.42*

* Not significant at 5% level.
Source: Beazoglou et al, 2001.

In 2020, the United States population is projected to be 332,145,221. Without factoring in productivity improvements, the required number of active private practitioners to maintain the 54.5 dentists per 100,000 population is 180,995, an increase of 27,564.

However, it is extremely improbable that for the next 20 years the growth in the level of dentist productivity would be zero. Therefore, assuming 1) that dentists' productivity grows at the same rate between 2000 and 2020 as it did between 1991 and 1998 (i.e., 1.05% annually) and assuming 2) the number of dentists in 2020 remained the same as in 2000, the same number of dentists—adjusted for productivity—would be equivalent to 35,646 additional dentists in 2020; far more than the required 27,564.

In conclusion, the national supply of dental services is likely to increase due to enhanced dental productivity. Moreover, there is potential to increase dental output by increasing the number of allied dental personnel working in dental offices. These factors indicate that a major increase in the aggregate number of dentists is probably not necessary at this time. Nevertheless, this issue must be followed continuously so that the nation will be ready to act if circumstances change.

Geographic Distribution of Practicing Dentists

The distribution of dentists varies substantially by geographic area. Reports indicate specific geographi-

cal areas are either currently experiencing or predicting declines in the number of practicing dentists (Dohm, 1999; Cooksey, 1999; and Smetanka, 2000). North Dakota anticipates losing 40% of its dentists to retirement in the next decade. South Dakota expects that 35% of its dentists will retire in the coming decade. Minnesota data indicate that dentist-to-population ratios, which improved through the 1980s, have reverted to 1973 levels in the last decade (Born, 2000). Other states indicate that they have sufficient numbers of practicing dentists, and some states have expressed concerns regarding an over-abundance of dentists.

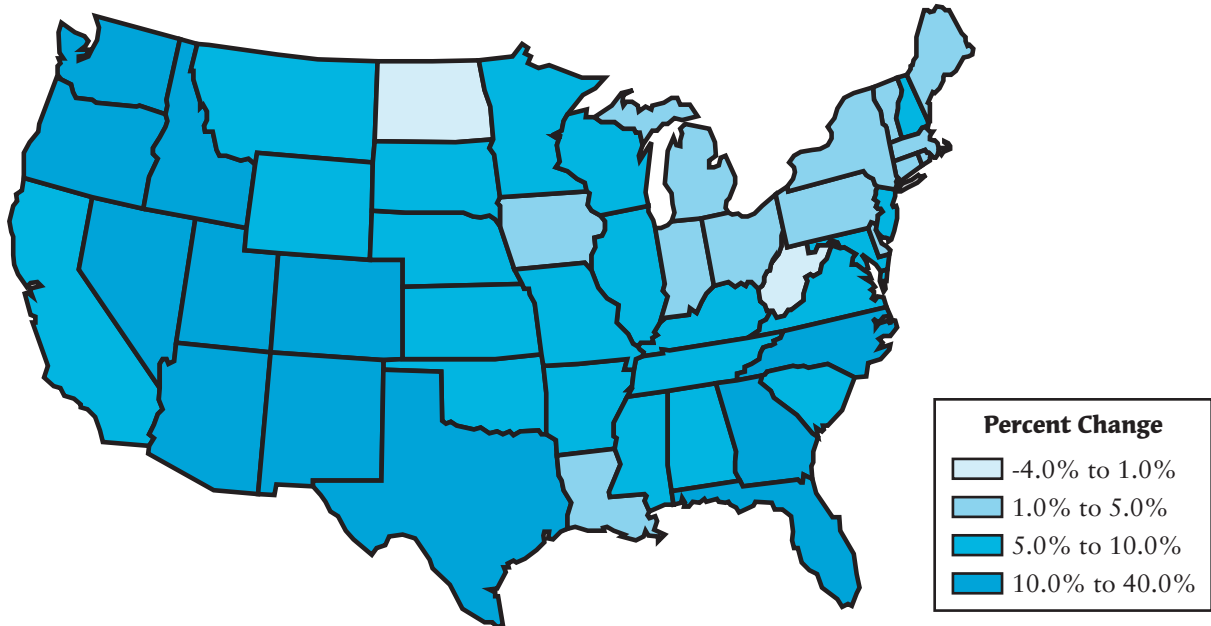
There are rather pronounced geographic imbalances in the dental workforce. One of the reasons for these geographic imbalances is the rapid shifts that are occurring in the United States population, which increased from 248.7 million to 281.4 million between 1990 and 2000—a 13.2% increase. The largest increases occurred in the Western and Southern states: Nevada, Arizona, Colorado, Utah, Idaho, Georgia, Florida, Texas, North Carolina, Washington, Oregon, and New Mexico all showed 20.0% or greater increases in their populations. Ohio, Rhode Island, Maine, Connecticut, Pennsylvania, West Virginia, and North Dakota showed smaller gains (less than 5.0%). Only the District of Columbia lost population with a decrease of 5.7%. (See Figure 3.4.)

Similar to the pattern of population growth, the largest increases in the number of active private practitioners were seen in the Western and Southern states: Nevada, Utah, Washington, Wyoming, Idaho, Florida, Arizona, North Carolina, South Carolina, Colorado, and Delaware all showed greater than 11.0% increases in the number of active private practitioners. Connecticut, Iowa, Wisconsin, Michigan and West Virginia showed less than 1% increases in the number of active private practitioners. Minnesota, the District of Columbia, and Missouri lost dentists between 1993 and 1999. (See Figure 3.5.)

While the number of dentists increased nationally and for almost all states, the dentist-to-population ratios declined in about one-half of the states between 1993 and 1999. (See Figure 3.6.) Several rapidly growing states, such as Nevada, Arizona, and Georgia saw their dentist-to-population ratios decline although they registered large increases in the number of dentists. Their populations were simply growing too quickly for the increase in dentists

FIGURE 3.4

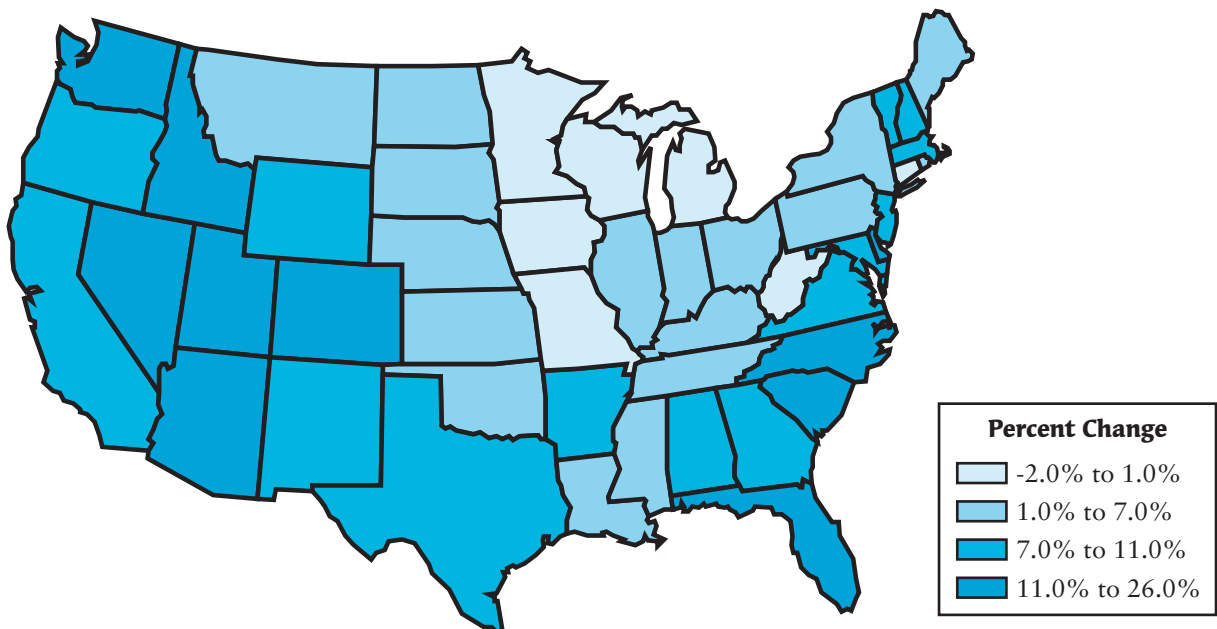
Percentage Change in the U.S. Population, by State, 1993-1999



Source: U.S. Department of Commerce, Bureau of the Census, 1990 and 2000 Census.

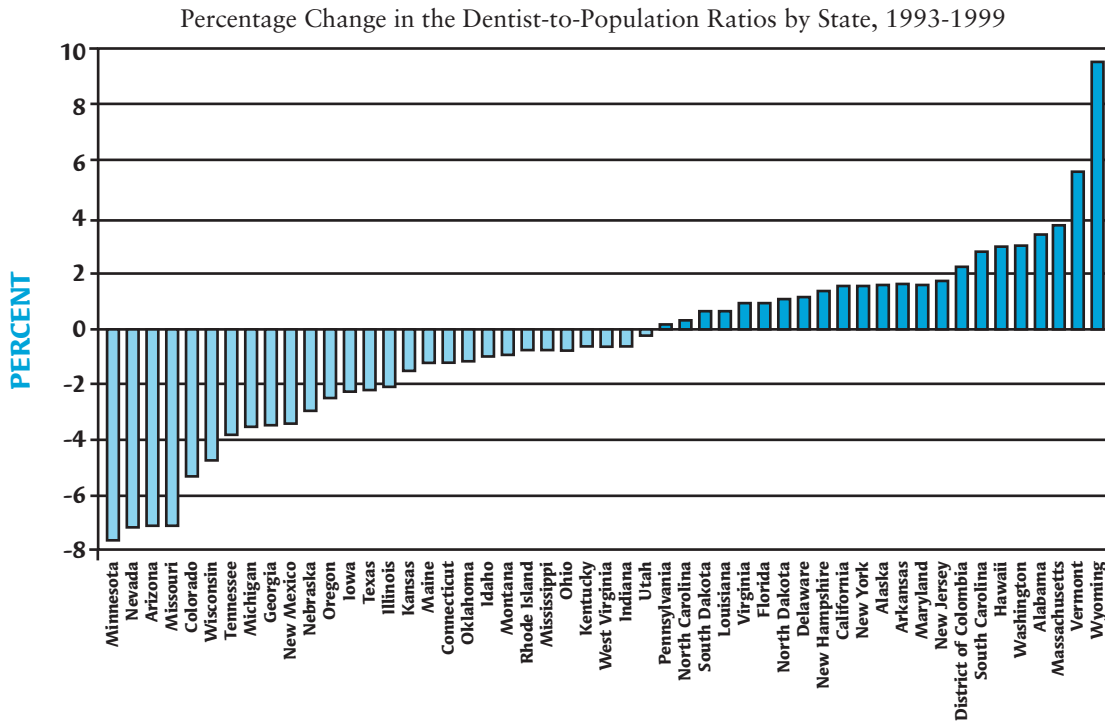
FIGURE 3.5

Percentage Change in the Number of Active Private Practitioners, by State, 1993-1999



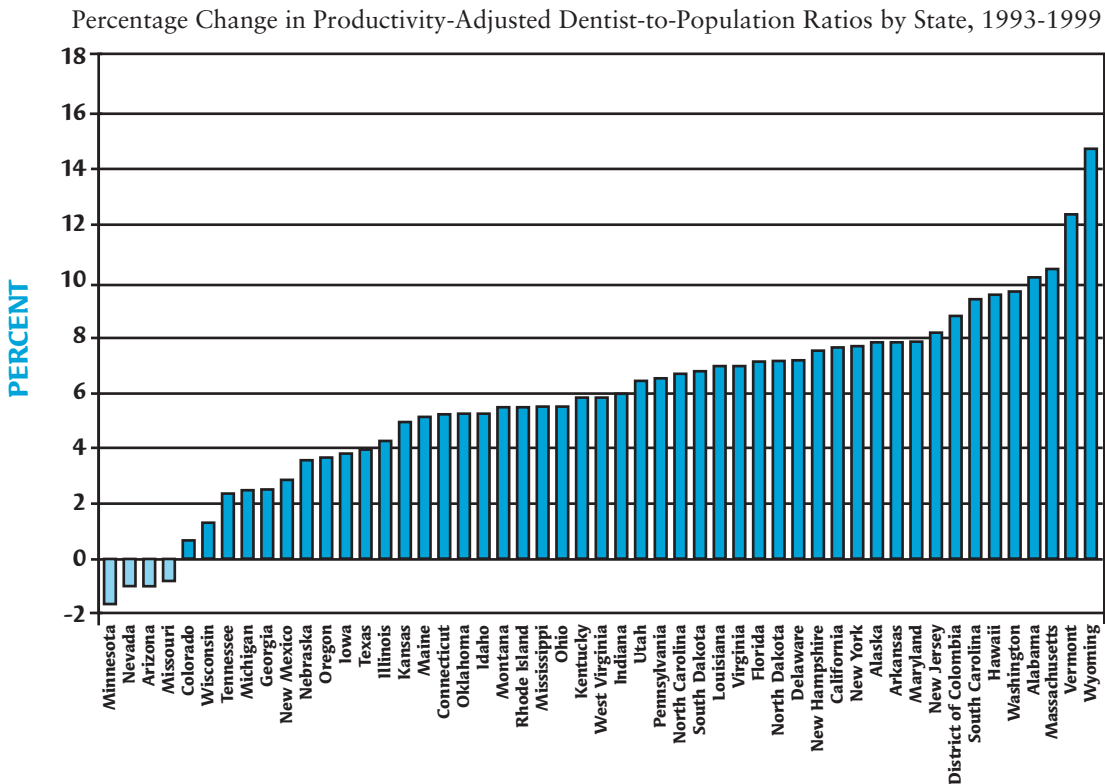
Source: ADA, *Distribution of Dentists*.

FIGURE 3.6



Source: ADA, *Distribution of Dentists*; and U.S. Department of Commerce, Bureau of the Census, 1990 and 2000 Census.

FIGURE 3.7



Source: ADA, *Distribution of Dentists*; U.S. Department of Commerce, Bureau of the Census, 1990 and 2000 Census; and Beazoglou et al, 2001.

to keep pace. Other states, such as Minnesota, Missouri, Michigan, Nebraska and Wisconsin showed declines in their dentist-to-population ratios even though their populations were not growing as quickly as the national average. The number of active dentists in those states grew little or not at all.

Nearly one-half of the United States states showed an increase in the dentist-to-population ratios. Most of these states have not expressed significant concerns regarding the adequacy of the size of their dental workforce. Some have expressed concerns that they may be entering a period of over-abundance of dentists.

As mentioned before, dentist-to-population ratios are crude measures of the adequacy of the dentist workforce and should be used with caution. Clearly, this admonition also applies to regional workforce assessments. When the dentist-to-population ratios are adjusted for productivity increases a different picture emerges (see Figure 3.7). The productivity-adjusted ratios show an increase in the productive capacity of the dentist per 100,000 population for most states between 1993 and 1999. However, some states have lost productive capacity, even with adjustments for increases in productivity.

In summary, the national dentist workforce seems to be adequate. Moreover, it can remain adequate if major new programs are not enacted, declines in dental school graduates do not occur, and productivity continues to rise. However, circumstances can change. The nation and the dental profession must follow the national workforce trends carefully and be ready to act when circumstances warrant action.

Regional workforce issues do exist and may become more pronounced in the future. However, given these widely varying workforce conditions among the states, it is apparent that one overall national policy will not fit the specific needs of various states. States with a sufficient number of practitioners will require a different policy than those states in which the number of dentists is declining. Those latter states face potentially serious workforce issues that should be addressed with their state-specific needs and circumstances in mind.

THE ORGANIZATION AND MANAGEMENT OF DENTAL PRACTICE

In 1997, 92% of active professional dentists were in private practice. Of these, 79% were sole pro-

prietors (Valachovic, 2000). Most dental school graduates plan to own their practice.

As owners of their practices, dentists must be skilled business managers as well as dedicated clinicians. They are the "CEOs" supervising production, expenses, and employment challenges of a business. As employers, dentists supervise the training, delegation of duties, and schedules for employees. This supervision also includes OSHA regulations, infection control, and waterline safety. Ethical considerations in patient management and business practices will remain an essential component to successful dental practice.

ALLIED DENTAL HEALTH PERSONNEL

The dentist's ability to expand the service capacity of his or her practice lies, in part, in the ability to delegate tasks to dental assistants and dental hygienists. Research from the 1970s has demonstrated that many functions could be delegated safely, effectively, and with quality comparable to those provided by dentists (Mullins et al, 1979; and Mullins et al, 1983).

Delegation of many functions to dental assistants and dental hygienists has proven to be beneficial to dentists and their patients (Mullins et al, 1979; and Mullins et al, 1983). As a result, the role and duties of dental assistants and dental hygienists is expected to increase.

Dental Hygienists

The number of dental hygienist graduates has increased from 3,953 in 1990 to 5,023 in 1997, an increase of 27.1% (ADA, 2000).

Although the number of graduating hygienists has increased during the past ten years, the availability of trained hygienists to dental practices appears to be reduced. In an unpublished survey of Minnesota dentists, 36% of those dentists responding indicated that they were unable to take new patients because of a lack of dental hygienists (Minnesota Dental Association, 2000). The average time required to hire dental hygienists was 23 weeks and the average time to hire a new registered dental assistant was 17 weeks in 2000 (Minnesota Dental Association, 2000).

Dental Assistants

Graduates of dental assisting programs increased

slowly through the 1990s but began declining in the 1997/98 academic year, from 5,958 in 1980 to 4,967 in 1997 (ADA, 2000).

Dental assistants are an important part of the allied dental personnel team. The American Dental Association contracted with International Communications Research to conduct a survey of allied dental workforce needs in 1999. Two-thirds of private practitioners employ full-time chairside dental assistants and more than half employ part-time chairside dental assistants (International Communications Research, 2000). In 1999, newly created positions accounted for 24.2% of hirings and in the coming year, 32.5% of responding dentists expected to fill a new chairside assistant position. The time to fill a position varied and was frequently extensive. Among those who hired a chairside assistant in 1999, it took an average of 5.3 weeks to fill the position with the majority (65.1%) indicating one to four weeks.

Many dentists perceive a problem with the availability of chairside dental assistants. Two-thirds (64.9%) of private practitioners felt there was not an adequate supply of chairside dental assistants in their area. A shortage of chairside dental assistants was reported to be disruptive to the practice and to affect the quality of patient care, have financial implications, and impact patient satisfaction. Two-

thirds (65.4%) of private practitioners felt a shortage of chairside dental assistants made it more difficult to provide quality care. Half felt it caused longer work days for dentists (50.1%) and longer appointment times for patients (50%). Nearly half (46%) indicated it caused longer waiting times for patients.

Dental Laboratory Technicians

Graduates of dental laboratory technician (DLT) programs decreased from 722 in 1989/99 to 490 in 1998/99. The number of accredited DLT programs peaked in 1984 with 59 and declined to 34 in the 1998/99 academic year. First-year student capacity is 1,016, yet first-year enrollment in 1998/99 was less than half of the potential capacity—487 students (ADA, 2000). This suggests that accredited DLT programs represent a diminishing source of technicians.

On the job training, supplemented by structured instruction and foreign-trained technicians, represent potential future sources of dental technicians. Conversely, if a shortage of DLTs becomes pronounced and overhead costs increase, United States dentists may find increasing amounts of laboratory procedures completed outside the United States.

II. CLINICAL DENTAL PRACTICE AND MANAGEMENT IN THE FUTURE

Given the improvement in the oral health of children and adults, and increasing knowledge of oral disease patterns and treatment options, it can be expected that future clinical practice will incorporate more diagnostic-based data into treatment plans along with prognosis for dental treatment (Anusavice, 1995).

For example, research suggests that patient recall intervals may need to be determined based on the susceptibility of patients to various oral diseases. Thus, as risk assessment strategies improve, high-risk individuals may require more frequent recall appointments than those at lower risk. Treatment plan presentation will continue to educate patients about their oral diagnoses, treatment options, risks and prognosis for various oral conditions.

FUTURE CHANGES IN ORAL HEALTH PATTERNS AND CLINICAL PRACTICES

Young people will experience fewer caries and this

pattern will continue into adulthood. In younger populations, individual risk assessment technology will become an increasingly applied practice (Douglass and Sheets, 2000).

The overall effects of the assumed changes will be that middle-aged and older populations will demand increased restorative, prosthodontic, endodontic, and periodontal care.

Older adults are currently retaining more of their teeth and will receive significantly higher rates of diagnostic, preventive, periodontal, esthetic, and endodontic care. For the next 20 years, these cohorts, who in earlier years experienced these high levels of disease, will continue to be high users of dental services. Services may include replacement of restorations, replacement of missing teeth, treatment of root caries, periodontal, and endodontic care.

With higher incomes and higher expectations of retaining their teeth, the demand for services from this segment of the population should remain

strong. Dental restorations have a finite life span. Materials fail, caries recur, teeth fracture, dental restorations wear, and esthetics change. The longevity of the new resin and resin-bonded restorations is yet to be determined. Implant-supported restorations will be used increasingly to replace lost teeth. Increased use of periodontal surgeries for pre-prosthetic and pre-implant treatment is anticipated as teeth retained into older age fracture and wear. Thus, it is anticipated that replacement of existing restorations will be a larger proportion of the dental practice.

Preventive services will increase as adults seek to maintain their oral health. This trend could increase significantly if research on the relationship between oral infections and systemic health strengthens.

New diagnostic and therapeutic tools to enhance risk assessment may include:

- ◆ Assessment of salivary function and cariogenic bacteria;
- ◆ Refined caries diagnosis utilizing digital radiography, optical fluorescence, and possibly ultrasound and electrical impedance;
- ◆ Selection of appropriate antibacterial therapy; and,
- ◆ Development of "smart restorations" that incorporate the release of fluorides and antibacterial agents over time.

Dental esthetic services will increase as the demand for all types of cosmetic services increase (American Society of Plastic Surgeons, 1999). An increase in implant services is also expected.

Absent major increases in third party coverage, the number of root-form dental implants placed each year in the United States will increase approximately 4% per year (about 610,000 in 2003). The much smaller number of non-root-form implants (for example, blades and subperiosteal) will gradually decrease as the availability of improved dental bone augmentation materials continues to expand care options for orofacial trauma. The convenience-driven shift from two-stage tooth-form implants to one-stage and immediate-loading designs will continue (Medical Data International, Inc., 1999). Future dental consumers will be more aware of the relationship of oral and systemic diseases, oral care products, technology, and oral health clinical services. Such information will be widely available through electronic media; and, oral health will become increasingly associ-

ated with overall health and success and achievement.

In addition to the changes in demographics and disease trends, economic factors will affect the demand for clinical services. If the economy remains strong, demand for services should remain strong as well. Even if costs increase, it is likely that more educated, affluent individuals will continue to avail themselves of both needed and elective dental services. However, an economic downturn of significance could create market force changes that could decrease the demand for clinical services, especially those of an elective nature. It is not clear what the effect of such a downturn would have on access to dental care for low income or other underserved populations.

TECHNOLOGICAL ADVANCES IN CLINICAL PRACTICE MANAGEMENT

Advances in technology are quickly transforming the dental workplace. New information management technologies and advanced diagnostic and treatment tools are improving diagnosis, patient care and patient care management. A major challenge for dental practice managers will be to achieve a coordinated, systematic, and secure approach to the integration and application of information technology. Many of the issues in sharing data and setting up such systems are not solely technical in nature, but rather involve legal, economic, and political considerations (Schleyer, 1999; and Willis et al, 1997).

The infrastructure for communicating patient information will evolve to a point where the information is readily available and where computers will anticipate the need for information and will provide it. Within the dental office, dentists will have access to all patient charts, radiographs, and other pertinent data. Scheduling likewise can occur chair-side. Computers will enhance communication between dental offices, and also between dental offices and other health care professionals.

Computers will become more effective tools for patient education both within and outside of the dental office. Scientific advances will require dentists to become increasingly techno-literate evaluators and users of new and improved technologies. More hours and a greater percentage of the typical dentist's continuing education time will be devoted to techno-literacy. This need will be partially addressed by technology vendors. However, the market for unbiased and accurate information

regarding the clinical capabilities and limitations of new technologies will continue to expand.

New technologies will be designed and marketed so that individual practitioners access their capabilities only when needed and, when possible, remotely. While computers will become smaller, less expensive, and possess more applications, dentists will invest significant dollars into information technology when it adds clear value to the practice.

Clinical Practice Management

Data collection and documentation will move to a digital form and will extend or augment what new applications in areas such as clinical decision support. New technologies will significantly improve productivity and information management.

Use of digital radiography, computerized charting, intraoral cameras, and probes for periodontal charting in the dental workspace will provide paperless charts and provide patient information anywhere in the office. Patient information such as digital x-rays, digital photos, and other documentation will be transmitted electronically to third parties for pre-authorization and treatment verification. Online adjudication, likewise, will be transmitted electronically to dental offices, greatly reducing treatment delays. Software for rapid electronic filing of claims is already available, often integrated with practice management software, and may also be provided to dental offices by claims administrators. Patients, in the future, will be able to access their own dental records electronically. Voice-activated technology will facilitate the collection of patient data, free dental assistants for other tasks, and increase the productivity of dentists and dental hygienists.

Dental practices in the future are likely to integrate electronic clinical data with practice management data. This integration of front and back office data will improve office efficiency.

A barrier to the universal adoption of such technologies is that digital information is subject to alteration and falsification. However, recent legislation, such as the Health Care Insurance Accounting and Portability Act, stipulates the use of encryption technology to safeguard the integrity and confidentiality of health care information.

Patient Diagnosis Technologies

Trends in the development of new diagnostic tools

and therapeutics combined with an aging population may require dental professionals to incorporate more medical treatment into dental practice, in addition to the traditional dental-surgical approach.

Computers will be used to facilitate the collection of clinical data and physiological parameters. Also, computers will provide analyses of collected samples (for example, saliva and tissue samples) as well as interpretation of these data. In effect, computers will provide practitioners with the data they need to make sound clinical decisions. Examples include (1) an emerging new screening tool, which images and analyzes cell samples obtained by brush biopsy and (2) the periodontal probe software that facilitates monitoring of changes.

Advanced optical technology used in diagnostics will be developed. As digital radiography software becomes increasingly refined, it will become more widely used to assess changes in bone density and changes in mineralization and demineralization of teeth and jaws.

Other technological advances that are not computer based are anticipated as well. Greater use of intraoral cameras will further enhance patient understanding of oral conditions and their treatment. New biochemical assays and interpretive methodologies are expected to improve diagnostic and prognostic capabilities.

Treatment Technologies

Computers will serve as decision-support tools in planning treatments that require the integration of multiple disciplines and types of clinical information. Software programs will help the dentist filter, evaluate, and prioritize information essential for establishing suitable treatment plans. Computers are also expected to play an increasing role in delivering care. The universal incorporation of CAD/CAM technology into individual dental practices is cost-prohibitive; however, as this technology expands, it will become affordable.

Current methods of taking physical impressions may be replaced by electronic transmission of both digital impressions and shades to dental laboratories for fabrication of customized restorations.

CAD/CAM technology is already being used in orthodontic practice for minor tooth movement. This technology could make orthodontic treatment more widely available. Advances in tissue engineering and nanotechnology will eventually result in treatment at the cellular, molecular, and atomic levels. Nanorobots and nanocomputers will enable the

regeneration of both hard and soft tissues, and through the maintenance of friendly oral microflora in the mouth, prevent the occurrence of disease (Coontz and Szuromi, 2000).

Advances in real-time visualization, miniaturization of instrumentation, and increasingly atraumatic methods will decrease the morbidity associated with invasive treatment.

Air abrasion and laser technology will find increased application. Rotary instrumentation will become more electronically driven rather than air-driven. Infection-control methods will improve.

Epidemiological Studies and Outcomes Assessment Technologies

As more patient data are stored on computers, a variety of outcomes analyses of patient records will become possible at three levels: patient, practice, and population. Computers will aid dentists in the assessment of a patient's health status over time.

Diagnostic codes will provide a basis for assessing treatment efficacy when measured against established parameters and will assist in assessing outcome data for patients and dental practices. It will be possible to collate local and regional data into larger dental epidemiological databases—important tools for assessing treatment efficacy.

Technologies for Communication with Colleagues and Patients

Advanced communication technologies may create new bridges among dentists. Advances such as videoconferencing and real-time on-line collaboration will make various forms of "teledentistry" possible and practical. Legal, licensure, and political considerations may prove more difficult to address than technical ones.

The nature of the patient-dentist relationship is likely to continue to evolve. Communication with patients will become more electronic, and also more automated. Some practice management systems already send automated recall reminders by e-mail. In the future, patients will likely have access to all or part of their own dental and medical records, and professionals will be able to exchange patient records electronically.

The Dental Workplace

Dental equipment will become more ergonomi-

cally friendly and more amenable to infection-control practices. Manufacturers will develop methods to further minimize biofilms in waterlines. Magnification, either through surgical microscopes and/or conventional magnifying eyeglasses, will increase in use. Equipment and instruments will become smaller and central delivery units will be available with ports that allow simple hookup for an array of mobile equipment for specific procedures. When not in use, this equipment would be stored outside of the operatory.

The Dental Workforce

Many factors will affect the required number of dentists. Aging and demographic changes in the dentist workforce need to be carefully evaluated on a continuing basis. Dentists' productivity should be monitored. The availability of allied dental personnel is critical.

Demand for dental services also plays an important role in workforce requirements. Dental expenditures are the usual measure of demand. Predicting growth in per capita dental expenditures is difficult because it depends on the growth in the overall economy, socioeconomic shifts in the population, changes in therapeutic and preventive interventions, and the impact of changing oral disease rates as well as dental fees. If major new funding programs become available or if major new treatment opportunities emerge, per capita utilization may increase. If, as younger Americans grow older, they need fewer dental services because they have experienced less oral disease than earlier generations, per capita utilization may decrease. The same could result if major new preventive breakthroughs materialize. If the demand for dental services grows more rapidly than expected, an increase in the supply of dental care services may be needed to meet that increased demand. Alternatively, if demand does not grow rapidly, dental care capacity could be adequate.

Unless trends change, there could be increasing difficulty in attracting students to dental assisting and dental laboratory technology programs. Retention issues related to dental hygiene could continue unless some action is taken.

Given an uncertain future, flexibility is a desirable strategy for workforce policy. If more dental capacity is needed in 2020 than available through productivity increases, an attractive workforce option is to increase the number of allied dental

personnel working with dentists. As mentioned in the previous section, the payoff in productivity would be substantial. This is a cost-effective way to generate additional dental services, without the training expense and long-term commitment necessary to increase the number of dentists.

It is worth repeating that regional issues do exist and may become more pronounced in the future. However, given these widely varying conditions among the states, it is apparent that one overall national policy will not fit the specific needs of various states. States with a sufficient number of practitioners will require a different policy than those states in which the number of dentists is declining. Those latter states face potentially serious issues that should be addressed with their state-specific needs and circumstances in mind.

Educational Technology

Technology will have a significant role in the new system for professional development. Through the assistance of the electronic medium, dentists will be able to supplement areas of care through a diagnosis of their own learning needs. Once the practitioner's desired knowledge base or skill level is determined, a customized curriculum could be developed and accessed. Advanced educational technologies will also present new opportunities for learning. Self-customizing educational software will assess the knowledge level, ability, and maybe even the learning style of the learner—whether novice or expert—and customize itself to his or her needs. This could result in a significant increase in the effectiveness and efficiency of the learning process.

Simulations, virtual reality, and other innovations will make new ways of learning available (for example, virtual dissection, diagnosis, and treatment).

Professional Development and Continuing Education

Given the rapid rate at which research and technology is expanding the scientific and practice knowledge base, continuous development of cognitive and clinical skills will be a standard expected of tomorrow's practitioners. The cycles of learning and practice will shorten.

A new system of professional development directed by dental schools, licensing boards and dental industry will be required to keep pace with the

explosion in science and technology. Dental schools and professional dental associations will continue to lead the way with more structured, organized systems involving curriculum, competencies, and outcomes.

The traditional lecture format will be increasingly supplanted by self-directed learning with measurable outcomes. A more highly organized system of curriculum, competencies, and outcomes will be needed to facilitate learning that keeps pace with new developments. Ideally, this system would be designed to serve as a basis for continued competency as well as quality assurance. It will be essential that the ADA and/or the Commission on Dental Accreditation develop criteria and guidelines for learning programs and paths established for licensed dentists. Appropriate evaluation of curricula and outcomes, and measures such as certification, would be necessary to ensure validity, content, quality, and methods.

Professional development will be more custom-ized and available in multiple formats from a variety of sources. There will be less interruption of the practice while the dentist learns new skills. A potential downside to technology-based learning might be to further disengage practitioners who already conduct their practices in relative isolation. Professional development will continue to be selected based on the value it adds to the dental practice and the improvement it has on the health of the patient.

Specialty Practice

New technology and procedures may drive additional groups of clinicians to seek recognized specialty status. The overlap of practice scope between dental specialties and between dental and medical specialties will continue.

Although most dental care will continue to be provided by general dentists, it is plausible that self-referral to specialists may increase somewhat—as the typical American grows older, better educated, wealthier, and shows greater interest in health issues. This trend will increase the overall demand for "specialty care" and may result in a need for more practitioners in some specialties. However, it seems likely that general dentists will perform more clinical tasks traditionally associated with specialty practices.

Assuming continued economic prosperity in the United States, there will be a need for dentists trained in preventive care, treating underserved pop-

ulations, orthodontics, periodontal services, endodontic services, and oral and maxillofacial surgery.

The demand for preventive dental services is expected to continue to grow. Preventive dentistry needs will be strengthened if it is clearly demonstrated (by intervention studies) that improved oral health leads to improved cardiovascular, respiratory, endocrine, and reproductive well-being. Indeed, well-demonstrated oral-systemic links could profoundly affect the traditional dental delivery model in the United States (Loesche, 2000). If these studies result in significant increases in third party dental coverage, this could produce a sudden, large, and disproportionate increase in the percentage of dental users. Such a scenario would further augment the demand for oral preventive services.

Although caries rates have declined in children, the need for dental services provided by pediatric dentists will likely increase due to the higher caries rates in young children (newborn to two years), special needs patients and low-income children (USDHHS, 2000a). This trend will be amplified by an increased tendency of Americans to avail themselves of the services of pediatric dentists as consumer awareness and average wealth increases.

The need for practitioners treating the underserved and public health dentists will increase as the numbers of underserved populations increase. Also, the need for community-based preventive and service programs will require increased numbers of public health dentists and practitioners treating the underserved.

Orthodontics for both children and adults will continue to thrive. Combined surgical-orthodontic protocols will continue to benefit patients with complex needs. Pediatric dentists, general dentists, and periodontists will continue to perform some adjunctive orthodontic procedures.

The need for periodontal services will continue to increase. New computer-based technologies will likely make treatment more affordable.

A growing demand for regenerative and cosmetic periodontal plastic surgery will also contribute to this demand. Moreover, the increasingly well-publicized link between oral infection and systemic health will result in dentists assuming a larger role in clinical oral medicine in collaboration with physicians and other providers (McFall, 1989). Perio-

dontal services will be performed by periodontists, general dentists, and to a limited degree, dental hygienists. The growth of esthetic dentistry may increase the need for more endodontic care. Endodontists and general dentists will continue to perform the bulk of endodontic procedures. The demand for endodontic services will remain high as many patients opt to maintain teeth rather than accept extractions.

The percentage of the population that is completely edentulous will decline in the future, however, the absolute number of individuals with at least one edentulous arch will increase through 2020 suggesting that the demand for traditional removable prosthodontic services will not decrease in the short term.

The demand for fixed prosthodontic services is expected to remain strong. A major medical breakthrough that significantly increases life span would increase the aggregate demand for prosthodontic services. The surgical placement of dental implants will remain part of the specialties of both periodontics and oral and maxillofacial surgery. Surgical placement of implants by prosthodontists and general dentists will continue to increase. Prosthodontists and general dentists will continue to direct the scope of implant restoration.

The scope of practice of oral and maxillofacial surgery will continue to expand. With a number of training programs offering a medical degree and additional training in facial reconstructive and plastic procedures, the boundaries between the specialties of oral and maxillofacial surgery, otolaryngology, and plastic surgery will continue to blur.

Dental Care Delivery

The dominant dental delivery modes will continue to be solo practices and small group practices (Valachovic, 2000). Special needs populations, such as medically compromised patients and nursing home residents, have access problems that extend beyond funding. Models of care delivery, such as school-based programs, hospital dental programs, mobile dental service, and portable dental practices will be needed to meet the oral health needs of these individuals. Health science centers with a critical mass of oral health expertise will become repositories for meeting the needs of complex patients.

III. PATHWAYS AND STRATEGIES FOR CLINICAL DENTAL PRACTICE AND MANAGEMENT IN THE FUTURE

The guiding vision for this discussion has been that in ten to fifteen years, every individual who needs oral health care will access that care from oral health care providers who are educated and skilled in the current best practices using the latest and most appropriate technology.

Achieving this vision requires a strategy that addresses the availability, accessibility, and acceptability of oral health care. The pathway is apparent: the future promises the diagnostic and technological advances necessary to improve the oral health of the entire United States population. There is new understanding of the etiology and pathogenesis of oral diseases and oral disease prevention, diagnosis, and treatment. Dentistry is experiencing improved efficiencies in practice, integration of computers into practice, and enhanced information transfer.

The objective is to make oral health care available, accessible, and acceptable to all. A key pathway toward achieving this objective is the development of suitable facilities and personnel.

Strategies to assure available facilities and personnel should begin with a comprehensive and ongoing assessment of the dental professional workforce. Additionally, the current dental workforce models should be continually evaluated, updated, and refined so that the most accurate predictions possible are available for the number, type and distribution requirements of dental personnel.

The dental profession, in collaboration with dental schools, federal and state governments, and private foundations, should develop endowed programs for scholarships and debt relief to enhance recruitment of lower-income, academically qualified students into dental education (DDS, DA, DH) to assure diversity in the dental workforce.

Stipend support and positions for post-graduate residency training must be made available to increase the numbers of dentists capable and willing to provide care to low-income and special needs populations.

Collaborative broad-based strategies for increasing the availability of all allied health personnel and insuring their retention in the dental workforce are needed. Recruitment should begin early, include traditional and non-traditional students, and, if necessary, extend to international efforts.

Increasing the number of dental hygienists and

dental assistants through recruitment and retention initiatives can enhance the productive capacity of the dental workforce. The dentist should remain responsible for diagnosis, treatment planning and assessment and supervision of delegated duties.

A task force should be convened which includes the dental profession, the dental laboratory industry and dental laboratory schools to address dental laboratory personnel recruitment, training and retention issues.

While the dental delivery system may continue as a predominantly private, solo practice model, new models are needed that expand capacity and provide quality care for the entire population including low-income, medically compromised, physically challenged and nursing home residents.

Strategies to assure that appropriate skills, knowledge, technology, and best practices are available and applied to dental care should begin with efforts to assist dentists.

Computers and associated information technology will become increasingly important in:

- ◆ Data collection, documentation and transmission;
- ◆ Diagnosis and treatment;
- ◆ Outcomes assessment; and,
- ◆ Communication with patients and colleagues.

Scientific advances in diagnostics and treatment as well as information technology will require dentists to become more techno-literate and sophisticated in their evaluation and application of such technology.

Efforts also should be undertaken to ensure the timely transfer and incorporation of new technologies into dental practice to enhance the effectiveness and efficiency of information transfer and clinical care. Application of systems that protect the confidentiality of patient information between dentists, dental specialists, physicians and other health care providers must be promoted.

As the use of diagnostic codes increases, dental practices will be in a stronger position to contribute to the development of the knowledge base of dentistry (i.e., outcomes of care) and eventual patient care modalities. Databases amassed from dental

practices will augment epidemiological, clinical and laboratory research endeavors.

Strategies to assure the acceptability of oral health care in the future should involve strong, collaborative efforts by the appropriate arms of the dental profession and other parties of interest to develop a long-range strategy for increasing the diversity of the dental workforce. Further, changing population demographics will require assessment and evaluation of risk-based care and, in the aging population, a greater understanding of chronic medical conditions.

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Financing of and Access to Dental Services

4

CHAPTER OVERVIEW

Most Americans today receive the oral health care services that they need and want. As noted in Chapter 2, the nation's overall oral health is improving. The inflation rate for dental services has been moderate, and dental care accounts for a smaller proportion of overall economic resources compared to previous generations.

Indeed, the near- and long-term outlooks for the affordability and accessibility of dental care for the majority of Americans remain excellent, a situation that owes in no small part to dentistry's outstanding record of prevention, efficiency and cost-control. However, dental care has not reached every corner of American society to the extent it has reached the majority of Americans.

Millions of children and adults from low-income families, people with disabilities, and the low- and fixed-income elderly—especially those in nursing homes—among others, have difficulty obtaining dental care. This is especially unfortunate because most oral disease is easily and economically prevented and treated. Providing basic preventive and restorative care to these groups is achievable, provided that law- and policy-makers at the state and federal levels are willing to work with the dental profession, other members of the health community and other stakeholders toward that goal.

The market for dental services is a well-functioning, competitive market. The overall performance of the general economy influences dentistry just as it does other sectors. Market conditions within and outside dentistry affect the amount and types of services provided, the geographical distribution of dentists, average income levels of dentists and auxiliary personnel, the financial strength of dental practices, and the number of applicants to and graduates from dental schools.

For the purposes of this discussion, access is viewed as the means of approaching and entering into the use of dental services. The availability of dental care does not, in and of itself, constitute access. Rather, access occurs when care is available and people are able and willing to utilize it. Access to dental services in the United States is a matter of degree. Not surprisingly, people in middle and high-income groups, those with extended education, and those who live in areas with abundant dental personnel have greater access to care. For individuals with meager incomes, especially those who live in areas with few dental personnel, access is more difficult. For individuals who have disabilities and other special problems, access to care can be exceedingly difficult.

This chapter discusses the trends in dentistry, the status of dental health in America and identifies future challenges for the financing of and access to dental care, including:

- ◆ Status of oral health in the United States;
- ◆ Unmet needs for dental services and the major barriers that prevent some people from receiving the dental services that they need and want, and how these barriers can be reduced or eliminated;
- ◆ Demand for dental services, changes in demand in recent years, and future patterns of demand; and,
- ◆ How people pay for dental services, important trends in the demand for dental prepayment, and how changes in dental prepayment may impact use of dental services and access to dental services.

I. FINANCING OF AND ACCESS TO DENTAL CARE TODAY

Any discussion of access and financing in the dental sector must begin with an assessment of the oral health of the nation. The goal of the dental profession is to produce optimal oral health for all Americans as efficiently as possible. Improvement in oral health is an important indicator of dentistry's progress toward that goal.

Changes in the oral health of the population also have a significant impact on the demand for dental services. As fewer Americans experience dental disease, and as the severity of the disease declines among the people who have it, fewer and less expensive dental services should be required to treat oral conditions. Additionally, the maintenance of oral health and the treatment of disease, when it occurs, are important elements in the patients' demand for services. In addition, as stated in the Surgeon General's report, oral health is integral to general health (U.S. Department of Health and Human Services, 2000).

NATIONAL TRENDS IN ORAL HEALTH

During the past 20 years there has been dramatic improvement in the oral health of the American population. Children have fewer dental caries than ever before. Comparisons of findings from four national probability surveys demonstrate that the number of dental caries has declined substantially. For the first time, recent analysis shows reductions in caries also have occurred among American adults (Brown et al, *In Press*; Brown and Swango, 1993). The number of untreated carious lesions has been reduced by almost one half since the early 1970s. This reduction occurred in all age groups from 18 to 45 years.

Caries is the dental disease that historically has engaged the most dental personnel and resources. Caries reduction has translated into adults requiring fewer restorations.

Untreated Caries in Permanent Teeth of Children

The average number of untreated carious permanent teeth among children age 6 to 18 years dropped by 76.9% between 1971-74, as measured by NHANES I¹, and 1988-94, as measured by NHANES III¹ (Brown et al, 1999). The decrease

represents a reduction of just over one untreated carious permanent tooth per child. In 1991, the midpoint of the NHANES III survey, there were approximately 45,605,000 children in this age category. Untreated caries in children declined by nearly 50 million teeth in this age group. The categories with the highest levels of untreated carious teeth in NHANES I experienced the largest absolute declines from NHANES I to NHANES III. Percentage decreases of 75-80% were achieved in all main categories of age, gender, poverty and race.

Although disparities based on income and race continue, absolute differences between these groups have narrowed markedly. African Americans had rates of untreated caries twice as high as Whites in NHANES I and NHANES III. However, the absolute disparity between African American and White children in the number of untreated dental caries declined to 0.24 teeth (NHANES III) from 1.12 teeth (NHANES I).

Children living in poverty continued to have more untreated carious lesions in their permanent dentition in the early 1990s than did non-poor children. Nevertheless, these children also experienced dramatic improvement both in the percent without caries, the average number of untreated carious permanent teeth, and in the extent of untreated caries among those with the condition. As illustrated in Figure 4.1, the difference in the average number of untreated carious teeth in children at or below the poverty level compared to those above 300% of the poverty level narrowed substantially between NHANES I and NHANES III, from 1.36 teeth to 0.35 teeth (Brown et al, 1999).

Although the condition of carious permanent teeth among children represents an oral health problem, its prevalence and extent have diminished for all poverty and race categories examined. During the two-decade interval between the two NHANES studies there has been a substantial improvement in the prevalence of untreated carious permanent teeth among children 6-18 years old.

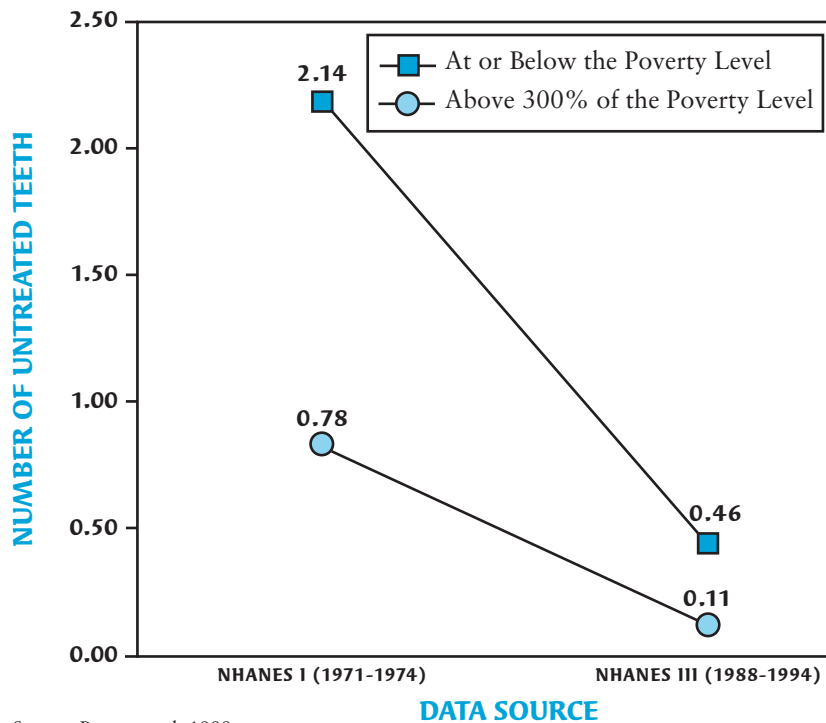
Untreated Caries in the Primary Teeth of Children

Children aged two to ten years old also have

¹ Data reported and discussed here are based on analysis of data from two of the National Health and Nutrition Examination Surveys, or NHANES I and NHANES III. The NHANES is a periodic survey conducted by the National Center for Health Statistics of the Centers of Disease Control and Prevention. A major purpose of this survey is to measure and monitor indicators of the nutrition and health status of the United States' civilian, noninstitutionalized population.

FIGURE 4.1

Average Number of Untreated Carious Permanent Teeth
Among Children 6 to 18 Years Old at or Below the Poverty Level
Compared with Those with Income Above 300% of the Poverty Level



Source: Brown et al, 1999.

shown improvement in the amount of untreated caries in the primary dentition (Brown et al, 2000a). Overall, the average number of untreated carious primary teeth dropped 55.6% between the NHANES I and NHANES III studies. This improvement occurred in both the group two to five years old (primary dentition period) and the group six to ten years old (mixed dentition). Untreated caries in primary teeth has diminished both in prevalence and extent across time for broad segments of two to ten year old children (African American and White, male and female). However, the reduction in untreated decay among children aged two to five years old who were at or below the poverty level was not found to be statistically significant.

Cumulative Caries

Trends in cumulative caries experience (both treated and untreated caries) and the percent of caries that was treated also demonstrate improvement for both the primary and permanent dentitions

of United States children between the early 1970s and the early 1990s (Brown et al, 2000b). However, the extent and scope of the improvements are somewhat different in the two dentitions (primary and permanent).

Cumulative caries in permanent dentitions declined by over 60% among the 6-11 year olds and over 50% among the 12-18 year olds. These improvements were seen in children living below the poverty level as well as children living above poverty.

Cumulative caries experience was less diminished in the primary dentitions of United States children, aged two to ten years old. This was especially true of preschool children among whom only primary teeth typically are present. The amount of caries in children, aged two to five years old living below poverty was the same in the early 1990s as it was in the early 1970s. Among children living above poverty the picture was somewhat better.

Their average cumulative number of decayed or filled primary teeth declined from 1.16 to 0.78.

Adult Edentulism

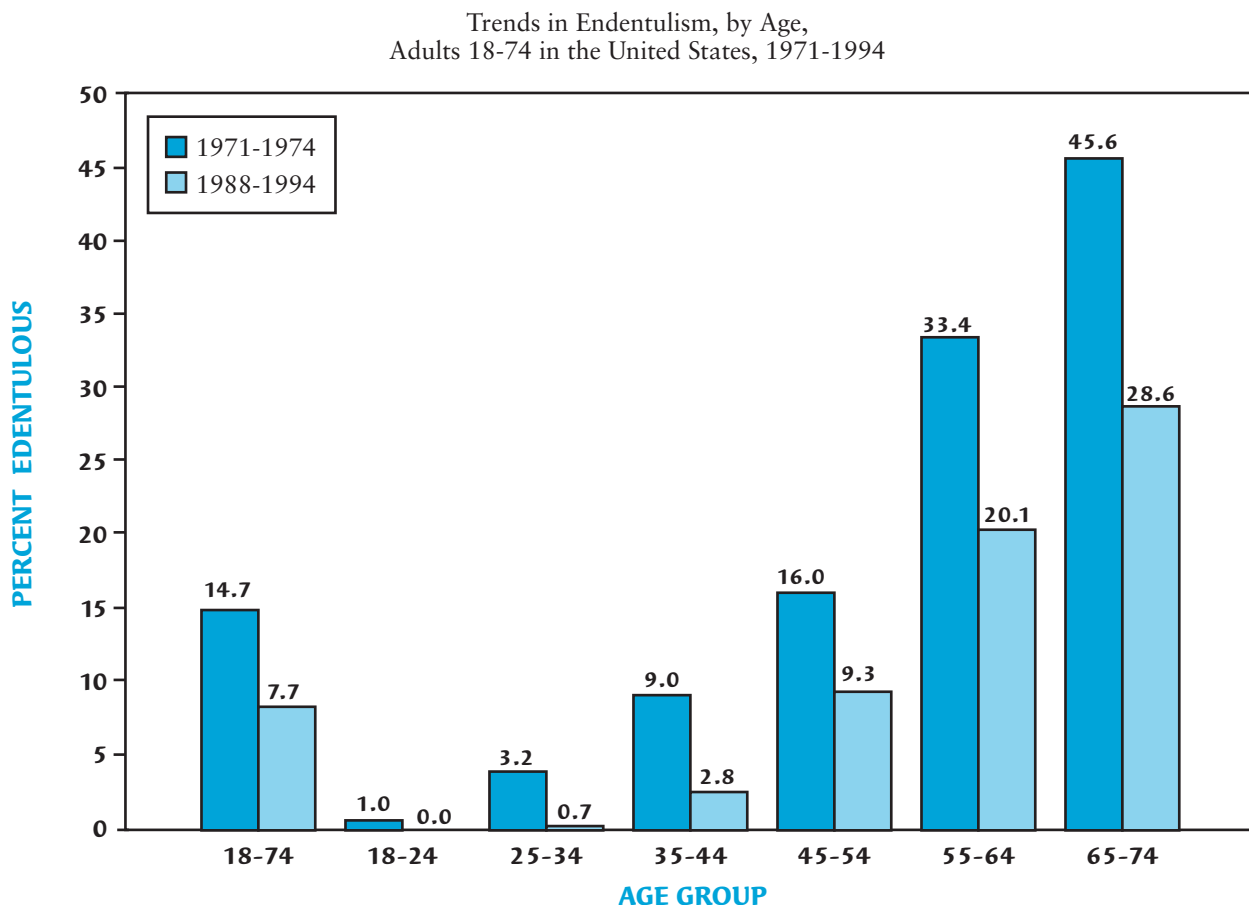
Adults of all age groups are retaining more teeth. As shown in Figure 4.2, total loss of teeth or edentulism occurs in a smaller percentage of today's elderly Americans compared to previous generations (Brown and Lazar, 1998). Despite the significant decrease in complete edentulism, almost 30% of the population over 65 years old are edentulous and will require substantial care.

ACCESS TO DENTAL CARE SERVICES

Most Americans can and do access dental services, and the dental care delivery system efficiently provides care for those who demand it. Nevertheless, important barriers impede access for too many people.

Most policy analyses of access to dental care have focused on two approaches: a "demand approach to

FIGURE 4.2



Source: Brown and Lazar, 1998.

dental care" and a "needs approach to dental care." The two concepts derive from very different disciplinary frameworks (Tuominen, 1994).

A clear distinction must be drawn between demand and unmet need for services in order to understand how future access to care is likely to evolve and what interventions are likely to be effective in altering access to care for some subpopulations in the future.

Unmet Need Approach for Determining Access to Dental Services

The need-based approach uses normative judgments regarding the amount and kind of services required by an individual in order to attain or maintain some level of health. The level of unmet need in a society is usually determined from health level measurements based on epidemiological founda-

tions or other research identifying untreated dental disease. The underlying assumption is that those in need should receive appropriate care. Once the level of need is determined, the quantity of resources that should be devoted to such a social problem is then determined based on a matching of unmet need and appropriate care.

Evaluation of unmet need is important for identifying populations in which access, for whatever reason, may be a problem. Epidemiological and health research in dentistry are designed to identify population-based dental care problems such as segments of the population with unmet need. An understanding of the economic and social conditions surrounding such groups, their reasons for not seeking professional dental care, and the role that price plays in determining effective demand helps analysts to identify weaknesses in the existing care system and establish a foundation for effective remedies.

In private practice most care is provided to those who are willing and able to pay the dentist's standard fee for the services rendered. Individuals with unmet needs who are unable or unwilling to pay the provider's fee generally do not effectively demand care from the private practice sector. These individuals with diseases not treated in private practice are likely targets for new public policies intended to improve their access to care. To be effective these new policies must have the necessary resources to translate unmet need into effective demand. With existing programs, too often such resources are inadequate (Barnett and Brown, 2000).

Demand Approach to Dental Care

Since most dental care in the United States is provided through private markets, an assessment of the demand for dental services is important for understanding access to dental care (Brown, 1989; Brown and Lazar, 1998; and Tuominen, 1994). The demand for dental services is significantly responsive to changes in dental fees - the higher the fees, the lower the demand. Other factors that influence the level of demand include income, family size, population size, education levels, prepayment coverage, health history, ethnicity, age, and other conditions.

Most factors that positively influence demand for dental care have been expanding. The United States economy has grown robustly for most of the past two decades, resulting in an increase in discretionary income among Americans (Beazoglou et al, 1993; Brown et al, 1994). People are becoming more knowledgeable about dental health and what is required to maintain it. As the population has become more affluent and educated, the value placed on oral health has increased. In addition, the desire for esthetic dentistry has grown and will probably continue to do

so. All of these factors have enhanced the demand for dental services. Disease levels and trends also are important to obtain a complete view of the conditions influencing the demand for care.

Dental caries has been the primary foundation of the demand for dental services in modern times and as shown earlier, dental caries has been declining in almost all segments of the child population and to a lesser degree in adults up to about the age of 45 years (Brown, 1989; Brown et al, 2000a; Brown et al, *In Press*). With this decline comes a decline in the need for dental services to treat caries. The population 45 years of age and older experienced caries in substantial amounts during their younger years and will require continued management of the consequences of the original caries.

Due to changing disease patterns, the dental sector is going through a transition from a service mix that has been predominately therapeutic to a service mix that will be mostly preventive. As seen in Table 4.1, cleanings and examinations more than doubled between 1959 and 1999, while amalgam

TABLE 4.1

Percentage of Patients Receiving Selected Dental Services from Private Practitioners in the United States, by Year

Procedure	1959	1969	1979	1990	1999*
Oral Examination	20.1%	27.8%	30.1%	42.8%	45.4%
Prophylaxis	19.9	25.5	24.9	38.6	37.2
Fluoride Treatment	0.9	4.0	6.8	9.8	10.6
Amalgam, 1 Surface	20.1	15.9	8.5	5.3	3.0
Amalgam, 2 Surfaces	20.6	16.4	9.6	7.2	4.0
Crown	1.6	2.9	5.2	5.3	5.9
Root Canal	1.7	2.9	3.2	2.6	3.3
Extraction	13.0	9.8	5.4	4.9	3.7
Resin - Anterior	NA	NA	NA	4.4	4.2
Resin - Posterior	NA	NA	NA	1.9	4.8

* The data for 1999 were derived prior to the publication of the ADA 1999 *Survey of Dental Services Rendered* report; and may, therefore, differ slightly from the published report. Source: ADA, 1994 and 2001.

restorations declined by 75% (American Dental Association [ADA], 1994 and 2001). The decline in amalgams is partly compensated by an increase during the 1990s in the number of posterior resins and other cosmetic materials provided, a trend that should continue in the future.

A study by Eklund et al, also reports these service mix changes (Eklund et al, 1997). In an insured population, there were marked declines between 1980 and 1995 in restorations, crowns, dentures, and extractions. Endodontic procedures declined in younger patients but were stable or increasing in older patients. Over the same time period, there were increases in diagnostic, preventive, and periodontal services (Eklund et al, 1997). Changes of this magnitude will have profound effects by reducing the demand for some services and enhancing the demand for others. The total effect of changes in disease patterns is likely to diminish overall demand but other factors, such as a growing economy, are likely to increase demand. The timing and impact of these factors, in combination, on the demand for dental services are not well understood.

FINANCING OF DENTAL SERVICES

This section discusses the financing of dental services as part of the evaluation of the universal and greatest barrier to receiving care; that is, cost.

Total dental expenditures in 2000 were about \$60 billion. Nominal expenditures have increased at annual rates ranging from 5-7% since 1982. Real expenditures have increased at 1.4%. The increase in real dental expenditures has been slightly less than the rate of growth in the real Gross Domestic Product (GDP) over this period. The major drivers of dental expenditures are the general wealth of the population, employer and public contributions to dental prepayment premiums, the perceived need for and value of dental services, and oral health status.

Dental Care Payment Arrangements Influence Demand

An important factor related to the demand for dental services, and thus access, is the availability, extent and character of third party financing for services (Tuominen, 1994). Individuals who value dental services are willing, under certain conditions, to have prepayment plans purchased on their behalf

by their employers. Employers as the purchasers of prepayment plans shape the demand for dental prepayment. They seek to provide employees with desired benefits while at the same time attempting to control the costs of fringe benefits for their companies.

Several factors determine the demand for dental prepayment (Feldstein, 1978). Other than premium cost, another factor that affects the demand for dental prepayment is family financial resources. Other things being equal, families with larger incomes will express greater demand for dental prepayment. The value that an individual places on good oral health also influences the demand for dental prepayment and the demand for dental care. In turn, the value that an individual places on oral health is influenced by income, education and cultural factors.

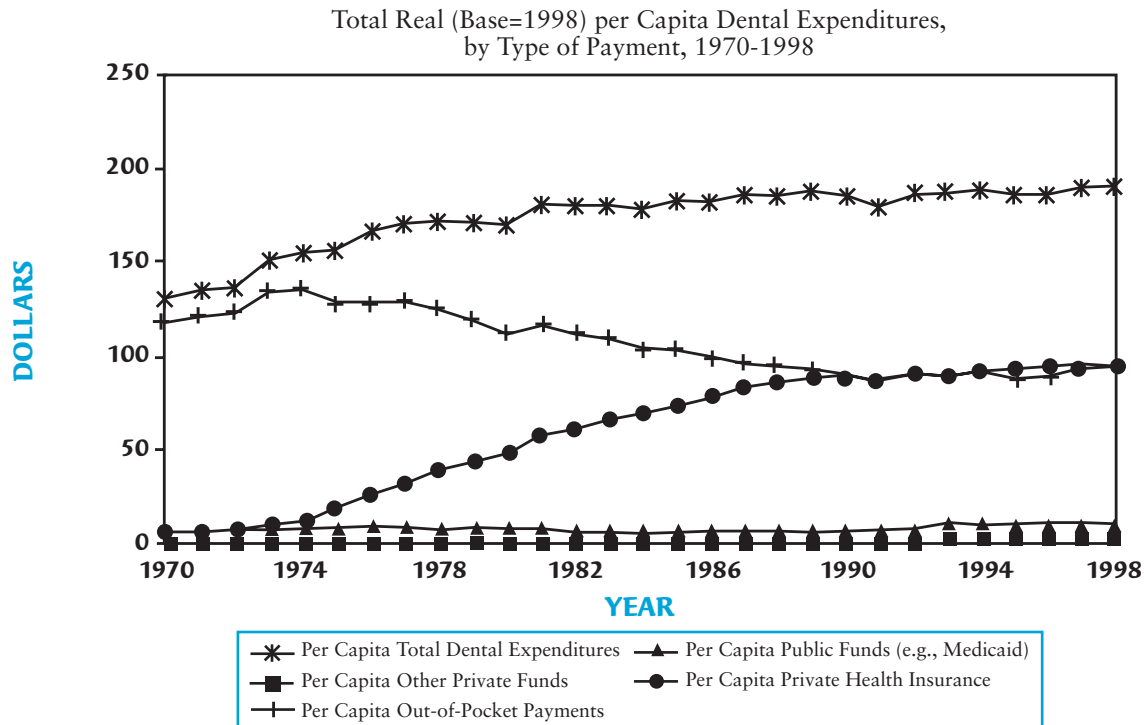
More specifically, dental coverage is generally viewed as a method of prepaying comparatively small, predictable expenses rather than insuring against large, unpredictable expenses. Since dental prepayment is often viewed as a budgeting mechanism rather than insurance, this raises the issue of whether the vast majority of Americans could access dental services even without dental prepayment. This may be the case. In fact, for many years dental prepayment was rare; only in the last thirty years has it become widespread. As shown in Figure 4.3, private dental prepayment expenditures have been increasing over the last 30 years; although leveling off in the late 1990s (Health Care Financing Administration [HCFA]). Nevertheless, most observers believe that dental prepayment enhances demand for dental services and would not be available if people did not value it.

Sources of Payment for Dental Care

Four basic sources of funds to pay for dental care are employer-based prepayment plans, direct patient payment, public prepayment, and free from the provider (e.g., charitable) services.

Health Care Financing Administration (HCFA) data indicate that until the early 1970s, more than 95% of the cost of dental care was paid for directly by patients (Figure 4.3). Through the 1970s and the 1980s, employer-based private prepayment grew rapidly. By the early 1990s more than 40% of all Americans were covered by some form of private dental prepayment. Direct patient payments, as a proportion of total financing, has declined. Today, self-pay and private prepayment account for nearly

FIGURE 4.3



Source: Health Care Financing Administration and U.S. Department of Labor, Consumer Price Index, Bureau of Labor Statistics.

equal amounts of payment for dental care, each at about 47% of the total, with government-financed care accounting for 4%, and other private funds accounting for about 2%. (HCFA expenditure data do not include free/charitable dental services.)

As noted, private prepayment dental plans enhance demand for care, and thus, access. Prepayment encourages people to receive routine preventive care and early detection of dental problems. Enrollment in employer-based dental prepayment is about 105 million people and has increased slowly in the past 10 years with the expanding economy. As part of the general shifts in the financing of dental care, membership in indemnity plans is declining and enrollment in Preferred Provider Organizations (PPO) is increasing. However, Dental Health Maintenance Organization (Dental HMO) plan membership is not growing at the same rate as PPOs. To date, capitated managed care has had relatively little impact on dental expenditures in most geographic areas of the country.

Public financing of services for economically disadvantaged populations has remained fairly constant. Annual federal and state government dental

care payment for the 35 million people eligible for Medicaid is about \$40 to \$70 per person compared to the approximately \$200 to \$300 per person spent among the non-poor. While improvements are being made in some states, Medicaid reimbursement levels, ranging from 10-50% of market fees, are grossly inadequate.

Patients pay approximately 47% of total dental expenditures, or \$25.8 billion (HCFA). This includes cost sharing and contribution to premiums for patients with dental prepayment and the full out-of-pocket payments for those without prepayment. This pattern of out-of-pocket patient costs has been relatively stable for the past 10 years.

Federal and state government payment for dental services was \$2.3 billion in 1998, 4.2% of total dental expenditures (HCFA). Most public funds support state operated Medicaid programs for low-income individuals that meet state program criteria. Medicaid dental services support is provided mainly to children. Few states cover indigent adults for basic dental services.

On average dentists receive less than half their usual and customary fees when paid by Medicaid

(United States General Accounting Office, 2000). The 1997 State Child Health Insurance Program (SCHIP) extends public funds to approximately 10 million near-poor children. Enrollment in this program has only reached 25% of the target population (HCFA, 2000).

A few states (e.g., Indiana and Michigan) have substantially increased dental Medicaid fees and expenditures and improved program administration. These changes have led to significant growth in dentist participation, patient utilization, and total expenditures (Drs. Stephen Eklund and Mark Mallat, Personal Communication, September 1, 2000).

Medicare covers dental services only when associated with the treatment of medical conditions, although some medical managed care plans offer limited dental benefits to attract elderly enrollees. In 1998, the Medicare program provided \$200 million for dental care (HCFA).

Approximately 110 million Americans have private dental prepayment (Wassenaar, 2000). From the late 1980s until the present the percentage of employees with dental prepayment declined modestly (Blostin and Pfunter, 1998), but the trend has reversed in the past several years of strong economic growth (Long and Marquis, 1999). Although less than half of the population has private dental prepayment, these patients account for 60-65% of patients in the average dental office (ADA, 1998). Dental expenditures and sources of financing information also are available from the 1996 Medical Expenditure Panel Survey (MEPS) (Cohen, 1997) and the 1987 National Medical Expenditure Survey (NMES) (Edwards and Berlin, 1989). These data allow for breakdowns of dental expenditures by major demographic variables such as age and income, which are not available from HCFA.²

The 1987 NMES survey indicates that \$1.6 billion, 5.0% of total expenditures, was provided without charge to the patient by providers (Manski et al, 1999). This estimate includes charitable care, professional courtesy, and bad debt. When this estimate is adjusted to 1998 dollars, it amounts to \$2.9 billion or \$19,936 per dentist. This compares favorably to the estimated \$2.0 billion (1998 dollars), 3.7% of total expenditures, from public sources for 1987.

Another estimate of the size of the charitable component of free care is available from the ADA's

1997 *Survey of Current Issues in Dentistry* (ADA, 1998). This survey indicates that 73.5% of private practitioners provided some charitable care in 1996. The total estimated value of this care is \$1.3 billion (1998 dollars). The average amount of charitable care per dentist (based on all private practice dentists in the United States) was \$8,637 (1998 dollars). The total value of charitable care is equivalent to about two-thirds of total expenditures from public sources reported above using the 1987 NMES data.

In addition, dentist volunteers have been providing care to needy patients through Donated Dental Services programs sponsored by state dental societies (Fox, 2000). According to the National Foundation of Dentistry for the Handicapped, Donated Dental Services programs are active in 26 states, include about 8,000 volunteer dentists, and have provided free care to about 30,000 persons at an approximate value of \$34 million.

Types of Dental Care Payment Arrangements

EMPLOYER-BASED PAYMENT PROGRAMS

Figure 4.4 presents estimates of the number of people enrolled in three types of private, group dental prepayment plans for the past six years: indemnity, PPO, and Dental HMO (National Association of Dental Plans, 2000).

INDEMNITY INSURANCE PLANS

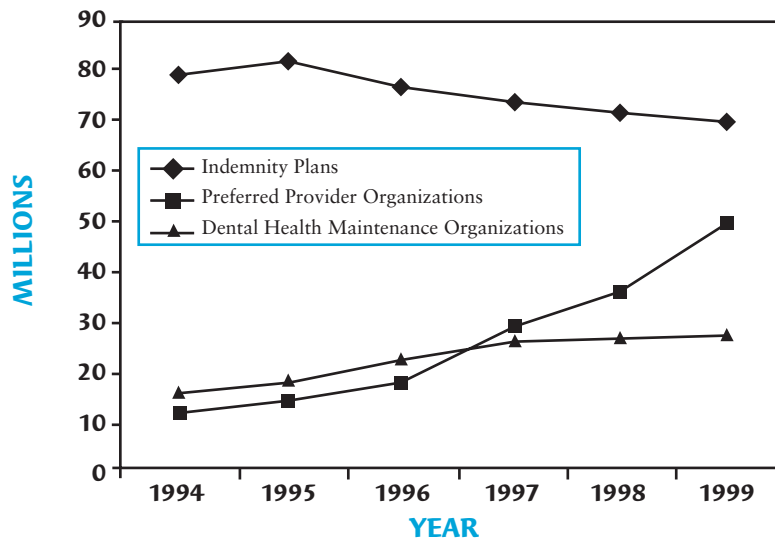
In the past, indemnity plans have been the dominant form of employer-based prepayment. Under the provisions of indemnity style coverage, the third party payer provides payment of a specified dollar amount for defined services, regardless of the actual charges made by the provider.

As recently as 1994, 75-80% of employer-based prepayment enrollments were estimated to be with indemnity plans. Dental HMO and PPO plans together represented only about 20% of enrollment. By 1999, about half of all people with group private dental prepayment were enrolled in indemnity plans. In absolute terms, the decline in the number of people covered by indemnity plans has been more modest, from about 80 million in 1994 to about 66 million in 1999.

² Dental expenditures in the 1987 NMES are based on charges. In the 1996 MEPS dental expenditures are based on the sum of payments for care received. Fortunately the 1996 MEPS also includes a measure of charges. In order to maintain consistency in terms of what is being compared over time, the results presented in this section are based on the total charges for dental services.

FIGURE 4.4

Enrollment in Indemnity Plans, Preferred Provider Organizations, and Dental Health Maintenance Organizations for Members with Employer-Based Prepayment, 1994-1999



Source: National Association of Dental Plans, 2000.

MANAGED CARE PLANS

Preferred Provider Organizations have experienced 20-30% annual growth in membership from 1994 to 1999. In contrast, enrollment in Dental HMOs leveled off in 1997 to about 19% of the employer group prepayment population. Forty-seven percent of Dental HMO members are from three states: California, Florida, and Texas (National Association of Dental Plans, 2000).

Dentists who participated in PPO plans reported that just over one-quarter (25.9%) of their patients were enrolled in PPO dental plans. Dentists participating in capitation dental plans reported a similar percentage of their patients in capitation plans (20.7%). However, a 1994 ADA survey of all dentists found much lower levels of patient participation in these two types of plans (ADA, 1995). At that time, only 3.1% of dentists' patients were enrolled in capitation dental plans and 2.1% of their patients were enrolled in PPOs.

A 1998 ADA survey of dentists in private practice, *1998 Survey of Capitation and Preferred Provider Dental Plans*, showed that dentists' participation in PPO plans has increased since a previous survey conducted in 1996 (ADA, 1997 and 2000). Almost 50% of responding dentists (47.7%) reported participating in PPO dental plans in 1997 com-

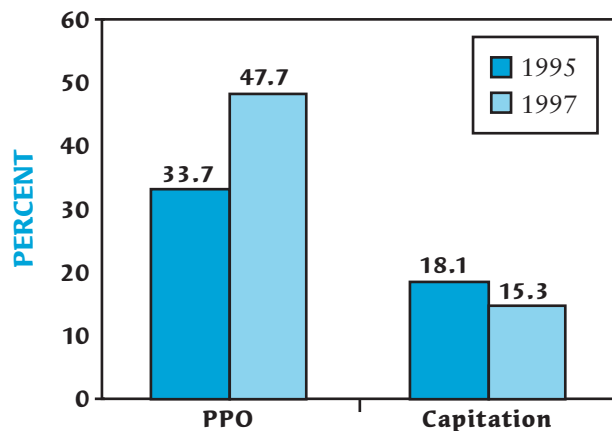
pared to 33.7% in 1995. (See Figure 4.5.)

Capitation dental plans (or Dental HMOs) showed a different trend, with the percentage of dentists declining in the period covered by the two ADA surveys. One of the reasons frequently mentioned for the decline in Dental HMO plans is that the cost of providing the services is greater than the remuneration received. As a result, some dentists left the programs. Others felt the way to resolve this imbalance was to limit the type and/or amount of treatment provided. Still other dentists offered services, procedures or materials that were not covered benefits, requiring the patients to assume greater financial burden than they had previously expected.

The ADA's *1998 Survey of*

FIGURE 4.5

Percentage of Dentists Participating in Preferred Provider Organization (PPO) and Capitation (Dental HMO) Plans, 1995 and 1997



Source: ADA, 1997 and 2000.

Capitation and Preferred Provider Dental Plans also asked dentists about their satisfaction with the plans (ADA, 2000). The largest percentage of dentists who participated in a PPO plan (44.5%) were somewhat satisfied with their largest PPO plan. About one-quarter of participating dentists (27.8%) were somewhat dissatisfied with the plan. Of those dentists reporting some level of dissatisfaction, the

largest percent were unhappy with the plan's fees (71.7%). The next most frequently mentioned reason for dissatisfaction was limitations placed on dentists by the plan (34.7%).

More than half of dentists who participated in capitation dental plans (54.0%) expressed some level of dissatisfaction with their largest capitation plan. Dissatisfied capitation plan dentists were most likely (54.0%) to list reimbursement levels as the most common reason. One-fourth of the responding dentists were dissatisfied with limitations placed on the dentists by the plan. Other most frequently cited source of dentist dissatisfaction included co-payment issues, paperwork, and patient compliance problems.

DEFINED CONTRIBUTION DENTAL PREPAYMENT PLANS

In addition to employer-based prepayment products, defined contribution plans are emerging. Under a defined contribution plan, the employer provides an agreed amount to a discretionary health services fund for each employee. The employee can use the fund to purchase the insurance coverage of his/her choice.

Defined contribution plans are a potentially important alternative to defined benefit plans. The enrollee has discretion to expend these funds as needed but there is no group risk sharing. While this approach currently represents a small portion of the prepayment market, several varieties of these plans have begun to develop. Two of these plan types will be discussed here (direct reimbursement and Medical Savings Accounts).

SELF-FUNDED PAYMENT ARRANGEMENTS

Direct Reimbursement

Direct reimbursement is a self-funded program in which the individual is reimbursed based on a percentage of dollars spent for dental care provided, and which allows beneficiaries to seek treatment from the dentist of their choice (ADA, 1999). Hybrid plans are developing with this concept. Growth varies according to region.

Medical Savings Accounts

Medical Savings Accounts (MSA) are available on a limited basis. MSAs are tax-exempt accounts, similar to Individual Retirement Accounts (IRA) (Goodman and Musgrave, 1994). Contributions

are not taxed, and the account balance grows tax-free over time. The funds accumulated in MSAs can be used to pay for routine eligible medical expenses. Money not spent in the account can be rolled over to the next year or transferred to an IRA. MSAs are usually considered supplemental to other basic coverage. At a minimum, an individual would want also to have a catastrophic health insurance policy as a safety net to protect against very high costs.

PUBLICLY FUNDED PAYMENT ARRANGEMENTS: THE DENTAL SAFETY NET

Medicaid

The poor and near-poor often cannot pay for dental care from their own resources. To date, public programs such as Medicaid have not provided adequate financial access to care. Thirty-two state Medicaid programs do not cover adult dental care, except for emergency services. Most Medicaid programs do provide coverage for indigent children and parents, mainly single mothers, enrolled in the Aid to Families with Dependent Children (AFDC) program (Bailit, 1999).

In addition, states are required by Federal law to provide basic dental care to all Medicaid eligible children under the Early and Periodic, Screening, Diagnosis and Treatment (EPSDT) program. About 20 million children are covered by EPSDT. Nevertheless, only 20-30% of Medicaid eligible children see a dentist annually and an unknown, but much smaller, percentage receives comprehensive preventive and curative care.

State Children's Health Insurance Program (SCHIP)

The 1997 Federal legislation establishing State Children's Health Insurance Program (SCHIP) promises to extend dental benefits to about 10,000,000 children not currently covered by Medicaid. The bill provides no direct legislative mandate for dental services, but Federal matching funds are available for states that cover dental benefits. To date, most states have enacted SCHIP through Medicaid expansions. Nine states have established dental programs separate from Medicaid, and three (Colorado, Delaware, Montana) have excluded dental services altogether in their initial filings. Pennsylvania offers dental care in only part of the state. Since most states have enrolled SCHIP-eligible children through an extension of their

Medicaid programs which themselves have had limited impact, the overall impact of SCHIP on access to dental care may be limited (Bailit, 1999).

Bureau of Primary Health Care, Health Resources and Services Administration

Another source of financial support for dental services is the Bureau of Primary Health Care, Health Resources and Services Administration. The Bureau gives grants to private non-profit Migrant and Community Health Centers to provide comprehensive health care, including dental services, to the poor and migrants. Approximately 56% of the 671 Migrant and Community Health Centers offer dental services, and in 1997 they provided dental care to 1.13 million people (Bailit, 1999).

The Indian Health Services

Several federal agencies provide direct services to specific, often disadvantaged, populations and to military personnel. The Department of Health and Human Services' Indian Health Service (IHS) provides oral health services to Native Americans and Alaska natives in dental facilities located in predominantly Native American communities and reservations. The IHS also purchases care from privately practicing dentists located near Native American communities (Bailit, 1999).

The United States Department of Veterans Affairs (VA)

The Department of Veterans Affairs (VA) provides the largest network of hospital based dental programs in the United States. VA Dental Services meet the oral health needs of eligible veterans. VA dentists have training and expertise in caring for medically compromised patients, many of who are homeless or reside in nursing homes or long term care facilities. A large part of VA practice provides oral health care to patients with complex medical problems such as substance abuse, psychiatric and psychomotor disorders, oral cancer and HIV (Bailit, 1999).

Dental Schools

Dental schools are an important source of care for the poor and individuals with disabilities. In part, this is because most schools are part of academic health centers that are located in older urban areas. A large percentage of patients treated at these cen-

ters come from the local neighborhood and have low incomes, making dental schools their primary source of dental care (Bailit, 1999). In addition, the majority of dental schools are public institutions that receive some state support. As such, the general public and state legislatures expect schools to function as safety net providers.

Some schools have dental clinics that provide care to low-income children who are covered by the Medicaid program or have no insurance coverage. These clinics are usually partially subsidized by state, county and municipal funds even though they bill Medicaid where possible. There are no comprehensive national data available on school-based dental clinics.

UTILIZATION OF DENTAL SERVICES

Whether, and how often, individual Americans obtain dental care are frequently studied as measures of access. Several reports have focused on the extent, determinants and likelihood of dental visits (National Center for Health Statistics [NCHS], 1972). Measured as the number of visits per year or the number of individuals with at least one visit during the previous year, these studies have provided useful information about dental services use.

The second measure of utilization is expenditures for dental services. Expenditures are a dollar measure of the extent of utilization of resources once entry into the dental delivery system occurs. Expenditures are influenced by a combination of several factors including, but not limited to, professionally determined need for care, ability to pay, perceived value of oral health and local supply and availability of providers.

Visits and Expenditures

VISITS

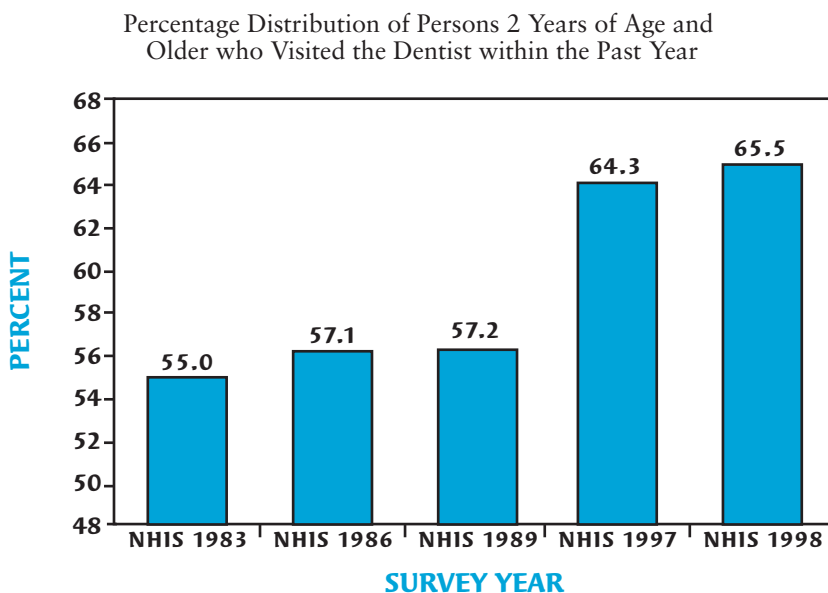
Americans seek dental care in considerable numbers. In 1996, Americans visited dentists about 294 million times (Manski et al, 2001).

The available data on use of dental care is characterized by variability from one source to another (Brown and Lazar, 1999). One survey suggests that 75% of the adult population have an annual dental visit (ADA, 1997), while another source puts the figure at 42% (Manski, 1987). Some of the differences between these and other estimates are likely to be due to differences in survey methods. All sources

of data agree that there are important differences in the use of dental care among subgroups of the population even though the true rate of annual dental visits in the United States is currently uncertain.

According to data from the National Health Interview Survey (NHIS), annual utilization of dental care in the United States has increased gradually over the past several decades. In 1983, 55.0% of the population 2 years and older reported a dental visit in the prior year, while in 1998 the annual rate was reported to be 65.5% (Jack and Bloom, 1988; Bloom et al, 1992; NCHS, 2000a; and NCHS, 2000b). Figure 4.6, which is based on data from NHIS, shows this gradual increase.

FIGURE 4.6



Source: National Center for Health Statistics, *National Health Interview Surveys*.

EXPENDITURES

According to the Health Care Financing Administration (HCFA) estimates, in 1998, \$53.8 billion was spent for dental services, representing 4.6% of total health expenditures. For the past seven years the annual rate of increase in dental

expenditures ranged from 5-11%. This is more than twice the rate of general inflation. Between 1993 and 1998, dental care expenditures were rising faster than hospital and physician services expenditures. This represents a historic shift in the comparative rates of growth between the two sectors. Many observers believe this is the result of the much larger penetration of managed care into the medical sector. It may also reflect the changing mix of dental services sought by the public with significant increases in cosmetic dental services.

In real dollars (base=1998), the increase in expenditures has been smaller, increasing from about \$43 billion in 1982 to \$53.8 billion in 1998, an average annual increase of 1.4%. This is only slightly greater than the rate of increase in the United States population, which is 1.1%. Factoring out population changes, real per capita expenditures (including both those with a visit and those without) have been almost level from the early 1980s through 1998, ranging from approximately \$185 to \$192 in 1998 dollars. As mentioned previously, the percent of the population who visited a dentist within a year increased during this same period (see Figure 4.6).

These trends imply that real dental expenditures among those with a dental visit have declined. To verify this implication, dental expenditure information from the 1996 Medical Expenditure Panel Survey (MEPS) and the 1987 National Medical Expenditure Survey (NMES) is helpful.³ Based on large national probability samples, MEPS and the NMES allow for examination of dental expenditures by major demographic variables.⁴

Average nominal dental expenditures (based on those with a visit) increased from \$295.55 in 1987 to \$435.80 in 1996. However, when these expenditures are expressed in 1998 dollars (i.e., adjusted for inflation), the NMES and MEPS data show a decrease in

³ Dental expenditures in the 1987 NMES are based on charges. In the 1996 MEPS dental expenditures are based on the sum of payments for care received. Fortunately the 1996 MEPS also includes a measure of charges. In order to maintain consistency in terms of what is being compared over time, the results presented in this section are based on the total charges for dental services.

⁴ Estimates of total national dental expenditures derived from the 1996 MEPS and the 1987 NMES are in line with national estimates from HCFA. For example, in 1996, HCFA estimated national dental expenditures at \$47.5 billion while the MEPS estimate for 1996 was \$50.3 billion. Although these numbers vary slightly, the two sources are in basic agreement.

average expenditures from \$541.99 to \$475.52 (see Table 4.2). While this per capita decrease in expenditures is not directly reflected in the per capita HCFA expenditure data (see Figure 4.3), when the HCFA expenditure data are adjusted to the increasing proportion of the population with a dental visit, a decline in real expenditures per patient is apparent.

As shown in Table 4.2, declines in inflation-adjusted per capita expenditures between 1987 and 1996 occurred in most demographic subgroups. Exceptions are in the youngest age group (2-4 year olds), African Americans and races noted as other, and those individuals with household income below 100% of the poverty level. The declines in all other groups is likely to reflect improving oral health and thus less need for restorative services.

Demographic Variations in Visits and Expenditures

GENDER

As shown in Table 4.3, the percent of females that visit a dentist has consistently been higher than males. Females also spend somewhat more on average than males (see Table 4.2). This difference narrowed between 1987 and 1996.

AGE

Dental care utilization also differs by age. Increasing utilization by both the youngest and oldest individuals in the more recent NHIS surveys is apparent (Table 4.3). The increase in young children may be due to an increasing realization of the importance of oral health in the young, and the increased utilization in the elderly is partly due to the reduced incidence of total edentulism in adults. The

TABLE 4.2

Real (Base=1998) 1987 NMES and 1996 MEPS Per Capita Expenditure Data For Persons 2 Years of Age and Older who Visited a Dentist⁵

	1987 Charges	1996 Charges	P-Value
Overall	\$541.99	\$475.52	.000
Age			
2 to 4	126.32	154.72	.099
5 to 17	625.58	536.59	.045
18 to 34	459.95	400.37	.026
35 to 54	553.53	475.50	.007
55 to 64	627.32	514.91	.008
65 and over	570.99	533.63	.428
Race			
White	558.52	478.11	.000
African American	403.34	408.13	.913
Other	444.43	545.82	.105
Ethnicity			
Hispanic	508.80	435.60	.148
Non Hispanic	543.74	478.71	.000
Poverty			
Below Poverty	371.24	420.07	.362
100%-200%	427.27	371.42	.095
201%-400%	538.97	478.92	.036
>400%	607.10	515.68	.000
Gender			
Male	517.60	461.90	.021
Female	562.19	486.76	.001

Source: Agency for Health Care Policy and Research, 1987 National Medical Expenditure Survey (NMES) and 1996 Medical Expenditure Panel Survey (MEPS).

role of edentulism in utilization of dental care is demonstrated clearly in the literature (Meskin and Brown, 1988). As fewer additional American adults become edentulous, more adults will seek regular dental care as older adults.

⁵ Per capita estimates were derived by ADA staff using NMES (Edwards and Berlin, 1989) and MEPS (Cohen, 1997) data available from the Agency for Healthcare Policy and Research (AHCPR).

TABLE 4.3

Percentage Distribution of Persons 2 Years of Age and Over who Visited the Dentist within the Past Year⁶

	NHIS 1983	NHIS 1986	NHIS 1989	NHIS 1997	NHIS 1998
Age					
2-4	28.4%	31.3%	32.1%	44.1%	44.3%
5-17	67.0	70.3	69.0	78.3	79.0
18-34	57.0	58.1	56.9	60.2	61.1
35-54	57.4	60.5	61.4	66.8	68.1
55-64	51.3	51.2	54.0	60.8	62.6
65 and over	38.6	41.7	43.2	54.1	55.8
Gender					
Male	53.0	54.9	54.9	62.2	63.0
Female	56.9	59.2	59.4	66.4	67.9
Race					
White	57.0	59.2	59.3	65.8	67.0
African American	41.8	43.6	44.5	57.7	58.5
Other	NA	NA	52.4	58.3	59.3
Ethnicity					
Hispanic	NA	NA	46.4	53.3	54.2
Non-Hispanic	NA	NA	58.2	65.7	66.9
Poverty					
<100%	NA	NA	NA	50.0	50.5
100%-199%	NA	NA	NA	49.2	51.0
200%-299%	NA	NA	NA	61.3	62.5
>=300%	NA	NA	NA	76.4	76.8
Poverty					
Below Poverty	NA	NA	41.3	50.0	50.8
At or Above Poverty	NA	NA	61.5	67.0	68.3

Source: National Center for Health Statistics, *National Health Interview Surveys*.

⁶ Data presented in this table for 1983-1989 came directly from the National Center for Health Statistics (NCHS) "rainbow series" *Vital and Health Statistics* reports. The 1989 poverty data, as well as all data for 1997 and 1998 were derived by ADA staff using public use data files available from NCHS.

RACE & ETHNICITY

As shown in Table 4.3, over time, dental visits have increased for both the White and African American population. Throughout the time period of 1983-1998, a higher percentage of the White population visited the dentist compared to the African American population. However, the difference has narrowed from 15.2 percentage points in 1983 to 8.5 percentage points in 1998. As for dental expenditures, Table 4.2 shows that Whites who visited a dentist spent more, on average, than African Americans in both 1987 and 1996. Again, this difference was smaller in 1996.

Non-Hispanics are more likely to visit a dentist than Hispanics. In contrast to racial patterns, this difference has not decreased over time. As for dental expenditures, non-Hispanics spend more than Hispanics and the gap does not appear to have diminished.

POVERTY LEVEL

The percentage of people who visited the dentist has increased for both those below poverty and those at or above poverty. However, there is approximately a 20 percentage point difference in the likelihood of a visit between these two groups. This difference is consistent for 1989-1998.

There has been a substantial increase in the percentage of children that visited the dentist between 1989 and 1998 (see Table 4.4). For children two to four years old below the poverty level, the likelihood of visiting a dentist increased by 21.9 percentage points, from 26.4% to 48.3%. For children 5-17 years old below the poverty level, the likelihood of visiting a dentist increased by 15.7 percentage points, from 51.1% to 66.8%.

Among children two to four years old, living above the poverty level, the percentage of those who visited the dentist increased by 9.2 percentage points, from 34.7% to 43.9%. For children 5-17 years old, living above the poverty level, the increase among those who visited the dentist was 6.8 percentage points, from 74.9% to 81.7%. The differ-

ence in the percentages visiting a dentist between children who are above and below poverty levels narrowed to one-half of the earlier percentage difference. Both pre-school and school-age children demonstrated this improvement. By 1998, pre-school children living below the poverty level exhibited as high a likelihood of visiting a dentist as those above poverty. This finding comes as a surprise and has not been seen before. Confirmation from other sources is necessary before it can be assumed that the poverty gap in utilization of dental services in this age group has vanished.

Among adults, the increase in the likelihood of a visit was smaller than that for children (see Table 4.4). Across all age groups, persons living below the national poverty level were less likely to see a dentist than those above the poverty level. However, both groups exhibited substantial improvement in the likelihood of a visit between 1989 and 1998.

T A B L E 4.4

Percentage Distribution of Persons Two Years of Age and Older who Visited the Dentist within the Past Year, by Poverty and Age Group⁷

Age Group	Below Poverty		At or Above Poverty	
	1989	1998	1989	1998
2-4	26.4	48.3 ⁸	34.7	43.9 ⁸
5-17	51.1	66.8	74.9	81.7
18-34	48.0	52.3	60.1	63.1
35-54	33.6	41.7	65.2	71.2
55-64	27.2	32.0	58.4	66.4
65 and over	22.6	32.7	47.4	58.4

Source: National Center for Health Statistics, *National Health Interview Survey* (1989 and 1998).

Unlike the experience of children, however, among adults the differences observed between poverty and non-poverty groups did not appear to narrow over this time period.

As might be expected, dental expenditures increased with the level of income (i.e., percent of poverty level) between 1987 and 1996. However, differences between individuals at the highest and lowest income levels narrowed by almost 60%, from \$236 (\$607-\$371) to \$96 (\$516-\$420) in 1996.

⁷ Data derived by ADA staff using public use data files available from NCHS.

⁸ The difference in these two means - the 48.3% utilization rate for 2-4-year-olds below poverty and the 43.9% utilization rate for 2-4-year-olds above poverty - is not statistically significant.

For children living below the poverty level, real dental expenditures increased. Among children 2-4 years old, the increase was from \$82 to \$187. Among children 5-17 years old, the increase was from \$235 to \$431. Real dental expenditures decreased among 5-17-year-old children from families living at the 100-200% of the poverty level. See Table 4.5.

TABLE 4.5

Real (Base=1998) 1987 NMES and 1996 MEPS Expenditure Data for Children 2 to 17 Years Old, by Age Group and Poverty Level⁹

	1987 Charges	1996 Charges	P-Value
2-4 Years			
Below Poverty	\$ 81.99	\$186.57	.003
100%-200%	131.51	100.22	.351
201%-400%	138.64	171.19	.249
>400%	123.40	137.89	.660
5-17 Years			
Below Poverty	235.03	431.46	.033
100%-200%	419.90	294.57	.081
201%-400%	654.68	549.09	.141
>400%	831.72	677.75	.102

Source: Agency for Healthcare Policy and Research, 1987 National Medical Expenditure Survey (NMES) and 1996 Medical Expenditure Panel Survey (MEPS).

Within each survey (NMES and MEPS), the largest expenditure differences between income levels are found in children 5-17 years old. Nevertheless, as shown in Table 4.5, this gap between the lowest and highest income groups in this age group decreased from \$597 in 1987 (\$832 - \$235) to \$247 in 1996 (\$678 - \$431). Much of these expenditure differences in this age group are related to orthodontic services primarily among teenagers.

The expenditure patterns for children's care, that of large expenditure increases per patient among the poorest children and decreases in expenditures among children from families with higher incomes, are somewhat surprising. A potential explanation may lie in the improvement of all children in

untreated caries. The data on untreated caries presented earlier clearly indicates that middle class children have low levels of caries and almost no untreated caries. Untreated caries in this age group is largely concentrated in lower income children. Thus, one explanation of these data may be that middle class children did not need as much restorative dentistry as lower income children. Without an increase in need for care, expenditures for middle class children were largely for preventive services and did not increase between 1987 and 1996. In contrast, lower income children may have had a larger need for restorative care, and somehow found the funds to receive it.

BARRIERS TO ACCESS

Everyone faces some barriers to access to dental services. Some see cost as a primary barrier to care. However, in a market delivery system, prices (dental fees) play an important role. They permit trade-offs to be made between competing goods and services that individuals desire. No nation, not even one as wealthy as the United States, has inexhaustible resources or productive capacity. Choices must be made regarding what is produced and who will receive it.

For most goods and services in the United States, those choices are made through markets.

Healthcare is a sector of the economy where market forces are supplemented by other sources of finance and other mechanisms of allocation. Within healthcare, the dental sector still relies on markets to a greater extent than the medical care sector. As the preceding sections have indicated, most people can and do access the dental care delivery system and receive the care they need and desire. Overall, for the United States, dentistry is health care that works rather well under its current financing structure. As new problems arise, dental markets in their broadest sense (i.e., markets for services, prepayment, education, etc.) can be expected to generate new financing arrangements that deal with those problems.

⁹ Data presented in this table were derived by ADA staff using NMES and MEPS data available from the Agency for Healthcare Policy and Research.

In the 1989 NHIS (Bloom et al, 1992), by far the most common reason given for not having a dental visit in the prior year was "no dental problem," regardless of age, sex, race and ethnicity, place of residence, income, prepayment, or activity limitations. Overall, "no dental problem" was cited by 46.8% of individuals as the reason that they did not have a visit in the prior year. This was the most common reason cited by virtually every subgroup, except for the oldest adults, where "no teeth" was the major factor. After "no problem" and "no teeth," the next most common reason given was "cost," which overall was cited by 13.7% of people as the reason for no dental visit in the prior year. Cost as a reason reached its highest levels in people with low incomes, no prepayment, and activity limitations.

While "no dental problem" "no teeth," and "cost" account for the vast majority of the reasons for not visiting a dentist, the category of "access problem" was rarely cited. This category includes the statements "don't know [a] dentist," "dentist too far," and "can't get there." Overall only 1.7% of non-users cited access as the primary reason for not having a dental visit.

Some subpopulations face unique barriers because they have special problems (e.g., persons with disabilities and complex medical conditions). Their conditions make it additionally difficult to access services. Although the economically disadvantaged may face similar barriers to care as the general population, these barriers force much starker tradeoffs and are much harder for disadvantaged persons to overcome without help.

Barriers for the Disadvantaged **COST BARRIERS**

For economically disadvantaged people, the cost of care is a significant barrier. They do not have the financial resources to meet the needs of everyday living and still afford dental care as easily as the rest of the United States population. Long-term solutions to improving their access to care are the same that will improve their economic status—such as better education, better job skills, safer neighborhoods, and more stable personal lives. But for immediate impact, increased direct financial aid is needed. This aid, which has been inadequate, has been usually provided through philanthropic endeavors or public-funded programs. More is needed in the way of public support for dental care for disadvantaged adults. To date, Medicaid and Head Start have provided limited care for disadvantaged children (Barnett and Brown, 2000).

MEDICAID PROGRAM LIMITATIONS

The Barnett and Brown study concluded that inadequate reimbursements and Medicaid administrative burdens limit the effectiveness of the Medicaid program (Barnett and Brown, 2000). Observers identify the cause of inadequate reimbursement as lack of political will.

Medicaid serves only a small fraction of the children that it is supposed to provide with dental care. Unfortunately, there is considerable uncertainty regarding the percentage of children eligible for Medicaid who actually receive dental care and more accurate data are needed.

At present, most analyses rely on data concerning services paid for by Medicaid. These data do not account for other services children receive outside of Medicaid - such as free care donated by the dentist. The amount of dental care that dentists provide free of charge could be of approximately the same magnitude as Medicaid services. Thus, the extent to which the Medicaid population is underserved is unclear, though it is obvious that Medicaid itself does not provide the level of services that it is intended to provide. Head Start, however, has increased the rate of dental care usage for its children substantially above the rate for higher income pre-school children. Barnett and Brown also identify a number of other barriers as important, though clearly of secondary importance compared to inadequate reimbursement.

LIMITED PROVIDER MEDICAID PARTICIPATION

Survey data indicate that the lack of dentists who are willing to accept new Medicaid patients is a significant problem. Dentists do not participate in Medicaid, primarily, because of low program reimbursement rates. In addition, the administrative burden and the high "no-show" rate of Medicaid clients discourage dentists' participation. For the vast majority of dentists, the opportunity cost of serving a Medicaid client is far higher than the Medicaid reimbursement rate (Barnett and Brown, 2000).

MICHIGAN'S HEALTHY KIDS DENTAL PROGRAM - A PROMISING EXAMPLE OF MEDICAID REFORM

The data suggest that for low-income persons, the major barriers to care appear to be perception of need and cost. There is promising early evidence that removal of the cost barrier can be a major

impetus to increasing utilization among Medicaid-eligible children.

The state of Michigan, in an attempt to secure access to dental care for its underserved children, made the bold step of removing the financial and administrative barriers from its program. The Healthy Kids Dental Program is administered by private dental benefits companies with rules, regulations and reimbursement schedules similar to those offered in the private sector. In a 22-county experiment in Michigan, conversion of the Medicaid program for children to private administration paying UCR fees, resulted in more than a 50% increase in the number of children receiving treatment in just the first 4 months of operation, and a 40% increase in the number of dentists providing care, compared to the same 4 months in the previous year (Michigan Department of Community Health, 2000).

The Healthy Kids Dental Program has been extremely successful. Children enrolled in the program now have access to dental care which is approaching that of children in the private sector. Other states looking to secure marketplace access for patients enrolled in their programs should look carefully at this example. Longer-term results from this program should be followed closely.

Other Potential Barriers

AVAILABILITY

According to the United States General Accounting Office (GAO), "while several factors contribute to the low use of dental services among low-income persons who have coverage for dental services, the major one is finding dentists to treat them." According to this report, "some low-income people live in areas where dental providers are generally in

short supply, but many others live in areas where dental care for the rest of the population is readily available." (United States General Accounting Office, 2000.)

PERSONAL FACTORS

Some observers have identified individual factors that create barriers to care. For example, many immigrants do not speak English; this can lead to communication problems with the providers of care and may result in more difficult access. Knowledge of appropriate dental care—and when to seek it—may be less developed among subpopulations. Finally, apprehension about going to the dentist may discourage use. While these factors may influence utilization and expenditures, evidence of their quantitative impact on access is not conclusive.

GEOGRAPHIC BARRIERS

People who live in areas where there are few, if any, dentists nearby must overcome circumstances to receive regular dental care, but there are no comprehensive data to quantify the effect of this barrier.

SPECIAL NEEDS POPULATIONS

Individuals with physical, sensory and developmental disabilities that limit mobility or are accompanied by exceptional treatment needs, face special challenges in receiving regular dental care, as they do with many aspects of everyday life. The skills and experience required to treat some of these individuals is sometimes beyond the capabilities of the average dentist. The costs involved also may be beyond the means of the affected families.

II. FINANCING OF AND ACCESS TO DENTAL CARE IN THE FUTURE

A primary determinant of access to dental care is having the financial resources to purchase services. The availability of resources is highly dependent on the overall growth of the economy. Dentistry has clearly benefited from the robust economy over the past two decades. Greater wealth has resulted in large increases in dental services utilization and total national expenditures.

These gains in purchasing power have affected all segments of the population, but as expected, the poor and near-poor have less purchasing power

than the wealthier segments of society. Although oral health and access to care have improved significantly among the disadvantaged during the past 30 years, these individuals do not utilize dental services to the extent of the general population. For some Americans with special problems, such as individuals with disabilities, those with congenital conditions, non-ambulatory individuals, and people in nursing homes, obtaining dental care remains difficult.

The most effective way to give the poor greater purchasing power is to subsidize their access to care

using public funds. While surveys suggest that most Americans support providing all citizens financial access to basic health care services, to date, federal and state legislatures have not allocated funds to provide the poor the same level of access to dental care as the non-poor. Without adequate public funding, the efforts by the dental profession and others to provide the poor adequate access to dental care will continue to fall short.

FUTURE FINANCING OF DENTAL CARE

It is expected that total dental expenditures will increase at an overall growth of 5-7%; but the real growth rate (i.e., after adjusting for inflation) will be 1-2%, slightly less than the rate of growth of the real Gross Domestic Product (GDP).

In the short run (5 to 10 years), private dental prepayment is likely to decline modestly. Annual maximums, which have not changed appreciably in the last 15 to 20 years, should increase with a moderate increase in premiums of 5% or less. If medical costs continue to increase as they have during the past two years (e.g., 8-15% annually), then employers are likely to either (1) shift costs to employees so that fewer employees opt for dental prepayment or, (2) cut back on the dental prepayment coverage they offer in order to help fund medical insurance. In the longer run, events and trends in the financing and organization of medical care may have substantial impact on dental care financing. The unpredictability of medical costs and the response by employers and government to this situation makes long-term predictions for dental coverage very uncertain.

The proportion of dental expenditures funded directly by patients, private prepayment and public programs will remain essentially the same for the next five years. Major increases in public funding of dental care for the poor or medically disabled are not expected, with the exception of modest increases in programs targeting children (e.g., SCHIP).

Within the structure of dental prepayment, the percent of the privately insured population with PPO plans will increase. In turn, there will be a decline in indemnity and Dental HMO enrollment. Also, there will be some increase in direct reimbursement and there will be more interest in Medical Saving Accounts as a market-based system to control medical care costs.

Although many dentists will treat patients with PPO plans, the overall impact of managed care on

dentists' management of patients and aggregate dental expenditures will be limited.

The concept of a "prepayment/insurance free" practice may grow as a result of the dentists' perceptions of the difficulties encountered in dealing with carriers. Dentists are more likely to refuse assignment of benefits and, therefore, more of the burden of dealing with the insurance company will be placed on the patient. In turn, this could put increasing pressure on insurance companies to simplify their administrative procedures and/or become more "provider friendly."

ACCESS TO DENTAL CARE IN THE FUTURE

In the short run, the demand for care is expected to continue to increase at about the same rate as it has for the past five years. Some of the major factors which are likely to influence demand are: 1) more affluent, educated and growing population, 2) new diagnostic and treatment technologies, and 3) some underserved populations will gain financial access to care and use services (e.g., SCHIP).

Unless the percent of the population seeking dental care continues to grow, overall demand may moderate, due to improving oral health among those who seek services. These trends may become more pronounced as younger cohorts with less caries experience replace the so-called baby boom generation. Nevertheless, a growing economy and new technologies must be factored into the situation before any final conclusions can be reached.

In the near term, increasing utilization and expenditure by elderly persons are likely to continue. This is because the next generation of elderly (the current 55-65 year-olds) is large in number and these individuals are already high users of dental care. They will, therefore, be the most affluent elderly generation thus far and their current dentitions will require high levels of maintenance. As the elderly population increases in number and influence, pressure may build to provide them with more dental coverage either through tax deferred Medical Savings Accounts or a combination of public subsidies and employer contributions. In the longer term, as the generation following the baby boomers begins to retire, demand among the elderly may decline because these future generations will be fewer in number and healthier.

While affluent people who live in rural areas have the means to seek care, low-income families in rural

communities may have a more difficult challenge in securing needed dental care. There is no reason to expect that within the next 5 to 10 years large numbers of dentists will establish practices in rural or economically depressed areas. Government programs to encourage dentists to locate in underserved areas are valuable in specific locations when they succeed, but so far, the number of dentists placed on a long-term basis is relatively small. This is unlikely to improve in the next decade and

may even become worse.

Physical and mental disability, whether associated with advanced age, illness, congenital condition, or injury, is a significant barrier to access. In addition to low-income and other health problems that are associated with disabilities, the fact is that most dental practices are organized with fully ambulatory patients as the primary, if not exclusive, focus. Disability and special needs will continue to be a significant barrier to access.

III. PATHWAYS AND STRATEGIES FOR FINANCING OF AND ACCESS TO DENTAL SERVICES IN THE FUTURE

The dental profession's vision for access to dental care is that all Americans will be able to receive the dental care that they both need and want. That is, all Americans, regardless of their financial, geographic, physical or other special circumstances, will have the ability to receive the highest quality dental care.

For most Americans the current dental services delivery system works very well. More than three out of four people from non-poor families report at least one dental visit in the previous year. For these people access is excellent and will continue to be in the future. Even among the disadvantaged, access to care and oral health has improved significantly in the last 30 years. Nevertheless, many financially disadvantaged people and people who live in geographically isolated areas continue to have inadequate access to care. The following strategies focus on achieving dentistry's vision for access.

IMPROVING FINANCIAL ACCESS

Low-income individuals and families are a diverse group. While many low-income people are unemployed, others are employed but make relatively little money. In 1996, 38 million people were low-income, defined as income below the poverty line, and long-term unemployed, representing 14% of the United States population. Low-income employed people are often referred to as "the working poor." The income of the working poor is generally defined to be 100 to 200% of the federal poverty level. In 1996, 53 million people, 20% of the population, were "working poor."

For the long-term unemployed, expansion of public financing that compensates dental care providers at or above market rates is indicated. It is essential

that professional fees for services provided to the disadvantaged not be allowed to fall below prevailing market rates. Therefore, in the long term, fees should be indexed accordingly.

These changes should be phased in over a 5-to-10-year period to allow the dental care system to accommodate to the resultant increased demand. In addition, priority should be given to covering children first. Private carriers, who would be responsible for managing programs for the disadvantaged, should use the same procedures and systems as employer-based dental prepayment plans. There is strong indication that this will increase utilization by the poor and participation by the dentist.

Some segments of the population may need additional support to obtain dental care. Examples of the kinds of support include education, transportation, and convenient access to care for institutionalized or semi-institutionalized populations.

The working poor are generally employed in economic sectors in which private dental prepayment is not prevalent. The issue with this group is lack of affordable private prepayment. Therefore, a two-pronged strategy to encourage financing of private prepayment might be necessary.

Under this strategy, the government would provide individuals with a stipend to subsidize the purchase of either a traditional prepayment plan or a dental savings account. The federal or state governments would facilitate the necessary approaches to risk-spreading by creating risk pools. The administration of the program would be contracted to the private sector. This will empower the disadvantaged to make choices regarding dental care in a manner similar to the rest of the population. By bypassing the employer and going directly to the individual, the dif-

facilities of providing employer-based prepayment for this segment of the market is avoided. However, individual employee contributions could be withheld from wages much like Social Security and Medicare.

By going directly to the employee, savings in administrative costs of employer-based programs in the small business market can be used to purchase dental services. This would also reduce the cost of the plan, making it more affordable to low-wage workers.

Individual employees could be responsible for some level of cost sharing. Although this is envisioned as a voluntary program, by making the individual's contribution amount small the program could encourage enrollment. There are existing methods for controlling adverse selection and other issues that result from a voluntary program. These changes should be structured so that they would not be competitive with existing employer-based prepayment coverage.

IMPROVING GEOGRAPHIC AVAILABILITY

Adequate availability of dental care is a problem for the poor in inner cities and rural areas. Over time, adequate financing should create the financial incentives needed to encourage the development of dental services for these groups.

Nevertheless, it is very difficult to attract and retain private dentists to disadvantaged rural areas. Dentists must have a strong financial incentive to practice in these areas, and this means reimbursement rates that are substantially above current market rates. In addition, loan forgiveness and other incentive programs such as tax credits may also be necessary to induce initial location in these areas.

Expansion of a National Health Service Corps or a similar program might be helpful for creating an effective plan for the rural areas. Eligibility for participation should not be limited to new dental graduates. Older dentists and those in semi-retirement may provide an important pool of personnel to address this issue. Again, long term funding at adequate levels is essential.

IMPROVING ACCESS FOR SPECIAL NEEDS POPULATIONS

Access for special needs populations and for individuals with disabilities may be the most difficult issue to address. It will be more expensive to provide dental services for these persons because of

their special needs and complex management. Many of these patients are either homebound or institutionalized. Furthermore, the health providers who care for these people require special skills and educational background. For these reasons, adequate financing for this group of people will require reimbursement at rates substantially above market rates.

Properly caring for populations with disabilities will require long-term funding well in excess of what is now available. Dentists will need to be reimbursed at appropriate rates to give them financial incentives to gain the additional clinical training and to devote their time to this segment of the population. Educational programs to train providers with the specialized necessary skills will be important. Additional attention within the dental profession to reach out to "physically challenged individuals" could have a positive impact on access for this group.

Clearly, utilization and access among the elderly have increased. Moreover, older people enjoy better dental health today than ever before. Nevertheless, the elderly as a group have considerably less dental prepayment coverage. There is evidence that employers are reducing retirement-based prepayment coverage for their former employees.

Establishing tax-deferred Dental Medical Savings Accounts in which the balances in those accounts accrue over time and can be used by the elderly offers a market-oriented strategy to address this lack of coverage. Not all elderly can or will participate. Nevertheless, this is a step in the direction of greater coverage. These initiatives combined with the growing economic resources of the elderly and their improving oral health should underpin the maintenance of their dental health in the future.

CULTURAL COMPETENCE

The dental profession should have the competence and skills needed to provide services to a growing and diverse patient population. In this respect, the prospects for success are greatly enhanced by the position taken elsewhere in this report.

ROLE OF DENTAL SCHOOLS

Dental schools have the potential to serve as a major safety net for the underserved without infringing on the private market sector. This will require schools to have senior students, postgradu-

ate students, and faculty providing care in community clinics and practices located in disadvantaged areas. Schools must also recruit and retain more minority students, auxiliary staff, and faculty. Dental education must include cultural competence and spe-

cial knowledge and skills to deal with these special populations. Over time, new and creative use of allied dental personnel is the preferred method for dealing with changes in needs. Schools will need to be adequately compensated to develop such programs.

APPENDIX A. OTHER TRENDS IN DENTAL PREPAYMENT

Some employees participate in voluntary and referral plans where employers do not contribute to the premium. In the former type plan, employers assist in plan administration, but employees pay the full cost of premiums. In the latter, employers direct employees to a network of dentists who provide services at a discount and employees pay for the full cost of services.

Five other trends in dental prepayment plans deserve mention. First is the rise in employee contributions to premiums. In the average family dental plan, employees now pay 41% of the premiums (Managed Dental Care, 1999; and Meskin and Brown, 1988). As dental prepayment costs increase, employers are passing some of these costs on to employees in the form of larger contributions to premiums.

Second is limited changes in member cost sharing (e.g., deductibles, co-insurance, maxima) or the services covered under the dental plan. A few insurers are now offering to cover selected cosmetic services, implants or other expensive treatments for a larger premium (Mr. Thomas Meyer, Personal Communication, September 27, 2000; and Meskin and Brown, 1988).

Third, some large employers (i.e., 1,000 employees or more) offer employees a range of options that allow them greater choice in paying for dental care. This includes the option of enrolling in an indemnity plan or preferred provider organization. With

rising dental care premiums, more employers are only offering the managed care plan (Mr. Thomas Meyer, Personal Communication, September 27, 2000; and Meskin and Brown, 1988).

Fourth, cafeteria plans, spending accounts, and medical saving accounts are benefit options provided to employees working for large companies—see Appendix B for a description of these benefits. The number of employees participating in these arrangements and their impact on dental expenditures are not known. From a theoretical perspective, they provide employees a financial incentive to opt out of conventional dental prepayment plans, thereby increasing plan costs for employees who do enroll and, in turn, reducing prepayment plan enrollment and total prepayment-based spending for dental care.

Fifth, personal financing plans: with the current strong economy, more insured and non-insured patients obtain personal credit to finance their dental expenses. Practitioners report an increase in the number of institutions offering to finance patient dental expenses. Often, dentists must discount their services by paying the lending entity 2 to 19% of charges. In other plans of this type, dentists pay an annual fee to have patients eligible for the loans (Dr. Myron Bromberg, Personal Communication, October 12, 2000; and Meskin and Brown, 1988).

APPENDIX B. GLOSSARY OF PREPAYMENT TERMS

Cafeteria Plan (Flexible Benefit Plan):

These are employee benefit plans in which an employer establishes a menu of benefits that are available to employees. Employees select their medical insurance coverage and other nontaxable fringe benefits from the list of options provided by the employer. Participants may receive additional, taxable cash compensation if they select less expensive benefits. Each employee chooses the benefits in which he or she

wants to participate. Employees pay for the benefits they select before taxes are calculated on their wages.

Defined Contribution Plan:

These are employee benefit plans in which the employer provides an agreed upon amount of funds to each employee. The contribution is to be used by employees to purchase any health insurance plan they want. The employee may add to the employer

contribution to purchase more extensive insurance coverage. The employees are the owners of the policies they purchase. To be workable, the employer contribution would not be taxed as employee income. Several defined contribution models, ranging from individual plans to managed competition have been described.

Direct Reimbursement:

Direct reimbursement is a funded program in which the individual is reimbursed based on a percentage of dollars spent for dental care provided, and which allows beneficiaries to seek treatment from the dentist of their choice.

Flexible Spending Account:

Flexible Spending Accounts allow employers and employees to use pretax dollars to pay for certain personal health care expenses that are not covered by medical or dental insurance. Funds are reimbursed to the employee for health care (medical and/or dental), dependent care, and/or legal expenses, and are considered a nontaxable benefit. This includes insurance cost-sharing expenses associated with deductibles and co-insurance. Employee reimbursement accounts are primarily funded with employee-designated salary reductions.

Indemnity Plan:

An indemnity plan is a dental plan where a third party payer provides payment of an amount for specific services, regardless of the actual charges made by the provider. Payment may be made either to enrollees or, by assignment, directly to dentists. Schedule of allowances, table of allowances, or reasonable and customary plans are examples of indemnity plans.

Managed Care:

Refers to a cost containment system that directs the utilization of health benefits by:

- a. Restricting the type, level and frequency of treatment;
- b. Limiting the access to care; and
- c. Controlling the level of reimbursement for services.

There are two general forms of managed care. Preferred Provider Organizations and Dental Health

Maintenance Organizations. Some plans are hybrids of the two forms.

Preferred Provider Organization (PPO):

A PPO is a formal agreement between a purchaser of a dental benefit program and a defined group of dentists for the delivery of dental services to a specific patient population, as an adjunct to a traditional plan, using discounted fees for cost savings. The panel or network of providers is limited in size and usually has some type of utilization review system associated with it. The discounts from usual and customary fees vary greatly usually ranging from 15% to 30%. In this paper discount programs of 5% common to some Delta Dental and Blue Cross "participating" provider plans are not considered preferred provider organizations.

Dental Health Maintenance Organization (Capitation):

A capitation program is one in which a dentist or dentists contract with the program's sponsor or administrator to provide all or most of the dental services covered under the program to subscribers in return for payment on a per-capita basis. These plans place providers at risk for some medical (dental) expenses. In dentistry, the risk is usually for basic services (e.g., diagnostic and simple restorations). More expensive elective services are usually provided under a discounted fee-for-service arrangement with substantial patient cost sharing.

Medical Savings Accounts (MSA):

The MSA is a tax-exempt account, similar to an Individual Retirement Account (IRA) that is used to pay for routine eligible medical expenses. Moneys not spent in the account can be rolled over to the next year's account or put into an IRA. It is a form of defined contribution in which contribution may come from employers, employees or public funds. In addition to the MSA, a catastrophic health insurance policy is required as a safety net to protect against very high costs.

Out-of-Pocket:

This refers to the payment for dental services by patients with their own funds. For individuals with-

out dental prepayment, the entire billing for dental services is paid by the patient or some designated person, usually a relative. For individuals with dental prepayment, this refers to the portion the billing for dental services not covered by the plan and is paid by the patient, or some designated person. These payments may be for noncovered services or as copayments for covered services. Types of copayments include: deductibles, copayments, and expenses above the maximum allowed by the plan.

Coinsurance:

A provision of a dental benefit program by which the beneficiary shares in the cost of covered services, generally on a percentage basis. The percentage of a covered dental expense that a beneficiary must pay (after the deductible is paid). A typical coinsurance arrangement is one in which the third party pays 80% of the allowed benefit of the covered dental service and the beneficiary pays the remainder of the charged fee. Percentages vary and may apply to table of allowance plans; usual, customary, and reasonable plans; and direct reimbursement programs.

Deductible:

The amount of dental expense for which the beneficiary is responsible before a third party will assume any liability for payment of benefits. Deductible may be an annual or one-time charge, and may vary in amount from program to program.

Maximum Benefit:

The maximum dollar amount a program will pay toward the cost of dental care incurred by an individual or family in a specified period, usually a calendar year.

Premium:

The amount charged by a dental benefit organization for coverage of a level of benefits for a specified time.

Referral Plan:

This is a type of plan that refers employees or members of a group, such as a professional association, to a group of participating dentists who will provide dental services at a discount from their

usual fees to individuals enrolled in the plan. The referral service may be provided free to employees or group members, or a membership fee may be charged. No insurance or third parties are involved. Financial arrangements are directly between the participating dentist and the member of the plan.

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Licensure and Regulation of Dental Professionals

5

CHAPTER OVERVIEW

Dentistry is a highly respected profession for many reasons. As individuals, dentists provide a valued service in their communities, enjoy strong relationships with their patients and are much regarded for their integrity, compassion and skills. Representatives of dentistry serve on state and regional regulatory boards as advocates for the public welfare. As a profession, dentistry maintains a clear commitment to high performance standards, life-long learning and support for strict accreditation standards of dental school programs and state licensure requirements.

State licensure requirements and scope of practice regulations, while serving to protect the public, can also have unintended and unfortunate consequences. Differences among states' rules can impede professional mobility and make it difficult for the dental workforce to respond to changes in the demand for skilled dental personnel, due to demographic changes in states or regions.

Differences among state Scope of Work regulations may also force some personnel out of the labor pool—particularly hygienists—if they must move to another state and find that they are required to take a battery of courses or exams to meet their new state's licensure requirements. Conversely, if their new home state defines Scope of Work more restrictively than their training allows, hygienists may not find it financially or professionally rewarding to continue their professional careers.

Further, differences among states may discourage the emergence of national consensus on dental curricula development. While dental educators work to build strong and innovative programs, reality may require that they keep a close eye on their students' facility with the material known to be key in their state examinations.

This chapter reviews dental licensure and regulation and identifies strategies to strengthen mechanisms that assure professional conduct and performance. The chapter considers:

- ◆ The scope of practice and licensing requirements for general and specialty dental practice and for allied dental health practice;
- ◆ Criteria for licensure and alternative approaches to traditional licensure examinations;
- ◆ Current procedures for assessing dentists' initial and continued competencies; and,
- ◆ The changing roles of federal, state, and local regulation of dental professionals.

I. LICENSURE AND REGULATION OF DENTAL PROFESSIONALS TODAY

A license to practice dentistry is a privilege granted by individual state and district governments. Through its legislature and licensing boards, each state or district promulgates statutes, rules and policies regarding professional licensure and regulation. The American Dental Association (ADA) describes the purpose of licensure as follows:

Dental licensure is intended to ensure that only qualified individuals provide dental treatment to the public. Among qualifications deemed essential are satisfactory theoretical knowledge of basic biomedical and dental sciences and satisfactory clinical skill. It is essential that each candidate for an initial license be required to demonstrate these attributes on examination, a written examination for theoretical knowledge and a clinical examination for clinical skill (ADA, 1976, 1977, 1989, 1992).

STATE BOARDS OF DENTISTRY

State boards of dentistry serve to ensure that dental professionals maintain their competence and practice in accordance with the law of that state. Dental board members include dentists, dental allied personnel, and representatives of the public. It is important for boards to have public representation as well as professionals with clinical knowledge and expertise that is critically needed to fulfill their responsibilities. Those responsibilities include evaluating dental professionals for licensure and disciplining errant dentists and allied personnel.

Two percent of all dental licensees had disciplinary actions filed against them by state boards of dentistry in 1997.

SCOPE OF PRACTICE

A dentist's "scope of practice" refers to the diagnosis and treatment a dentist can legally perform for a patient in the practice of dentistry by virtue of his or her license to practice within a state.

Most state dental practice laws specifically define or refer to the ADA definition of the practice of dentistry. Dentistry is defined by the ADA as:

The evaluation, diagnosis, prevention, and/or treatment (non-surgical, surgical, or related procedures) of diseases, disorders, and/or conditions of the oral cavity, maxillofacial area, and/or the adjacent and associated structures and their impact on the human body; provided by a dentist, within the scope of his/her education, training, and experience, in accordance with the ethics of the profession and applicable law (ADA, 1997).

The scope of practice in all of dentistry, including its specialties, has continually evolved. State board definitions of the scope of specialty practices have not kept pace with the dynamic advances in dental materials and techniques.

Most dental practice laws allow for licensure exemption for dentists in the military service or public health service, dentists offering clinical instruction who are teaching in their jurisdiction, and physicians and surgeons engaged in the practice of dentistry.

SPECIALTY PRACTICE

Each specialty defines its own scope of practice within its educational and training parameters. The type of license, requirements for licensure, and practice limitations of each specialty dental practice vary among jurisdictions.

Seventeen licensing jurisdictions have some specific statutes and/or regulations that define the scope of specialty practice and issue some sort of license for dental specialists. Twenty-two states set standards for announcements by licensed dentists who have not completed specialty training but choose to limit their practice to a special area.

While most states require that specialists also have a general dental license, a few states issue a specialty license that does not require the specialists to pass its general dentistry licensing examination. In these states, the specialist is limited to the practice defined for the specialty. The type of license issued may restrict the specialist's scope of practice.

Traditional areas of expertise for specialties have begun to overlap. For example, periodontists and oral and maxillofacial surgeons both perform implant surgical procedures. Similarly, some pediatric specialists now perform orthodontic procedures.

Dental boards in a number of states are working to address concerns raised by state medical boards about oral and maxillofacial surgeons who provide head and neck cosmetic procedures that have been traditionally defined under the state's "practice of medicine" statutes and regulations.

Another challenge facing dental boards is the issue of "dual degrees." Dental boards are struggling to define the scope of practice of oral and maxillofacial surgeons, for example, that have a dental degree and a medical degree but are licensed only under a medical degree. With the M.D. degree, the specialty graduate applies for a medical license and does not fall under the statutes and regulations governing dentistry in that state. The medically licensed oral and maxillofacial surgeon then performs procedures that are defined in the dental practice act as the "practice of dentistry." Dental boards across the country are developing new rules and regulations to address such dual-degree issues.

ALLIED DENTAL HEALTH PRACTICE

The three nationally and professionally recognized allied dental health fields are dental hygiene, dental assisting, and dental laboratory technology. To protect the health and safety of the public, licensing jurisdictions regulate certain tasks performed by allied dental personnel. Nowhere are the regulation and licensure and certification of dental personnel more varied from state to state than in the allied fields.

The competent performance of any allied professional who works under the supervision of the dentist is ultimately the responsibility of the supervising dentist.

Dental Hygiene

Most state dental statutes and regulations define the scope of practice for dental hygienists, who must be licensed to practice. The dental hygienist (except in Alabama) must be a graduate of an accredited educational program. There are 255 dental hygiene programs accredited by the Commission on Dental Accreditation (CDA) (ADA, 2001).

The scope of practice for dental hygiene varies from state to state. Although basic functions are universal, in some states expanded functions may be permitted if proof of additional education and training is accepted by the licensing jurisdiction.

Many states also allow for indirect or general supervision of dental hygienists by dentists. This

means that dental hygienists can provide services for patients without a dentist being present during the procedure as long as the dentist has directed that the procedure is appropriate. Each state establishes its own limitations and parameters. A few states allow the independent practice of dental hygiene.

The demand for dental hygienists has increased as consumers seek more preventive dental services. However, because of the differences in licensure from one state to another, it is often difficult for a hygienist trained in one state to transfer to another state. The need for more licensed dental hygienists has prompted many states to seek nontraditional educational pathways to increase the number of practicing hygienists.

States must consider these factors as they address the freedom of movement for dental hygienists, a greater uniformity in their scope of practice, and, most importantly, patient protection concerns.

Dental Assisting

Dental assistants are not licensed. The majority of state dental statutes and regulations do not define "dental assisting." Assistants are permitted to perform services specifically defined by each state dental practice act. The procedures allowed are always procedures that are reversible and do not fall under the definition of the practice of dentistry or dental hygiene. In all jurisdictions, a dental assistant's duties must be performed under the supervision of a licensed dentist.

Voluntary national certification programs have been established for dental assistants, and the CDA conducts site visits and accreditation reviews for most dental assisting programs. There are 258 accredited programs for dental assisting (ADA, 2001). However, since neither formal education nor certification is required many dental assistants are not formally educated, but are trained while employed by a licensed dentist.

Dental Laboratory Technology

The expansion of the predoctoral dental curriculum limits the amount of time dental schools have to teach their students the laboratory skills that were traditionally taught in the past. The aging of the population creates an increased demand for fabrication of fixed and removable prostheses to replace teeth and related dental structures. Dental laboratory technicians are helping to meet this demand, aided in part by more efficient laboratory procedures, materials and equipment.

Like dental assisting, dental laboratory technology has voluntary national certification programs. The ADA CDA conducts educational program site visits and has written standards. There are 28 CDA accredited programs (ADA, 2001).

Most states do not regulate dental laboratories or dental technicians. Generally, laboratories work as directed by prescriptions from licensed dentists.

LICENSING EXAMINATIONS

Basic Biomedical Sciences

Every dental licensing jurisdiction in the United States accepts the National Board dental examinations on the basic biomedical sciences, administered by the Joint Commission on National Dental Examinations. Some jurisdictions also require additional written examinations for licensure, such as a theory examination and a state jurisprudence examination. Increasingly, states are accepting the National Board written dental examination in lieu of other examinations.

Clinical Dental Sciences

Clinical dental sciences examinations are sometimes administered by the individual state or jurisdiction. However, many states have joined one of the regional testing services (Western Regional Examining Board [WREB], Southern Regional Testing Agency, Central Regional Dental Testing Service [CREDTS] and Northeastern Regional Board [NERB]) to pool their resources and improve the quality of their examinations.

Forty-one of the 53 licensing jurisdictions subscribe to the services of one or more regional testing services. The remaining 12 jurisdictions continue to examine individually. WREB and CREDTS mutually recognize their exams to be equivalent and urge their member states to accept these results. No governmental or private agency accredits dental licensing examinations.

Clinical examinations in dentistry have changed dramatically in recent years. The public, the practicing dental community, dental educators, examiners, examination candidates and others have demanded greater accountability from examining agencies.

The result has been a call for in-depth evaluation of clinical examination reliability and validity by the testing agencies. Many of the agencies are respond-

ing and now utilize psychometric standards and professional test analysts. The science of clinical examination analysis is evolving because of this self-evaluation, and the quality of clinical examinations continues to improve.

Expressing concern about patient welfare, liability, and examination variability, a number of interested parties have advocated removing live patients from the licensing examination process. Several licensing jurisdictions have instituted the use of mannequins and other artificial patients with varied results. Unfortunately, no simulation techniques are available that duplicate live-patient experience to the satisfaction of most testing agencies.

Alternative Approaches to Licensure

In 1997 clinical testing agencies, licensing jurisdictions, and organizations within the licensure community developed *The Agenda for Change*, which offers 12 objectives to facilitate improvements in the clinical licensure process. (See Table 5.1.) The *Agenda's* objectives address the development of uniform clinical content and standardized calibration of examiners, the use of human subjects in clinical licensure examinations, improving and standardizing the appeals process, and providing remediation programs for candidates who fail the clinical licensure examinations.

The *Agenda for Change* promotes acceptance by all licensing jurisdictions of the National Dental Board Examination in lieu of a separate written examination on oral diagnosis and treatment planning, and suggests collecting statistical data on examination results to begin to address the profession's concerns about failure rates on clinical examinations.

State-specific licensure requirements limit professional mobility and make it difficult for the dental workforce to respond to geographic shortages in personnel. *The Agenda for Change*, if coordinated with a proposed study of scoring practices and post-examination analyses, would constitute significant progress toward standardizing all clinical licensure examinations.

A number of alternatives to the traditional licensure examination are emerging.

PRE-GRADUATION EXAMINATION

Many examining agencies offer clinical examina-

T A B L E 5.1

Agenda for Change in the Clinical Licensure Examination Process

1. Promote the interaction of all testing agencies and boards of examiners to explore the concept of more uniform content and methodology in licensure examinations.
2. Develop and promote the acceptance of guidelines for administration of a common content clinical examination and standardized examiner calibration.
3. Encourage testing agencies to work with dental school faculties to develop and participate in calibration activities.
4. Minimize the use of human subjects in clinical licensure examinations, but where human subjects are used, ensure that the safety and protection of the patient is of paramount importance and that patients are procured in an ethical manner.
5. Develop and promote policies and procedures to make clinical licensure examinations more candidate-friendly.
6. Encourage the development of publications, orientation sessions and other methods to better communicate to candidates information regarding clinical examination logistics.
7. Minimize the time needed to notify candidates of examination results.
8. Improve and standardize to the extent possible the testing agencies' appeals process.
9. Urge the American Association of Dental Schools to encourage all dental schools to offer remediation programs for candidates who fail the clinical licensure examinations.
10. Promote further study of the pregraduation examinations by the clinical testing agencies and encourage the testing agencies and dental schools to work together to offer the pregraduation examinations to the extent possible.
11. Promote the acceptance by all licensing jurisdictions of the National Board Dental Examination in lieu of a separate written examination on oral diagnosis and treatment planning.
12. Address the profession's concerns regarding the failure rates on clinical examinations, by collecting statistical data on examination results within the limits imposed by the need to protect confidentiality.

* These objectives were developed by participants in the Invitational Conference for Dental Clinical Testing Agencies held March 4, 1997. The objectives were endorsed by the American Dental Association, the American Association of Dental Examiners, the American Association of Dental Schools, and the American Student Dental Association.

tions to senior dental and dental hygiene students prior to graduation. This allows the candidate to utilize more fully the dental school resources during the examination and to enter practice more rapidly after graduation.

LICENSURE BY CREDENTIALS

Licensure by credentials, or licensure without examination, is now an acceptable pathway in more than 30 licensing jurisdictions. Credentialing allows many established dentists and dental hygienists to obtain a license to practice without repeating a clinical performance examination.

The ADA has supported these efforts and has established "Guidelines for Licensure," which outlines attributes that states should consider when

granting a license by credentials. The licensing jurisdictions also have created individual requirements for licensure without examination, thereby reducing the uniformity among the requirements. Continuing competence may become an important aspect of credentialing.

The Canadian system of initial licensure is closely tied to institutional accreditation. Graduates of these accredited Canadian dental programs face minimal additional examinations for licensure, since licensing representatives are part of the accreditation process. This system relies almost wholly on the accreditation process and faculty evaluations, since outside examiners do not test individual candidates for clinical competence.

Graduates of Canadian dental schools are treated the same as graduates of dental schools in the

United States and Puerto Rico, because there is an accreditation agreement between the two accrediting agencies.

CREDENTIALS FROM NON-ACCREDITED SCHOOLS

The Commission on Dental Accreditation (CDA) is the recognized agency for accrediting educational programs in dentistry. The goal of accreditation is to assure students, licensing boards, and the public that a graduate of an accredited educational program is prepared to practice competently. The accreditation process evaluates the educational programs and the physical facilities, not the clinical skills of the graduating students. The CDA considers all dental schools outside the United States to be non-accredited except Canada by reciprocal agreement; therefore, graduates of these schools must meet individual state requirements before they can be licensed.

Most states will not license a graduate of a non-accredited school unless that individual attends an accredited school for a specified period of time and is either granted a degree or certified as equivalently educated by the accredited institution. Only California, Hawaii, and Ohio license a graduate of a non-accredited dental school without these requirements.

POSTGRADUATE TRAINING

As an alternative to the clinical performance examination, some United States licensing jurisdictions are considering granting licenses to dentists who have completed an additional year of training in an accredited postgraduate dental education program. No such programs have been implemented to date.

COMPUTER-BASED EXAMINATIONS

Computer-based clinical simulation examinations may soon provide an additional tool for measuring the diagnostic, treatment planning, and treatment application skills of new graduates and established practitioners.

INITIAL AND CONTINUING COMPETENCY

Initial Competency

In the early 1990s the American Association of Dental Examiners established criteria that licensing agencies across the country could use as a guide to

create more valid and reliable examinations of graduating dentists. These criteria addressed all aspects of the written and clinical examination, including qualifications of examiners, the format and content of the test, grading guidelines, test security, and the appeals process. Nevertheless, varied results continue. This may reflect the new graduates' lack of clinical experience and underscore the fact that dentistry is an art, which requires practiced skill, as well as a science.

As the scientific and technical aspects of education have expanded, some dental schools have added to their didactic curriculum, often having to reduce the clinical experiences for the students to do so. As a result, some graduates may have developed technical competence but have not received enough experience with patients to develop in-depth clinical competence. This can lead to poor test results on the initial competency exam.

A 1995 Institute of Medicine study (Field, 1995) recommended that reform in the accreditation process should focus on educational outcomes and on standards and methods that will identify and improve those schools that are not educating their students effectively.

Continuing Competency

The Dentist's Pledge affirms a commitment to an ongoing pursuit of knowledge and skills:

I shall accept the responsibility that as a professional, my competence rests on continuing the attainment of knowledge and skill in the arts and sciences of dentistry.

The ADA's Principles of Ethics and Code of Professional Conduct, 2A, requires this commitment stating:

The privilege of dentists to be accorded professional status rests primarily in the knowledge, skills, and experience with which they serve their patients and society. All dentists, therefore, have the obligation of keeping their knowledge and skill current.

At its 1999 House of Delegates meeting, the ADA defined continuing competency as the continuance of the appropriate knowledge and skills by the dentist in order to maintain and improve the oral health care of his or her patients in accordance with the ethical principles of dentistry.

Forty-seven states have mandatory continuing

education requirements for relicensure. All recognized dental specialties have initial certification procedures, and several have developed recertification processes to ensure that certified practitioners remain current. In addition, other organizations, such as the Academy of General Dentistry, have programs that grant fellowship and mastership status to general dentists who achieve milestones in continuing professional education.

Organized dentistry established wellness programs to protect the public and enhance professional competency by promoting the physical and mental well-being of dentists.

REGULATION OF THE PRACTICE OF DENTISTRY

Hundreds of regulations affect the practice of dentistry. Accounting procedures, the protection of patient records, and the use of specific equipment in certain clinical procedures are the more apparent areas where there are efforts to regulate details of clinical practice (Palmer, 2000a and 2000c; and Berthold, 2000). Regulation of the dental practice is so extensive today that new entrepreneurial entities have emerged offering courses to teach dental office personnel appropriate compliance techniques for city, state, and federal regulations. Regulations governing the dental practice range from local zoning requirements regarding parking lot requirements, to requirements for apparel worn in public places that could be contaminated from the workplace, to the disposal of wastewater.

Federal and State Regulation

In the United States, government has traditionally taken a "hands-off" position with respect to the doctor-patient relationship (Jost, 1997). Health care at one time was a private matter between the health care professional and the patient. As health insurance became commonplace, the third party payer entered into the relationship. The resulting complex of responsibilities, relationships and priorities created a mandate for regu-

lations to protect the interests of patients.

Complex and specialized care, provided in widely dissimilar environments, and an increasing ability to solve medical problems with new science and technology have provided additional impetus for protective regulations. The consequent cost is significant; it is estimated that the cost of federal regulation to a family of four is about \$7,600 each year (Wendy Lee Gramm, Personal Communication, May 15, 2000).

The health care system increasingly has been affected by regulations such as the Americans with Disabilities Act, which do not primarily target the health professions, but which have had profound implications for health care delivery. Other regulations, such as the Occupational Safety and Health Administration's (OSHA) Bloodborne Pathogen rule, which was written largely with the hospital environment in mind, have had significant cost implications for dental care. In each case, laws and the attendant regulations were created to respond to problems and address perceived needs. And in each case, these laws and regulations have had unforeseen consequences, some of which have worked counter to original intentions.

In recent years, the political environment has become less favorable for such sweeping regulations, especially when promulgating them has dramatic cost implications for the affected sector and its consumers without identifying offsetting funding. This trend began in 1995, when Congress began closely scrutinizing the procedures for rulemaking and culminated recently when it took the unprecedented step of repealing the prior administration's ergonomics standard. That action was a response to vigorous opposition to the rule.

Certainly, the ergonomics issue typifies the rule-maker's dilemma: how to impose restrictions on the marketplace that balance the costs and benefits. Purported benefits are difficult to estimate accurately. Nevertheless, estimates are needed. Potential costs are more easily developed and should be available for any regulation.

II. LICENSURE AND REGULATION OF DENTAL PROFESSIONALS IN THE FUTURE

Licensure and regulation are intended to protect the public safety and assure the provision of quality dental services. Regulation of the dental workplace is intended to protect the safety of dental practice employees and patients.

To a significant extent, licensure and regulation should reflect and encompass those advances in technology, education, and workforce that best serve the public interest. Thus, the most important assumption about changes in licensure, scope of

service regulations, competency examinations and workplace regulation may be that the nature of the requirements will undergo review and revision regularly, so as to recognize and encompass the many positive developments that will emerge over time.

FUTURE CHANGES IN MOBILITY, COMPETENCY AND SCOPE OF PRACTICE

The desire for greater professional mobility will promote more consistent examiner calibration, more uniform exam content, and more state recognition of multiple regional boards. There will be increased demand for continued development of computer-based simulation as a valid method for testing clinical skills. Current competency assessment will be an integral factor in decreasing barriers to mobility for dental professionals. Alternatives to traditional licensure and state-specific licensure will be implemented in an effort to reduce geographic shortages by allowing dental professionals easier interstate mobility.

There will be increased efforts to assure initial and continued competency. Greater demand will exist for documented and formalized continuing competency assessment. Greater emphasis will be placed on in-depth clinical competency for the initial competency examination.

Changing workforce requirements, advances in technology and recognition of the complexities and relationships between oral and systemic disease will require redefinition of the scope of practice for dentists and allied dental professionals.

Telehealth will require cooperation among state and national jurisdictions, and possibly the restructuring of dental governance. Telehealth may stimulate more uniform scopes of practice among the state statutes and regulations. Further restrictions on dental assistants could result in a reduction of available employees for dental offices and would therefore alter the delivery of dental care to the public. A critical under-supply of laboratory technicians will occur in the future unless the number of students in this field is increased. The exponentially expanding aspects of technology will provide new materials and procedures that will initiate expanded functions for allied personnel.

The complexities and interrelations of oral and systemic diseases will continue to evolve and require more extensive examination and diagnosis by a licensed dentist for every dental patient.

FUTURE CHANGES IN REGULATION OF DENTAL PROFESSIONALS

Federal and state activities are likely to increase in the near future in the area of access to care for Medicare beneficiaries, and for Medicaid and SCHIP beneficiaries.

Federal activity is also likely to occur in addressing issues of the workplace environment and likely will include new proposals that will increase the cost of delivering care, thereby increasing consumer costs and, ultimately, decreasing access to oral health care.

Two examples that pose this possibility in the near term are a promulgated but not yet enforced rule on medical information privacy and a guidance document issued by the U.S. Department of Health and Human Services (USDHHS) stating that health professionals must provide translation services to non-English speaking patients.

The privacy regulation, intended to guard the confidentiality of individually identifiable health information, includes oral communication in addition to paper and electronic records. This could possibly mean that health professionals would not be able to discuss patients' care in physical settings where the conversation might be overheard. The recent trend in dental office design has been toward exactly this type of open space, and a strict interpretation of this rule could have staggering compliance costs, much of which would be passed on to patients.

Similarly, a strict interpretation of the USDHHS guidance on providing translators for non-English speakers, with no counterbalancing funding, could create a situation in which dentists could no longer afford to provide routine preventive care to such patients. These are but two examples of why the regulatory pendulum will likely continue to swing between extremes of cost control and consumer protection.

III. PATHWAYS AND STRATEGIES FOR LICENSURE AND REGULATION OF DENTAL PROFESSIONALS IN THE FUTURE

Public policy as it is expressed in legislation and regulation may have significant impact on the dental profession in the coming decade. In 1983 the ADA House of Delegates adopted five recommendations from the Future of Dentistry report and one resolution from the House of Delegates as part of a strategic plan to be developed for the ADA. It was considered imperative that the profession's ability to influence public policy be strengthened. Since then, the demand for regulation has increased.

Public attitudes and opinions, shaped by the proliferation of ideas and assumptions, both correct and incorrect, must not be allowed to lead to legislative initiatives or regulations without scientific validation. All affected parties must work together to ensure that valid science is the basis for necessary and appropriate regulation. It appears very likely that one of the greatest issues of today—access to care—may be addressed tomorrow with regulation and legislation at state and federal levels.

All licensing jurisdictions should develop consensus regarding standards for the validity and reliability of all phases of licensure examinations, both written and clinical, and for licensure without examinations (credentialing). States should also assure that all regulation is based on valid scientific evaluation and solutions. More dental professionals should serve as advocates and resources for developing regulatory policy development.

It is very important that the dental profession continue to maintain the competency of dentists and allied dental personnel through innovative approaches to education, strengthened standards for continuing education credits, and outcome assessments for relicensure and recertification.

SCOPE OF PRACTICE

In the interest of increasing access to dental care, independent practice by dental hygienists and dental laboratory technicians does not best serve the public; however, allied personnel may be trained to perform more technical procedures of dentistry with the dentist being responsible for diagnosis, treatment planning, implementation, assessment, and supervision.

Increased recruitment efforts will be necessary to assure sufficient numbers of dental hygienists, dental assistants, and dental laboratory technicians.

State licensing boards should develop a uniform scope of practice for allied personnel that is mutually recognized among states. This will allow increased interstate mobility.

To increase access to preventive dental care for children of low socioeconomic status, medicine and dentistry should partner in certain aspects of patient care.

The aging population is creating a demand for more services that need the laboratory technician's expertise in the fabrication of fixed and removable prostheses to replace the teeth and related dental structures. The expansion of the predoctoral curriculum has limited the dental schools ability to teach their students the laboratory skills that were traditionally taught in the past. Dentistry must proactively promote dental laboratory technology as an attractive career choice, as well as increasing the availability of education for dental laboratory technicians.

LICENSING

The dental profession should be cautious about the creation of multiple types of licenses to practice dentistry (limited scope specialty licenses) because regulations and overlap of scope may render it difficult to establish clearly separate responsibilities. All licensing jurisdictions should meet basic psychometric standards for validity and reliability of all phases for licensure examinations, both written and clinical. Accreditation of the evaluation process for licensure examinations should be investigated. If and when the accreditation process includes outcome assessments of the clinical skills of dental school graduates, a diploma from an accredited dental school could eliminate an entry-level exam.

The dental profession should consider whether the Commission on Dental Accreditation should be involved in accrediting non-U.S. dental schools to ensure similar standards and outcome of graduating dentists.

Licensure without examinations (credentialing) should be encouraged as long as it includes a meaningful evaluation of the applicant's competence to practice dentistry and includes a thorough investigation of the applicant's personal history.

Alternatives to live-patient examinations should continue to be investigated. However, any alternative must prove to be equal to live-patient examina-

tions in measuring the candidate's clinical skills and abilities to solve high-level problems.

COMPETENCY

Dental professionals have many opportunities to meet competency requirements in a positive and beneficial manner. The challenge is to find more effective and efficient ways to continue to improve the process.

Dental schools must develop a system to give students more clinical experiences and remediation when needed. Currently, residency programs are available only to the highest-ranking students. One possibility is a mandatory PGY-1 curriculum or collaborative clinical experiences with off-campus clinics that serve populations of low socioeconomic status. Funding of this additional educational experience would require the cooperation of other entities.

The profession must be proactive to ensure that the policies promoted by advocacy groups are based on scientific fact, not anecdotal information. For example, increased federal regulation and the geographic mobility of dentists have stimulated the search for a simplified measurement by which to judge the competence of a dentist.

Outcome assessments could be a surrogate for relicensure and/or recertification. The ADA supports the science-based approach to outcome assessments as an integral part of relicensure or continued competency. In the ADA Environmental Scan Report of 1999, references to "best practices" criteria are presented in discussing the global perspectives.

Continuing education courses could be strengthened with more definitive pre- and post-tests. The Internet creates many possibilities for education as well as examination. Continuing competency examinations (as well as study) could be available over the Internet. By involving the appropriate accrediting agencies, the criteria for validity, reliability, uniformity, objectivity and current knowledge could be met in programs offered over the Internet. A flexible menu of competency assessment mechanisms could be developed, with the dentist's confidentiality ensured while testing his/her skills. If mandatory continuing competency examinations were developed, dentists might have a time window in which to take, learn, and retake exams without prejudice if necessary.

REGULATION

Regulation must be based on valid scientific eval-

uation and guard against over-regulation caused by special interest, single-focus groups. Dentistry must foster scientific examination, evaluation, and prevention in the area of regulation as it has in oral health. If successful, the profession will be able to continue its service to the public unimpeded by unnecessary regulation.

The ability of the profession to influence public policy must be improved by dentists participating in the legislative and regulatory activities. Representatives of the practicing dental community must be involved in the decision-making process as Medicare, Medicaid, and SCHIP evolve. The profession must be the inspiration for legislative and regulatory activity affecting dentistry. This time of great change may introduce operating systems that are not well thought out and certainly are not well tested. Such times endanger both the profession and the public. Time-proven, value-driven systems may be destroyed and lives hurt in the process unless there is an appropriate deliberative process for the institution of regulatory change. Regulation will be beneficial if it adds safety and value to the services provided.

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CHAPTER OVERVIEW

The generation of new knowledge through research and scholarship, and the transmission of that knowledge through teaching, learning and practice are at the heart of dental education's commitment to quality patient care and professional renewal.

The relationship between the quality of dental education and the training of dental professionals is clear—all dentists are the product of dental education. The contemporary dental school provides the dental profession with two critically important benefits. First, the nation's dental schools are the practicing profession's sole link to the university, and with it the esteem and professional status that dentistry enjoys. As Lord Rushton wrote more than 40 years ago, dentistry became a profession when it entered the university (Rushton, 1957). And second, dental schools continually generate and expand the science and technology base that permits dental professionals to maintain the public's trust, and to practice in a progressively more advanced and effective fashion.

Today, in 2001, the United States dental profession is stronger and healthier than ever before, and there is a legitimate sense of optimism among dental professionals about their future. United States' dental schools have achieved immense success and unparalleled accomplishments. However, many schools are financially over extended, operate in antiquated physical facilities, and face a serious faculty shortage. While the opportunities for future dental professional education are bright, the dental education system's ability to help its students realize those opportunities may be in some doubt.

This chapter explores the key issues facing dental schools and the implications of these issues for the future of the dental profession. The following topics are discussed:

- ◆ The dental schools' obligations and responsibilities to society;
- ◆ The relationship between the dental schools and their university environments;
- ◆ The financial resources that support dental education;
- ◆ The status of the applicant pool and the characteristics and interests of dental students;
- ◆ The challenges faced by dental schools in recruiting, developing and retaining a first rate cadre of dental academics;
- ◆ Dental school curriculums and their efforts to incorporate new knowledge and modern information technology;
- ◆ The state of the classrooms, dental laboratories, clinics and research facilities in dental schools;
- ◆ Future priorities of schools of dentistry in developing dental specialists as practitioners and teachers for the future;
- ◆ The implications of the changing dental workforce for the future of dental education;
- ◆ Trends and future directions for professional continuing dental education;
- ◆ Recent developments and challenges in the education of the allied dental team; and,
- ◆ Dental education's role in promoting improved workforce productivity by the dental team.

Dentistry's future has long been of interest to practicing and teaching dentists alike. An early exploration of the topic, published in 1872, notes: "To refuse to see that great changes are at hand, as concerns the standing and practice of the dental profession, is simply to shut one's eyes. Of no thing are we more fully assured than that the dentistry of today must either advance or give place; to attempt to confine it to its present limits is to seek to control that progress which is itself evolution." (Dental Cosmos, 1872.)

¹ All data and references to dental schools in this chapter pertain to schools located in the United States.

I. DENTAL EDUCATION TODAY

THE DENTAL SCHOOL'S RESPONSIBILITY TO SOCIETY

The 54 dental schools in the United States are national resources that educate general dental practitioners, dental specialists, and dental academics/researchers. Dental schools develop new technologies and information of value to the nation as a whole and provide important and much needed direct services to their communities.

Society grants dentistry the privilege of self-regulation in exchange for dental professionals' commitment to their patients and the advancement of oral health. Dental professionals maintain this responsibility by committing to a defined set of professional behaviors known as the Principles of Ethics and Code of Professional Conduct, and by embracing life-long learning through the pursuit of formal continuing dental education.

The fundamental objective of dental education is to educate dental professionals to accept responsibility to act in their patients' and society's interest. Society allows universities analogous privileges of self-regulation to enable the education of health care professionals, including dentists, to safeguard the public's health.

The nation's dental education institutions are central to the nation's future oral health through their contributions to:

- ◆ Education and training of the nation's dental health professionals;
- ◆ Conduct of research and the generation of new knowledge for application to oral health care; and,
- ◆ Direct provision of dental care services for the public.

Professional education and training is the most widely recognized responsibility of dental schools. Virtually all of the nation's dentists and a significant proportion of all registered dental hygienists have been educated and clinically trained in the nation's 54 dental schools.

The second responsibility of dental schools is to conduct research. Advancing dental science is also a well-recognized responsibility of dentistry.

The third responsibility, to provide direct patient care, is central to students' clinical training and to faculty involvement in the dental education process. The

amount of patient care that schools are able to provide, however, is limited in relation to the amount needed to actually meet the public's oral health care needs.

The strength and leadership of the nation's dental schools are essential to the achievement of these three responsibilities. Unfortunately, the dental education sector is stretched to its limit and faces difficult challenges.

A greater sensitivity on the part of public and governmental agencies regarding the resource needs of the academic dental centers is needed if dental education institutions are to continue to serve their obligations to society.

The status quo, or worse, the diminishment in the nation's dental education system exacerbate the range and depth of the oral health challenges and patient care deficiencies outlined in the Surgeon General's Report on Oral Health in America (U.S. Department of Health and Human Services, 2000).

DENTAL SCHOOLS AND THEIR ENVIRONMENTS

The University Setting

A positive relationship between a dental school and its parent university provides an environment that promotes a scholarly, research-based approach to clinical excellence in dental education (Haden and Tedesco, 1999).

However, in the early 1980s, it became apparent that not all the university-based dental schools were successful in maintaining that relationship. Dental schools were burdened by operating with the highest per student educational costs on the campus. Some had limited or unimpressive research programs. Faculty members and dental school leadership did little to promote interaction with the rest of the university community. And a surprising level of antagonism to dental education emerged—from within the practicing dental community itself.

The failure of some dental schools to meet the academic and research norms of their parent institutions, together with the acknowledged high cost of dental education, has compelled some university leaders to examine how much their dental education program contributes to the mission of the larger university (Haden and Tedesco, 1999).

The dental education community did not anticipate closure of its educational programs. In 1986, a dental school was closed in Oklahoma. Between 1988 and 1993, five more universities closed their

dental schools, and another closed in 1998.

Critical review of their dental programs will almost certainly be undertaken by private universities, which are not under state mandate to promote dental education and may not maintain a fundamental mission to support dental education. Indeed, all seven dental school closings occurred in private or private/state-assisted universities.

The closure of private schools is troublesome not merely because of the potential negative impact on the workforce, but because when prestigious private universities elect to close dental schools, it is a measure of the declining value academe places on the dental academia and research enterprise. These closures also potentially compromise oral health care and promotion of prestigious academic health centers. Although other dental schools are opening, confirming societies perceived need for dentists, they are not located in prestigious private universities, thereby adding momentum to the loss of academic esteem.

The Academic Health Center

The need for dental schools to be more attuned to the mission of their university was vigorously addressed by the 1995 Institute of Medicine (IOM) study, *Dental Education at the Crossroads* (Field, 1995); by the 75th Anniversary Summit Conference sponsored by the American Association of Dental Schools (AADS) (AADS, 1999); and by J.E. Albino (Albino, 1999).

The IOM study emphasized that dental schools must move closer to the academic, research, and patient care missions of medical schools specifically and academic health centers in general (Field, 1995). In many dental schools faculty members are following IOM recommendations and are collaborating with medical school faculty, especially in research, at unprecedented levels. Extensive dental/medical research interactions have, for example, been promoted and funded by the National Institute of Dental and Craniofacial Research (NIDCR), particularly through the P-01, P-20, P-50, and P-60 research programs operating in the nation's dental schools. The dental school/medical school collaboration is also evident in the curriculum of nine dental schools that share the first two years of basic sciences courses with the medical students (National Institute of Dental and Craniofacial Research [NIDCR], 2000).

Patients have also seen more interaction between dental and medical faculty resulting in better under-

standing of each other's competencies. This proliferation of interactions appears to have occurred because of the increasing number of dental faculty members who have the formal qualifications and higher degrees, the scholarly and clinical skills, and the resultant self-confidence to interact comfortably and productively as equals with research and clinical colleagues in schools of medicine, public health, nursing and pharmacy. Moreover, research trends in molecular biology, epidemiology, molecular genetics, bioinformatics, biomimetics, and new diagnostic technologies have increasingly focused on the inter-relationships of all systems in the human body. This has had the effect of lessening traditional distinctions between the medical and the dental sciences (NIDCR, 1997).

The Community

Each of the nation's dental schools serves as a resource for its immediate community and, to some extent, for the geographic region in which it is located.

The dental school's provision of patient services, in many cases for people who have no other access to good quality treatment, is critically needed in communities across the country. Some dental schools operate teaching/service clinics in remote geographic areas, further increasing access to care.

Like their medical counterparts, dental schools also possess a nucleus of tertiary care specialists who accept referrals, thus serving as a key resource for the practicing dental community.

Dental school faculty and students interface with community school systems in projects aimed at promoting and advancing science education in the kindergarten through grade 12 public school systems. Dental schools further serve their communities by offering extensive Continuing Dental Education (CE) programs whose purpose it is to periodically update the general practitioner and dental specialists, and thereby to elevate the standards of dental care available in the community.

Lastly, in each community where a dental school is located, the institution provides a substantial number of excellent jobs, and the school is therefore responsible for generating very significant economic activity within its service region.

FINANCING FOR DENTAL EDUCATION

Dental education is among the most costly, if not

the highest cost, professional training program. There is considerable variation in the per student cost of dental education among the nation's schools.

The most significant factor contributing to the high cost of dental education is the clinical education and patient care training programs—programs that are part of the university budget. This makes dental care program costs highly visible to university financial officers.

The cost of clinical education and patient care training in medicine is largely borne by hospital budgets, not the university. This type of cross-subsidy is not available to dental education programs.

Dental School Revenues

Dental schools receive operating revenues from a surprisingly broad array of sources. The relative importance of any source varies greatly among schools and is generally influenced by whether the institution is a public dental school, a private dental

school, or a private/state institution.

Table 6.1 provides a summary of revenue by source and school type. In 1998 the nation's dental schools reported aggregate revenues of over \$1.4 billion. The primary revenue source for public schools are state or university system appropriations, followed by clinic income, sponsored research/training, tuition and fees, other revenues, indirect cost recovery, gifts/endowment, and several lesser or indirect revenue sources. In contrast, for private schools tuition and fees are the most significant revenue sources, followed by clinic income, sponsored research, gifts/endowment, other income, and several lesser or indirect categories. The revenue pattern for the private/state-related schools is similar to that of private institutions.

While Table 6.1 provides the best data available, the data are incomplete and understate aggregate revenues necessary to operate the nation's dental schools. One major category of funding not reported is the extramural practice income of full-time clinical faculty. In contrast, intramural practice

TABLE 6.1

Summary of Dental School Revenues from All Major Sources, FYE 1998

Source of Income	Public Schools	Private Schools	Private-State Related Schools	All Schools
Student Tuition and Fees	\$136,488,706 (36)	\$206,264,263 (14)	\$44,181,424 (5)	\$386,934,393 (55)
State and Local Governments	410,292,736 (36)	3,193,612 (6)	11,214,652 (5)	424,701,000 (47)
Federal Government	2,061,421 (4)	8,171,600 (1)	247,613 (1)	10,480,634 (6)
Dental Clinic Revenue	156,900,972 (36)	80,041,528 (13)	15,239,522 (5)	252,182,022 (54)
Gift Revenue	31,899,761 (35)	33,471,236 (14)	2,938,618 (5)	68,309,615 (54)
Recovery of Indirect Costs	27,749,654 (35)	7,700,615 (13)	711,143 (4)	36,161,412 (52)
Other Educational Revenue	34,580,882 (28)	12,604,447 (13)	6,342,685 (2)	53,528,014 (43)
Educational Revenue: TOTAL	799,974,132 (36)	351,447,301 (14)	80,875,657 (5)	1,232,297,090(55)
Sponsored Education/Research/Training	113,263,892 (36)	32,409,679 (13)	3,437,350 (5)	149,110,921 (54)
Financial Aid Revenue	18,225,357 (33)	5,090,101 (10)	2,082,063 (4)	25,397,521 (47)
Revenue: GRAND TOTAL	931,463,381 (36)	388,947,081 (14)	86,395,070 (5)	1,406,805,532(55)

*Numbers in parentheses indicate the number of schools included in the calculations of summary values.
Source: ADA, 2000.

Dental Education

income is substantial, and is reported as a school revenue source by 42 institutions.

For all dental schools an annual challenge is to ensure that revenues will cover or exceed expenditures. This challenge is complicated by the diversity of revenues dental schools rely on to make their budget. A detailed analysis by Douglass and Fein reported dental school revenue trends for the 1973 to 1991 period, adjusted for inflation (Douglass and Fein, 1995). The trends revealed a major decline in federal support for dental education (more than 50%), while increases were noted for student tuition (doubled), clinical revenue (doubled), and other revenues, such as gifts, endowment income, and continuing education income (rose by 80%).

Table 6.2 provides dental education revenue trend information for the years 1992-1998 and reports CPI-adjusted revenue data, where 1998=100. The most significant recent trends for total dental education revenues are:

- ◆ Total annual revenues for 54 dental schools were \$201 million higher in 1998 than in 1992, measured in constant 1998-dollar terms. This represents an annual average growth rate of just over 2.6% for total revenues.
- ◆ Annual tuition and fee revenues increased \$106 million in constant dollars during the 1992-1998

period, an average annual increase of less than 5.5% per year.

- ◆ Annual revenues from state and local government, which had been essentially level from 1979 to 1991, declined from 1992 to 1998 by a total of \$46 million (constant 1998 dollars), for an average annual decrease of just over 1.5%.
- ◆ From 1992-1998 annual federal government support increased by \$13 million in constant dollar terms, for an average annual increase of 1.9%.
- ◆ Dental schools' annual clinic income between 1992 and 1998 increased \$52 million in constant dollars, for an annual growth rate of 4%.
- ◆ Other annual income revenue increased \$76 million in constant dollars, for an average annual growth rate of 10% over the 1992-1998 period.
- ◆ Continuing dental education annual revenues increased a modest \$2 million in constant dollars, for an annual growth rate of 2%.

Dental School Expenditures

The typical dental school has a complex table of operating expenses. As indicated in Table 6.3, the total expenditures of 54 dental schools in the United

TABLE 6.2

Summary of Dental School Revenues (in millions of dollars), by Source, 1992-1998
(Adjusted for Inflation: 1998=100)

	Total Revenue		Tuition & Fees		State & Local		Federal		Clinic Revenue		Other Revenue		Continuing Education	
	Dollars	%Change	Dollars	%Change	Dollars	%Change	Dollars	%Change	Dollars	%Change	Dollars	%Change	Dollars	%Change
1992	\$1,206	NA	\$281	NA	\$496	NA	\$129	NA	\$200	NA	\$100	NA	\$16.1	NA
1993	\$1,234	2.33%	\$296	5.12%	\$476	-4.04%	\$143	11.09%	\$212	6.13%	\$107	7.25%	\$15.7	-2.91%
1994	\$1,257	1.87%	\$311	5.32%	\$472	-0.88%	\$134	-6.34%	\$223	5.28%	\$117	8.79%	\$15.7	0.31%
1995	\$1,291	2.69%	\$325	4.46%	\$464	-1.62%	\$141	5.21%	\$240	7.30%	\$121	3.67%	\$15.6	-0.72%
1996	\$1,299	0.59%	\$339	4.16%	\$428	-7.79%	\$149	5.23%	\$240	0.17%	\$143	18.62%	\$16.4	5.12%
1997	\$1,347	3.70%	\$360	6.15%	\$444	3.69%	\$135	-9.08%	\$245	1.99%	\$164	14.05%	\$17.2	4.56%
1998	\$1,407	4.48%	\$387	7.65%	\$450	1.40%	\$142	5.13%	\$252	2.96%	\$176	7.64%	\$18.1	5.46%
1992-1998		2.61%		5.48%		-1.54%		1.87%		3.97%		10.00%		1.97%

Source: ADA, *Surveys of Predoctoral Dental Educational Institutions*; and U.S. Department of Labor, Consumer Price Index, Bureau of Labor Statistics.

States were more than \$1.34 billion in 1998. Comparing this amount with the \$1.41 billion aggregate revenue 1998 figure presented in Table 6.1, it appears that dental schools generated sufficient revenues to offset their aggregate expenses.

Table 6.3 also indicates that the differences in expenditure patterns among the three categories of schools (public, private, and private/state assisted) are not as pronounced as are the differences in revenue sources.

An important question suggested by Table 6.3

is whether dental schools are allocating expenditures in an appropriately strategic fashion. For example, 42 dental schools report intramural practice revenues, yet only 34 report practice expenditures. Also, in 1998, 47 dental schools allocated only 0.98% of expenditures to computers and information technology services. This figure is surprisingly low, and may reflect that the central university campus financially supports dental school information technology development activity.

TABLE 6.3

Summary of Dental School Expenditures to All Major Sources, FYE 1998

	Public Schools	Private Schools	Private-State Related Schools	All Schools
Instructional Expenses				
Basic Science	\$103,326,718 (35)	\$18,914,878 (14)	\$6,099,696 (4)	\$128,341,292 (53)
Clinical Science	266,132,427 (36)	80,920,053 (14)	23,925,173 (4)	370,977,653 (54)
Behavioral Science	9,211,614 (24)	672,412 (7)	3,745,603 (4)	13,629,629 (35)
Continuing Education	14,327,062 (32)	5,021,789 (13)	470,198 (4)	19,819,049 (49)
TOTAL	392,997,821 (36)	105,529,132 (14)	34,240,670 (5)	532,767,623 (55)
Sponsored Educational Programs				
Basic Science	519,053 (7)	- (0)	- (0)	519,053 (7)
Clinical Science	6,704,294 (13)	4,738,956 (5)	18,362 (1)	11,461,612 (19)
Behavioral Science	8,145 (1)	- (0)	- (0)	8,145 (1)
Learning Science	- (0)	- (0)	- (0)	- (0)
Other	270,479 (2)	3,037,342 (3)	75,023 (1)	3,382,844 (6)
TOTAL	7,501,971 (15)	7,776,298 (7)	93,385 (2)	15,371,654 (24)
Sponsored Research and Training				
Basic Science	49,942,177 (27)	8,491,132 (9)	1,616,659 (4)	60,049,968 (40)
Clinical Science	40,361,169 (32)	10,514,507 (12)	623,233 (2)	51,498,909 (46)
Behavioral Science	4,288,661 (10)	539,161 (2)	10,305 (1)	4,838,127 (13)
Training Grants	8,881,192 (25)	1,762,258 (7)	351,320 (1)	10,994,770 (33)
TOTAL	103,473,199 (35)	21,307,058 (12)	2,601,517 (4)	127,381,774 (51)
Other Educational Expense				
Library Expenses	15,909,474 (35)	4,827,974 (14)	1,608,915 (5)	22,346,363 (54)
Learning Resources	4,176,108 (30)	1,026,120 (13)	113,011 (1)	5,315,239 (44)
Computer Services	10,388,971 (33)	2,604,077 (12)	655,307 (2)	13,648,355 (47)
Dental School Administration	60,979,843 (36)	38,616,419 (14)	7,936,311 (5)	107,532,573 (55)
Patient Care Services	201,202,546 (36)	96,055,971 (14)	20,065,734 (5)	317,324,251 (55)
Physical Plant	53,873,534 (35)	25,231,348 (14)	3,518,523 (4)	82,623,405 (53)
General University Overhead	66,835,415 (35)	36,168,860 (14)	11,785,280 (5)	114,789,555 (54)
Financial Aid	19,003,876 (30)	11,113,205 (12)	2,787,507 (5)	32,904,588 (47)
Other	15,043,095 (19)	6,193,209 (8)	636,968 (2)	21,873,272 (29)
TOTAL	447,412,862 (36)	221,837,183 (14)	49,107,556 (5)	718,357,601 (55)
Sub-Dental Expenses: TOTAL	776,700,548 (36)	322,855,185 (14)	70,401,380 (5)	1,169,957,113 (55)
Other Expenses: TOTAL	174,685,305 (34)	33,594,486 (8)	15,641,748 (4)	223,921,539 (46)
Expenses: GRAND TOTAL	951,385,853 (36)	356,449,671 (14)	86,043,128 (5)	1,339,878,652 (55)

*Numbers in parentheses indicate the number of schools included in the calculations of summary values.
Source: ADA, 2000.

DENTAL SCHOOL APPLICANTS

The Applicant Pool

Like other professions, dentistry goes through cycles during which the applicant pool rises, declines, rises again, continuing in this wavelike pattern over time.

As indicated in Figure 6.1, the number of dental school applicants peaked in 1978, and then dropped precipitously to a 30-year low in 1989. The next year, in 1990, applications began a dramatic increase and reached a high in 1997 of just over 9,800. Between 1998-2000, applications have

A second reason the decline is not expected to be long lasting is that the current environment for dental practice is extremely favorable, and especially so for new practitioners. Whether relying on anecdotal reports of increasing practice opportunities, or on the reports that assert or predict dental workforce maldistribution, virtually all signs point to a favorable professional practice climate for the next few cohorts of dentists. Such a situation should also act as a brake on the current decline in the applicant pool.

Third, the potential size of the applicant pool has grown significantly since 1980, some say it has nearly doubled, due to an increased number of female applicants. In most schools women now represent 30-40% of the student body.

Fourth, the number of dental school seats to be filled is 30% smaller than was the case in the early 1980s. This suggests that some decline in the size of the applicant pool can be accommodated without serious academic consequences.

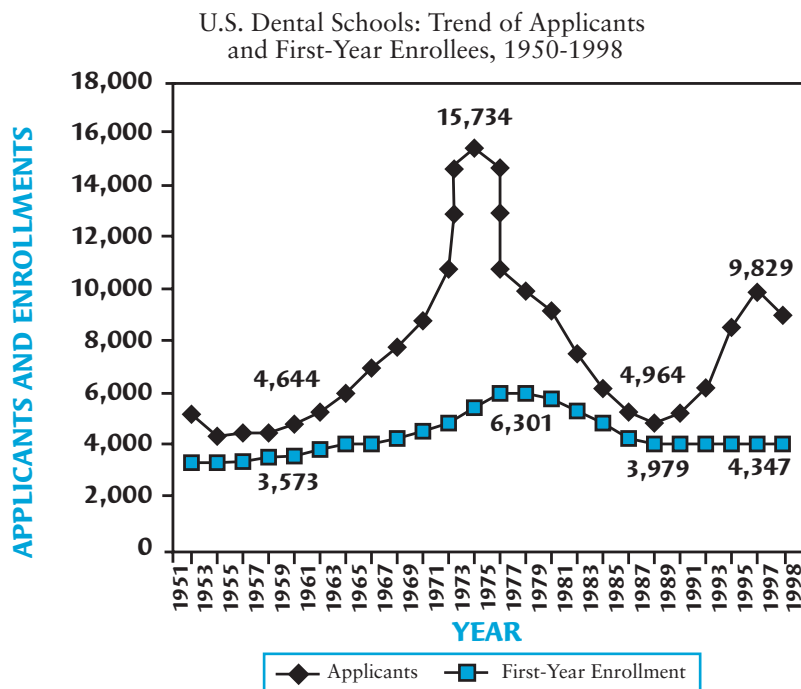
Fifth, there is informal evidence from dental admissions directors that, contrary to past experience, the modest decline in the size of the applicant pool has not been accompanied by a parallel decline in the grade point average (GPA) of entering students. In fact, quite the opposite seems to have occurred in a number of schools, a phenomenon that requires explanation.

In spite of these positive factors, it would be foolish to be complacent about the current decline in the size of the dental applicant pool. Much more

needs to be done to understand it in order to better manage dental school admissions policies and programs in the future.

A potentially important factor that may discourage dental school applicants may be the recent rise in dental school tuitions, and the associated increase in indebtedness among the graduates from dental schools. Dental students graduate with somewhat higher debt loads as compared to medical students. This applies to comparisons

FIGURE 6.1



Source: ADA, *Surveys of Predoctoral Dental Educational Institutions*.

declined modestly. The latest decline, however, has not led to a corresponding enrollment or academic decline. There is some concern that the almost 30% drop in Dental Aptitude Test (DAT) participants in early 2000 may presage a sharper, short-term decline in dental school applicants.

There are some factors that suggest that the latest decline in size of the dental applicant pool may be less drastic and have lesser consequences than the dramatic applicant pool shrinkage experienced during the 1980s.

across public, private and private/state related dental and medical schools. Nevertheless, student indebtedness in other professional schools is also surprisingly high, suggesting that students considering dentistry will not get significant short-term financial relief by choosing other professions.

Indebtedness of Dental Students

Debt financing for education is a widely accepted vehicle to allow students to invest in their university education for the ultimate opportunity of graduating into satisfying and financially rewarding careers and professions. The evidence is strong that successive levels of university education are associated with progressively higher income levels. Studies reported between 1969 and 1994 repeatedly showed that the rate of return on a dental education is consistently positive, whether using the return-on-investment or the internal rate-of-return method (Maurizi, 1969; Nash and House, 1982; Dunlevy and Niessen, 1984; Burnstein and Cromwell, 1985; Weeks et al, 1994; and Capiluto et al, 1995). More recently, however, career opportunities in the information technology fields have caused some to question whether prolonged attendance in universities is highly compensated by downstream earnings as once may have been the case. For the moment, it seems that dentistry and medicine still hold a strong attraction for the best of university students, and such students indicate a continued willingness to invest financially for the sake of their future careers.

As indicated in Table 6.4, in 1982, students graduated from dental school with an average debt of \$26,000. By 1998, the equivalent figure had risen to \$84,089. The average 1998 indebtedness is lower for students graduating from public schools (\$70,752), highest for those finishing the private schools (\$108,256), and at an intermediate level for private/state schools (\$97,684). Using

the Consumer Price Index (CPI) to adjust for inflation, with 1998=100, per capita dental student debt has nearly doubled since 1982. In inflation-adjusted terms, the annual rate of growth in student indebtedness was 4.0%. Concern over this growth rate above the level of inflation is heightened when comparing the graduating students indebtedness trend with the growth in dentists' average net income from the primary practice. Nominal average net income from dental practice from 1982 to 1998 rose at an annual rate of 6.4%, while inflation-adjusted net income rose by 3.0%. This suggests that, in constant dollar terms, dental graduates' indebtedness is accelerating at a faster rate than the real net income of practicing dentists.

TABLE 6.4

Growth in Graduating Dental Student Debt vs. Practice Net Income, 1982-1998

Year	Graduating Dental Student Mean Debt		Mean Net Income from Primary Private Practice, Independent Dentists	
	Nominal Dollars	Real Dollars (base=1998)	Nominal Dollars	Real Dollars (base=1998)
1982	\$26,600	\$44,931	\$59,530	\$100,553
1984	32,000	50,202	65,460	102,695
1986	37,200	55,325	74,040	110,114
1988	39,300	54,150	85,690	118,068
1990	54,550	68,031	96,500	120,348
1992	55,550	64,538	107,220	124,568
1993	59,387	66,990	115,280	130,039
1994	62,776	69,045	127,430	140,156
1995	67,772	72,486	134,590	143,951
1996	75,748	78,693	135,870	141,152
1997	81,688	82,960	144,940	147,198
1998	84,089	84,089	158,810	158,810
Annual Growth	7.5%	4.0%	6.4%	3.0%

Source: AADS, *Surveys of Dental School Seniors*; and ADA, *Surveys of Dental Practice*.

The full effect of dental students' debt has not been fully analyzed. These increases in indebtedness may be a barrier to individuals seeking careers in dentistry, especially for individuals from disadvantaged backgrounds. In addition, indebtedness may be a barrier to some post-dental school career choices.

Dental Student Diversity

The demographic profile of dental students, and of the dental applicant pool, is a key indicator of the ability of dentistry to improve its diversity. Recent studies indicate that individuals prefer to be treated by physicians and other professional caregivers that share the patients' racial and ethnic background. The demographics of dentists in practice, research and education and the student population are not reflective of the nation's population.

GENDER

During the past 30 years significant changes have occurred in the gender composition of the dental student body. As shown in Figure 6.2, the number of women enrolled in dentistry increased dramatically, and appears to have leveled at 35% to 38% of overall enrollment.

The dental school experience for women students has improved considerably as the proportion of women in the dental student body has risen.

Women students feel less isolated than before, and are forming strong peer support networks.

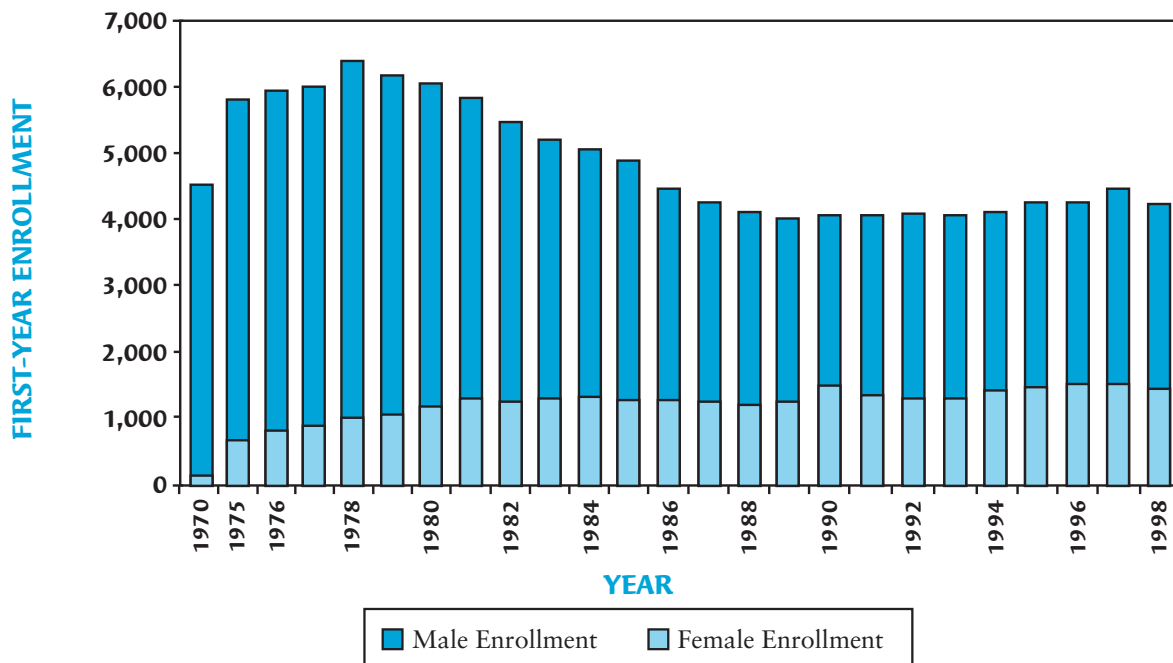
MINORITY POPULATION ENROLLMENT

In 1998, 34% of first-year dental school enrollees were members of minority groups, an increase from only 13% in 1980. Nationwide, the majority of this increase is due to Asian/Pacific Islander students entering dental school in substantially larger numbers. Enrollment of Asian/Pacific Islander students increased from 5% of enrollees in 1980 to about 24% in 1998. Enrollments of other minorities, primarily African American, Hispanic, and Native American students, have increased only slightly from 7.5% in 1980 to nearly 10% in 1998 (Valachovic, 2000).

Most minority enrollment gains were achieved in the 1980s. As Table 6.5 illustrates, the enrollment of under-represented minority students has declined appreciably since 1994. Much of that decline is due to a decrease in the enrollment of African American dental students. Data reporting the enrollment of Hispanic dental students is also disappointing. During

FIGURE 6.2

First-Year U.S. Dental School Enrollment by Gender, 1970-1998



Source: ADA, *Surveys of Predoctoral Dental Educational Institutions*.

TABLE 6.5

Under-Represented Minority Dental Student Enrollments, 1994-1999

Academic Year (Total)	African Americans	Hispanics	Native Americans	Total Number of Under-Represented Minority Students
1994	973 (5.95%)	1,045 (6.39%)	56 (0.34%)	2,074 (12.68%)
1995	951 (5.75%)	966 (5.84%)	73 (0.44%)	1,990 (12.02%)
1996	891 (5.40%)	824 (5.00%)	83 (0.50%)	1,798 (10.90%)
1997	883 (5.22%)	825 (4.87%)	96 (0.57%)	1,804 (10.66%)
1998	841 (4.93%)	823 (4.83%)	97 (0.57%)	1,761 (10.33%)
1999	810 (4.68%)	913 (5.28%)	99 (0.57%)	1,822 (10.53%)
% of U.S. Population in 1990	12.1%	9.0%	0.8%	21.9%
% of U.S. Population in 2025	12.9%	18.1%	0.8%	31.8%

Source: ADA, *Surveys of Predoctoral Dental Educational Institutions*; and 1990 U.S. Census Projections - Internet Release January 13, 2000.

the 1999 academic year, African American students constituted 4.7% of the total dental student population, Hispanics 5.3%, and Native Americans 0.6%.

Among all three populations, enrollment percentages were below the equivalent representation of these minority groups in the total United States population. By 2025, the relative growth in under-represented minority groups will have occurred largely among Hispanics, whose relative presence in the United States population will have doubled by that time, moving past African Americans in numbers.

There is a high concentration of minority dental students in a few schools. During 1998-99, Howard University and Meharry Medical College enrolled 42% of all African American dental students, while the University of Oklahoma enrolled 27% of all Native American dental students (Furlong, 1999).

The Joint Oversight Committee on Minority Recruitment and Retention, an ADA and American Dental Education Association (ADEA) jointly funded program, has identified four critical reasons dental education needs a proactive recruitment and retention program focused on minorities: (1) to promote access to health care, (2) to encourage culturally sensitive care, (3) to encourage access to the profession, and (4) to ensure future leadership.

These aims are consistent with objectives adopt-

ed by the ADA entitled *Exploring Common Ground* (ADA, 1999). The first *Common Ground* objective states, "Recognize the need for building a dental workforce that reflects the cultural, racial, and gender diversity of the nation." Another objective states, "Create a collaborative effort and develop programs as appropriate, to recruit qualified minority applicants to dental schools."

For universities and their dental schools, the combined effects of three decisions regarding affirmative action--the Bakke decision (MIT, 2001), *Hopwood vs. Texas* (Texas Aggie, 2001), and Proposition 209 (MIT, 2001) in California--have complicated the process of continuing and improving education-based solutions through pro-active diversity programs. Progress has been made in improving the dental school experience for minority students, but the rate of improvement has not equaled that achieved by women students. Virtually all dental schools make significant and meaningful efforts to provide a supportive learning and professional socialization environment, and minority students appreciate these efforts. Nevertheless, the relatively small numbers of minority dental students in each class, and the lack of minority teachers, inhibit the development of peer networks and diminish the presence of role models. These are voids felt strongly by the minority students.

THE TEACHING FACULTY

Faculty Overview

Perhaps the most critical element in ensuring a strong and excellent dental education system for the United States is the quality of the system's teaching faculty. Reports suggest new challenges in the retention of full-time faculty (FT).

Past dental school retention efforts focused on preventing faculty losses to competing dental schools. Today's retention issue, however, centers on the loss of faculty to more financially attractive opportunities. Competition today comes from full-time private practice, often in the geographic region immediately surrounding the university. Depending on the dental specialty, income differentials can significantly favor practice-based opportunities. A study by Haden et al. reports that after retirement, entering private practice is the second most common reason for full-time faculty separations in United States schools of dentistry (Haden et al, 2000).

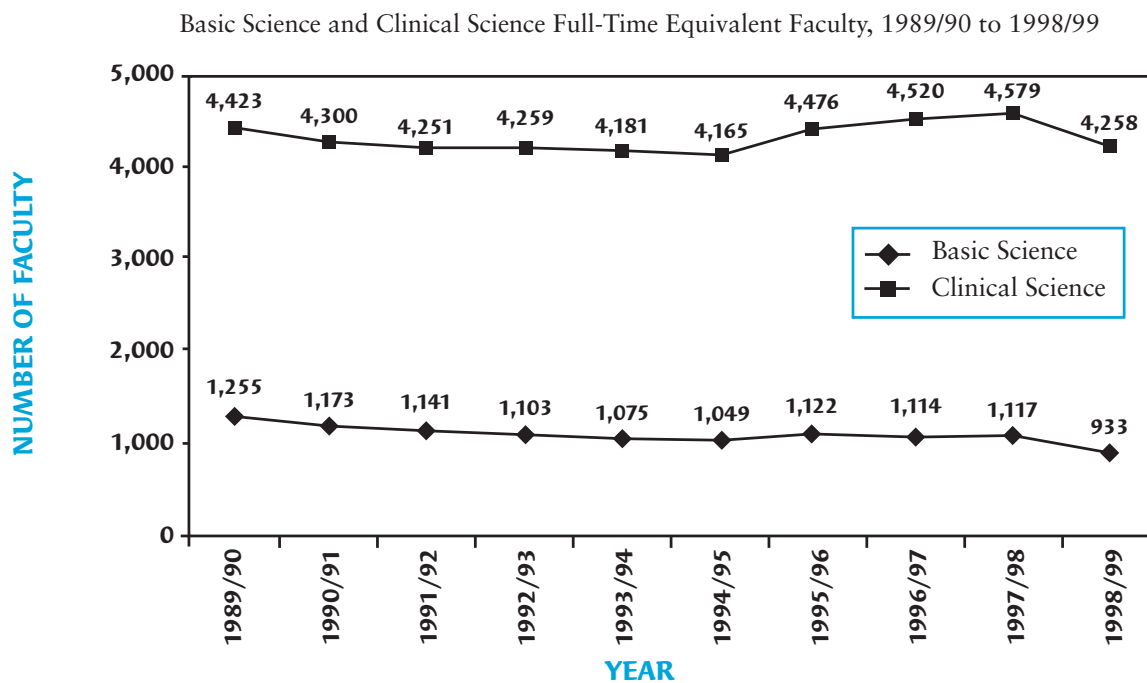
A reliable analysis of faculty characteristics and trends in dental education is not available. The studies that are available, especially those longitudinal

studies reporting trends since 1980 or earlier, tend to ignore the decline in the number of dental schools.

It seems intuitively obvious that the decline in the number of dental schools, and an even greater decline in the number of students enrolling in dental education (6,301 in 1978; 3,979 in 1990), would be accompanied by some adjustment in the dental education workforce. In some respects, the major conclusion from the currently available data is that detailed analyses will be required against which current perceptions and anecdotal evidence can be evaluated. Figure 6.3 provides a longitudinal series of the numbers of clinical and basic science full-time equivalent (FTE) faculty employed by dental schools. Table 6.6 presents similar data, enrollment figures, and adds student-to-FTE faculty ratio data for both the basic and clinical sciences (ADA, 2000). Figure 6.3 and Table 6.6 together indicate that:

- ◆ The number of full-time equivalent (FTE) clinical faculty declined from 1986 to 1994, rose through 1997/98, and has begun to decline again.
- ◆ The number of FTE basic science faculty declined by 322 from 1989/90 to 1998/99.

FIGURE 6.3



Source: ADA, *Surveys of Predoctoral Dental Educational Institution*; and AADS, *Surveys of Dental Educators*.

TABLE 6.6

Student to Faculty Ratios for Basic and Clinical Sciences, 1986-1997

Year	FTE Faculty		Total Enrollment	Enrollment to Basic Faculty Ratio	Enrollment to Clinical Faculty Ratio
	Basic	Clinical			
1986	1,442	4,611	17,985	12.47	3.90
1987	1,436	4,512	17,412	12.13	3.86
1988	1,296	4,509	16,823	12.98	3.73
1989	1,255	4,423	16,404	13.07	3.71
1990	1,173	4,300	15,068	12.85	3.50
1991	1,141	4,251	15,865	13.90	3.73
1992	1,103	4,259	15,959	14.47	3.75
1993	1,075	4,181	16,353	15.21	3.91
1994	1,049	4,165	16,336	15.57	3.92
1995	1,122	4,476	16,552	14.75	3.70
1996	1,114	4,520	16,570	14.87	3.67
1997	1,117	4,579	16,926	15.15	3.70

Source: ADA, *Surveys of Predoctoral Dental Educational Institutions*.

◆ The basic science student-to-FTE ratio has risen from 12.5:1 in 1986 to 15.1:1 in 1997.

◆ The clinical science student-to-FTE ratio has remained relatively steady—varying between 3.5:1 and 3.9:1 during the 1986-1997 period.

Faculty Shortages

The observations noted above indicate that a dental faculty shortage may be developing—a conclusion some analysts have already drawn (Meskin, 2000).

Table 6.7 presents data from an American Dental Education Association (ADEA) survey of deans and department chairs that inquired about vacant, funded faculty lines in dental schools (Bertolami et al, 1999; and Haden et al, 2000) report on similar data collected by the ADEA in the summer and fall of 1999.

Table 6.7 indicates a steady rise in reported vacant faculty positions in schools since 1992-93. The reports are particularly dramatic for the clinical FT category, which shows 244 vacant positions in 1996-97. Folding in other categories of faculty positions increases the reported number of vacancies to 311 across 54 dental schools, an average of 5.8 positions vacant per school.

Generally, in examining dental faculty data it is important to recognize methodological differences related to the ADEA data and those from the ADA reported in Figure 6.3 and Table 6.6. The ADA methodology pools full- and part-time faculty into FTE faculty, and reports data using these FTE units. The ADEA reports raw counts of full-time faculty and part-time faculty separately, and occasionally pools only the latter category into full-time equivalents.

TABLE 6.7

Vacant Faculty Positions Reported by Dental Schools

	1992-93 N=55	1993-94 N=54	1994-95 N=54	1995-96 N=54	1996-97 N=54
Clinical Science					
FT	139	156	212	218	244
PFTE	66	55	23	13	14
Basic Science					
FT	16	19	10	16	38
PFTE	10	1	0	.5	.5
Allied					
FT	6	6	9	4	14
PFTE	1	2	3	.1	.1
Total					
FT	161	181	231	238	296
PFTE	77	58	26	14	15
FT+PFTE	238	239	257	252	311

*FT=full-time and PFTE=full-time equivalence of part-time faculty.

Source: Bertolami et al, 1999.

TABLE 6.8

Full-Time Dental Faculty by Race/Ethnicity and Gender

Race/Ethnicity	1990 (56 Schools)	1994 (54 Schools)	1997 (55 Schools)	1999 (55 Schools)
Native American	14 (0.3%)	26 (0.5%)	43 (0.8%)	28 (0.6%)
Asian/Pacific Is.	270 (5.1%)	306 (6.1%)	369 (7.2%)	376 (7.7%)
African American	230 (4.3%)	253 (5.0%)	230 (4.5%)	246 (5.1%)
Hispanic	133 (2.5%)	148 (2.9%)	162 (3.2%)	183 (3.8%)
White	4,336 (81.5%)	4,051 (80.4%)	4,228 (82.5%)	3,843 (79.0%)
Other/Not Reported	335 (6.3%)	254 (5.0%)	92 (1.8%)	188 (3.9%)
Gender				
Male	4,305 (81.0%)	4,021 (81.0%)	3,972 (77.5%)	3,683 (75.7%)
Female	918 (17.3%)	1,016 (17.3%)	1,152 (22.5%)	1,181 (24.3%)
Not Reported	95 (1.8%)	1 (1.8%)	5 (0.1%)	0 (0.0%)
TOTAL	5,318	5,038	5,124	4,864

Source: Haden et al, 2000; and ADA, *Surveys of Predoctoral Educational Institutions*.

Dental Faculty Diversity

GENDER

The number of women faculty members has significantly increased. As indicated in Table 6.8, however, the proportion of women faculty members continues to lag behind the increasing number of women dental students. By 1999, women constituted 24.3% of the total full-time faculty. Based on the 35-38% dental school enrollment rate by women at the end of the 1990s, the percentage of full-time women faculty in United States dental schools can be expected to continue its rise in the years ahead.

UNDER-REPRESENTED MINORITIES

Relatively few minority faculty members are teaching in the nation's dental schools (see Table 6.8). In 1999, for the total faculty among the 54 dental schools, there were 5.1% African Americans, 7.7% Asian/Pacific Islander Americans, 3.8% Hispanics, 0.6% Native Americans, and 82.9% White and others (Haden et al, 2000). Howard University and Meharry Medical College employ a

substantial proportion of the African American faculty, and the University of Puerto Rico employs a large proportion of the Hispanic faculty.

Again, the recent legal proceedings in Texas and California have impinged somewhat upon traditional approaches to recruiting minority faculty.

Logically, greater success in recruiting minority students will ultimately increase the possibility of recruiting more minority faculty members. However, even with successful minority dental student recruitment now, developing minority faculty for the future requires leadership, commitment, and nurturing on a continuing basis. The strategy of enrolling and advancing minority students through dental school, guiding them to and through advanced dental education qualifications, then recruiting the subset interested in academic positions back into the university is realistic, but long-term, and subject to the vagaries of time.

Three issues of great concern to women and minority dental faculty are: (1) that their relative under-representation on the faculty now creates a void in the mentoring and role-modeling opportunities for women and minority dental students; (2)

that faculty-to-faculty mentoring and support are perceived to be lacking for women and minority dental faculty in the dental schools; and (3) that opportunities for tenure, promotion, and advancement to higher positions in the school and university are perceived to be disproportionately limited for women and minority dental faculty.

Dental schools must be both leaders and partners with other university units and professional organizations to do all that is possible to ensure a positive and equitable career environment for women and minority faculty in the nation's dental schools.

ADVANCED DENTAL EDUCATION

Full-time, certificate and/or degree granting post-DDS advanced dental education programs fall into three broad categories: (1) ADA-recognized clinical specialty programs, (2) General Practice Residency (GPR) and Advanced Education in General Dentistry (AEGD) programs, and (3) non-ADA-recognized clinical specialty training programs.

Enrollment has increased more or less steadily since 1971, largely due to the influence of increasing enrollments into GPR and AEGD programs.

ADA-Recognized Specialty Training

There are nine ADA-recognized specialty training programs; eight are patient-based clinical specialties and one, Dental Public Health, is non-patient-based specialty. In 1999, the ADA House of Delegates approved the recognition of Oral and Maxillofacial Radiology as a ninth specialty program.

Since 1971, annual first-year enrollment into ADA-recognized specialty programs has consistently hovered at just under 1,200 students per year. This stability in enrollment is quite remarkable in light of two factors. First, there was the very significant decline in the annual number of dental school graduates during the 1980s and 1990s, as was previously noted. Yet this decline in the number of dental graduates had no depressing effect on applications to the ADA-recognized specialty programs. Second, the enrollment numbers seem to defy explicit calls for a reduction in dental clinical specialty training. The 1980 Kellogg/AADS Study recommended a one-third reduction in first year positions in the ADA-recognized clinical specialty training programs. This recommendation was not implemented. Between 18-21% of dental school

seniors apply to dental specialty programs (Valachovic, 2000).

Changes in federal legislation have made clinical training in dental specialties eligible for both Direct and Indirect Graduate Medical Education (DGME and IGME) funds. Provided by Medicare, DGME and IGME funds are available for training clinical dental residents if the dental school can work out a formal agreement with a partnering hospital. Eligibility is limited to residents who are United States nationals and resident aliens.

Dental residents that qualify for DGME and IGME funds receive a healthy stipend while training to become specialists. This removes one of the major financial burdens currently faced by dental specialty training programs, whether based in a dental school, a hospital, or other institutional setting. Removing the burden for funding, dental specialty residents will significantly facilitate training opportunities. It must be kept in mind, however, that advanced dental education's eligibility for GME funds is constantly subject to governmental review and modification.

General Practice Residency (GPR) and Advanced Education in General Dentistry (AEGD)

The number of students that continue for dental specialty training has been stable for nearly 30 years. However, increasing numbers of dental seniors are successfully completing GPR and AEGD programs. These programs must continue to evolve but are clearly an important factor in the education and training of dental generalists system-wide. GPR programs are increasingly one- or two-year hospital-based training programs that focus on in-patients, medically compromised patients, or other special-need individuals. With rising frequency, GPR programs may be better understood as hospital dentistry programs.

The AADS reports that 30% of senior dental students apply to either GPR or AEGD programs or both for the over 1,300 positions available (Valachovic, 2000). AEGD programs are generally not eligible for GME funds. GPR residency positions may be funded under the Medicare GME program.

GPR programs vary considerably among different institutions, and are often shaped by the interests of the respective program directors. Some GPR programs have retained the original emphasis on general dentistry, others provide heavier emphasis on

cases treated in the hospital operating room, while yet others attempt to focus on oral medicine, placing special emphasis on managing oral soft tissue diseases.

As American hospitals have come under increasing financial pressures during the late 1990s, some GPR programs are being asked to contribute to patient care income. This trend has placed considerable pressures on GPR programs, forcing some to significantly refocus their missions.

AEGD programs were first established in the early 1980s, and have experienced growth ever since. The number of students enrolling in AEGD programs exceeds the number enrolling in GPR programs.

AEGD programs are typically housed in dental schools, and are usually one year in duration. AEGD programs consolidate, through intensive and supervised practice, the clinical training the new dental graduate receives in the four-year DDS program. AEGD residents participate to varying degrees in structured educational experiences such as seminars and colloquia, but their major effort is directed at engaging in active clinical practice across the various clinical fields that constitute dentistry. Some practice management skills may also be developed in AEGD programs. In a dental school, the AEGD experience most replicates how the general dentist functions in private practice.

Non-ADA Recognized Advanced Training

Some dental schools and hospitals offer advanced clinical training programs that are not recognized as specialties by the ADA. Oral medicine, geriatric and special care dentistry, dental anesthesiology, and operative dentistry are four examples of such programs.

These programs serve a valuable function in dentistry. First, they offer significant scholarly, research and clinical outlets for faculty who have a special interest in these fields. Second, in most cases, faculty members who focus on these informal areas receive referrals from dentists in the practicing community. These referrals are of major benefit to the patient and the referring dentist, and ensure that the public sees the dental profession as providing the broadest and most comprehensive forms of patient care possible.

One-Year Postgraduate Experience (PGY-1)

The significant increase in scientific knowledge and the rapid technological changes so prevalent in dentistry make it difficult to offer a full, well-round-

ed education and clinical training program within the confines of the current 4-year curriculum. Therefore, the concept of making available a one-year postgraduate experience (PGY-1) to all dental graduates has tremendous appeal. Financing the PGY-1 experience has been the major impediment to its wider implementation. The AEGD, GPR and dental specialty programs together provide the equivalent of a PGY-1 experience for approximately half the dental graduates in the United States.

THE ALLIED DENTAL TEAM

It is universally held that success in providing optimal oral health of the public requires an effective, team-based dental care delivery system. For the most part, the chief components of that team are the dentist, the dental assistant, the dental hygienist and the dental technician, although office managers, insurance clerks and other administrative team members may be active in larger group dental practices. Only dentists and dental hygienists require licenses to permit professional practice. In terms of dental care productivity, the actual contributions and effectiveness of the various dental team members are best analyzed within the context of studies and human resource economics. (See also Chapter 3, *Clinical Dental Practice and Management*.)

A number of significant differences are apparent between dental education and dental assisting, dental hygiene and dental technician education. Among these differences are the focus of education, the duration of education, the degree/certificate earned, the application of accreditation standards, and the availability of alternative pathways qualification, including on-the-job training. The disparate educational routes for dental team members have a major bearing on their respective entry into the dental workforce.

Because of the heterogeneity in education and training of allied dental team members, the data that describe current and likely future educational issues are relatively shallow and rather uneven. A brief overview of trends in allied dental education follows.

Table 6.9 indicates that between 1990 and 2001, the number of accredited dental hygiene programs increased by 26% (ADA, 2001a). With the exception of Alabama, dental hygienists must earn their educational qualification in an accredited program; hence the growth in accredited programs has a significant bearing on the capacity and the distribution of the system for dental hygiene education.

TABLE 6.9

Number of Accredited Allied Dental Education Programs, 1990-2001

Year	Dental Hygiene	Dental Assisting	Dental Laboratory Technician	Total
1990	202	244	49	495
1991	204	242	47	493
1992	209	228	43	460
1993	208	231	41	480
1994	214	231	38	483
1995	215	230	35	480
1996	223	237	35	495
1997	230	240	35	505
1998	237	250	34	521
1999	250	251	33	534
2000	256	257	30	543
2001	255	258	28	541

Source: ADA, *Surveys of Allied Dental Education*.

Table 6.9 also indicates a 5.7% growth in accredited dental assisting programs during the 11-year period. There has been a 42.9% decline in the number of dental technician programs during the same period.

It is unclear whether allied dental education programs are enrolling students to the level of program capacity. In 1998-99, it appears that dental hygiene enrolled 6,087 first year students against a first-year capacity of 6,471. For dental assisting, the equivalent figures were 6,162 (enrollment) against 8,270 (capacity). In the case of dental laboratory technicians, 487 first-year students enrolled against a capacity of 1,026 student spaces. In the case of dental assistant and dental technician students, it is not clear whether these numbers allow for any further first-year attrition in student numbers. Thus by mid- or end-of-year, first-year enrollments could be lower.

Table 6.10 indicates an appreciable growth in the number of dental hygienists trained. Overall, the number of dental hygienist graduates increased from 3,904 in 1989/90 to 5,281 in 1998/99, an increase of 35.3%. Interestingly, the 5,281 graduates in 1998/99 compare to an initial enrollment of 5,868, and a capacity of 5,990 two years earlier. If dental hygiene education enrollment continues to increase, and appli-

cation numbers do not drop, it may be expected that the number of dental hygiene program graduates will continue to increase in the short to medium term.

Table 6.10 also indicates that the number of graduates from accredited dental assisting programs increased from 1989/90 to 1996/97, thereafter trending downward once again. It is clear from ADA Survey data that attrition in dental assisting programs is moderately high. Assuming a one-year training program, the 4,720 dental assistant graduates in 1998/99 resulted from an enrollment of 6,350 and a capacity of 8,220 a year earlier. With respect to dental laboratory technicians, the number graduating from accredited programs has declined markedly. In 1998/99 a total of 490 dental technicians graduated, from an enrollment pool of 702 and a capacity of 960. Enrollment data suggest that further decreases in the dental technician graduation numbers may be expected in the near term.

For both dental assistant and dental technician careers, formal post-high school education is not a barrier to entry. Thus, there may exist significant numbers of non-accredited training programs. More importantly, it is virtually certain that an unknown capacity for on-the-job training is a major

TABLE 6.10

Graduates of Allied Dental Education Programs, 1989-1998

Year	Dental Hygiene	Dental Assisting	Dental Laboratory Technician
1989/90	3,904	3,960	722
1990/91	3,953	3,940	596
1991/92	4,229	3,999	655
1992/93	4,431	4,077	585
1993/94	4,637	4,382	638
1994/95	4,553	4,490	608
1995/96	4,668	4,679	510
1996/97	4,855	5,032	507
1997/98	5,023	4,967	436
1998/99	5,281	4,720	490

Source: ADA, *Surveys of Allied Dental Education*.

factor in bringing dental assistants and dental technicians into the dental workforce.

Applications and Admissions

During the period from 1994/95 to 1998/99, applications to dental hygiene programs have consistently exceeded 20,000 students per year for a system capacity of between 5,883 and 6,471 first-year spaces. Dental hygiene program admission requirements vary significantly: 46% of programs require a high school diploma/GED; 16% require some college courses; 27% require one year of college; 8% require two years of college; and 3% use some other standard. Males accounted for 3.0% of all enrolled dental hygiene students in 1998/99, while African Americans constituted 3.1% of the dental hygiene student body.

Dental assisting applications have exceeded 11,000 in each year of the 1994/95 to 1998/99 enrollment. Acceptances exceeded 8,000 in four of the five years. For 98% of programs, the minimum entry qualification was a high school diploma/GED. Males constituted 3.0% of enrolled dental assisting students in 1998/99, while African American students accounted for 12.1% in the same year.

Dental laboratory technology applications have declined from 1,469 in 1994/95 to 1,100 in

1998/99. Acceptances fell from 1,118 to 856 during the same period. All but one program required a high school diploma/GED as a minimum entry requirement. In 1998/99, dental laboratory technician programs enrolled 224 males and 263 females into first year and 215 males and 198 females into second year. African Americans constituted 13.9% of the enrolled dental laboratory technician students.

Tuition and Fees for Allied Dental Education

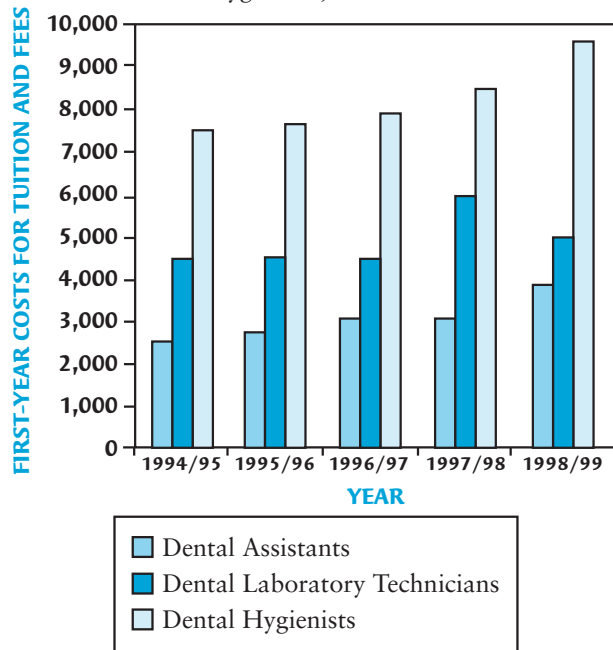
Figure 6.4 provides the trend in the cost of tuition and fees related to allied dental education. The data reflect first-year educational costs applicable to "in-district" students (i.e., students who live in the district the school or community college serves). The costs are close to "in-state" tuition and fees, though the latter are about \$1000 higher in the late 1990s. For publicly-funded institutions, out-of-state tuitions and fees are substantially higher for all allied dental education programs. However, most allied dental education students tend to enroll in programs fairly close to their place of residence, suggesting that in-district or in-state tuition and fees would be the norm. The data presented in Figure 6.4 include university, community college, technical institute, vocational school and other category tuition and fee structures. Except for dental hygiene, there are relatively few university-based allied dental education programs.

Allied Dental Education Teaching Faculty

There is relatively little information describing the teaching faculty for allied dental education. Anecdotal reports suggest that dental hygiene, in particular, finds it increasingly difficult to recruit faculty for its programs. This problem has been exacerbated in part by the continuing decline in the number of university-based dental hygiene programs, institutions that have traditionally supplied a significant proportion of the faculty and faculty leadership for dental hygiene teaching programs in general.

FIGURE 6.4

Mean In-District First-Year Costs for Tuition and Fees for Dental Assistants, Dental Laboratory Technicians, and Dental Hygienists, 1994/95 to 1998/99



Source: ADA, *Surveys of Allied Dental Education*.

Contemporary Allied Dental Education Issues

There are a number of issues related to allied dental personnel and the oral health care delivery system that are encountered in the environment of the dental workplace, rather than the educational setting. These dental workforce issues are often colored by emotion and controversy. Recruitment, salary, flexible schedules, organizational behavior, professional respect, retention, and other major challenges are vexing problems within the oral health care delivery system. Dental education has a role to play in seeking solutions to these challenges.

EDUCATIONAL CAPACITY

It is clear from the data in Tables 6.9 and 6.10 that the allied dental education system responds quite rapidly to changes in demand for allied dental personnel. It is very difficult for dental schools to implement or terminate a program to respond to market conditions. In some settings it may be easier to start a new program than to expand an existing program, so long as economies of scale do not

become an over-riding concern. The relative ease of capacity building has the additional advantage that it enables state community college systems to locate training programs in a larger variety of communities, thereby creating a more effective geographic distribution of the needed allied dental workforce.

PROGRAM ATTRITION

One of the significant problems faced by all allied dental education programs is attrition among enrolled students, particularly those in first year. Excessive attrition among enrolled students has multiple causes, both internal and external to the particular educational program. But in all cases such attrition reduces the economic efficiency of the training program, becoming a greater problem the costlier the program per student. Fortunately, the student attrition among dental hygiene students appears to be declining. While student attrition can never be eliminated, more efforts may be advised to understand and counteract the problem.

BACCALAUREATE AND CERTIFICATE EDUCATION

There is an unfortunate tension between those who see only an either/or relationship between baccalaureate and certificate education of dental hygienists, and those who see opportunity and benefit in the complementary nature of these two educational outcomes. The clear majority of dental hygienists graduated each year leave college with a certificate or an associate degree. True baccalaureate hygienists are in the minority. However, the majority of both groups enter in-office dental hygiene practice.

Among the baccalaureate dental hygienists are significantly greater numbers who have the education background and the leadership capabilities that make them ideal professionals for the teaching and the dental public health sectors. The long-term vitality of the United States dental hygiene services depends on strong and capable educational leadership functioning on behalf of the 255 accredited dental hygiene programs in this country.

APPROPRIATE DUTIES

Historically there has been great concern about the scope of duties for all members of the allied dental team. Quality dental hygiene programs can train dental hygienists properly for a variety of duties

beyond the minimal set permitted. Quality dental assisting programs may also have the potential to teach expanded duties to well-qualified dental assisting candidates. The rational delegation of duties can only be resolved and codified by state licensing boards. Therefore, the dental and allied dental education communities are dependent upon aspects of the oral health care delivery system, other than themselves, to determine what, where and to whom appropriate patient care procedures may be taught.

ACCREDITATION OF PROGRAMS

Dental educators are strong supporters of accredited programs for professional and health care related education. Subjecting one's program to evaluation and accreditation by external agencies is always a stressful and expensive undertaking. The benefits gained in higher and more uniform standards, as well as in facilitating the movement of professionals, vastly outweigh the institutional stresses and anxieties that accreditation brings.

DISTANCE EDUCATION

Dental assisting and dental hygiene programs, especially the latter, are showing considerable innovation and leadership in successfully introducing a variety of distance education modalities into their training programs. Using both satellite and Internet-based technologies, these innovative programs are bringing quality didactic presentations to more remotely located students. In these cases, clinical training is accomplished through intensive, institution-based programs, combined with organized and supervised local opportunities. Programs such as these, operating in states as diverse as Louisiana, Wisconsin and Virginia, are important indicators of future potential.

DENTAL LABORATORY TECHNOLOGY

As Tables 6.9 and 6.10 show, the major problem faced by dental laboratory technology education appears to be its imminent demise if current trends continue. The seeds of the decreasing number of dental laboratory technology graduates may be numerous, but chief among them is the lack of a sufficient salary differential for entry positions in the commercial dental laboratory sector. One implication to be drawn from this situation is that in pure-

ly economic terms there may be insufficient value provided by dental laboratory technology education to justify a salary premium. In addition, as commercial entities, the dental laboratories may simply be more efficient with their in-house training methods. Another reason for decreasing student interest in dental laboratory technology may be related to the reports, mostly anecdotal, of a steady migration of dental laboratory work to cheaper labor markets in Asia, as well as in Central and South America.

DENTAL SCHOOL CURRICULUM

In the United States, formal and comprehensive studies of the dental school curriculum began with the publication of the landmark Gies Report (Gies, 1926). Undertaken at the request of the Carnegie Foundation for the Advancement of Teaching, the Gies Report established the university-based pre-dental plus professional school curriculum that is still in use today. The ADA first recommended in 1934 the four-year professional curriculum that is the norm today (Field, 1995).

As reviewed by Tedesco, a number of subsequent studies of the dental curriculum have followed, most by either the Council of Dental Education of the American Dental Association, or by the American Association of Dental Schools (now the American Dental Education Association) (Tedesco, 1995). The most recent in-depth study of United States dental education, including the dental school curriculum, was undertaken and published by the Institute of Medicine, a part of the United States National Academy of Sciences, as *Dental Education at the Crossroads: Challenges and Change* (Field, 1995).

During the past two decades in part through the active collaborations of many individual dental faculty members, and organizational entities including the ADA Council On Dental Education, the Commission on Dental Accreditation, and the AADS, there has been much progress in developing a competency-based curriculum for dental education. Concurrently, a number of dental schools have adapted problem-based learning (PBL) from medical schools, and have initiated full or partial PBL-based curricula.

There is considerable heterogeneity in the dental curricula among dental schools. Data collected by the ADA and the Commission on Dental Accreditation concerning the hours of instruction devoted to various topics in the modern dental curriculum shows wide variances. Differences in curriculum time allo-

cation among dental schools enable an ongoing assessment of curriculum performance, and help the dental education community to develop strategies to more effectively and efficiently teach the dental sciences. Thus, retaining a certain amount of diversity in curricular content is healthy and positive.

Observers of dental education are surprised by the speed with which new clinical information and technology is integrated into dental curriculum. Recent examples include digital image processing, osseointegrated dental implants, digitally generated ceramic dental inlays, modern cleft lip/palate treatment, diagnostics of oral viral lesions, and the rotary cutting technologies for endodontics. As faculty and curriculum committees identify outdated techniques these procedures are de-emphasized or eliminated from the dental curriculum.

DENTAL EDUCATION FACILITIES

The majority of dental education facilities are more than 30 years old. While significant efforts have been made to keep the equipment in these facilities up-to-date, like dental practice, dental education has undergone immense technical changes that are rendering the physical facilities in which most dental schools must function increasingly obsolete.

From the 1950s to the early 1970s, federal and state governments allocated resources to permit the construction and expansion of dental schools. The nation once again faces a qualitative, if not quantitative, deficit in the physical facilities available for dental education. There are signs that in some states initial steps are being taken to address the facilities issue. However, the problem is national in scope, and a great deal of timely and high quality planning will be necessary to bring about the necessary facility upgrades.

Further considerations need to be addressed as well. For example, if significant changes to the size and or composition of the dental workforce become necessary, this too will have facility implications. Moreover, if significant alternative models to dental education evolve, including more emphasis on community-based clinical education, that also will require the facility question to be addressed.

DENTAL EDUCATION'S ROLE IN LIFE-LONG LEARNING

The dental profession maintains a fundamental commitment to life-long learning through continu-

ing dental education (CE). There is clear evidence that the dental profession's commitment to life-long learning is increasing. The number of CE programs and courses offered by commercial businesses, professional organizations and universities has been greatly increased.

In addition, a growing number of state dental licensing bodies have implemented mandatory continuing dental education for re-licensure. Prior to 1990, only 18 states linked mandatory CE to dental license renewal. Today, 47 states require mandatory CE for renewal of practice licenses for dentists and dental hygienists. Most have also implemented advanced approval systems for identifying credit eligibility of CE sponsors and courses. Ten states require CE for registration renewal by dental assistants (ADA, 2001b).

Life-long learning is a major tenet in the education of every dental student. Many schools require dental students to earn a certain number of CE credits in order to qualify for graduation. It is believed that such a CE requirement reinforces the practitioner role model the dental schools seeks to develop as students prepare toward graduation, and a career as an independent health care professional.

Virtually all United States dental schools are major providers of continuing dental education. Dental schools have multiple motivations for the delivery of dental CE. One reason is certainly economic. A menu of quality dental CE courses can generate sizable income for the dental school and its faculty. Secondly, CE also is offered by dental schools as a means to expose clinical faculty to the external practicing community, thereby cultivating healthier town-gown relationships and increasing the potential to generate referrals for the school's practicing clinical specialists is increased. A third reason that dental schools offer CE is to help practitioners who may be referred to the school by the state licensing board to fill gaps in the individual's knowledge base or clinical skills.

The vast majority of CE offered by dental schools is of the lecture format variety. However, an important but lesser utilized form of dental CE has consisted of participation courses. Longer duration, hands-on programs have been most conveniently offered within dental schools, using the institutions' laboratory and clinical facilities. Recent expansion in the availability of participation courses can be linked to the more rapid deployment of advanced, new dental treatment technologies. These technolo-

gies, such as osseointegrated implants, guided tissue regeneration, and CAD/CAM technology for ceramic inlays are examples of clinical innovations requiring hands-on experience for successful adoption of the new technology in dental practice. A third form of CE consists of a collaboration between professional dental organizations and dental schools to offer a set of journal-based articles and valid testing procedures to evaluate course participants' performance for the purpose of providing CE credits. One emerging strategy is for dental schools to take advantage of self-directed and/or distance

learning technology by partnering with an established commercial vendor of Internet or computer services. Thus far, dental schools' experiences and successes in pursuing such partnerships remain very limited.

In short, while Internet-based CE is still quite novel, there appears little doubt that for most dental schools it will become an increasingly important dental CE delivery modality in the not-too-distant future. Failure for dental schools to become involved in this new modality of dental CE delivery risks the dental schools' future in the CE arena.

II. DENTAL EDUCATION IN THE FUTURE

This chapter has focused on the broad array of factors that contribute to dental education and the development of a well trained, professionally responsible and individually committed dental workforce. The following section looks forward to anticipate the impact of these factors on the future of dental education and dentistry itself.

The quality of dental professional education and training, and the capacity of the dental care workforce, will be intimately shaped by dental education's ongoing efforts to become more effective, efficient and productive in transmitting knowledge, in generating scientific research, and in raising the clinical quality of dentistry.

The quality, comprehensiveness and ethics of dental education bear directly on the vitality and standards of the dental profession, which in turn impact the oral health and the quality of dental care available to the American public.

FINANCIAL SUPPORT FOR DENTAL EDUCATION

Without concerted effort by the organized dental profession at both the national and the state level, public (governmental) financial support for dental education will continue to decline, resulting in multiple and serious compromises to the quality of dental education in the United States. Continued erosion in state and federal financial support to dental education will continue to shift dental educational institutions to lower tier institutions, both public and private. Such a trend appears currently underway, and if it continues will cause the gap between medical and dental schools to widen rather than to narrow, as was recommended by the IOM Report (Field, 1995).

Research funds, primarily available through the National Institutes of Health (NIH), reflect societal interest and commitment to the value of dental schools in advancing the science base of dentistry.

Significantly more public investment will be needed if the nation's dental schools are to reverse their currently declining infrastructure, and prepare themselves to meet the challenges of the future oral health care system.

THE SUPPLY OF APPLICANTS TO DENTAL EDUCATION

Subject to a sound, market-based dental care economy, there will be a continuing flow of well-qualified applicants to dental education. This assumption incorporates the reality that there will be acceptable sinusoidal swings in the dental applicant pool.

Several factors indicate that the latest decline in dental school applicants may be less drastic and have fewer consequences than the experience during the 1980s. First, the 1999/2000 academic year was the first time that potential school applicants took the Dental Aptitude Test (DAT) program online. The new method and the new access locations for taking the online dental aptitude tests may have had a temporary attenuating effect on the numbers of test takers.

The environment for dental practice is extremely favorable, and especially so for new practitioners. Perhaps most important, there is informal evidence from dental admissions directors that the modest decline in the size of the applicant pool has not been accompanied by a parallel decline in the grade point average of entering students. In fact, quite the opposite seems to have occurred in a number of schools.

GENDER AND DIVERSITY IN THE DENTAL STUDENT BODY

Attainment of dental student diversity will require ongoing, proactive effort. Such efforts should be rewarded by increases in under-represented minority dental students. Women students will continue to constitute about 40 percent of dental school enrollees, although market place changes could cause this percentage to increase slowly.

DENTAL STUDENT INDEBTEDNESS

Due to student indebtedness, talented students from lower-income families and under-represented minorities may shy away from dental careers.

- ◆ The direct and indirect negative effects may result in reduced access to oral health care for families of lower socioeconomic status.
- ◆ Indebted young practitioners might emphasize monetary priorities during the critical early phases of their practices.
- ◆ Personal bankruptcies may continue to increase.

Dental student tuition and student indebtedness will continue to rise in the absence of extraordinary interventions by state and federal governments. An important factor that could reduce the size and quality of the dental school applicant pool is the recent rise in dental school tuitions and the associated rise in debts incurred by graduates from dental schools. This cost disparity applies across public, private, and private/state dental and medical schools. Increased state and federal government support for dental students, if it occurs at all, will be tied to increasingly robust service payback schemes.

THE FUTURE FACULTY FOR DENTAL EDUCATION

Concern is growing that there will be a shortages of qualified and committed dental teaching faculty. A thorough and intensive follow-up study on the extent and future magnitude of a dental faculty shortage is urgently needed to allow better policy formation regarding future dental faculty development. Such a study must also place major emphasis on recommending solutions to avoid dental faculty shortages. Emphasis should be placed on identify-

ing the true, underlying causes of the dental faculty shortage that appears looming at present.

Moreover, it would be helpful to know the acceptable base-rate of dental faculty vacancies. The assertion that over 300 faculty vacancies are fully funded at the present time needs to be substantiated. Such a study must also make clear that the university expectations of future dental faculty will be higher than has been the case over the past few decades, which can only exacerbate the current faculty shortage. A formally qualified, scholarly and adequately sized full-time dental faculty will be essential for dental schools to maintain their standing in the university community. Part-time dental faculty cannot provide, long-term, the standards or productivity in academic scholarship required by the modern research university. The future availability of quality dental faculty will be strongly influenced by:

- ◆ The overall dental workforce supply (e.g., shortage will have a negative impact, while an excess will have a positive impact);
- ◆ Disparities in salaries between private practice and university settings (e.g., increased disparities will have negative impact, while decreased disparities will have a positive impact); and,
- ◆ The dental care economy (e.g., a weak dental care economy will have a positive impact, while a strong dental care economy will have a negative impact).

Diversity of the dental faculty, in terms of gender, race and ethnicity, will need continuing encouragement. Mentoring for women and under-represented minority faculty will require increased effort.

THE EVOLUTION OF THE DENTAL CURRICULUM

The dental curriculum will continue to evolve in periodic burst-like fashion, and will adapt in this way to the changing dental environment, both technical and economic, in which dental education operates. Dental education will generate both technological and quality change in dentistry, and similarly will efficiently absorb into the curriculum externally generated technological advancements.

For the first decade of the 21st century, digital information technology will be the most influential force shaping the dental curriculum and changing even more profoundly its delivery to the dental student.

While the clinical curriculum will be delivered mainly in the traditional dental school based clinic, a variety of community-based initiatives may be developed to provide new sites for dental students to obtain a portion of their clinical training. This development will occur as one possible way to counter the higher cost of operating university campus-based clinical facilities. The longer-term economic viability of such arrangements still needs to be tested.

The demographics of the ever-growing United States population are changing dramatically. The proportion of the population 60 years or older will rise to an unprecedented level, bringing with it changing demand for dental and oral health care. The current dental curriculum, and the current specialization structure of the dental profession, has barely begun to think seriously about the implications of this change.

New basic science and clinical science discoveries will diffuse into the dental curricula. For the next 10-15 years, there simultaneously exists the major challenge of altering the delivery of the dental curriculum. The ongoing approach to absorbing emerging science and technologies into dental education and clinical practice can be expected to continue, and perhaps, even to accelerate.

This new challenge is squarely linked to the immense changes in how information is transmitted through the use of modern information technology, the emergence of the World Wide Web, and the development of the Internet/Intranet. The scale and completeness of the changes in how information is created, transmitted, received, perceived, and managed for future reference is still not fully apparent to all.

Dental education must embrace the new information science technology, the World Wide Web and the Internet, and dentistry must shape these technologies and their use in the educational process. That process includes the didactic, laboratory and clinical phases of dentistry.

Because the task dentistry faces in adapting to the information technology revolution is so extremely large and complex, it may be anticipated that the next 10 years will be spent on grappling with approaches to digital information processing and delivery, while ensuring that issues of curricular content are not ignored. The challenge of developing the electronic curriculum is daunting from three points of view - namely (1) complexity of the new technology; (2) the cost of establishing and maintaining modern and robust networking technologies; and (3), the production costs necessary to produce sufficiently profes-

sional software to hold the learners' interests.

Coping with both the complexity and the cost of developing the electronic dental curriculum of the future may require a commitment to collaboration and cooperation among institutions in ways not considered previously. The age of the Internet has furthered electronic communications in ways not dreamed of only a few years ago, and already academics are collaborating much more easily on projects with colleagues at dental and medical institutions around the world.

The process of educational research has changed. But while the ability to interact with colleagues has never been simpler and more effective, the challenge of the electronic curriculum of the future is an immense undertaking that will require significant financial and institutional commitment.

Early and fragmented experiences suggest that the development of new electronic curriculum products may require the recruitment into dental schools of specialized computer and Internet expertise that traditionally has not resided in schools of dentistry. The challenge of information technology (IT) product design and development is such that even the most talented clinician may be insufficiently trained in the IT aspects of education. The implication is that a cooperative division of labor between dental teacher and IT specialist may well lead to better dental curriculum products for the future.

Historically, when the practice of certain clinical procedures became sufficiently infrequent, that procedure was gradually eliminated from the dental school curriculum. However, with the promise of sophisticated three-dimensional simulation, e.g. virtual reality, uncommon clinical conditions and their treatment could be taught effectively. The question will be: How much in the way of resources should be devoted to develop simulation technology for managing uncommon conditions, or conditions observed with inevitably declining frequency?

In some settings, e.g. the military and civil aviation, virtual reality is already being used extensively in training adults to carry out procedures with a high level of success. Dental education will similarly need to evaluate its own position with respect to simulation technologies.

DENTAL SPECIALTY EDUCATION IN THE FUTURE

Dental specialty education will remain at current capacity in the aggregate, resulting in about 30% of dental graduates choosing to specialize. Shifts toward

and away from individual dental specialties will be determined in the main by economic factors, particularly supply and demand. New, officially recognized dental specialties will form over time, particularly in response to demonstrated service demand by patients, and to some degree by pressure from members of informal but aspiring specialties.

A one-year postgraduate experience (PGY-1) will continue to be seen as an essential and widely supported form of education that assists the new dental graduate to consolidate recently acquired clinical skills.

Specialty training choices will greatly impact the future of dentistry. While certain broad professional, social and economic forces affect all the dental specialties, factors shaping individual dental specialties may also have considerable impact on future trends in dental education.

Specialty-specific forces will continue to be very important in shaping the future development of the individual dental specialties, and in turn their contributions to dental education. Moreover, it continues to be a problem to attract potentially high-earning dental specialists to a career in dental education.

Two general considerations will likely affect the dental specialties in a more systematic fashion. First, as the ADA 1997 *Survey of Dental Practice* revealed, the net income of dental specialists is double that of general dentists (ADA, 1998). Moreover, in a recent economic study focusing on orthodontics and oral and maxillofacial surgery, it was determined that there remains a strong incentive to invest time and resources into dental specialty training based on the usually accepted economic indices (return-on-investment, internal-rates-of-return) for economic evaluation of decisions.

The same methodology has not been applied recently to evaluate the economic outcome related to training and working in other dental specialties, but positive returns may be expected relevant to the majority of the dental specialties. As long as there are positive financial incentives to specialization, dentists will become specialists.

Recognized dental specialties represent less than 25% of the dentist workforce. Thus, dentistry is not in imminent danger of becoming overspecialized, although a slow increase to the 30% level is quite likely. Moreover, the demand for specialized dental services appears to be growing, while interest in becoming a specialist has held remarkably steady, in absolute numbers, for the past three decades.

It is reasonable to expect that the economic incen-

tives for dental professionals to specialize will continue to be present in the foreseeable future. During a time when many aspects of dentistry are being increasingly affected by rapid technological change, specialization is a dental professional's rational response to be better grounded in the delivery of more advanced and complex clinical services for patients.

Well-trained, scholarly dental specialists will also be increasingly important to help the nation's dental schools to maintain a first-class teaching faculty. The shortage of full-time teaching faculty across the aggregated dental schools has been commented upon elsewhere in this chapter. While the faculty shortage is reflected by more than just the clinical dental specialties, it remains the case that scholarly dental specialists should continue to form the backbone of the full-time teaching faculty in American dental schools.

In the nation's dental schools a great deal of the applied and clinical research will be carried out by investigator teams functioning within one or other of the dental specialties. That most of such research will be collaborative, spanning several other dental, medical and biological sciences, does not alter the tendency for most of such research to focus on specialty-specific clinical problems. As such, teams involving dental specialists, their graduate students and postdoctoral students will generate much of the growth of dentistry's future clinical knowledge. This scenario suggests that specialists, dental and non-dental alike, through their capacity to generate new knowledge for dentistry, will be essential to a dynamic dental education system, and thus will be critical to the future vitality of the whole dental profession.

Monitoring of non-ADA recognized specialty training is needed. As it has recently done for oral and maxillofacial radiology, the dental profession would do well to continue reviewing the informal specialties for their potential to rise to formal specialty status. Given the rapidly changing population demographics, it may be advisable to study the merger of GPR, hospital dentistry and geriatric dentistry programs into a specialty of geriatric/special care dentistry.

LIFE-LONG LEARNING AND CONTINUING DENTAL EDUCATION

Life-long learning is an integral element of the dental profession, a theme first taught in the dental school. Ample availability of high quality continuing

dental education is the vehicle for life-long learning in dentistry. Dental education's long-standing leadership role in continuing dental education will be increasingly challenged by for-profit entities, both dental and non-dental in nature. Continuing dental education will be increasingly delivered in three formats:

- ◆ The standard, traditional lecture;
- ◆ Interactive self-instruction, along with automated real-time testing, both via the Internet; and,
- ◆ Hands-on, participation courses.

Continuing education (CE) will take advantage

of Internet communication. Most dental CE experts predict that much of the current lecture-style dental CE format will increasingly move to the Internet, where sophisticated interactive programs will offer a very large range of high quality CE courses at relatively low prices. Many individual dental faculty members have already become involved in offering dental CE using the Internet as the registration, payment, delivery and testing system. Internet-based dental CE will pose a major challenge to dental schools because of the academic institutions' low investments in, and generally limited resources for, the types of information technology (IT) and production facilities necessary for competitive Internet-based dental CE program offerings.

III. PATHWAYS AND STRATEGIES FOR DENTAL EDUCATION IN THE FUTURE

The United States should have a dental education system that generates the knowledge base and that provides the ethical and professional dental workforce necessary to meet the nation's oral health needs.

Today's dental education system must be strengthened and made more dynamic if the country is to achieve this vision. Achieving this goal will require energetic leadership and willingness to embrace needed change, by the dental profession, the dental education community and the public.

The public, through the leadership of its state and federal agencies, must recognize the value of optimal oral health and must therefore accept the ultimate responsibility to ensure the education of dental researchers, dental teachers and dental care providers. Only in this way will dental knowledge be transmitted by dental educators to dental students who become the providers of professional dental services for the public. Research, education and service are the triad that will assure a healthy public.

The dental profession, as individuals and through its professional organizations, also benefits from a high quality dental education system. In the United States that system takes just four years to transform talented university students into highly competent and ethical dental professionals whose provision of complex services for the public allow the dental professionals to enjoy a fulfilling and rewarding career. All dental professionals are the product of dental education, a reality on which dentistry and dental education could well build a stronger and more pro-

ductive partnership for the future.

Dentistry and dental education should both realize that modern science points to an ever-increasing convergence between oral health and total health. This powerful reality does not presage the weakening or disappearance of dentistry, rather it provides the rationale for dentistry to play a more confident role in the modern academic health center, and for dentists to develop a closer partnership with their medical colleagues. In all academic health centers medicine is the lead engine of health care education and research, and dentistry flourishes and becomes more if it pulls in unison with the other partners in the academic health setting. In the long run, neither dentistry nor dental education will flourish if dentistry seeks to go it alone at every opportunity.

In working toward the vision for dental education for the future, there are many actions that the dental profession, as individual practicing and retired dentists or through their leadership organizations, can undertake. For example, the dental profession should continue efforts to educate Congress and the state legislatures about the pressing need for substantially increased facilities and financial operating support for dental education. Other actions include:

- ◆ Collaborate with the ADEA to fund and formulate a program to proactively and constructively promote dental education within the nation's universities and academic health centers.

- ◆ Conduct a comprehensive, sophisticated and well-financed study of the future United States dental workforce. Such a study must generate alternative models that include existing categories of dental personnel, as well as potentially new or modified categories of dental care providers.
- ◆ Advocate governmental programs to reduce dental student indebtedness, including incentive and loan forgiveness programs in exchange for specified service commitments in designated underserved areas.
- ◆ Seek major funding to undertake a comprehensive study of methods to assure an adequate future supply of full-time dental school faculty. Such a study must account for specialty and regional effects that will bear on the faculty question.
- ◆ Encourage dental schools to become more active and sophisticated in their fund raising programs for the specific purpose of raising philanthropic funds designated for endowments to support faculty professorships and dental student scholarships.
- ◆ Keep as a priority for dental education the development of programs to recruit, mentor and retain women and under-represented minority faculty.
- ◆ Consider providing financial support and thereby stimulating the development of IT-based dental curriculum materials for which one-time production costs are so extraordinarily high.
- ◆ Monitor, and act proactively when appropriate, to encourage the formation of new specialties and related advanced dental education programs. Geriatric dentistry, based in large part on the existing dental GPR training in many hospitals, would appear a prime candidate given the emerging population demographics after 2010.
- ◆ Encourage the establishment and funding of additional PGY-1 positions as a preferred way for new dental graduates to consolidate their clinical skills.
- ◆ Encourage dental schools to examine their future role in continuing dental education to ensure that the infrastructure and/or partnerships are developed to support the main CE modalities in the future.

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Dental and Craniofacial Research



CHAPTER OVERVIEW

Research is the process by which new information is obtained and existing tenets are modified. Research involves experimentation and observation, and through this mechanism information is converted to practical application.

Research has enabled advances in diagnosis, disease treatment and management and in the prevention of oral diseases and conditions. Through research, the preventive effects of fluoride for dental caries and specific risk factors for periodontal disease were identified. These findings led to improved interventions and a reduction in the oral disease burden. Ongoing and future research concerning the fundamental mechanisms of oral disease will continue to drive change in dental practice.

Through epidemiological and behavioral research, the dental profession has made advances in understanding the causes and progression of dental disease. Epidemiological research, through national surveys of oral health such as the National Health and Nutrition Examination Survey, has been invaluable in improving the understanding of the extent, distribution, and determinants of most dental diseases and their relationships to general health.

Epidemiological research demonstrates that underserved populations shoulder a disproportionate burden of disease. For example, the death rate from oral cancer for African American males is double that for White males despite only a 20% higher incidence rate of oral cancer among African Americans. This disparity reflects the fact that African Americans have more advanced disease at the time of diagnosis and initiation of treatment. Additional epidemiological research is needed to characterize disease patterns in specific population groups, to understand why diagnoses are not made earlier, to develop new strategies for reaching people who are at risk for oral diseases, and to evaluate treatment outcomes.

Research has shown that behaviors that are under the direct control of the individual can influence the development of many dental conditions. Examples include the relationship between sucrose consumption and caries, poor oral hygiene and periodontal diseases, and smoking and oral cancer. More behavioral research is needed to design effective interventions to deter individuals from harmful personal habits and to promote preventive behaviors.

The transfer of research-based knowledge and technology to practicing dental professionals has lagged behind the expansion of the knowledge base on the etiology of dental diseases and methods of treatment. Hence, there is a need to evaluate and improve the speed and quality of information and technology transferred from the laboratory and other research settings to the public domain.

This chapter discusses the current state of knowledge about nine defined categories of oral diseases and conditions, and identifies research directions for the future with respect to these diseases and conditions.

The chapter is not inclusive of all dental diseases; rather, these disorders are intended to illustrate the directions and challenges for dentistry in the future. The discussions underscore the fundamental importance of research to dentistry's future and demonstrate the value of research to all aspects of dentistry, including:

- ◆ Diagnosis, treatment and prevention of oral health problems;
- ◆ Education and student training opportunities;
- ◆ Adaptation of medical versus surgical models in the treatment of oral disease;
- ◆ Identification of the relationships of oral infection to many systemic diseases; and,
- ◆ Incorporation of non-dental health care personnel into programs that promote early identification of oral disease.

Progress through research will challenge dentists and students with a need to become familiar with the molecular and genetic basis of oral diseases. This process will help to assure that dentistry continues as a vital and progressive profession.

As the relationships between oral and systemic diseases are clarified, issues will arise about which professionals have the responsibility for diagnosing and managing oral disease and who will pay for treatment. These questions will impact dentistry's future role in the health care system.

I. DENTAL AND CRANIOFACIAL RESEARCH TODAY

THE ROLE OF RESEARCH IN THE IMPROVEMENT OF ORAL HEALTH

Dentistry evolves and is continuously becoming a stronger and more capable health profession because of its commitment to research. The dental profession's recognition of the value of a constantly expanding scientific base is clear. It was largely due to the efforts of the ADA that the National Institute of Dental Research (later to become the National Institute of Dental and Craniofacial Research [NIDCR]) was established in 1948 as one of the first three institutes of the National Institutes of Health. Since then, dental research has contributed to major improvements in the nation's oral health. Approximately \$4 billion dollars are saved each year as a result of the nation's investment in dental research (Brown et al, 1994).

The ultimate objective of research is to improve oral health, eliminate health disparities and enhance quality of life. Dental research has led to developments in disease prevention, diagnosis and treatment modalities. During the past century, there has been a shift from an approach based on treatment of disease to prevention of disease. The caries-preventive modalities of fluoride and of dental sealants have had a major impact on the dental health of Americans.

Community water fluoridation, the country's mainstay caries preventive measure, is one of ten top public health achievements of the past century (Centers for Disease Control [CDC], 1999). Uncovering the harmful effects of tobacco use on oral cancer and periodontal diseases has suggested the potential importance of tobacco control programs delivered by the dental profession. The dental office, with patients returning for care on a regular basis, is an ideal location for smoking cessation programs. In the future, members of the dental health care team will become active providers of smoking prevention and smoking cessation programs for dental patients. This will be equivalent to oral hygiene programs that are now standard of care in dental offices.

Dentistry is now among the family of health professions addressing these and other risk factors common to many diseases and conditions that plague our nation. For individuals who have not benefited

from the available preventive measures, the development and refinement of restorative materials and equipment, such as the high-speed handpiece and radiography, have enhanced the capacity to manage oral diseases for those who can avail themselves of professional care. An increased understanding of the interdependent role of personal lifestyle behaviors, professional care and community-based programs has demonstrated how oral diseases differ from some other diseases and emphasized the importance of the partnership among these components.

The Research Process

The behavioral and biomedical research process generates new knowledge to promote health and manage diseases and disorders. The research process evolves from a stage focused upon knowledge acquisition to one of knowledge validation. Ultimately, the acquired knowledge needs to be transferred and disseminated effectively, efficiently and in a timely manner to those who will use it. This includes active participation and involvement of the dental profession.

Figure 7.1 demonstrates the research spectrum that parallels this creation and distribution of knowledge. Both behavioral and biomedical research include basic research that pursues the fundamental underlying mechanisms and evolves to applied research and development. At the applied stage, animal studies may be involved, as well as preliminary human studies. Patient and population-oriented studies may include clinical, epidemiological and health services research. Clinical studies include a variety of experimental designs with the design for randomized controlled trials as the gold standard. At this stage of research, efficacy and safety of an intervention or technology are determined. To assess the effectiveness of an intervention demonstration, research projects are undertaken to test the intervention. Education research is also important to determine how best to transfer the research findings into practice, whether it is to be used by patients, clinicians or community programs.

As seen in Figure 7.1, the research process is not unidirectional. As a result of information gathered, further refinement may be necessary before proceeding to the next stage.

Biomedical and behavioral scientists are contributing to an enhanced understanding of the causes, progression and sequelae of diseases and conditions that affect the oral cavity and surrounding tissues. The definition of the role of microbial oral infections—bacterial, viruses, fungi—and their interactions with host immune response and the environment, has suggested ways to prevent diseases and arrest their progression.

The complex nature of the most common oral diseases, dental caries and periodontal diseases, emphasizes the importance of effective biological, behavioral, and environmental approaches for successful prevention and management. Increasingly, investigators are studying viral infections, such as herpes simplex and fungal infections such as candidiasis. Microbial genomes are being completed for several periodontal pathogens, as well as for *Candida albicans* and *Streptococcus mutans*. Researchers are also pursuing studies of normal and abnormal growth and development of teeth, jaws and other craniofacial structures, and are studying conditions such as cleft lip/palate, one of the most common birth defects.

Disabling diseases and conditions such as oral cancers, mouth, face and head injuries, temporomandibular disorders and Sjögren's syndrome are

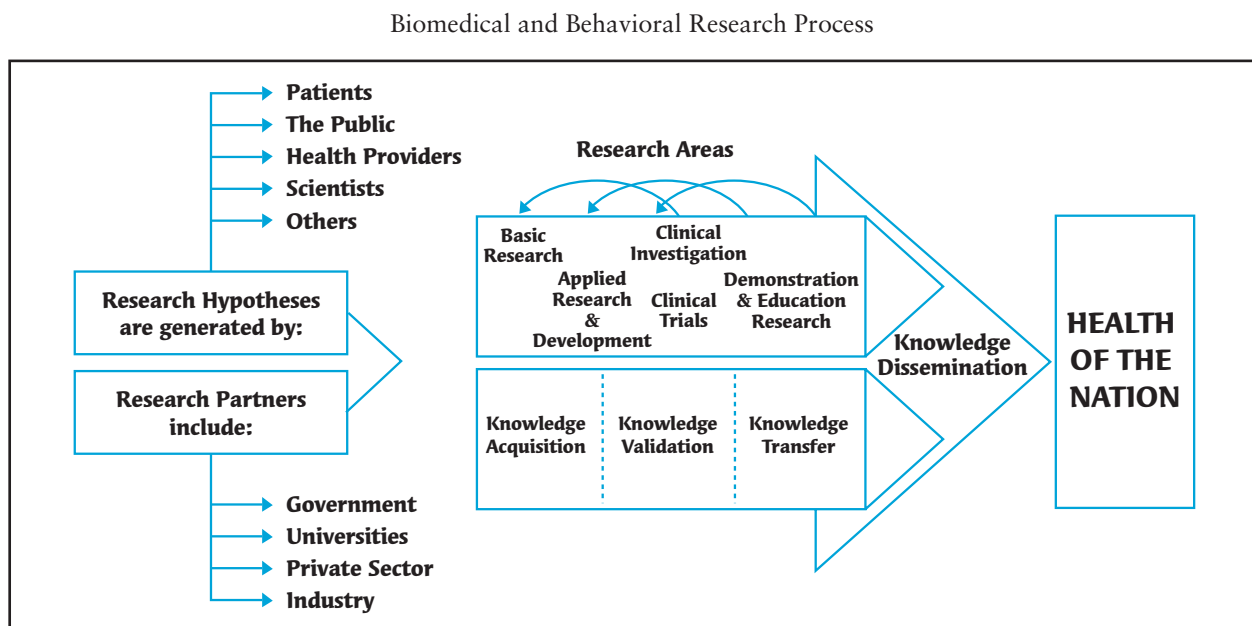
under investigation. Of particular interest are studies of the associations among oral infections and systemic conditions and diseases. These investigations, which are looking at the relationships among periodontal diseases and diseases and conditions such as diabetes, cardiovascular diseases and low birth weight and/or premature babies, are of considerable interest to the entire health care community.

The Dental Research Agenda

During the past 40 years dental research agendas have been developed to highlight those areas that warrant additional study. These agendas include an extensive range of research needs, and vary depending upon the eventual use of the research findings. Also included in these agendas are investigations related to health services delivery and reimbursement, occupational health issues, biomaterials development and testing, disease etiology and pathogenesis as well as prevention, diagnosis and treatment, and studies of health promotion.

The ADA Research Agenda of Importance to the Practicing Dentist (ADA, Council on Scientific Affairs, 2001) emphasizes the practice of dentistry, while other agendas may focus on a subgroup of the population or on a specific disease or condition.

FIGURE 7.1



Source: Adapted from Biomedical Research Spectrum as conceived by the National Heart, Lung and Blood Institute.

Research agendas also emphasize the need for international collaborative research that develops global approaches aimed at managing oral diseases and conditions. International collaboration is important for many diseases and conditions, such as oral cancer, cleft lip/palate and oral manifestations of HIV infection. The common component of all agendas is a call for more clinical research.

For those oral diseases that have not or cannot be prevented, dental research has enabled development and refinement of techniques and procedures that have improved the management of disease.

Dentistry's science base has supported its evolution and stature as a health profession and has helped the nation improve its overall health. Schools of dentistry have evolved and their curriculum has expanded to cover the essential basic and clinical sciences that comprise the competencies for the initial practice of dentistry.

Growing understanding of the distinctive oral health requirements of special needs populations and low-income populations presents challenges to the research community. As dentistry continues to pursue research that enables providers and the public to have safe and effective disease prevention and management, dentistry's active involvement in health promotion research is required.

Maintaining a strong multi-disciplinary and international research base is critical to the future evolution of dentistry as it continues to work with its partners in the health professions.

Financial Support for Dental Research

Funding for dental research comes from both public and private sources. The primary public agency that supports behavioral and biomedical research is the National Institute of Dental and Craniofacial Research. Dental research support also is provided by other agencies in the Department of Health and Human Services. For example, the Centers for Disease Control and Prevention works with the state and territorial dental directors and academic institutions to support disease prevention and health promotion activities and research. The Agency for Healthcare Research and Quality supports health services research and evidence-based reviews, and the Health Services and Resources Administration and the Indian Health Service provide support for research focusing on access to care and services for underserved populations. Other

departments such as the Department of Veterans Affairs, the Department of Defense and the Department of Commerce also conduct and support dental research.

Most publicly funded dental research in the United States is conducted in dental institutions by investigators who come from a wide variety of disciplines. United States investigators located in dental schools also have established collaborations with investigators throughout the world. Industry (i.e., dental product manufacturers, pharmaceutical companies, biotechnology firms and foundations) also provides funding for dental research and development. Much of this support is also for research conducted in dental institutions.

Nevertheless, funding for dental research lags behind that for other diseases and conditions. Greater investments in research are required for dentistry to expand its capacity to promote health, diagnose and manage individual and community risk factors, and enhance functional rehabilitation.

Research Workforce

To ensure the nation's research capacity, a concerted effort is needed to develop and build the dental research workforce. There is a paucity of new investigators entering careers in dental research. The reasons for this situation are complex.

Despite the NIDCR's support, there has been a critical decrease in the number of researchers. Six percent of the NIDCR's budget is devoted to extramural training. Approximately 400 trainees, in 30 centers across the country, receive their training through institutional and individual awards. Training is also available for junior faculty career development. A listing of mechanisms to support research training may be found on the NIDCR website.

A recent Blue Ribbon Panel on Research Training and Career Development in oral health research investigated the dimensions of the problem and proposed several solutions (NIDCR, 2000). The panel expressed serious concern that the research discoveries could be at risk if sufficient numbers of appropriately trained scientists do not enter the workforce. Specifically, the panel found:

- ◆ There will continue to be a rise in interdisciplinary studies requiring scientists to acquire a broader mix of skills and ability to work collaboratively;

- ◆ There will be an expanded phase of functional genomic analyses following an extended period of rapid advances in genetics and genome-based research; and
- ◆ There will be a greater emphasis on applied research, including domestic and international collaborative, translational, and clinical research; epidemiology; oral health promotion; and health services research.

Barriers to entering a career in research included a lack of candidates with an expressed interest in research, a relative lack of workforce diversity, student debt, and misconceptions about the rewards of a career in research. Lack of a diverse pool of mentors also discourages the consideration of research as a career.

Of great importance to the future of dentistry is the need to promote the clinician scientist who will be able to work in an interdisciplinary environment, to transfer basic findings to the clinical setting (translational research), to design clinical trials, and to undertake health promotion research. All such dental clinician scientists should receive formal training to become a member of a clinical research team.

While this strong emphasis on training may appear to contradict the recent National Research Council report that did not call for expansion of Ph.D. training in the biomedical sciences, this does not apply to dental and craniofacial research. The NIDCR report calls for targeted training.

This chapter includes a discussion of dental biomaterials and summaries of the current status of research for nine selected diseases and conditions:

- ◆ Dental Caries/Dental Biomaterials;
- ◆ Periodontal Diseases;
- ◆ Systemic Diseases;
- ◆ Cleft Lip, Cleft Palate and Craniofacial Development Disorders;
- ◆ Malocclusion and Tooth Agenesis;
- ◆ Oral and Pharyngeal Cancers;
- ◆ Oral Mucosal and Autoimmune Diseases and Other Infections;
- ◆ Salivary Gland Diseases; and,
- ◆ Temporomandibular Disorders.

The following sections provide examples of the many disease-specific research areas and provide a flavor of the breadth of research contributions and needs.

DENTAL CARIES/DENTAL BIOMATERIALS

Despite a remarkable decline in prevalence during the past 20 years, dental caries continues to be a major problem in the United States for adults and children (Kaste et al, 1996; and Winn et al, 1996). Ninety-four percent (94%) of dentate adults have evidence of treated or untreated carious lesions, and 23% have carious lesions on their root surfaces. Furthermore, although 25% of 5-17 year olds have 80% of carious lesions, by age 17, 40% of the population has 80% of carious lesions. Dental caries remains the most prevalent disease of childhood.

The decline in the prevalence of carious lesions has been a result of water fluoridation and fluoride-containing products, such as fluoride dentifrice, varnishes and restorative materials (Burt and Fejerskov, 1996; and Jenkins, 1985). Where one or both of these measures are in place, the prevalence of carious lesions has generally been stabilized.

Dental Caries as an Infectious Disease

The initiation and progression of dental caries are attributable primarily to cariogenic bacteria, especially *Streptococcus mutans* and recently identified *lactobacilli*. Root caries are initiated by the same bacteria as enamel caries and are manifested by loss of mineral in the same way as coronal caries. After the mineral loss, enzymes of bacterial origin degrade proteins on the root surface. Older persons with gingival recession are especially at risk.

As an infectious disease, dental caries is a dynamic multifactorial process that involves one or more tooth tissues (substrate), microorganisms capable of converting dietary components to demineralizing acids, deposits of these microorganisms on the teeth (dental plaque), a sufficient supply and frequency of dietary nutrients (sugars) to shift the chemical equilibrium between the plaque fluid and the tooth to a state of demineralization, and adequate time for significant mineral loss (calcium and phosphate) to occur.

Dental Caries Prevention and Management

Current methods of prevention, detection, and treatment of dental caries are only partially effective. Water fluoridation is only associated with a 30-50% reduction in caries (Burt and Fegerskov, 1996; and Newbrun, 1989).

Management of the disease process can be practically accomplished by reduction in the concentration of cariogenic microorganisms through plaque removal, the use of chemotherapeutic agents (including chlorhexidine and fluoride), and control of the diet (reduced frequency and quantity of sugars and substitution of sugar-free sweeteners).

Conventional restorative dentistry, which removes the carious and surrounding sound tissue to eliminate the disease, weakens the tooth structure, often leading to physical damage later in life. The major drawback of conventional restorative dentistry is that it does not address the underlying causes of the caries.

Lasers have recently been approved for clinical use for the removal of dental caries. Readily accessible caries can be removed by this laser technology and much less sound tissue is removed than is the case with the high-speed drill (Seka et al, 1995). The Er:YAG and the Er:YSSG lasers specifically target the water in carious lesions, explosively ablate the carious tissue, and can ablate surrounding sound tissue to result in a very conservative cavity preparation.

Management of dental caries as an infectious disease is an emerging approach to minimize the risk of restorative over-treatment and under-treatment (because of low diagnostic sensitivity) and to allocate more resources to underserved populations and to those who are at a moderate to high risk for this disease (Anderson et al, 1993; Anusavice, 1997; and Featherstone, 2000).

The caries process can be thought of as a balance between pathologic factors and preventive factors. The pathologic factors include cariogenic bacteria, lack of salivary function, dietary fermentable carbohydrates, and subcomponents of those items, such as highly virulent strains of cariogenic bacteria. The protective factors include fluoride, elimination or reduction of fermentable carbohydrates as a substrate, antibacterial therapy, therapy to inhibit bacterial colonization, and enhancement of salivary flow and function.

Cost-effective methods to prevent dental caries are available (i.e., sealants), but generally are underutilized. A high bacterial challenge does not neces-

sarily progress to dental caries but does require a high level of protection to combat it. Normal salivary function, even supplemented by fluoride, may be insufficient to balance a high bacterial challenge.

Intraoral radiography is a crude detection method, adequate only for inter-proximal lesions at a very advanced state. New methods for detecting caries have recently become or soon will be available:

- ◆ Electrical impedance and ultrasound show promise for detecting caries at an early stage or for determining the degree of progression.
- ◆ Digital radiography can be used to track lesions over time to assess progression or reversal.
- ◆ Optical methods based on fluorescence (using chromophores generated by the bacteria), when effectively utilized, will accurately assess caries in occlusal surfaces (Lussi et al, 1999). Optical coherence tomography may provide two- or three- dimensional images that could become part of the patient's electronic record for insurance purposes and for diagnostic and treatment purposes (Everett et al, 1999).

Synthetic metals, ceramics, polymers, and composites have been used fairly effectively during the past 20 years or more to:

- ◆ Restore teeth destroyed or damaged by primary caries and secondary caries;
- ◆ Rebuild tooth areas degraded by wear or fracture;
- ◆ Seal pits, fissures, and defective margins;
- ◆ Improve esthetics; and,
- ◆ Release fluoride at variable release rates to inhibit demineralization and enhance remineralization.

These materials are being improved to reduce technique sensitivity, increase survival times, improve esthetic potential, and more effectively release therapeutic agents. Nevertheless, a significant percent of restorations made from these products are replaced because of secondary caries. Other failure causes include: fracture, chipping, cracking, excessive wear, discoloration, pulpal effects and malocclusion. Furthermore, little improvement has occurred in the development of more durable and

less abrasive dental ceramics. The fracture toughness and marginal quality of these prostheses have increased during the past 20 years, but they are still brittle materials that require special precautions. The design of ceramic-based prostheses must be more durable to resist degradation leading to debonding and marginal leakage and to protect against secondary dental caries.

IMPLANTOLOGY

When teeth are lost and traditional approaches to tooth replacement are not an ideal solution, the replacement of teeth with dental implants now represents a new therapeutic option. Implants are used not only in patients who have lost teeth due to caries and periodontal disease, but are becoming an important part of the restoration of form and function in patients treated for trauma, craniofacial cancers, or other abnormalities.

The evidence base for the survival of the endosseous dental implant is extensive and has been recently reviewed (Cochran, 1996; and Fritz, 1996). Many longitudinal studies exceeding five years in length are in the literature; individual populations have been studied for periods exceeding 15 years. The predictability of endosseous dental implants in fully and partially edentulous patients has been clearly demonstrated in longitudinal studies (Albrektson et al, 1988; Spiekermann et al, 1995; and Buser et al, 1991). Many implant designs and surfaces have shown high success rates (often exceeding 95% in good quality and 85% in poorer quality bone such as the posterior maxilla). While most evidence is available for titanium implants, there is evidence to support the use of hydroxyapatite and titanium plasma sprayed implant surfaces (Cochran, 1996; and Fritz, 1996). As well, there is evidence to support the use of both two-stage and one-stage implant systems (Cochran, 1996; and Buser et al, 1988). Replacement of lost teeth will rely on traditional prosthodontic techniques combined with the application of tooth-sparing dental materials.

DENTAL BIOMATERIALS

Dental biomaterials are incorporated into almost every phase of practice. Diagnostic, restorative and surgical procedures involve biomaterials either as enabling technologies (e.g., resorbable sutures, etchants, NiTi wire) or as definitive replacements for

both hard and soft tissues (e.g., calcium phosphate bone cements, silicone-based polymers, ceramics). Advances in clinical practice have often derived from the development of new materials or their co-optation from other fields (e.g., engineering) often nearly coincident with their emergence for non-dental uses.

Dentistry relies on a wide range of materials, including: (1) metals; (2) metallic alloys; (3) cements based on acid-base reactions between metal oxides and either mineral or organic acids as well as products of polymerization reactions; (4) glasses; (5) polycrystalline ceramics; (6) glassy and rubbery polymers (both filled and unfilled) based on acrylic, urethane and epoxy chemistries; (7) amalgam; (8) waxes; (9) textile products; (10) monomers and oligomers of polysulfide, silicone, and vinyl siloxanes; (11) alginates, and (12) gypsum products. Bioactive materials are available, having therapeutic activities ranging from anti-microbial, to promotion of mineralization, to the enhancement of bone formation and maintenance.

Computer-directed materials processing and the collection and manipulation of three-dimensional data sets are today part of dental practice. Dental office CAD/CAM systems allow for single appointment delivery of inlay, onlay and full coverage restorations fabricated from ceramics or resin-based composites. Computer-assisted fabrication systems based in the dental laboratory allow for delivery of prostheses based on titanium or polycrystalline ceramics, such as alumina and zirconia.

PERIODONTAL DISEASES

The human periodontal diseases are a group of inflammatory disorders that affect the supporting tissues of the teeth. Periodontal diseases result from the host response to the bacterial infection of the teeth and subgingival environment. The classification of periodontal diseases was recently modified and now includes eight disease categories (Armitage, 1999). The major disease categories are gingival diseases (plaque-induced and non-plaque-induced), chronic periodontitis, aggressive periodontitis, periodontitis as a manifestation of systemic disease, necrotizing periodontal diseases, abscesses of the periodontium, periodontitis associated with endodontic lesions and developmental or acquired deformities and conditions.

Broadly defined for purposes of disease progression, gingivitis is gingival inflammation without loss of alveolar bone and periodontal ligament, while

periodontitis is gingival inflammation with loss of alveolar bone and periodontal ligament. In some patients inflammatory gingivitis can exist for many years, with only limited amounts of marginal bone loss over decades. In other individuals, gingivitis progresses to periodontitis. At present, the specific events that lead to the transition of gingivitis to periodontitis are not defined, but are likely to involve a qualitative or quantitative shift in the bacterial infection, with activation of inflammatory cascades and production of mediators with catabolic effects.

The currently accepted model for progression of periodontitis consists of periods of disease activity and inactivity. The amount of loss measured on a tooth site is variable and can be dependent on many factors including identifiable risk factors as well as the sensitivity of the technique used for measuring change (Armitage, 1996).

Approximately one dozen species of bacteria, primary Gram-negative anaerobic organisms, have been associated with chronic periodontitis: *Actinobacillus actinomycetemcomitans*, *Actinomyces naeslundii*, *Bacteroides forsythus*, *Campylobacter rectus*, *Eikenella corrodens*, *Eubacterium species*, *Fusobacterium nucleatum*, *Peptostreptococcus micros*, *Prevotella intermedia*, *Porphyromonas gingivalis*, *Selenomonas sputigena*, *Streptococcus intermedius* and *Treponema species*.

Among the host inflammatory mediators that have been proposed as important to the pathogenesis of periodontitis are the arachidonic acid metabolite prostaglandin E₂, enzymes known as matrix metalloproteinases (collagenases and other connective tissue-degrading enzymes) and the cytokines interleukin (IL)-1, IL-6 and tumor necrosis factor- α (TNF- α) (Schwartz et al, 1997). The prevalence of moderately severe to severe periodontitis is remarkably consistent in different populations throughout the world ranging from 8-12% (Papapanou, 1996). The prevalence of early-onset forms of periodontitis ranges between 0.1% and 0.5% in the United States (L oe and Brown, 1991).

Risk Assessment and Diagnosis

Periodontitis is a multifactorial disease. A number of risk factors for periodontitis have been identified, including cigarette smoking, type 1 and type 2 diabetes, increased age, existing periodontitis, male gender, low socioeconomic status, limited access to dental care, as well as the periodontal pathogens *Porphyromonas gingivalis* and

Bacteroides forsythus, and an exuberant inflammatory response as evidenced by increased production of inflammatory mediators.

The most important environmental risk factor for periodontitis is cigarette smoking. This finding has emerged within the last ten to fifteen years. A recent report by Tomar and Asma calculated that 41.9% of all cases of periodontitis were attributable to current use of cigarettes, and 10.9% of cases were attributable to former smoking (Tomar and Asma, 2000).

Greater extent and severity of periodontitis have been associated with both type 1 and type 2 diabetes. Recent studies have begun to define the molecular mechanisms that account for this association. The binding of advanced glycation endproducts in the periodontium to their receptor on macrophages, endothelial cells, and other structural cells can induce a hyperinflammatory state. Increased production of proinflammatory cytokines (IL-6, TNF- α) can then contribute to tissue damage (Lalla et al, 1998; and Mealey, 2000).

Today the diagnosis of periodontal disease relies on clinical and standard radiographic techniques and parameters:

- ◆ Probing attachment level and bleeding following probing;
- ◆ Radiographic analysis of the height of alveolar bone with periapical or bitewing exposures;
- ◆ Subtraction radiograph to determine if loss (or gain) of alveolar bone has occurred during a defined interval (limited to research environments because the software and hardware necessary for the subtraction are not commercially available); and,
- ◆ Digital radiography.

Diagnostic tests have been developed that identify specific microbial pathogens by use of culture DNA probes or specific cell surface antigens (Zambon et al, 1995). The host response can be assessed by analysis of gingival crevicular fluid, saliva, or blood. These methods have not been widely accepted as a routine part of patient management (Lamster, 1997; and Kaufman and Lamster, 2000).

Treatment and Prevention

Treatment of periodontal diseases focuses on reducing and removing plaque and calculus accu-

mulations, and controlling tissue inflammation. This is achieved in a number of ways:

- ◆ Plaque removal by the patient, and professional plaque and calculus removal in the dental office;
- ◆ Use of chemotherapeutic agents (such as essential oils, cetylpyridium chloride, and chlorhexidine) delivered in toothpastes, mouth rinses, and occasionally by oral irrigation devices;
- ◆ Systemic antibiotics, ideally targeted to susceptible microorganisms, used only for advanced and aggressive disease, or for medically compromised patients;
- ◆ Local (subgingival) delivery of antibiotics/antimicrobials, including tetracycline HCl incorporated into a polyvinyl acetate carrier, doxycycline HCl incorporated into a thixotropic gel, and chlorhexidine in a gelatin matrix; and,
- ◆ Host-modulating agents to decrease the inflammatory response (low-dose doxycycline, which has been shown to block the action of matrix metalloproteinases).

The surgical treatment of periodontal disease has focused on the elimination/reduction of excessive probing depths. There is considerable interest in surgical procedures that promote regeneration of lost periodontal tissues:

- ◆ Placement of barrier membranes to promote regeneration of the surgical wound with cells capable of forming new periodontal tissues (Tatakis et al, 1999);
- ◆ Allogeneic and xenogeneic bone grafts (Nasr et al, 1999); and,
- ◆ Xenogeneic enamel matrix proteins that rely on biomimicry to promote regeneration.

In addition, mucogingival surgical procedures are widely used to cover exposed root surfaces and improve esthetics (Wennstrom, 1996).

SYSTEMIC DISEASES

Systemic conditions, such as diabetes, have long been known to affect oral tissues, and oral medicine

has focused on the diagnosis and treatment of these oral manifestations of systemic diseases. Recently, however, the results from epidemiologic studies have shown a relationship between severe oral infections, especially periodontal diseases, and other health problems: atherosclerosis, heart attacks, strokes, chronic obstructive pulmonary disease, and premature births. For example, it appears that periodontal disease may increase the risk of dying from a heart attack or having a stroke.

These early findings require confirmation by additional prospective and ultimately intervention studies, and many years of clinical and basic research will be needed to determine whether the association between cardiovascular/cerebrovascular conditions and periodontal disease is actually causative in nature. However, these associations provide the impetus to move the profession of dentistry towards periodontal medicine—a medical model of diagnosis, prevention, and therapy.

New studies are shedding light on how periodontal organisms cause damage beyond the periodontal pocket. These organisms are capable of entering the bloodstream and can target certain organs, such as the liver, major blood vessels, and the placenta, to potentially cause inflammation at distant sites.

Three key organisms that are closely associated with periodontal diseases, *Porphyromonas gingivalis*, *Treponema denticola*, and *Bacteroides forsythus*, have been implicated in the periodontal infection-systemic disease relationship. They do not colonize easily and require a lush biofilm ecosystem to support adherence, growth, and emergence. They rely mainly on host serum proteins and blood components for sustenance. These organisms have special enzymes and proteins that enable them to trigger mild host inflammation and enhanced gingival crevicular flow to ensure an adequate food and nutrient supply from the serum. These organisms target the liver and activate the hepatic acute phase response. Elevated levels of serum inflammatory mediators and hepatic secretion of acute phase proteins, such as C-reactive protein and haptoglobin, characterize the acute phase response.

Theoretically, over the years, inflammatory mediators and bacteria present in the systemic circulation, even at low levels, cumulatively damage systemic health. Thus, it is the direct systemic action of blood-borne oral bacteria or bacterial products and the chronic inflammation, caused by this hematogenous exposure, which are currently thought to provide a risk to health.

Not everyone gets periodontal diseases, though all are exposed to similar oral pathogens during their lifetime. Some patients never get periodontal diseases, no matter how poor their oral hygiene habits. It now appears that genetic and behavioral characteristics influencing individual inflammatory responses are key predictors of severe periodontal disease (Kornman et al, 1997).

Diabetes and smoking each enhance the inflammatory response to bacterial LPS and impair the ability to fight infection by compromising neutrophil function. An exaggerated inflammatory response results in more tissue destruction clinically seen as severe pocketing and bone loss. This hypothesis does not necessarily negate the potential importance of oral infection as a contributor to systemic diseases, however, it points out that there may be underlying mechanisms not yet identified that may better explain the observed associations between periodontal diseases and other systemic conditions.

Heart Disease and Stroke

Five longitudinal studies have shown that pre-existent periodontitis, as determined by direct oral examination, independently confers excess risk for increased morbidity or mortality due to cardiovascular disease. The increased risk ranges from a modest 20% (odds ratio 1:2) to 180% (odds ratio 2:8). Another study demonstrated a dose-response relationship between periodontitis and death caused by myocardial infarction and stroke (Beck et al, 1996). Most of these studies began as cardiovascular disease studies and have controlled for traditional risk factors such as sex, smoking, body mass, serum lipids, exercise, familial history, socioeconomic status, education, and other cardiovascular risk factors. Analyses of the NHANES III data show a strong association between a history of heart attack and increasing periodontitis severity in a dose-response manner: the greater the periodontal disease the greater the risk, with odds ratios greater than five for the most severe periodontal disease groups (Arbes et al, 1999a).

Pregnancy Outcomes

Case-control and prospective human studies suggest that periodontitis is a potential risk factor for premature births, low birth weight, and preeclampsia (Offenbacher et al, 1996; Dasanayake, 1998; and

Jeffcoat et al, 2001). Other human studies show no association, but there are supportive data from animal models (Collins et al, 1994b). Preliminary reports of interim findings from larger prospective studies continue to show a significant association between more severe periodontitis and increased incidence of premature delivery. Preliminary reports suggest that periodontal treatments reduce the risk of premature births (Mitchell-Lewis et al, 2001), but these early findings using convenient study populations must be supported by multicenter, placebo-controlled, randomized controlled trials.

Chronic Obstructive Pulmonary Disease and Aspiration Pneumonia

Data from case-control studies and population surveys suggest that periodontal pathogens shed into the saliva can be aspirated via the bronchia to the lung and potentially cause pneumonia, especially in debilitated, infirm, and aged individuals (Joshi et al, 1991). The more severe the periodontal disease status of the patient the greater the apparent risk for aspiration pneumonia. Furthermore, the mature periodontal flora can serve as a habitat for respiratory tract pathogens, especially in hospitalized individuals with dysphagia secondary to stroke (Scannapieco and Mylotte, 1996) and during prolonged intubation. This oral colonization of respiratory pathogens in these compromised individuals appears to increase the risk for pulmonary involvement (Scannapieco, 1999). An association between periodontal diseases and chronic obstructive pulmonary disease has been reported, based upon the NHANES III data set of over 10,000 individuals. Prospective studies on this association are needed.

Diabetes

The preponderance of the data suggest that periodontal diseases are metabolic stressors associated with insulin tolerance, and that periodontal therapy (debridement and systemic antibiotics) can reduce the level of glycosylated hemoglobin—a marker of glycemic control (Grossi et al, 1997). Many epidemiologic studies have confirmed that diabetes is strongly associated with periodontitis, with an odds ratio in the range of 2-3. More recent lines of investigation have clearly demonstrated that periodontal diseases are associated with impaired fasting glucose (Grossi and Genco, 1998; and Taylor et al, 1996),

and an increased demand for insulin, apparently a consequence of insulin resistance (insulin tolerance). The metabolic stress of infection shifts a person with normal glucose tolerance towards a pre-diabetic state of type 2 diabetes. It has been suggested that this metabolic effect is a consequence of systemic LPS, TNF and IL-1, and IL-6, all of which enhance insulin resistance. Experiments are underway to definitively determine whether periodontal therapy reduces the need for insulin in diabetics and reduces the risk for the onset of type 2 diabetes.

Animal Models

Animal models of infections with periodontal pathogens and experimental periodontitis have demonstrated the deleterious effect of infection on atherosclerosis, diabetes, and fetal growth (Collins et al, 1994a; and Lalla et al, 1998). These data not only help establish biological plausibility but also provide important clues regarding the mechanisms of cellular and molecular pathogenesis.

CLEFT LIP, CLEFT PALATE AND CRANIOFACIAL DEVELOPMENTAL DISORDERS

Orofacial clefting is the second most common birth defect (CDC, 1995), and the most frequent of all birth defects affecting the craniofacial region. Only congenital heart defects occur more often.

Oral clefts are classified and distinguished into two major types based on whether the palate only versus the lip or both the lip and palate are involved (Gorlin et al, 1990; OMIM, 2001; and Cohen, 2000). This classification reflects the embryologically distinct events of closure of the lip versus closure of the palate. These two major types of clefting are caused by substantially different genetic and environmental factors, although recent evidence suggests that some overlap in etiology also exists.

◆ *Isolated cleft palate (CP)* is a cleft affecting the palate only, posterior to the incisive foramen. They may affect the soft palate only, or both hard and soft palates. This category includes submucous cleft palate where the cleft affects the musculature of the soft palate but with intact overlying mucosa. Isolated clefts of the palate represent approximately 33% of all clefts.

◆ *Cleft lip with or without cleft palate (CL/P)* are clefts affecting the lip and sometimes also the adjacent maxillary alveolus, or alveolus and palate, typically in the vicinity of the lateral incisor. They may be partial or complete, and unilateral or bilateral. Clefts of the lip, with or without alveolar clefts, represent approximately 17% of all clefts. This condition may occur with cleft palate. Complete lip, alveolar and palate clefts represent approximately 50% of all clefts.

An important distinction is also made depending on whether or not other major or minor physical or mental/neurological anomalies also affect the patient.

◆ *Syndromic clefts* involve the presence of one or more physical and/or mental/neurological patterns of abnormalities in addition to the cleft. The presence of minor anomalies or of major anomalies that might be unrelated to the etiology of the cleft occasionally makes classification uncertain. About 30% of orofacial cleft cases are attributed to the over 350 syndromes recognized to date.

◆ *Nonsyndromic oral clefts* occur without any physical or mental/neurological anomalies. Approximately 70% of oral clefts appear to be nonsyndromic.

Most oral cleft syndromes have a major hereditary cause (Gorlin et al, 1990; and Cohen, 2000). Purely environmental causes are relatively rare, and even these may be affected by genetic differences influencing metabolism of teratogens following maternal and fetal exposures. About 55% of the syndromes associated with syndromic clefting have a monogenic autosomal dominant or recessive or X-linked mode of transmission, 15% involve chromosomal rearrangements, about 5% have primarily an environmental (i.e., teratogenic) etiology, and the cause for the remaining 25% is unknown. The specific gene defects for some of the monogenic syndromes have been identified, such as three different collagen genes for the three types of Stickler syndrome. Genes for other syndromes, such as van der Woude, have been mapped to a small chromosomal region, and gene identification is expected soon.

The causes of nonsyndromic orofacial clefting involve complex gene-environment interactions (Schutte and Murray, 1999; and Carinci et al, 2000). To date, only a very small number of candidate gene polymorphisms have been evaluated.

These have been selected based on theories about craniofacial development derived from mouse models or genes that metabolize teratogenic or protective dietary nutrients such as folate. These studies have either been consistently negative, inconsistent among studies, or account for a tiny fraction of the heritable risk of nonsyndromic orofacial clefting. It appears that six or more genes probably have major effects on susceptibility, though none of these have been convincingly identified and independently replicated to date (Prescott et al, 2000). Variation at dozens of other genes probably contribute smaller influences on risk. Exposure to smoking, alcohol and certain prescription medicines such as anticonvulsants during pregnancy increases risk (Gorlin et al, 1990; Wyszynski and Beaty, 1996; and Houdayer and Bahau, 1998) and protective substances in the maternal diet such as folate and multivitamins appear to reduce risk (Loffredo et al, 2001).

However, most studies indicate that inherited variation has the greater overall effect on susceptibility. Furthermore, some of the individual genetic variation important for modifying orofacial clefting risk may occur at genes controlling the metabolism of the teratogenic and dietary factors associated with risk. At present, empirical risk tables are based on epidemiological studies and thus provide only population averages rather than individualized risk assessments, but these still permit genetic counselors to predict the average risk of recurrence of nonsyndromic clefting for different kinds of clefting and reflecting an individual's family history of the disorder. In a small proportion of nonsyndromic families, evidence suggesting a monogenic dominant or X-linked pattern of transmission can be used to further refine risk estimates. The growing list of possible environmental teratogens can also assist in pregnancy counseling to reduce, but not eliminate, risk of having a child with a cleft.

In the United States, approximately 7,000 children are born each year with cleft lip or cleft palate. Estimates of actual incidence vary, but a reasonable range would be between 1 in 750-1000 live births for Whites, with approximately twice this incidence for Native Americans and Asians, and half this incidence for African Americans. Cleft lip with or without cleft palate is about twice as common in males as in females, while the reverse is true for isolated cleft palate.

The total lifetime cost for each year's cohort of children born with oral clefts is estimated at \$697 million (CDC, 1995)—about \$100,000 per child. This total includes \$97 million for medical services,

\$20 million for non-medical direct costs such as special education, and \$599 million for indirect costs of patient work limitations and caregiver costs. These figures do not account for the psychosocial impact of the disease on patients and their families, a component of the disease for which treatment may be insufficient even in developed countries (Turner et al, 1998). The lack of advanced medical services, including surgery, often unavailable in undeveloped countries, contributes to substantial morbidity and mortality and to even greater psychosocial stress on patients living with unrepaired oral clefts. Clearly, there are very strong financial and humanitarian incentives to reduce the frequency of oral clefts both in the United States and worldwide.

Mutations in single genes have been identified for a number of craniofacial developmental disorders that involve structures of the craniofacial complex. Examples include holoprosencephaly-3 (mutations in the sonic hedgehog homolog gene), several types of craniosynostosis (mutations in *MSX2*, *fibrillin-1*, or fibroblast growth factor receptor genes), and basal cell nevus syndrome (mutations in the *Patched* gene) (Gorlin et al, 1990; Cohen, 2000; and Cohen and MacLean, 2000). Most of these syndromes are rare, but in aggregate the group has a substantial impact on human health.

For both syndromic forms of orofacial clefting and for other craniofacial developmental disorders, where specific disease gene mutations have been identified, genetic counseling is both feasible and desirable. Dentists often have an important role to play in both the quick and accurate identification of the syndrome and referral for counseling. For nonsyndromic clefting, it is also important for dental professionals to make referrals for genetic counseling and to help educate the public about the risks of maternal smoking and alcohol consumption and the benefits of prenatal vitamin supplementation and a well-balanced overall diet for disease prevention.

The current standard of care for patients with clefts and other craniofacial developmental disorders is based on the concept of interdisciplinary team care, including significant contributions from many dental specialties. The Parameters for Evaluation and Treatment of Patients with Cleft Lip/Palate or Other Craniofacial Anomalies (American Cleft Palate-Craniofacial Association, 1993), clearly delineates the important role of the dental profession in this field. The malformation affects multiple functional systems, including speech, hear-

ing, dental development, facial growth, facial esthetics, facial animation, occlusion and mastication, and psychosocial development. The dental components to the cleft/craniofacial team represent some of the most significant contributions to total patient rehabilitation, including pediatric dental care, orthodontics, oral and maxillofacial surgery and prosthodontics. In addition, the dental specialists on the cleft/craniofacial team play key roles at almost every age and stage of care of the patient with a cleft. Consequently, they are also uniquely positioned to document and record treatment outcomes, and participate in the clinical research efforts into treatment efficacy and effectiveness.

Research efforts to determine optimal ways to deliver health services to these patients have been hampered by a lack of consensus on minimal standards for documenting outcomes, as well as agreement on which outcomes are relevant indicators of successful treatment in the first place. Current outcomes research has traditionally excluded parent participation in defining treatment success or failure, a serious shortcoming emphasized by the Surgeon General's Conference on Children and Oral Health (Satcher, 2000). Furthermore, evidence for something as basic as the cost-effectiveness of team care is currently lacking, in spite of overwhelming support among care providers, of its appropriateness. Finally, while the large number of centers providing treatment for clefts improves patients' geographical accessibility to care, it simultaneously creates a fractionation of the cleft population thereby reducing the probability of developing patient samples of adequate size to enable valid research. While several recent research initiatives such as the Eurocleft project in Europe (Shaw et al, 2001) and the Craniofacial Outcomes Registry in the United States (<http://www.cfregistry.org/>) have begun to remedy this problem through significant inter-center collaboration and establishment of common data bases, the lack of collaboration between these various initiatives themselves, continues to limit the benefits of the globalization of this effort.

MALOCCLUSION AND TOOTH AGENESIS

Malocclusion, or faulty intercuspation of the teeth, is usually caused by a moderate variation or distortion of normal growth and development of the teeth or bones of the mandible and maxilla. Usually it occurs without any other dental or medical problems, though

occasionally it develops as a symptom of a systemic or syndromic disease. Malocclusion is a continuum from slight irregularity of the bite to severe difficulty with mastication. Abnormal tooth and jaw alignment can affect speech, and in severe cases an abnormal facial appearance may affect the psychological well-being of the individual (Berscheid, 1980).

Although a single specific cause of malocclusion may sometimes be apparent—e.g., trauma, oral habit, dental anomalies of tooth shape or number, or a genetic syndrome—malocclusion is usually the result of a complex interaction among multiple hereditary and environmental factors that influence growth and development. This interaction occurs in, and has an effect on, the craniofacial skeleton, dentition, orofacial neuromusculature, and other soft tissues, including those that border the airway. Although in the past there has been controversy and debate about the relative importance of hereditary versus environmental influences on the etiology of malocclusion, there is evidence of a genetic influence on many aspects of dental and occlusal variation (Mossey, 1999).

Incidence

Estimates of the incidence of malocclusion in the United States vary with the criteria used. The Index of Treatment Need (IOTN) (Brook and Shaw, 1989) relates malocclusion to the need for treatment, using psychosocial and facial considerations, in addition to dental health (traits) to assign five grades of treatment need. One study, using only the dental health (traits) component of the IOTN, estimated the prevalence of malocclusion and orthodontic treatment need in the United States from data in the third National Health and Nutrition Examination Survey (Proffit et al, 1998). This study found that 15% of the population has dental irregularity severe enough to affect both social acceptability and function.

Correction of these severe problems may require major arch expansion or extraction of some teeth. About 20% of the population has deviations from ideal bite relationships. One in 50 of these deviations is severe enough to be disfiguring. Many of these problems are at the limit of treatment by orthodontics alone and may require orthognathic surgery. Another study found sagittal molar asymmetry in 30% of a group of untreated 8-10 year olds and in 23% in a group of untreated 14-15 year olds (Sheats et al, 1998). In the latter group, 12% also showed facial asymmetry and 21% displayed noncoincidence of dental midlines.

Tooth agenesis (missing teeth) and supernumerary teeth (more than the normal number of teeth) are common problems. Tooth agenesis occurs in about 20% of the population, and third molars are by far the most commonly affected teeth. Missing maxillary lateral incisors and mandibular premolars occur at the next highest frequency (Graber, 1978). Most supernumerary teeth are present in the anterior maxillary region (Garvey et al, 1999). Some cases of tooth-number abnormalities occur sporadically (without any family history). However, aside from the common variation of third molars, the pattern often is transmitted through multiple generations of families, indicating that the cause is due to a single gene of major effect. Mutations in key regulatory genes of the homeobox family such as *MSX1* and *PAX9* have recently been identified as the cause of different forms of hereditary tooth agenesis (Vastardis, 2000; and Stockton et al, 2000).

Treatment

It is likely that there are disparities in access to treatment for malocclusion and tooth agenesis. Just over 30% of White teenagers receive orthodontic treatment in the United States, nearly three times as many as in the Hispanic population and four times as many as in the African American population (Proffit et al, 1998).

Traditional orthodontic approaches to the correction of malocclusions are effective, but new approaches to therapy will continue to appear. For example, a removable appliance-based, computer-assisted treatment modality has been introduced for minor tooth movement in adults. The profession should continue to evaluate the efficacy of new treatment modalities to increase access to orthodontic care. Appropriate peer review of studies and claims is required to assure evidence-based treatment.

ORAL AND PHARYNGEAL CANCERS

In 2000, more than 30,000 Americans developed oral and pharyngeal cancers. Almost 8,000 Americans died from this disease (Greenlee et al, 2000). Tongue cancer incidence and mortality are reported to be increasing significantly, especially among young White males (Moore et al, 2000; and Myers et al, 2000). This could be due to increased use of smokeless tobacco, but there have not been increases in rates of cheek, gum and other mouth cancers, which are close-

ly linked to smokeless tobacco use. Increases in tongue cancer have also been observed in the United Kingdom where oral snuff and chewing tobacco are infrequently used (Blot et al, 1996). Oral cancer in young adults appears to be associated with the traditional risk factors of tobacco smoking, drinking alcohol and low consumption of fruit and vegetables, rather than due to any unique or new etiological agent (Mackenzie et al, 2000).

Oral Cancer Etiology

Oral cancer presents a highly complex challenge in terms of understanding its etiology, diagnosis and treatment (Blot et al, 1996; Silverman, 1998; and Winn et al, 1998). A large number of factors influence risk of developing oral and pharyngeal cancers:

- ◆ *Heavy cigarette smoking and alcohol consumption* are strongly associated with increased risk of oral and pharyngeal cancers (Blot et al, 1996; and La Vecchia et al, 1997). Persons who consume large quantities of both tobacco and alcohol have an estimated 80-fold higher risk of oral and pharyngeal cancers than do people that never used these substances. Cessation of tobacco and alcohol use is associated with a significant reduction of risk after about 5 to 10 years. Dental professionals can be effective in helping people to quit using tobacco by using interventions in dental office settings (Severson et al, 1998; and Crews et al, 1999).
- ◆ *Diets high in fresh fruits* and possibly some vegetables have been associated with a 50% reduction in risk for oral and pharyngeal cancers, even after adjusting for the effects of tobacco and alcohol (Blot et al, 1996; and La Vecchia et al, 1997).
- ◆ *Human Papilloma Virus (HPV)* infection has been suggested to increase risk of developing oral cancers. This has led to hope of possible reduction in cancer incidence through use of HPV vaccines now undergoing clinical trials for genital-tract cancers. However, current data suggest that only a relatively small portion of head and neck cancers have major HPV etiological involvement, though additional data are needed to confirm this conclusion (Schwartz et al, 1997; and Franceschi et al, 2000).
- ◆ *Oral lesions* that may be considered "pre-malignant" are found in about 2% of the population and

include leukoplakia, erythroplakia, and possibly lichen planus, chronic candidiasis, pemphigus vulgaris and verrucous hyperplasia. Estimates of the chances of progression of these lesions to oral and pharyngeal cancers vary from 6% to 36% over a 10-year period for leukoplakia and erythroplakia (Warnakulasuriya, 2000).

◆ *Inherited susceptibility* influences both chances of becoming addicted to heavy alcohol and tobacco use, and activities of carcinogen-metabolizing genes such as alcohol dehydrogenase (Harty et al, 1997) and glutathione transferase (Park et al, 1999). Although oral cancer does not generally appear to be as heritable as some other forms of cancer, risk has consistently been shown to be elevated in close relatives of oral cancer cases (Jefferies and Foulkes, 2001).

Concern has been raised about possible increased risk associated with use of alcohol-containing mouthwashes, but recent studies indicate risks appear to be relatively small compared to the major risk attributable to high levels of alcohol drinking (Elmore and Horwitz, 1995; and Winn et al, *In Press*).

After adjusting for age, African American males have about a 50% higher incidence of oral and pharyngeal cancers than males of European ancestry (Ries et al, 2000). Five-year survival (relative to the rest of the population of similar age) is 29% for male African Americans and 53% for White males in the United States. The difference in mortality is due primarily to the more advanced stage at which oral cancers are usually detected in African Americans (only 15% at a localized stage when treatment is much more effective, versus 37% for Whites) (Ries et al, 2000).

Other factors that may contribute further to differences in mortality include socioeconomic status and differences in treatment (Arbes et al, 1999b; and Skarsgard et al, 2000). However, only about half of the excess mortality experienced by individuals diagnosed with oral cancer is attributable directly to the cancer itself. For newly diagnosed oral cancer cases, only about 30% of White and 40% of African Americans die from an outcome directly related to their oral cancer within five years. Instead, 30% of newly diagnosed White oral cancer cases and 40% of African American oral cancer cases die due to other causes within five years (Arbes et al, 1999b). This "other" mortality is much higher than expected for average individuals in the population of the same

age range, and is due to the fact that most oral cancer cases consume very high amounts of tobacco and alcohol.

Causes of death that are excessive among oral cancer cases include primary cancers of other organs, ischemic heart disease, chronic obstructive lung disease, liver cirrhosis and other tobacco and alcohol-related diseases. This perspective emphasizes that even fully successful treatment of the oral cancer itself by no means restores patients to a normal level of health (Skarsgard et al, 2000).

Diagnosis and Treatment

Oral examinations by dental professionals and education of the public about oral and pharyngeal cancers are important steps to increasing early diagnosis. Early detection and surgical removal of lesions when they are small and localized greatly improve prognosis. Five-year survival rates relative to individuals of similar ages who are not affected by oral cancer are 81% when the tumor is localized, 44% when restricted to the oral region, but only 21% when metastasized to distant locations (Ries et al, 2000). Unfortunately, health professionals perform thorough oral examinations far too infrequently, and only 36% of oral and pharyngeal cancers are diagnosed when the disease is confined to the local area.

There is very sound scientific justification to encourage examinations for these cancers as standard practice, especially for individuals at high risk due to advanced age or heavy use of tobacco and alcohol. Furthermore, there may be benefits to the dental profession in terms of health insurance compensation, which may be strongly justified for the purpose of screening for this serious disease condition, comparable to examinations now routinely performed by physicians for prostate or breast cancer with full insurance compensation.

The American Cancer Society recommends that persons 40 years and older have an oral cancer examination once every 3 years (Smith RA et al, 2000). Unfortunately, in 1992 only 15% of United States adults reported that they had ever had an oral cancer examination, and only 7% of respondents over age 40 had received such an examination in the previous year (Yellowitz et al, 2000).

Standard treatment for oral and pharyngeal cancers depends on the size, location, and histopathological state of the lesions and usually includes surgery and radiation. Interventions for cancers detect-

ed at later stages are highly disfiguring and require post-treatment reconstructive surgery, which greatly reduce the quality of life even when the patient is completely cured of cancer.

ORAL MUCOSAL AND AUTOIMMUNE DISEASES AND OTHER INFECTIONS

Mucosal Diseases

Oral mucosal diseases represent an array of conditions of multiple etiologies and various pathobiologies whose clinical effects range from mildly annoying to life threatening. Included here are the blistering diseases, such as pemphigus vulgaris and pemphigoid; ulcerative diseases, such as aphthous stomatitis and Behcet's disease; and iatrogenic conditions, such as stomatotoxic reactions associated with drug and radiation therapies for cancer.

The overall frequency of these diseases and conditions is high. Aphthous stomatitis affects 20% of the world's population (Woo and Sonis, 1996) and lichen planus affects 1-2% of adults over the age of 50 years (Scully et al, 1998). About 20% of individuals who receive chemotherapy develop painful mucositis of such severity as to require significant intervention or alteration in their cancer treatment plan (Epstein and Schubert, 1999). Among patients with head and neck cancer who are treated with radiation, mucositis is virtually a universal event often resulting in the need for breaks in treatment and hospitalization.

Whereas aphthous stomatitis typically has an age of onset in the first or second decade, lichen planus, pemphigoid and pemphigus vulgaris tend to occur in older populations (Flaitz, 2000). Erythema multiforme is most common in the second decade. Aphthous stomatitis, lichen planus, mucous membrane pemphigoid and pemphigus vulgaris have a gender predilection for females. Erythema multiforme is most common in males.

With the exception of mucosal injury induced by radiation or drug therapy for cancer, virtually all of the oral mucosal diseases are thought to be manifestations of autoimmune processes, although the nature of their etiology is not fully understood (Popovsky and Camisa, 2000). The complexity of the etiopathogenesis of these conditions is illustrated by aphthous stomatitis, which is the most common oral mucosal disease (Barrons, 2001). A number of systemic conditions predispose to the devel-

opment of aphthous stomatitis. Patients infected with Human Immunodeficiency Virus (HIV), having certain vitamin deficiencies or with quantitative neutrophil disorders, are at risk for the condition. Yet, the majority of patients appear to be genetically predisposed for the condition. Specific HLA types associated with recurrent aphthous stomatitis have not been demonstrated. Similar to lichen planus, aphthous stomatitis appears to be the result of cell-mediated immune injury. Yet, the clinical manifestations of the two conditions are very different.

The blistering diseases, mucous membrane pemphigoid and pemphigus vulgaris, have an autoimmune etiology, and are the consequence of autoantibodies directed at different molecules in the basement membrane zone (pemphigoid) or at desmosomes (pemphigus) (Rye and Webb, 1997). The immunologic complexity of pemphigoid is only now being dissected. Identification of autoantigens has shown that they differ among anatomic sites affected by this disorder. The etiology of pemphigoid remains elusive (Dayan et al, 1999). The fact that oral mucous membrane pemphigoid is a disease of the elderly may suggest the development of abnormal basement membrane antigens to which destructive autoantibodies are produced. Pemphigus vulgaris, in contrast, develops at a younger age (fourth or fifth decade) and has an immunogenetic predisposition. Linkages of the disease to certain genetic regions among large percentages of patients at risk for the condition support this hypothesis.

The explosive onset of erythema multiforme (Laskaris and Satriano, 1993) and its predisposition for young males set this condition apart from other oral blistering diseases. The observation that the disease is often sequelae to Herpes Simplex Virus (HSV) infection or the administration of certain medications suggest a mucosal autoimmune disease directed at aberrant antigens acutely expressed on the oral mucosa.

A major area of controversy surrounds one of the most common mucosal diseases, lichen planus, and focuses on its pre-malignant potential. Strong cases have been made on both sides of the issue (Silverman, 2000; and Eisenberg, 2000). Nonetheless, despite issues with diagnostic criteria, a review of studies in the area leads to the conclusion that patients with some forms of lichen planus are at risk for developing oral cancer. The risk has been reported to range from a frequency of 0.4% to 3.3%. To put this risk in perspective, consider that

the United States population in the age range at risk for oral cancer (ages 50 to 70 years) numbers 51 million. If the estimated frequency of lichen planus is 1%, then among that age group there are 510,000 cases of lichen planus. The expected rate of oral cancer among individuals in that risk group is about 30 cases per 100,000. With a risk of 3.3%, the expected number of oral cancers in the lichen planus group would be five times that (150 cases). Clearly, the issue of lichen planus as a premalignant lesion needs to be better defined and studied. It seems likely that not all forms of lichen planus are at equivalent risk of developing into a malignancy.

Oral mucosal diseases are frequent, symptomatic, and biologically complex. For many of these conditions, current treatment is palliative and/or anti-inflammatory and often unsatisfactory. New molecular biological techniques, the definition of the human genome, and the association between specific genes with effector proteins should lead to a better understanding of the etiology and pathophysiology of these conditions, and ultimately to new therapies.

Other Infections

The mouth is home to a great variety of organisms. Fortunately, the majority of these are not of any serious health consequence. Nevertheless, knowledge about infectious agents and their natural histories is essential for the practicing dentist. Dentists must be able to recognize the oral manifestations of infectious diseases (Lynch, 2000) especially those associated with HIV infection, be aware of the serum tests used to identify hepatitis A, B, and C infections and be aware of the role of the "carrier" (an apparently healthy individual who shows no sign of an infectious disease but is able to transmit the disease to others).

Within the last 20 years, considerable attention has been devoted to the need for universal infection control policies in the dental office. Federal and state regulations have been formulated which can lead to monetary fines and other sanctions if these procedures are not followed.

In recent years, several developments in medicine have further increased the significance of infectious diseases in modern dental practice. These include the widespread use of agents that suppress the immune system, as well as immunosuppressive drugs used to treat patients having organ trans-

plants and other medical problems, reducing immunity and increasing susceptibility to infections. Some of the infections seen in immunocompromised patients were, hitherto, very unlikely to be seen by the dental practitioner.

The most common viral infection identified and treated by dentists is the HSV, and the most common fungal infection is due to *Candida albicans* (Glick and Siegel, 1999). Herpes viruses are characterized by their ability to establish latent infections that can be reactivated, especially in the immunocompromised patient (Oakley et al, 1997). HSV type 1 is responsible for most intraoral infections. In immunocompetent patients, herpetic ulcers are most frequently found on keratinized mucosa (Regezzi and Sciubba, 1989). In contrast, immunosuppressed patients can develop lesions at any intraoral site, with nonkeratinized sites representing half of all sites involved (Woo and Lee, 1997; and Oakley et al, 1997).

Fungal infections have emerged as an increasing problem in patients immunocompromised by disease or treatment. Oropharyngeal candidiasis is perhaps the most frequently encountered fungal infection and constitutes a major cause of morbidity and mortality in immunocompromised patients (Lynch, 1994; and Phelan et al, 1997). In most patients the organism isolated is *Candida albicans* (Odds et al, 1989), but in recent years other *Candida* species such as *Candida glabrata* are increasingly associated with oropharyngeal infection (Coleman et al, 1995). Because of its oral bioavailability and lack of serious side effects, fluconazole is the current drug of choice for fungal infections (Reents et al, 1993). Unfortunately, the widespread long-term use of fluconazole in recent years has led to the development of resistance of oral isolates to azole drugs and, in some cases, cross-resistance to polyene drugs as well (Rex et al, 1995).

Other bacterial infections that occur in the mouth are related to *Treponema pallidum*, *Mycobacterium tuberculosis* and *Neisseria gonorrhoeae*. Other viral infections (e.g., human papilloma virus) and fungal diseases (e.g., histoplasmosis, coccidiomycosis and cryptococcosis) also manifest in the oral cavity. These "deep" fungal infections have a low incidence, but in some regions of the United States certain fungal infections are epidemic (i.e., histoplasmosis in the Southwestern United States).

SALIVARY GLAND DISEASES

Saliva modulates oral microbial ecosystems, aids in the preparation of the food bolus, lubricates oral tissues, and supports other critical oral functions. The initial phases of dental caries development are reversed in part by saliva, which buffers acids and is supersaturated with calcium and phosphorus. The salivary mucins are a heterogeneous population of glycoproteins that bathe and protect oral soft tissues (Schenkels et al, 1995). Salivary glands are a part of the mucosal immune system.

Salivary Dysfunction

Decreased salivation results in decreased secretion of antimicrobial and antifungal proteins such as salivary IgA, lysozyme, lactoferrin, peroxidases, and histatins (Atkinson and Fox, 1992). Individuals with inadequate salivary function are at risk for rampant dental decay, recurrent mucosal candidiasis and salivary gland infections, esophageal disease, gastric reflux, altered nutritional intake, and a decreased quality of life.

The most pronounced salivary dysfunction occurs in three groups of patients:

- ◆ Patients with Sjögren's syndrome, a systemic autoimmune disorder primarily affecting the salivary and lacrimal glands.

Current prevalence estimates for Sjögren's syndrome, using the European Community criteria, range from 0.6% to 3.3% of the adult population (Dafni et al, 1997; and Thomas et al, 1998), but the diagnostic criteria used in these studies are not accepted universally. International researchers primarily use one of three sets of criteria to select patients for studies (Fox, 1997). This lack of uniformity in patient selection represents a significant barrier to research progress. Diagnostic uncertainty inhibits genetic studies and makes it impossible to compare studies of pathophysiology and therapy.

- ◆ Patients who have received therapeutic radiation to the head and neck.

Radiation treatment of oral and pharyngeal malignancies typically includes salivary tissue within the field. At doses above 40 Gy, the damage is rapid and irreversible, and the mechanisms for this unfortunate side effect are not understood.

- ◆ Patients taking medications that interfere with salivary secretory processes, such as signaling pathways. More than 300 medications can cause oral dryness, and certain classes of medications are more likely to inhibit salivation and cause xerostomia. These include sedatives, antipsychotics, antidepressants, antihistamines and certain anti-hypertensive agents. Medications with anticholinergic activity can potentially decrease salivation (Atkinson and Fox, 1992).

Diagnosis, Prevention, and Treatment of Salivary Dysfunction

When evaluating a patient, the dentist should consider the patient's medical, dental, and social histories to identify medications and predisposing conditions. A history of past radiation therapy, both internal and external, is important. The diagnosis of Sjögren's syndrome is usually established by a complete ophthalmological examination, a minor salivary gland biopsy and tests for serum autoantibodies.

Any patient with salivary gland dysfunction will benefit from an aggressive oral hygiene program that includes the use of topical fluorides (Ripa, 1989). Other prevention strategies could include the use of remineralization dentrifices, which currently are under evaluation in postradiation patients (Papas et al, 1999). Radiation damage to salivary glands can be limited by preradiation planning (conformal and static, multisegmental intensity modulated radiotherapy, IMRT) that spares as much salivary tissue as possible from the radiation field (Eisbruch et al, 1999). The use of pilocarpine and the oxygen radical scavenger amifostine during radiation treatment may decrease damage to glands (Valdez et al, 1993; and Jha et al, 2000). Some investigators are surgically repositioning submandibular salivary glands to the submental space before radiation to maintain gland function (Bohuslavizki et al, 1999).

The availability in the last decade of systemic agents that can stimulate salivary output (secretagogues) has been a major advance in symptomatic management of patients with salivary gland hypofunction (Fox, 1998); however, they have significant side effects that limit their utility and patient acceptance.

TEMPOROMANDIBULAR DISORDERS (TMD)

Temporomandibular disorders (TMD) are characterized by regional signs and symptoms, including pain in the area of the TM joint and/or masticatory muscles, often with limited mandibular range of motion, and/or TM joint sounds (clicking and/or crepitus). Some definitions include a broader range of symptoms, including headaches, earaches, dizziness, and pain in contiguous structures of the head and neck.

Incidence and Causes

The causes of TMD, and why some patients develop chronic, persistent symptoms, are not well understood. The NIH Technology Assessment Conference on Management of TMD recommended the "Parameters of Care for Oral and Maxillofacial Surgery" to help classify patients (NIH, 1996). Some TMD patients may be classified using the International Headache Society's diagnostic classification (Okeson, 1988), and some patients should be evaluated for neurological conditions and for systemic conditions such as fibromyalgia. Furthermore, the American Academy of Orofacial Pain has expanded and modified this classification scheme to include a wider range of orofacial pain and TMD (Okeson 1996).

Research and consensus conferences have not ruled out malocclusions, joint anatomy, and skeletal malformations as significant etiological factors. Attempts to classify or subdivide TMD have relied on groupings of signs and symptoms. A diagnostic classification has been developed for research purposes (Dworkin and Le Resche, 1992); however, its clinical utility and validity as a research tool have not been established. At this time, the most reasonable clinical diagnostic classification appears to be that published by the American Academy of Orofacial Pain.

Cross-sectional studies of TMD indicate that between 40% to 75% of the population experience at least one sign or symptom at any given time; 34% of the population reported having a temporomandibular disorder. Only 4% to 5% of the population is believed to have a clinically significant TMD (Von Korff et al, 1988). Most TMD are self-limiting and resolve with time or palliative care (Okeson, 1996), and studies show a lower prevalence of signs and symptoms associated with TMD at older ages. Clinically serious TMD are infrequent in children. A small percentage of patients develop chronic pain related to their TMD (Kinney et al, 1992). It is not known why some patients progress and others do not.

While epidemiologic studies find slightly higher frequency of signs and symptoms in females than in males, the small differences cannot explain the high proportion of women (7:1) who seek care for TMD (Okeson, 1996). Many individuals with symptoms of TMD do not receive care, and older adults do not tend to seek care. The NIH Technology Assessment Conference on Management of TMD (NIH, 1996) noted that there is no research documenting societal barriers and prejudices that prevent appropriate treatment.

Systemic factors and conditions may play a role in several TMDs. Factors such as degenerative, endo-crine, infectious, metabolic, neoplastic, neurologic, rheumatologic, and vascular disorders, have not been systematically studied. Also the NIH Technology Assessment Conference noted that systemic conditions, such as polymyositis, dermatomyositis, hereditary myopathies and fibromyalgia can affect the masticatory muscles.

Diagnosis and Management

Diagnosis and management of TMDs remain controversial. The NIH Technology Assessment Conference (NIH, 1996) states that, "diagnosis and initiation of treatment should be based on data from physical examination and should include medical and dental history, information about audiological, speech, and swallowing problems, pain and dysfunction. . . Evaluation should encompass examination of orofacial tissues, musculature, and neurological function. . . . Psychosocial assessments should determine the extent to which pain and dysfunction interfere with or diminish the patient's quality of life. However, the consideration of psychosocial factors has the potential for inappropriate use, and it is imperative that such assessments be managed by skilled professionals using validated instruments." It also is important to rule out symptoms that may be due to cancer, various arthritides, neurological diseases and other systemic medical conditions that should be referred to specialists.

Evidence-based guidelines strongly support the use of conservative, noninvasive, and reversible strategies for treating TMD. Current evidence suggests that strategies that permanently modify the occlusion and/or joint structures should be avoided. The guidelines recognize the need for patient education, adequate pain control using pharmacologic and behavioral means, and the possibility of physical therapy and stabilization splints. Surgical approaches may be necessary in a small percentage of patients.

II. DENTAL AND CRANIOFACIAL RESEARCH IN THE FUTURE

Advances in understanding the etiology, pathogenesis, and diagnosis of oral diseases and conditions have led, and will lead to, improved methods of disease management. Dental practice must evolve and broaden to incorporate this knowledge. Furthermore, differences in the burden of oral disease, evident throughout the United States, will challenge the profession to take a leadership role in improving access to care and delivery of dental services.

As noted, the disease-specific discussions illustrate many changes and advances that can be anticipated by the dental profession. But these nine oral disease categories are hardly inclusive of all dentistry.

One topic not addressed in this chapter but discussed elsewhere in the report of the Future of Dentistry is the aging of the population. It should be noted that with fewer severe carious lesions and fewer dental extractions, a continuing decrease in edentulism means that older individuals will retain more teeth, thus increasing risk for periodontal diseases and root caries. These individuals will require more preventive and therapeutic dental care. Conservative management of periodontally involved teeth will be the rule for this segment of the population. General dentists and dental hygienists can be expected to assume most of this increasing responsibility. To adequately treat older patients, who often have concomitant medical problems, it will be essential that dentists become more familiar with geriatric medicine.

FUTURE CHANGES IN DENTAL CARIES RESEARCH/DENTAL BIOMATERIALS RESEARCH

The future of dentistry will require new approaches and new ways of delivering proven methods if the profession is to be successful in further reducing or eradicating dental caries. New thinking in relation to public health dentistry and community dental health measures are needed to address the dental caries problem that occurs in underserved populations.

Dental caries remains a problem for a significant portion of the population, and is the most common disease of childhood. Certain high-risk children and adults suffer from extensive disease. Nevertheless, early identification of at-risk individuals is elusive, and research effort towards this outcome is required.

Approaches to the management of carious lesions in the near future will rely on remineralization. When

restoration is required, conservative repair without unnecessary removal of uninvolved tooth structure will be the rule. The shift in restorative dentistry to metal-free restorations is likely to expand with the introduction of improved composite-based materials, and new "smart" biomaterials to provide improved resistance to recurrent caries and wear.

The same bacteria involved in other forms of caries cause early childhood caries, especially among disadvantaged populations, but there are also other causal factors that are not yet fully understood. Future efforts are needed to treat the infection of the mother and/or the caregiver who is the primary infective agent in bacterial transfer to the child. Addressing this aspect in the environment of families and extended families is a major public health issue for the future. The association of increased caries incidence and impaired cognitive development needs further study.

Caries Risk Assessment

Caries management by risk assessment will be essential in the future of dentistry (Anusavice, 2000; and Featherstone, 2000). Risk assessment must be conducted prior to the removal of active caries and the placement of restorations. Future risk assessment strategies will include:

- ◆ Analysis of the frequency of cariogenic challenge/diet.
- ◆ Assessment of the oral status of caregivers.
- ◆ Quantitative determination of cariogenic bacteria with molecular biology tools. Antibodies designed to interact with the surfaces of specific species of cariogenic bacteria have been developed and can be tagged by fluorescent molecules that can be measured photometrically. This technology will enable rapid, chair-side assessment of the level of the bacterial challenge (Krasse, 1988).
- ◆ Assessment of the quantity and quality of salivary function.
- ◆ Measures of dietary challenge and salivary protective factors.

- ◆ Assessment of fluoride exposure.
- ◆ Information management systems to store and evaluate data on the bacterial challenge, salivary status, fluoride exposure, history of caries, and other risk factors, as a basis for planning a rational treatment protocol for the individual patient.
- ◆ Identification of specific genes or genetic markers that are associated with increased risk for severe, extensive caries.

Dental Caries Prevention and Management

New and improved dental products and antibacterial agents are on the horizon. Products that more effectively deliver fluoride and that provide antibacterial action at the same time will prevent dental caries:

- ◆ The wider use of sealants in combination with other preventive measures will occur.
- ◆ Chlorhexidine is currently the only antibacterial agent that effectively kills mutans streptococci. Lactobacilli are resistant to chlorhexidine; thus, other treatments will be necessary to reduce or eliminate them.
- ◆ Slow-release fluoride products are also likely to become widely utilized.
- ◆ Antibacterial agents attached to antibodies that react with the surfaces of cariogenic bacteria will likely be developed.
- ◆ Products will be developed to supplement saliva's function and protective components.
- ◆ Plant-derived genetically engineered antibodies such as sIgA are currently under development as a tool for inhibiting colonization of specific cariogenic bacteria.

Products incorporating specifically targeted antibacterial agents will become available for use in the dental office and most likely by prescription in the home environment. Such products could also be utilized in targeted community programs for reducing dental caries in populations and for blocking the transfer of infection from the caregiver to the child.

Both positive and negative interactions occur

between different species of bacteria inhabiting the same ecosystem. This provides the basis for a novel approach to preventing microbial diseases called "replacement therapy." In this approach, a harmless effector strain is permanently implanted in the host's microflora. Once established, the presence of the effector strain prevents the colonization or outgrowth of a particular pathogen.

To prevent dental caries in the future, replacement therapy will involve construction of an effector strain derived from a clinical *S. mutans* isolate. Recombinant DNA technology will be used to delete the gene encoding lactate dehydrogenase making it entirely deficient in lactic acid production (Hillman et al, 2000). Because of its strong colonization properties, a single application of the effector strain to patients should result in its permanent implantation and development of indigenous, disease-causing *S. mutans* strains over time. Thus, replacement therapy for the prevention of dental caries is an example of biofilm engineering that offers the potential for a highly efficient, cost-effective augmentation of conventional preventive strategies. Attendant concerns are the compatibility of the engineered organism with the normal flora, the ability of the organism to successfully colonize the oral cavity, and the regulatory issues related to safety of the new organism (Mandell, 1996).

There has been considerable interest in the development of a caries vaccine (Smith and Taubman, 1997; and Russell et al, 1999). These studies have considered the importance of humoral immunity in the caries process. Concerns have been raised about the safety of newly introduced vaccines and the relative effectiveness compared to other preventive approaches. Vaccines based on systemic inoculation are unlikely to be approved. Rather, approaches that may be more practical are based on mucosal immunization and production of salivary IgA antibody to mutans streptococci and passive immunization. Furthermore, the use of such a vaccine would likely be limited to high-risk individuals, i.e. patients with persistent xerostomia (Mandell, 1996).

Laboratory studies have shown that specific laser irradiation can alter the surface mineral of the enamel and make it highly resistant to subsequent acid dissolution (Featherstone et al, 1998). Consequently, carbon dioxide lasers with specific laser characteristics designed for this purpose, and potentially Er:YAG and Er:YSSG lasers, could be used to treat specific areas in caries-susceptible individuals to inhibit caries progression. Ideally,

pits and fissures can be treated in this way. When lasers remove early cavities, conditions can then be changed to treat the walls of the cavity preparations, thereby inhibiting secondary caries around restorations (Konishi et al, 1999). Controlled clinical trials are needed to make this technology fully accepted. New lasers with different wavelengths are currently in development that will be even more efficient and effective at removing caries. These lasers can be selective in carious tissue removal, leaving the surrounding tissue intact and much stronger than is the case for a conventional amalgam preparation. Flowable composites can be used to fill these cavity preparations, and better materials will become available for this purpose.

New approaches to remineralization of limited carious lesions represent an important future approach to the clinical management of caries.

The process of tooth remineralization has received significant attention over the past four decades (Koulourides et al, 1961; Silverstone et al, 1981; Larsen et al, 1987; White, 1988; Geiger et al, 1992; and Linton, 1996) although the concept was documented in the early 1900's (Head, 1912). There exists some controversy regarding the extent to which demineralized tissues can be remineralized and the means by which demineralization should be diagnosed in the clinic (Thylstrup and Fejerskov, 1994).

The visual signs of white spots that may disappear or reduce in size may be attributable to wear and polishing of the partially dissolved external surface of an active lesion. However, several studies have demonstrated an increase in hardness and mineral content and reduced subsequent demineralization at the surface of tooth tissues that were remineralized (Shannon and Edmonds, 1978; Retief et al, 1983; Vissink et al, 1985; Larsen and Fejerskov, 1987; White, 1988; and Linton, 1996).

Restorative materials are continually being improved. In the future, they will be able to:

- ◆ Release antibacterial agents or fluoride on demand. The so-called "actively smart materials" represent a potential approach if they will release sufficient concentrations of therapeutic agents at specific times when they are needed, i.e., when the disease is active.
- ◆ Be readily placed in very small conservative cavity preparations. For temporization of cavitated teeth in individuals at a high risk of caries, "actively smart materials" similar to glass ionomer, but with greater fracture

resistance, must be developed to increase the survival times. Highly viscous glass ionomer materials have been used for this purpose, but approximately 20% of these temporary restorations fail over a period of three years when used for the atraumatic restorative treatment technique. Currently, these materials are used primarily in developing countries where electricity and pressurized air and water are not available.

- ◆ Remain durable and flexible and become an integral part of the tooth.
- ◆ Stimulate growth of new or reparative dentin.
- ◆ Be utilized with the increased application of CAD-CAM technology. This will reduce cost and time require for extensive rehabilitation of severely involved dentitions.

Extension of coronal or root caries into the pulpal tissue requires endodontic therapy for the affected tooth. The recent focus on improved instrumentation and use of magnification during endodontic therapy will improve the effectiveness of treatment. The use of lasers in endodontic therapy, including indirect and direct pulp capping, vital pulp amputation and preparation of the root canal system, will see increased emphasis, with attention to specific approaches to clinical application (Matsumoto, 2000). The future will also see new emphasis on treatment of disease processes that affect the periradicular tissues, including persistent apical disease, tooth perforations and fractures, and internal and external resorption. Definition of the importance of growth factors in pulpal repair will likely be an important area of future research, with a focus on clinical application (Roberts-Clark and Smith, 2000). Concern has been raised, however, about delivery of these agents to injured pulp tissue (Tziafas et al, 2000). The potential impact of untreated endodontic disease as a risk factor to certain systemic diseases needs to be explored (Grau et al, 1997).

IMPLANTOLOGY

The use of osseointegrated dental implants will expand in the future. Improved understanding of wound healing associated with implant placement, with a particular emphasis on the implant-bone interface, will be a focus of future research. Relying on both metallurgical and biological science, these studies will lead to improved implant surface coatings. As the demand

for dental implants continues to grow, cost will remain a limiting factor for many people. The challenge for the future is to reduce the cost of this treatment so more patients can benefit from these advances.

In the next 10 years, new approaches to treatment planning and diagnosis will be introduced (e.g., micro-computerized tomography) which will more precisely guide the use of dental implants in regions of the jaws that currently show low success rates. In addition, it is likely that algorithms will be developed to identify patients at risk for implant failure.

DENTAL BIOMATERIALS

Research of importance to the practicing dentist necessarily includes topics associated with dental biomaterials. Advanced materials processing and forming methods have already been introduced into both clinical and dental laboratory settings. It is anticipated that advanced process development will continue. Much focus will remain on the optimization of current materials, minimizing contraindications and broadening use of esthetic materials for posterior restorations. "Actively smart materials" are under development that combines diagnostic, restorative and therapeutic (controlled release) capability. Work continues on improving adhesive chemistries and on mercury-free restorative materials. Increased focus is being given to the development of laboratory tests that validly reproduce clinical behavior. Interest is increasing in promoting systematic evaluation of the technique sensitivity of restorative materials. Biomimetic approaches are being investigated, as are tissue engineering concepts for the development of materials more closely resembling those being replaced. Surface chemistries and topologies of implantable materials are being studied to enhance cellular interactions.

Advanced forming systems, almost all involving some computer control, will (1) broaden the range of currently available materials that can be used in dental practice, (2) improve the precision and automate dental laboratory fabrication, (3) foster development of novel prostheses and craniofacial implants, and (4) provide routes to novel materials. One promising technology undergoing development involves three-dimensional printing of powder/binder combinations followed by sintering to form solid objects from ceramics or alloys (Cima, 1996). One application involves 3-D data sets obtained pre-surgically for use in fabricating custom titanium

maxillofacial implants (Hong et al, 2001). This technology also provides a route to structures made of gradient materials, i.e. materials having a gradation of properties such as solubility, elastic moduli, and translucency that may provide novel clinical performance.

Direct resin-based composites, in particular, will continue to be improved. Active research efforts are underway, targeting decreased polymerization shrinkage. Decreased polymerization shrinkage is important for reducing stresses at the material-tooth interface that lead to gap formation and degradation of material-tooth bonding. Ring-opening monomers and certain epoxy systems that can expand during polymerization are being developed or investigated for dental use (Guggenberger et al, 1998; and Tilbrook et al, 2000). Improved filler phases, bonding agents and toughened polymer matrixes are being investigated to improve wear and structural behavior and add remineralizing capability (Antonucci et al, 1991; Stansbury and Antonucci, 1992; Skrtic et al, 1996; Schumacher et al, 1997; Stansbury and Antonucci, 1999; and Xu et al, 2000). Novel posterior restorative materials are being developed, including mercury-free, condensable silver fillings and esthetic interpenetrating-phase composites (non-shrinking), based on the resin infiltration of porous, three-dimensional ceramic skeletons (Dariel et al, 1995; Eichmiller et al, 1996; Giordano et al, 1997; Kelly and Antonucci, 1997; and Sabrosa et al, 1999). "Wear-kind" ceramics are increasingly conceivable, as more information becomes available regarding intraoral damage mechanisms and microstructure-property relationships. Research efforts continue to be expended on broadening the use of titanium in fixed prosthodontics, particularly with respect to improving the interface with fired porcelains (Könönen and Kivilahti, 2001).

Many academicians recognize the need for a more robust evidence base to guide clinical decisions involving comparisons among materials and the rational development of clinical indications for new materials (Laskin, 2000). Investigations are being called for to identify the relative technique sensitivity of restorative systems with respect to clinical outcomes. Research is anticipated in the development of *in vitro* test methodologies predictive of clinical behavior to evaluate dental biomaterials and assist in standard test development. Additional work is anticipated in standardized protocol development for clinical evaluations of dental biomaterials in

both university-based and private practice-based settings. This interest derives from dissatisfaction with the validity of surrogate data from laboratory testing and the limited comparability (e.g., in meta-analysis) of too large a percentage of published dental clinical trials (Kelly, 1999; and Palmer and Sendi, 1999). Rather than focusing on component material properties, dental prostheses are being evaluated as engineered structures for purposes of design evaluation and improvement (Kelly et al, 1995; and Goetzen and Anusavice, 2001).

Improving and directing the interaction of cells and cellular processes with implanted materials remains a research focus to both enhance the clinical application of titanium dental implants and to induce the rapid restoration of normal tissue architecture in repaired hard and soft tissues (Hallab et al, 2001; and Ogawa et al, 2000). The development and microstructure of tissues continues to be studied with the hope that biological processes can be mimicked in the fabrication of biomimetic prosthetic materials (Marshall et al, 2001; White et al, 2001; Kamat et al, 2000; and Kirkham et al, 2000). Scaffold materials are receiving much attention in tissue engineering research as initial carriers of cells, growth factors and molecular species designed to direct and enhance defect repair, especially in bone (Ma and Choi, 2001; Loty et al, 2000; Reddi, 2000; and de Bruijn et al, 1999). Tissue engineering approaches may also provide clinicians with the capability to restore salivary gland tissues and function (Baum et al, 1999).

FUTURE CHANGES IN PERIODONTAL DISEASES RESEARCH

Periodontal Disease Risk Assessment and Diagnosis

The diagnosis of periodontal disease will continue to evolve over the next 10 years. Clinicians will begin to identify individuals who are at risk for active periodontal diseases using genetic tests and biologic tests that identify specific microorganisms in subgingival plaque and/or inflammatory mediators in gingival fluid and/or saliva. In addition, digital radiography will be used more in periodontal diagnosis, and practical systems will be introduced to perform subtraction radiography in the dental office.

Attention is focusing on ways to identify patients at risk for advanced forms of periodontitis. One

such approach is the recent report of a periodontitis-associated genotype that has been linked to elevated production of proinflammatory cytokines IL-1 α , IL-1 β , TNF- α (Kornman et al, 1997). Future research will form an improved definition of genetic, environmental, and microbial risk factors for periodontitis that will lead to development of a profile for patients at risk for advanced disease.

Digital radiography has been introduced for clinical use, and its application is likely to increase because it reduces radiation exposure and facilitates storage of diagnostic information. It can be anticipated that subtraction radiography will be introduced as part of patient management, but may be limited to specialized treatment centers.

The use of laboratory tests (microbial challenge, host response) has been intensely studied, and it is possible that this area of investigation will see renewed interest because of the growing body of evidence linking periodontal diseases and various systemic diseases. These tests will likely be formatted in a user-friendly style, utilizing saliva or blood to measure a parameter reflective of the patient, rather than a particular tooth. Research in this area will be linked to studies of the relationship of periodontal diseases and cardiovascular disease, cerebrovascular disease, pre-term low birth weight babies, and diabetes mellitus. The effect of periodontal treatment as a means of reducing the risk for these medical disorders will also be explored.

The identification of the genetic basis for syndromic and nonsyndromic rapidly progressive forms of periodontal disease offers to dramatically improve our understanding of basic mechanisms that account for destruction of the supporting tissues of the teeth. As an example, a specific mutation on chromosome 11q14 associated with the gene encoding of the enzyme cathepsin C was detected in a consanguineous family with prepubertal periodontitis (Hart et al, 2000). These studies will become an important part of periodontal disease research, in tandem with the general emphasis on using information about variations in the human genome, and the protein products of those genes, to explain human diseases.

Periodontal Disease Management

The improved understanding of the pathogenesis of the periodontal diseases should lead to new and improved treatments. Antimicrobial approaches have focused on local delivery of antimicrobials/ antibiotics

into the gingival crevice. The use of systemic antibiotics will be reserved for the most aggressive forms of disease, and also may be employed as part of periodontal therapy for patients with certain systemic diseases that have been linked to periodontitis. Considerable research effort has focused on the use of newer anti-inflammatory agents for treatment of periodontitis. While systemically delivered agents have been used in both animal and human studies, topical delivery of these agents (mouth rinses, toothpastes) seems the most logical approach for the future. In addition, recent understanding of the specific events in the pathogenesis of periodontal disease will lead to highly specific and novel therapies. For example, IL-1 receptor antagonists may be employed as anti-inflammatory agents (Graves et al, 1998), and, in the case of diabetes-associated periodontitis, blockade of the receptor for advanced glycation endproducts (Lalla et al, 2000) may be selectively utilized in affected patients.

Advances in treatment of periodontitis will focus on procedures to induce regeneration of lost periodontal tissues. Among the specific mediators being studied for application in periodontal therapy are recombinant bone morphogenetic proteins and combinations of growth factors. The success of these therapies will depend on the identification of the appropriate biological mediator and the appropriate delivery system.

FUTURE CHANGES IN SYSTEMIC DISEASES RESEARCH

Although there are a few negative findings (Hujoel et al, 2000), the evidence in support of a link between periodontal and systemic diseases continues to mount. Oral infections are suspected to be a risk factor for certain systemic diseases (that is, cardiovascular disease, cerebrovascular disease, aspiration pneumonia) and for pre-term low birth weight babies.

As supportive research evidence becomes available, dentists will need to provide more intense management of patients' oral infections. Increased communication by dentists with other health care professionals can be expected.

However, without intervention studies demonstrating a systemic therapeutic benefit from periodontal therapy, there is no concrete evidence to justify a change in oral health care policy or current standards of care. New studies in progress have the potential to alter this position rapidly. Evidence suggests that poor oral health may be as detrimental

to general health as other risk factors, such as smoking or high cholesterol levels.

As the relationship of oral infection and certain systemic diseases is further defined, dentists will be expected to be active participants in the management of patients with certain systemic diseases, and to broadly consider how medical management of patients will influence dental health and dental care. For example, longitudinal medical studies have demonstrated that good glycemic control limits the onset and prevalence of complications from diabetes mellitus. Consequently, an important part of managing periodontal diseases in these patients is the medical management of the patient. When indicated, dentists should be checking hemoglobin A1c. Periodontal diseases are the sixth complication of diabetes mellitus. Since dentists may see patients more regularly than physicians, dentists should be screening for diabetes mellitus in their patients who are at risk.

If, in the near future, multicentered, randomized, controlled clinical trials confirm that periodontal disease causes systemic conditions, several issues will confront the dental profession:

- ◆ Studies will need to be conducted to determine the effectiveness of screening patients in the dental office for certain diseases with obvious ramifications for the oral cavity (i.e. diabetes mellitus). Furthermore, the effectiveness of screening for oral disease by physicians and other non-dental health care workers should be assessed. If effective, these programs will enhance the oral health and general health status of patients.
- ◆ There will be a growing appreciation by the public and physicians that dentistry can no longer be considered solely a luxury, elective health care. Recent polls indicate that 85% of the public is already aware of the fact that poor oral health can worsen general health.
- ◆ The recognition of the medical necessity for periodontal care will increase the perceived importance of dental services, and the demand for dental services will increase. Thus, the larger problems are the perception among health care professionals, the nature and system by which health care is delivered, and access and utilization.
- ◆ Research findings providing a clear demonstration of the medical necessity for periodontal care among

pregnant women would undoubtedly lead to a rapid and profound increase in the priority of dental services in such high-risk populations.

◆ This view of the future has profound implications for the dental profession—from education to practice to public policy—that will require considerable planning and redirection.

FUTURE CHANGES IN CLEFT LIP, CLEFT PALATE AND CRANIOFACIAL DEVELOPMENTAL DISORDERS RESEARCH

Given the many new developments in studies of the etiology and treatment of oral clefts and craniofacial developmental disorders, and the pivotal role played by dental specialists on the cleft/craniofacial team, the dental profession will have opportunities in the future to make significant contributions to research. Training dentists in the benefits and conduct of epidemiological, basic science, social science and clinical trial research will enable them to participate more fully in these areas. Current research efforts are pointing the way to promising directions, especially in the areas of etiology/prevention and outcomes.

Etiology and Prevention

◆ Family studies have for many years demonstrated that inherited genetic variation has a very large effect on risk of nonsyndromic oral clefts, and this is the basis of current genetic counseling based on averages obtained from population studies. The challenge for the future is to identify the specific genes and DNA polymorphisms that influence risk. This will move us towards an era of "individualized medicine" where risk of orofacial clefting can be much more accurately predicted based on the "genetic blueprint" of the parents. The human genome project has now produced the tools and knowledge in the form of millions of single nucleotide polymorphisms (SNPs, pronounced "snips") which will enable this line of research to move forward at a greatly accelerated pace.

◆ Further studies of teratogens and potentially protective dietary factors such as vitamins and folate are needed to better understand the role of environmental factors in both nonsyndromic and some forms of syndromic orofacial clefting. Continued development of biomarkers to more reliably measure subjects' nutrition rather than relying solely

on self-reports from questionnaires will benefit this area of research. Since gene-environment interactions are presumed to be common and important, these studies will also benefit from the incorporation of large scale SNP-mapping into the design.

◆ Animal models of spontaneous and teratogen-induced clefting have yielded candidate biological mechanisms and candidate genes for evaluation in humans (Diehl and Erickson, 1997). These models warrant further exploration using modern genomic techniques that have very substantial promise to quickly identify a number of specific genes that have major effects on risk of orofacial clefting and craniofacial developmental disorders.

◆ Studies in animals and of human inter-racial marriages have clearly demonstrated that the maternal genotype has a very important effect on risk of nonsyndromic orofacial clefting. Future research in humans should more thoroughly evaluate the maternal genotype in addition to that of the fetus in determining risk of this birth defect.

◆ Continued efforts should target the identification of additional gene mutations involved in currently unresolved syndromic forms of orofacial clefting and craniofacial developmental disorders. Basic research should also work towards obtaining a better understanding of the molecular pathways that are disrupted by mutations at these genes.

The very high overall genetic component of susceptibility to these birth defects, combined with the evermore powerful tools of human and animal genetics, promise to reveal their basic causes with continued investment. However, the nature of clinical research requires very long-term commitments of major resources for patient recruitment and evaluation, laboratory assays, and data management and statistical analysis. Because of the complex nature of these diseases, multiple independent studies of large collections of subjects and their families or appropriate control groups will be needed to provide the statistical power necessary for making definitive findings. Groups around the world currently focused on this research effort will need continued support for many years to achieve major success. Clinical trials of new means of prevention for some disorders such as nonsyndromic oral clefts will also be very expensive and worthwhile, but it must be recognized that these efforts are likely to be years

away from producing strategies that will completely prevent clefts, so treatment will continue to be necessary for the foreseeable future.

Treatments and Outcomes

Given the complexity of the genetic contributions to clefting, and the long time-frame before prevention is a reality, immediate research goals must also address the issues of access to care, delivery of care, quality of care, and outcome of care. Some recent research and initiatives have begun to address these issues and can be used as guidelines for planning future directions.

◆ The 1992 Eurocleft project was one of the first attempts to comprehensively compare treatment outcomes from different centers, each with widely differing treatment protocols. Using multidisciplinary outcome measures and strict research methodology, these studies not only demonstrated the fact that outcomes can vary considerably based on the particular treatment approach used, but also that well-planned retrospective use of standardized treatment records can allow for valid research approaches.

◆ A 2000 survey of 201 cleft palate centers in Europe indicated that there were 194 different primary surgical protocols. With the likelihood that the dental protocols used by different centers vary as much or more, the need for clinical trials and outcome studies to establish the efficacy and effectiveness of various treatment approaches is obvious. Few randomized control trials have been carried out in the cleft/craniofacial field, and these are essential in order to objectively determine the relative merits of different treatment methods.

◆ The lack of standardized recording and reporting results of treatment has led to several recent initiatives having the potential to greatly facilitate future outcomes research. For example, the Craniofacial Outcomes Registry is an attempt to establish standard outcome measures for all aspects of cleft care, and to provide a centralized repository where individual cleft/craniofacial centers can register patients online and then subsequently submit treatment information and outcome measures. The dental profession has the potential for making significant contributions to this effort, both in terms of participation in the establishment of valid and reliable outcome measures, and also through

submission of properly recorded and analyzed patient data. The range of outcome measures in areas of importance to dentistry include assessments of pre-surgical orthopedic treatment, pediatric dental management, alveolar bone grafting, orthodontic and orthopedic management, orthognathic surgical results, and dental implants in the bone-grafted cleft alveolar ridge, among others.

◆ An extension of the 1992 Eurocleft study has set up a network of nearly all cleft/craniofacial teams in Europe to establish standards for recording and reporting treatment outcomes in many areas of cleft care with the aim of improving effectiveness and efficiency. Dental specialists have played a major role in the creation of this organization. As with the Craniofacial Outcomes Registry, the Eurocleft Project has the potential for providing collective information on cleft/craniofacial treatment outcomes which will enable more productive future research efforts to identify the most effective treatment regimes.

◆ Advances in fields such as gene therapy and tissue bioengineering will eventually revolutionize the treatment of orofacial clefts and craniofacial developmental disorders (Lorenz et al, 2000). These long-term research efforts need to receive ongoing support in order to achieve their potential. Encouraging interdisciplinary interactions between experts working on these "futuristic" approaches and dental professionals experienced in applying today's best treatment methods will also enhance progress.

As a result of these developments, the potential future impact of the dental profession on improvements in the treatment and research of orofacial clefts and craniofacial developmental disorders is significant. Since many of the projects moving towards globalization of the research effort are still early in planning stages, dental professionals have a great opportunity to shape these efforts to ensure that dental concerns in cleft/craniofacial care are properly addressed. Appropriate training of dental scientists in the execution of valid and reliable outcome studies and randomized control trials will facilitate the development and use of evidence-based treatment decisions by future cleft/craniofacial teams. Future research of a high caliber should finally allow for the scientifically-based elimination of treatment methods which fail to produce outcomes and benefits necessary to justify their continued use.

Additionally, research agendas aimed at evaluating the efficacy, cost-effectiveness, and benefits of team care will need to be designed such that patients with orofacial clefts and craniofacial developmental disorders continue to be treated in interdisciplinary centers by care-providers with focal interest in, and high-volume experience with, problems unique to this group of patients. Finally, there is also a need for the development of outcome measures which incorporate the potentially more meaningful issues of patient/parent expectations, satisfaction, and quality of life evaluations (e.g., orofacial aesthetics, speech and non-speech functions, and self image) which may be greater indices of successful treatment than other more traditional data.

FUTURE CHANGES IN MALOCCLUSION AND TOOTH AGENESIS RESEARCH

Research on human genetic variation that influences the development of the craniofacial complex may be one way to bridge the gap between developmental biology and the study of clinical variation. It has been shown that certain craniofacial types have tendencies towards certain types of malocclusion—for example, dolichocephalic/leptoprosopic craniofacial types are associated with Class II malocclusion (Enlow and Hans, 1996).

Understanding the genetic basis for malocclusion represents one of the major challenges for the future. Furthermore, there is a need to understand the contribution of genetic versus environmental contributions to malocclusion. Genetic linkage analysis is a powerful approach for identifying genes that have a major effect on familial skeletal Class II or Class III malocclusion and familial forms of tooth agenesis and supernumerary teeth.

Research using both cell and tissue culture and animal models will greatly increase our knowledge of the process of cellular control, suture biology, genetic factors, and the interaction of environmental factors with genetic susceptibility. A major task will be to apply the increasing knowledge of craniofacial developmental biology (Thesleff, 1998) to research on malocclusion and agenesis in humans. Investigators must also evaluate epigenetic factors that may activate expression of regulatory genes and influence postnatal growth (Carlson, 1999).

Future diagnoses for some of these disorders will include the analysis of genetic polymorphisms associated with specific growth and development ten-

dencies and/or the ability of the craniofacies to respond to epigenetic signals.

Research is needed to capitalize on potential benefits of three-dimensional imaging of both hard and soft tissue, digital radiography, and imaging without ionizing radiation (e.g., magnetic resonance imaging).

Relatively new techniques for treatment of malocclusion, such as osteodistraction and implant/onplant-based anchorage, arise from basic research in biomaterials/bioengineering/biomimetics. In the future, a combination of biological and biomechanical signals may direct growth and development where it is needed.

With this consideration, increased understanding of the various morphogenetic signaling pathways that regulate development of the craniofacies should allow manipulation of the proliferation, patterning, and differentiation of tissue in order to treat malocclusion due to skeletal discrepancies. Furthermore, it should be advantageous to induce tooth development in areas of tooth agenesis (Nuckolls et al, 1999). As more is learned about cell biology and tooth movement, the effect of different biomechanics may be studied and applied to clinical practice (Gu et al, 1999).

Research on factors that may contribute to external apical root resorption associated with orthodontic movement of teeth, including genetic factors (Harris et al, 1997), may help decrease the incidence of this unwanted side effect.

Nanotechnology and materials science may lead to ways to generate biomechanical forces in a more controlled and biologically appropriate manner. Joint conferences between academic and industry communities could be of benefit.

Scientific evaluation of the clinical outcomes following application of different protocols, techniques, and appliances to treat malocclusions is needed. Retrospective/prospective investigations (Johnston, 1998a,b) or randomized clinical trials (Ghafari et al, 1998) may be employed. The power of these investigations will increase with better communication and interactions among centers pursuing these studies. Furthermore, advances in bioinformatics may improve the reliability of predicting treatment outcomes.

While treatment of major malocclusions will remain in the domain of the orthodontic specialist, general practitioners will have an expanding role in the early diagnosis of malocclusions and early, interventional therapy. The specialist will utilize new three-dimensional imaging techniques and conservative tooth movement approaches utilizing computer-guided pro-

jection of desired outcomes to affect tooth movement. New techniques that cross specialty barriers (e.g., oseointegrated implants used for anchorage, distraction osteogenesis) will be utilized to achieve optimum results in particularly challenging cases.

FUTURE CHANGES IN ORAL AND PHARYNGEAL CANCERS RESEARCH

A number of new diagnostic approaches will facilitate an expanded role for dental practitioners in identifying the risk for oral cancer, and the early diagnosis of oral cancerous lesions. A recently introduced brush biopsy-computerized cytological identification system has shown promise for diagnosis of epithelial cancers without the need for a surgical biopsy. In the future, new saliva-based diagnostic approaches based on the improved understanding of the genetic basis of oral cancer will become available for clinical application.

Clinicians will be able to use algorithms to identify persons at greater risk for development of malignancy. These algorithms will combine the effects of environmental and genetic risk factors. Other diagnostic procedures, including quantitation of nuclear DNA, may be used to identify the prognosis and predict the clinical outcome of patients with intraoral epithelial dysplastic lesions.

Chemoprevention research is aimed at reversing the growth of advanced premalignant lesions using retinoic acid derivatives and other substances (Geyer et al, 1998). This approach may also help prevent new primary cancers in patients who already have oral and pharyngeal cancers and may increase the effectiveness of methods aimed at treating the primary cancers themselves. Additional basic research and clinical trials are needed to evaluate promising chemoprevention approaches more rapidly and effectively. Since such individuals are at very substantially elevated risk of developing oral cancer, they could be prioritized for frequent oral examinations for early cancer detection and for smoking and alcohol cessation intervention programs (Prochazka, 2000).

Advances in the understanding of the molecular basis for progression, angiogenesis, invasion, and metastasis of oral cancers (Califano et al, 2000; Grandis et al, 2000; Hanzawa et al, 2000; Nitta et al, 2000; and Smith BD et al, 2000) is especially important for developing new methods to detect these tumors and new treatments to halt their growth and metastasis.

Future research should focus on the following challenges and opportunities:

◆ Continued research on promising improvements in the detection and diagnosis of oral mucosal lesions, including cancers, using molecular tools:

- Staining with toluidine blue to focus attention on lesions progressing toward malignancy (Ephros and Mashberg, 1999; and Kerawala et al, 2000).

- A neural network computational approach using an oral brush biopsy and computerized cytological detection of abnormalities to facilitate detection of dysplasia and carcinoma (Sciubba, 1999).

- Molecular assays such as those based on mitochondrial DNA mutations to provide highly sensitive and non-invasive early oral cancer detection (Fliss et al, 2000).

- Following-up on a very exciting recent development regarding the use of abnormal DNA content (tetraploidy or aneuploidy) to assess the risk of cancer development from oralleukoplakias (Sudbø et al, 2001). A carcinoma developed in only 3% of normal diploid lesions, versus 60% of tetraploid and 84% of aneuploid lesions during a mean follow-up period of over eight years.

◆ New treatment approaches using gene therapy combined with chemotherapies (Khuri et al, 2000), immunotherapy (Chikamatsu et al, 1999) and approaches directed at reducing invasiveness (Simon et al, 1999).

◆ Investigating ways to reduce oral cancer patients' excess morbidity and mortality from causes other than due to oral cancer itself, mostly due to the patients' high levels of alcohol and tobacco use.

◆ Developing more effective methods to educate dental professionals about oral cancer risk factors and to encourage high quality and frequent oral examinations for early cancer detection (Yellowitz et al, 2000).

◆ Research should also investigate optimal and cost effective ways to inform both health professionals and the general public about the great value of decreasing high-risk behaviors such as smoking and alcohol drinking and increasing consumption of fruits and vegetables.

- ◆ Improving methods based on molecular and genetic assessments, in combination with alcohol, tobacco and dietary risk-factor profiles, to more accurately predict which common non-malignant oral lesions present the most significant danger to the patients (Warnakulasuriya, 2000).
- ◆ New advances in biomaterials and biomimetics to provide improved tools for tissue reconstruction, reducing the impact of treatment on patients' quality of life.
- ◆ Increasing knowledge of how inherited susceptibility and gene-environment interactions influence cancer risk. The potential for advances in this area has been greatly enhanced by the human genome project's discovery of several million human single nucleotide polymorphisms and strategies to relate these genes to disease risk (Chakravarti, 2001; and Peltonen and McKusick, 2001). In addition to greatly facilitating the identification of genes most strongly associated with oral cancer risk, these tools will also usher in an exciting new era of individualized risk assessment and therapy. Treatments will be custom-tailored to each person's genotype, with potentially great improvements in effectiveness.
- ◆ Continued research aiming at better understanding of the processes of tumor initiation, progression and metastasis at the cellular and molecular levels. These efforts will be greatly accelerated by new and powerful tools such as microarrays capable of assessing very large numbers of genes and/or proteins simultaneously, and laser capture microdissection that promises to extend resolution to the level of single cells.

FUTURE CHANGES IN ORAL MUCOSAL AND AUTOIMMUNE DISEASES/OTHER INFECTIONS RESEARCH

The oral cavity can be the site of infections that cause disorders other than dental caries and periodontal diseases. Most of these bacterial diseases (e.g., *Mycobacterium tuberculosis* and tuberculosis, *Treponema pallidum* and syphilis, *Neisseria gonorrhoeae* and gonorrhea) and viral diseases (e.g., human papilloma virus) are rare in the oral cavity. Other infections are more common (e.g., *Candida albicans*, herpes simplex virus 1).

Diagnosis and chemotherapeutic management of these infections will become a regular part of dental practice as more dental patients are older and taking

more medication. The resulting reduction in salivary flow will result in an increased incidence of fungal, viral and less common bacterial infections.

With the identification of specific risk factors for oral diseases, and the clear understanding that many oral diseases are multifactorial, risk analysis for these infections will be considered as part of treatment planning for at-risk patients. Computer-based algorithms will be created, patients' variables will be entered, and a measure of risk for future diseases will be determined. Such risk determinants can guide the clinician in preventive strategies or treatment decisions.

A bacterial cause of aphthous stomatitis has been suspected for years, but evidence was limited to studies in which bacteria were identified by conventional culture. The use of polymerase chain reaction techniques has made it possible to study the potential relationship of bacteria to aphthous stomatitis at the molecular level. Evidence supports a frequent association between *Helicobacter pylori* and aphthous stomatitis. If true, this finding might suggest a reason why clinicians have long reported the response of canker sores to treatment with tetracycline, as well as suggesting new approaches to treatment (Birek et al, 1999).

Descriptive and immunohistochemical microscopic studies have done much to define components of the cellular and humoral immune system that participate in oral blistering diseases and aphthous stomatitis. Elements of the immune system are active in the mucosa during periods of disease, but the identification of the precipitating antigen that triggers the reaction has been elusive (Dabelsteen, 1998).

Relationships between mouth conditions and specific HLA types have been identified between HLA-Te22 antigen and antinuclear antibody in Chinese patients with lichen planus (Sun et al, 2000). With the identification of the human genome, it can be anticipated that genetic associations and risk definitions for many of the diseases of the oral mucosa will be possible. A challenge facing researchers is to differentiate casual or coincidental associations from those that are of etiologic or clinical significance.

The clinical changes associated with pemphigoid are the consequence of antibody deposition at the junction of the epithelium and the underlying connective tissue. Recently, researchers identified the presence of a unique integrin that functions as the antigenic driver of the disease and shows a genetic link to the expressed integrin (Kumari et al, 2001). This type of discovery may lead to identification of at-risk individuals and populations, and for developing genetic

manipulation to reduce the likelihood of the disease.

Recent research has suggested a possible association between aphthous and herpes virus type 6 (HHV-6). Specific HHV-6 IgM was detected in a significant percentage of patients with aphthous stomatitis. Also, high levels of anti-HHV-6 antibody were found in patients with lichen planus (Ghodratnama et al, 1999). The dissimilarity of the two conditions notwithstanding, the finding points to the need for additional studies to define the role of the virus in both conditions.

Thalidomide is now available for treating major aphthous stomatitis, especially that associated with HIV infection (Jacobson, 2000). Data from a series of studies suggested that a cytokine, tumor necrosis factor-alpha (TNF- α), was a critical mechanistic driver of the development of these large, persistent, and highly symptomatic ulcers. Consequently, compounds that were effective inhibitors of TNF- α may prove to be an effective therapy.

There may be a relationship between lichen planus and oral cancer. While the World Health Organization defines oral lichen planus as a premalignant lesion, it has been argued that only those lesions demonstrating dysplasia are truly premalignant. A simple quantitative comparison between the number of individuals with lichen planus and the number with oral cancer intuitively seems to negate the hypothesis that all cases of oral lichen planus are premalignant. The use of increasingly sophisticated techniques, such as microsatellite analysis in which oral lichen planus was evaluated for loss of heterozygosity, are needed to ultimately resolve this issue (Zhang et al, 1997).

One of the recent advances that may aid in the faster diagnosis of oral HSV infection in immunocompromised patients involves in situ hybridization of cytobrush smears using an automated smear apparatus (Kobayashi et al, 1998). New treatment and prevention modalities that are targeted to immunocompromised patients are also emerging. Low dose interferon alpha administered orally has been successfully used to treat both animal and human oral herpetic disease (Scalvenzi and Ceddia, 2000). In addition, certain advances have been made in the vaccine development arena with the most notable being the potentially protective immunity generated with a vaccine based on the use of attenuated *Salmonella typhimurium* as an expression vector of HSV antigens (Karem et al, 1997).

Dentists will need to recognize infectious diseases or immunocompromised states that show oral manifestations. Various diagnostic tests have already

been developed which can assist the dentist in determining, chair-side, the presence of an herpetic or a monilial infection. At present, these tests do not seem to be in widespread use (Laga et al, 1993; and Contreras et al, 1996). It is expected that there will be more chair-side tests developed that will permit a dentist to make a definitive diagnosis of an opportunistic infection, treat the infection and encourage the dentist to arrange for an early referral for definitive care by a medical specialist.

Furthermore, the greatest future threat to patients will, in all likelihood, come from newly emerging infectious diseases. As illustrated by the HIV pandemic (Casiglia and Woo, 2000), a new human pathogen indirectly led to the dramatic increase in previously recognized oral infection (*Candida albicans*), as well as the occurrence of previously unrecognized oral pathology, including hairy leukoplakia (due to the Epstein-Barr virus), linear gingival erythema and necrotizing ulcerative periodontitis. The successful identification and management by dentists of these emerging infections will, as illustrated in the past, depend upon close collaboration between infectious disease specialists and dental health care professionals.

There will be continuing developments and better understanding of infectious disease control policies. Research will no doubt lead to the availability of new vaccines (Cho, 2000) similar to the Hepatitis B vaccine now widely accepted by the dental profession. There will be a more complete understanding of the precautionary measures that can be taken to reduce the infectious disease hazards of patients and members of the dental team in the dental environment.

FUTURE CHANGES IN SALIVARY GLAND DISEASES RESEARCH

The testing and introduction of secretagogues with longer duration of action and fewer side effects will occur in the near future. The development of controlled-release formulations of these agents also can be anticipated. Furthermore, improved anti-inflammatory and immune-mediating agents are expected, in the near future, that will be therapeutic for Sjögren's syndrome and other salivary gland inflammatory conditions. Examples include thalidomide derivatives that have immunomodulating activity without the devastating teratogenic side effects, and new tolerance-inducing regimens that may markedly reduce the incidence and severity of autoimmune conditions. Both cytokine and anti-cytokine therapies are

being evaluated in clinical trials.

Better criteria for defining Sjögren's syndrome and other autoimmune conditions should enable the development of agents that block or reverse critical mechanisms of the pathophysiology and that have fewer serious side effects than current therapeutics. These include gene therapy to salivary glands using the major salivary ducts to deliver relevant molecules directly to the affected site (Baum and O'Connell, 1999). This approach enables the delivery of proteins to the salivary glands and also to the oral cavity through the salivary secretions and to the systemic circulation by an endocrine route.

Better animal models of Sjögren's syndrome are needed. Non-Obese Diabetic (NOD) mice develop severe diabetes, which is a confounding factor in studies with these animals. Strains of NOD mice that lack severe diabetes have been reported, but these animals have not been studied extensively (Robinson et al, 1998).

If the critical autoantigen can be identified, several strategies could be utilized to prevent or halt the autoimmune exocrine destruction. Autologous salivary tissues harvested from the individual, expanded *ex vivo*, and then re-implanted in an appropriate matrix, is used to induce regrowth and repair (Baum and Mooney, 2000). Tissue could be harvested prior to a course of head and neck radiotherapy and then placed back into an individual after radiation and a healing period.

Tissue engineering could create an implantable fully functional salivary gland using allogeneic tissues (Baum and Mooney, 2000). This would have application in cases where there has been complete loss of salivary function from disease or therapy. The basic principles for production of an "artificial salivary gland" have been detailed, and initial experimental work has begun.

Advances in detailing the human genome will have a major impact on studies of the genetics of salivary gland diseases and their treatment. With full definition of the proteome, it will be possible to recognize individual genetic variations responsible for responses to treatments.

FUTURE CHANGES IN TEMPOROMANDIBULAR DISORDERS (TMD) RESEARCH

The current emphasis on conservative and non-invasive therapies for TMJ disorders clearly suggests that with appropriate training all dentists can treat affected patients, with referral indicated only for the most recalcitrant cases. Further research emphasis on

orofacial pain will promote the use of new imaging techniques for improved patient management.

The NIH Technology Assessment Conference (NIH, 1996) recommended future approaches to research on treatment:

- ◆ "Medical management" model rather than a "dental treatment" model.
- ◆ Interdisciplinary teams to manage the patient.
- ◆ Randomized controlled clinical trials to determine the safety and efficacy of treatments.
- ◆ Repair and regeneration of living tissue using tissue engineering and biomimetic approaches.
- ◆ Biocompatibility of materials used in implants.
- ◆ Multidisciplinary collaborations.

Information related to TMD is available on the NIDCR home page and on the TMJ Association Website. However, many practitioners are inadequately trained to manage TMD. This was the conclusion from the Third Educational Conference to Develop the Curriculum in Temporomandibular Disorders and Orofacial Pain. It is estimated that at least 13 million patients seek care for chronic orofacial pain annually. There is a need for increased emphasis on predoctoral courses in orofacial pain and for significant increases in dentists completing advanced training devoted to this area.

Private industry has been involved in practice management, marketing, and the development of diagnostic and treatment instruments and devices for TMD. There have been concerns about whether testing of new diagnostic and treatment products have been adequate. Until more is known about the pathophysiology of the various TMDs, it is unlikely that progress will be made in the development of valid and reliable preventive/diagnostic and diagnostic interventions and cost-effective treatment. There is need for industry/university collaboration.

Since many TMD involve pathophysiologies similar to conditions affecting other muscles and joints of the body, the knowledge gained from research on the basic mechanisms of these diseases will likely be applicable to TMD and the studies of TMD will shed light on other musculoskeletal conditions. Currently, the primary source of funding for TMD

research is the NIDCR, which has significantly increased its support of TMD research in the past decade. Recently a TMD Interagency Working Group has been established to increase the scope of activities related to TMD. This group includes many institutes and offices of the NIH, the Food

and Drug Administration, the Agency for Health Care Research and Quality, the Health Care Financing Administration, and the Department of Defense. This multidisciplinary effort should promote a focused clinical and research agenda for TMD.

III. PATHWAYS AND STRATEGIES FOR DENTAL AND CRANIOFACIAL RESEARCH IN THE FUTURE

This chapter has described selected research efforts underway that hold much promise for oral health and the future of dentistry in the United States. The research points to four key issues and strategies.

First, while the prevalence of dental caries and periodontal diseases may be changing for the entire population, these disorders are still common among segments of the population, especially those who are economically disadvantaged, and particularly racial and ethnic minorities. Within the next decade, the dental profession and the United States health care delivery system should make primary dental treatment available to these underserved populations.

Second, if a causal relationship can be established between dental infections and severe, life-threatening medical conditions, primary physicians may become active in diagnosing oral diseases and in referring their patients for dental care. Thus, dental and medical professionals should take a team approach to the prevention and management of dental diseases to limit their impact on overall patient health.

Third, within the next 10 to 20 years, research will lead to new biological therapies for use by dental practitioners. Additionally, advances in molecular diagnostic and imaging technology will likely enhance and facilitate the detection and monitoring of dental diseases. Thus, the dentist of the future will require a degree of facility with, and an understanding of, fundamental biology in order to provide optimum patient care as novel treatments become available for dental caries, periodontal diseases, and other oral disorders.

Fourth, researchers have seen an increasing frequency of significant age-associated oral conditions. These include salivary gland hypofunction, mucosal lesions, and related tissue discomfort, dysphagia, and chronic orofacial pain. Additionally, many medical therapies have significant effects on oral tis-

ues and functions, ranging from conventional pharmaceuticals that cause dry mouth to extensive mucosal lesions in persons receiving cytotoxic chemotherapy, to mucosal candidiasis in immunosuppressed patients. Dental practitioners will require more advanced training in managing age- and pharmaceutical-associated oral problems.

To establish a pathway toward achieving the vision articulated at the outset of this discussion, the following strategies are suggested:

ECONOMICS

The dental profession should consider:

- ◆ Exploring, in association with public and private health care delivery agencies, plans by which routine primary dental care can be provided to economically disadvantaged individuals.
- ◆ Advocating for third party medical insurance coverage for oral health care for selected patients.
- ◆ Supporting the concept of medical insurance benefits for medically necessary dental care as defined by the Institute of Medicine in 1999.

DISEASE PATTERNS

The dental profession should consider:

- ◆ Coordinating programs whereby resources and services are better provided to underserved populations.
- ◆ Promoting the concept of evidence-based research as the predominant knowledge base that defines dental training and the practice of dentistry. Dental schools should serve as models for the evidence-based practice of dentistry by requiring outcomes assessment for dental care.

- ◆ Developing a general classification scheme for all dental/oral diseases and disorders.
- ◆ Exploring the potential impact of advances on dental education and dental practice that are leading to effective nonsurgical therapies for dental caries and most forms of periodontal diseases.

SCIENTIFIC DEVELOPMENT/TECHNOLOGY

The critically important transfer of research-based knowledge and technology to practicing dental professionals has lagged behind the expansion of the knowledge base for the etiology of dental diseases and methods of treatment. There is a need to evaluate and improve the speed and quality of information and technology transferred from the laboratory and other research settings to the public domain.

Considering the importance of the NIDCR to the development of the profession, dental education and therapy for dental disease, the dental profession should consider:

- ◆ Maintaining support for the NIDCR as a separate institute within NIH.
- ◆ Accelerating the transfer of knowledge about systemic disease and oral disease to the dental school curriculum through the process of accreditation and working with the NIDCR and the American Dental Education Association (ADEA). The new developments in healthcare, including molecular biology, genetics and bioengineering, must be an important part of the dental school curriculum.
- ◆ Creating national clinical research networks that link treatment approaches and treatment outcomes in private practice settings. These networks, which exist for medical care, will enable large-scale evaluations of treatment protocols.
- ◆ Working with local and state dental societies to strongly support the need to increase resources available for dental research.
- ◆ Promoting the use of laboratory tests to diagnose oral disease. These tests include genetic tests, blood tests, salivary and gingival crevicular fluid analyses, and microbial tests. There is a need to link diagnostic tests with therapeutic strategies.

- ◆ Working closely with the NIDCR, ADEA, the American Association for Dental Research (AADR), and dental schools to establish links for information and technology transfer for health care providers. This network will provide current information on the knowledge base related to the practice of dentistry.

- ◆ Increasing translational and clinical research activities that adopt the new science into the practice of dentistry to improve oral health and the delivery of dental care.

- ◆ Establishing educational guidelines regarding the pathogenesis of different oral diseases. Promote these guidelines for adoption in the dental school curriculum, and by other fields such as general internal medicine, geriatrics, genetics, and information technology.

- ◆ Urging the NIH/NIDCR to increase the percent of its budget devoted to clinical research concerning the diagnosis, prevention and treatment of oral diseases. The percent of the NIDCR budget devoted to clinical research is now below that of other institutes.

- ◆ Continuing to support research funded by the NIDCR, corporate sponsors and foundations on issues of infection control in the dental office, including water line infections and percutaneous injuries.

WORKFORCE

Oral and craniofacial research efforts have been remarkably successful in promoting oral health and reducing the prevalence of oral disease. This effort is in danger of losing momentum due to the shortage of individuals who are pursuing careers in academics and dental research. The dental profession should consider taking an active role in developing the teachers and researchers of the future. This effort should include incentives for those who pursue these career choices. Furthermore, the dental profession should support the need to increase support for research training of dental students and recent dental graduates. Workforce for clinical research will be derived from dental academic institutions and dental practitioners.

Dental specialties should take an active role in promoting the development of dentists who wish to pursue a career in academics and research. Financial incentives should be established and mentoring pro-

grams should be instituted.

Finally, the dental profession should begin to educate medical practitioners and other non-dental health care workers on the causes and identification of dental disease, and on the need for appropriate referral. In turn, the dental profession will need to explore the dental office as a site for screening of systemic diseases with implications for oral disease.

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CHAPTER OVERVIEW

As information about other nations' experiences and situations becomes more readily available, and the United States population becomes more culturally diverse, Americans have begun to recognize the value of approaching national concerns from a global perspective. New technologies such as the Internet have quickened the pace and lowered the cost of communication. A new appreciation is emerging for the value of global opportunities to innovate and partner.

Health care in general and dental health care in particular, are benefiting from this new way of thinking and the tools that are making it possible. Microbes have no geographic boundaries. Today disease travels as quickly as information, perhaps faster.

The future of dentistry and oral health demands that the dental profession think broadly and act globally. As the demographics of the country continue to change and reflect multiple cultures from around the world, answers to many of the disease management, disease prevention, and health promotion questions will be found through collaborations with other countries.

Through collaborative research efforts and shared data, many oral health problems that exist in countries around the world may be effectively addressed. The ability of dental professionals to recognize and respond appropriately to the different attitudes and practices of patients from other countries and cultures will also benefit from the new global perspective.

Dentistry in the United States must be fully involved in international organizations and activities for research, education, clinical practice, product development and distribution, and health promotion. This involvement requires a commitment to learning from other countries and cultures and creates a mandate for leadership with sensitivity.

The United States will benefit from dentistry's global involvement. Collaborative networks must be established to facilitate funding and to implement activities related to research, education, and practice. Also, the emergence of common markets increases the need and the opportunity to develop common standards for product development, approval, and distribution.

Dentistry has evolved into a global profession in which collaboration among countries will result in better oral health. In this age of rapid scientific advancement, information technology, and instant communication, the future of dentistry will depend on the ability to exchange knowledge and expertise with others around the world in a free and open environment. Only through international cooperation and collaboration will dentistry in the United States attain its highest potential.

To date, recognition and acceptance of a leadership role in international health have not been priorities among dental professionals in the United States. The future of dentistry will favor a philosophy that joins dentistry in the United States with the global dental community. Success in preventing and controlling oral disease in the United States is increasingly dependent on an ability to share knowledge and expertise with others around the world.

This chapter examines goals and mechanisms through which the dental profession can contribute to and learn from other countries about improvements in oral health globally. Dental professionals can enhance the oral health of the United States and other countries by participating in shaping the policies and regulations related to dental education and research, dental practice, and international product standards.

This chapter discusses:

- ◆ The status of oral health worldwide and the contribution that comparative outcomes measurement can

make to advance the prevention and treatment of oral disease;

- ◆ Strategies to guide the dental profession's international activities and programs;
- ◆ The potential benefit of global approaches to education of health professionals, service delivery and administration, health promotion, research, and dental product development and distribution;
- ◆ The impact of international standards for products and best practices guidelines for clinical services on United States dentists and United States dental products; and
- ◆ The roles of foreign-trained dental personnel currently in the United States and in the 21st century, and conversely, the appropriate role of American dental professionals abroad.

I. GLOBAL ORAL HEALTH TODAY

DETERMINANTS OF GLOBAL ORAL HEALTH

"Global health" refers to health status, issues, and concerns that transcend geographic and political boundaries. The study of global oral health patterns reveals trends, profiles, and lessons for preventing disease and promoting health for our own population. Within the United States, the distinction between domestic and international health is losing its validity and may even be misleading in light of the rapid rate at which the United States population is becoming ethnically and racially diverse. Protecting the public health in the United States is a national responsibility for health professionals that might be well served by addressing global determinants of health and disease. By engaging in collaborative actions that cross borders, the American Dental Association (ADA) can understand the factors associated with global health and develop innovative strategies to improve oral health in the United States. Failure to engage in global activities, which enable the United States to prevent disease and ameliorate health, could jeopardize the nation's health and ultimately impact the economy (Institute of Medicine [IOM], 1997).

In 1974, Marc Lalonde, then Minister of Health of Canada, set the stage for identifying four determinants of health and disease: human biology, lifestyle, environment, and organization of health care. Since then, a number of studies have been conducted to specify factors associated with those four determinants and global oral health. Two large World Health Organization (WHO) international collaborative studies of oral health outcomes (in which the United States participated) tested several approaches related to these determinants (Arnljot et al, 1985; and Chen et al, 1997). At the outset, it was believed that the availability of dental personnel was directly associated with oral health outcomes, but the evidence showed that perceived need for oral health services was a better predictor of dental visit utilization and oral health than were availability, accessibility, or acceptability of dental services. Only prevention services seemed to be of equal or greater significance. A second WHO study suggested that two environmental factors—fluoridation and the lack of cariogenic food policies—were additional, powerful determinants of oral health out-

comes and override the effects of delivery of oral health services. Promotion of oral health clearly emerges as a possible mechanism to make more salient for decision-makers the need for either individual health services and/or community-based prevention, such as fluoridation and healthy food policies.

Global maps of oral diseases reveal widely different patterns of oral health status that are not related to dental workforce, availability of services, or economic development. For example, utilizing data from the WHO Global Oral Health Database, Barmes reported in 1999 that for most of the developing countries represented in the database, the prevalence of dental caries was low to very low (Barmes, 1999). Some countries experienced hardly any perceptible increase over time, some showed increases in urban areas, others showed large differences between low rural and high urban areas, and others experienced caries at levels as high as many of the emerging market countries. However, by assessing workforce capacity and service availability, he reported that Latin American countries form a special group because they have a high prevalence of caries, a deficit of personnel and services, and a large number of informally trained workers who emerged, presumably, in response to a high disease rate. Global data do not show clear demarcation on destructive periodontal disease among population groups.

The prevalence of dentofacial anomalies varies among populations within and between countries, and levels of demand for treatment vary by age, gender, culture, and available services. At present, the prevalence for cleft lip, cleft palate, salivary gland disorders, and oral cancers are not in the database. Basic methods and procedures for collecting these data are needed, and the methodology must be refined for recording dental caries and periodontal diseases.

The important lesson learned from these and other international comparative studies is that causes and solutions to specific health issues might evolve from multiple factors and that relying on only one set of factors may obscure more cost-effective and beneficial outcomes possible from alternative approaches. The perceptions of the public concerning their own needs for services and community-based preventive services further complicate the assessment of workforce requirements. Whether the solutions are food safety policies, more creative financing models,

or new diagnostic and treatments interventions, all countries, including the United States, stand to benefit in terms of health and quality of life.

GLOBALIZATION AND PARTNERSHIPS

As globalization advances rapidly in this new century, crosscutting issues emerge that demand a collaborative approach to solving health problems. At the top of priority concerns is the global burden of infectious diseases and their effect on economic development within and across countries. A prime example is HIV/AIDS, but other infectious diseases having oral manifestations and other systemic diseases or conditions associated with oral pathogens are also of concern. In addition, other genetically and environmentally triggered oral diseases and disorders—such as craniofacial birth defects, dental caries, and head/neck cancers—are candidates for a collaborative approach.

A number of international partnerships and collaborations are in place, both formal and informal. In addition, international organizations offer opportunities for partnerships.

World Health Organization (WHO)

WHO is an arm of the United Nations and is an intergovernmental coordinating authority for international health, and its mission is the attainment by all peoples of the highest possible level of health. Since the inception of WHO in 1948, the ADA has collaborated with the Oral Health Program at WHO headquarters in Geneva, providing technical and scientific expertise, and financial support. In addition, the ADA has consistently advocated for an oral health presence at WHO's Regional Office for the Americas, the Pan American Health Organization (PAHO), in Washington, D.C. As organizational members of the United Nations that also work with their private sector partners, WHO and PAHO often influence national decisions with regard to oral health priorities and programs. While WHO benefits from ADA's expertise and experience, ADA's own international volunteer programs are greatly enhanced by WHO linkages to other training and assistance programs and to the WHO's global databases. WHO technical expert panels convened to examine such issues as amalgam safety, fluoride applications and uses, and health systems analyses, also enhance ADA's scientific pro-

grams. Currently, WHO is considering a cut in permanent positions devoted to oral health. If this happens, applying lessons learned from global experiences in reducing oral health disparities within countries will be made considerably more difficult. Gains accrued from worldwide efforts over the last 50 years may be lost if the United States does not advocate for and ensure continued strong oral health leadership on the permanent WHO headquarters staff.

FDI World Dental Federation (FDI)

The FDI is recognized as the association that ties together most (145) national dental associations and focuses on dental professional issues and policies. It was established in Paris in 1900 and currently represents a constituency of more than 700,000 dentists from nearly every country in the world. The organization's objectives are "to represent the profession of dentistry on a voluntary, non-governmental, international basis; to arrange an Annual World Dental Congress and to establish and encourage international programs which will advance the science and art of dentistry and the status of the profession of dentistry in the interest of improved oral and general health for all peoples." (FDI Constitution) The ADA is a member of the federation and, therefore, the ADA has an opportunity to participate in the development of partnerships in oral health services, planning, delivery, and assessment, as well as dental and craniofacial research, professional and public education, and executive leadership through collaborations with the FDI.

International Association for Dental Research (IADR)

IADR is another essential partner in the oral health sciences, representing over 11,000 basic, translational, patient-oriented, and community-based scientists in more than 80 countries. The work of these scientists can, does, and will increasingly affect the activities of educators, practitioners, and administrators. ADA's own scientists and consultants recognize the need to support the IADR as that organization launches new sections, divisions, and regional networks across the globe. Although the IADR was created in the United States, its non-United States membership growth currently outpaces its United States division. The ADA will benefit as the IADR nourishes science in other industrialized

nations, assists the development of scientific capabilities in developing nations, and provides networking through meetings, publications, and electronic sharing of data and reports.

International Dental Manufacturers (IDM)

IDM is a global trade association that, through its national dental association members, represents over 1000 individual companies in the global dental industry. Founded in 1988 by five national trade associations representing the United States, Europe, Japan, and Australia, the IDM now has member associations for South America and Central America as well as North American associations that cover Canada. The IDM publishes a directory and a calendar. The calendar is part of its mission to coordinate international exhibition dates to help guarantee a certain quality of the exhibit in terms of attendance and organization. Another part of IDM's mission is to "level" the playing field in "untapped" markets, such as Russia and China, with the influence of its General Assembly.

International Organization for Standardization (ISO)

ISO is a non-governmental organization whose main objective is the development of worldwide standards that facilitate international trade and product safety. The ISO is represented in the United States by the American National Standards Institute (ANSI) through the United States Technical Advisory Group (TAG). The ADA is the ANSI-designated sponsor of a Technical Advisory Group for Dentistry, and the ADA Council on Scientific Affairs provides technical expertise to ISO/TC106, the subcommittee which casts the vote for United States on all international dental standards. In addition, experts have been named to various working groups within subcommittees of ISO/TC106. This ensures that the United States interests are considered in the development of international standards. The United States Technical Advisory Group is composed of seven Sub-TAGs which are responsible for a particular category of standards: (1) Restorative Materials; (2) Prosthodontic Materials; (3) Terminology; (4) Instruments; (5) is inactive); (6) Equipment; (7) Oral Hygiene products; and (8) Implants. Membership on the Sub-TAGs are open to all United States-based individuals and companies that indicate that they are directly and materially affected by the activity of the TAG.

International Federation of Dental Education Associations (IFDEA)

IFDEA was incorporated in 1999 and is beginning to serve as an independent worldwide voice for dental education, promoting advances in dental education through better communications among national and regional associations. Its meetings could provide a forum for sharing information about improved methods of teaching and learning and about research on health sciences education. Current efforts supported by the European Union to "harmonize" (the term used by the European Union to describe the process of bringing into common agreement) dental curricula certainly present a conceptual challenge and a model from which the United States educational community might reasonably draw some lessons. This developmental period of the IFDEA is an opportune time to explore the potential of partnership through the American Dental Education Association. As the United States faces severe faculty shortages (Haden et al, 2000) and new challenges to meet curricular requirements stemming from rapid advances in science and technology, it is critical that expertise be shared and resources leveraged to find creative solutions to international problems.

Global Health Council (GHC)

GHC provides another avenue of international involvement. It embraces other health care domains and gives the ADA access to discussions with physicians, researchers, educators, and government and non-governmental public health advocates. The ADA is a founding member of the GHC and has been a member for over 25 years, since the founding of the original National Council on International Health (NCIH). In the past, the ADA has had board representation, influenced strategic planning and reorganization, held dental forums, and participated in the NCIH and GHC annual conferences. This is one of the few opportunities for ADA involvement that integrates dentistry into other health care arenas, helps expand dental awareness and markets, and is an important approach to getting across the message that "oral health is important to total health."

Health Volunteers Overseas (HVO)

HVO benefits ADA member dentists who volunteer in the international community. The HVO

training program and volunteer activities educate and serve selected international communities. Dentists work alongside physicians, nurses, physical therapists, and other health care professionals to educate community leaders and provide health care to those who may not otherwise receive it. The primary goal is to increase local capacity by teaching health professionals, that is, train the trainers, rather than to only provide health care services. Members enjoy sharing their skills, ideas, and educational techniques, and the experience gives them a broader appreciation for worldwide dental problems and solutions.

Other Global Programs

Several professional organizations with which the ADA has close ties are involved in global oral health programs. Some of these might be leveraged as joint ventures to increase their impact. The Pierre Fauchard Academy and the International College of Dentists encourage exchange of information and good will among members of the profession throughout the world. The Rotary Foundation supports many health care projects, including dentistry, and the Academy of Dentistry International focuses on continuing education of dental professions worldwide for the purpose of improving the dental health and well-being of people across the globe. ADA members who also are members of these organizations have opportunities for volunteerism via direct personal involvement and indirect support for the efforts of these organizations.

The ADA encourages international volunteerism through its International Volunteer Award Program, which recognizes members who have given freely of their time, 14 or more days, to practice dentistry in another country. Individual volunteers work with programs such as "Healing the Children" and "Direct Relief International," and various faith-based/missionary and private volunteer groups that sponsor international programs.

The ADA Online reaches out internationally and connects to dental colleagues around the world through the Internet. The ADA also attempts to be a clearinghouse in the United States for international dental activities. The ADA publication "International Dental Volunteer Organizations: A Guide to Service and Directory of Programs" lists many opportunities for volunteerism around the world. Members also can access the ADA Department of International Health to find out

about international programs and activities.

The United States Government has various components of its executive branch, including the National Institute of Dental and Craniofacial Research (NIDCR) of the National Institutes of Health and the Division of Oral Health, Centers for Disease Control and Prevention, which include international programs and activities in their missions. The NIDCR is also a designated WHO Collaborating Center for purposes of research and research training. The United States Department of Defense, through its military installations overseas presents additional opportunities for collaboration with international governments and professional colleagues. Partnerships may leverage opportunities to learn of innovations in emergency care delivery, scientific investigations, continuing education in civilian populations at overseas sites, and emerging health issues encountered by researchers and Department of Defense personnel working abroad.

GLOBALIZATION OF DENTAL EDUCATION

Globalization of education is the inevitable result of several factors present during only the past several decades:

- ◆ The expansion of international travel during the past 50 years has greatly increased dental professionals' appreciation of the need for international cooperation and, even more importantly, of the value of international experience in improving the quality of education in their home institutions;
- ◆ The professional and scientific literature has become much more international; most major publications encourage contributions from all over the world;
- ◆ The mass media, especially television, have brought vital information on health status, quality of life, and socioeconomic factors from around the world directly into living rooms, making other countries and cultures seem familiar; and,
- ◆ The introduction of the Internet has made information available instantaneously throughout the world.

Status of Dental Education in Various Countries

Assessing the level of dental education in individ-

ual countries is a difficult, but essential, task if globalization of dental education and research is to be realized. Unlike in the United States and Canada, where dental education is largely homogeneous and relatively consistent, dental education in other parts of the world varies considerably from country to country and often within the same country. Certain countries are well advanced and at least comparable in many respects with United States dental schools; other countries have much less technically developed systems; others are closely linked to medical models; still others have no formal system of dental education.

A currently active project, DentEdEvolves, supported by the European Union's Directorate for Education and Culture (see details on www.dent-ed.org/dentedevolves.php3) promotes convergence of standards of dental education through collaboration, self-assessment, and a systematic series of peer reviews conducted by visiting panels of educators from other nations. DentEdEvolves has over 100 partners in Europe and is linked to the Association for Dental Education in Europe and to other educational associations, including the American Dental Education Association. The first major stage of the project, known as DentEd, culminated in convening the Global Congress on Dental Education held in Prague, March 2001. A second phase, known as DentEdEvolves, expands the network to include partners in North America and elsewhere around the world.

Exchange Programs in Dental Education

Traditionally, international involvement within United States dental schools was informal and sporadic. Largely, programs were the result of efforts of individual faculty members who have a personal interest in or contacts with a colleague in another country. The success or failure of these programs rested squarely on the shoulders of the participating faculty members in the two institutions. Very little organized effort was made, and as interests of the individual participants changed or other factors intervened, these programs frequently were dropped.

Over the past several years, the importance and value of international collaboration have been realized, and exchange of faculty and students among dental schools throughout the world has accelerated. Many dental schools now have long-term exchange programs in operation. More recently, formal "sister" relationships have developed between United

States and international dental schools. The purpose of these contractual agreements is to promote shared learning experiences among faculty and students. Yet, the programs continue to be organized by individual schools of dentistry, without broad nationally-based organizational support. Within the American Dental Education Association, however, there is a growing special interest group discussing issues of exchange programs.

One problem that arises from exchange programs is the desire of a graduate student or a visiting professor to remain in the United States. This situation, commonly referred to as the "brain drain," can be devastating to the visitor's home institution. The percentage of international students who stay in the United States has not been studied, and may be overestimated; however, to the extent that the brain drain is a concern, steps must be taken to minimize this effect. The objective of exchange programs is to share knowledge for the benefit not only of the individual, but also for the home institution and country. While the overriding goal should be the return of the visitor to the home country, there are issues of faculty shortage in the United States that are being addressed with this important talent pool.

Foreign-Trained Dentists as Faculty Members in United States Dental Schools

Fewer professionals trained in the United States are opting for academic and research careers on dental faculties. Several factors explain this problem: lack of encouragement by faculty, inadequate role models, large debts upon graduation, and the perceived or actual potential income to be realized in private practice. Thus, American dental schools are beginning to look to the international market for academic talent. Foreign-trained dentists are a rich source of talent for faculty positions. Many have received an excellent education in their home countries, and many also have completed graduate training in the United States or at other top-rated institutions (Haden et al, 2000).

A major obstacle to hiring foreign-trained dentists for faculty positions is their inability to obtain a license in the state in which the dental school is located. Most states require that an applicant for licensure be a graduate of an accredited dental school in either the United States or Canada. Without a license, the dentist cannot supplement an academic salary through private patient care. Most

dental schools encourage their clinical faculty members to practice privately a prescribed number of hours each week. The presence or lack of such opportunities can tip the balance in favor of or against a person's accepting a faculty position. As the dental faculty market becomes tighter, this factor is becoming more important.

Certain states grant a "teaching license" to foreign-trained dentists, which enables the person to practice under certain prescribed conditions, usually the direct treatment of patients for the purposes of teaching and research. In some instances the dentist cannot charge directly for services rendered. This type of license does not allow the foreign-trained dentists to supplement their incomes.

Licensing of foreign-trained dentists raises certain concerns within the dental community, as expressed in the 1995 Institute of Medicine study (Field, 1995), *Dental Education at the Crossroads*: "The committee recognizes that foreign dental graduates who do become licensed in the United States may provide needed services, and it opposes discrimination on the basis of nationality. Nonetheless, the committee is troubled by shortcomings in the processes of assessing student performance and graduate competency, and it is concerned that these shortcomings may be even more serious for foreign dental graduates who enter with advanced standing. The committee urges dental educators, accrediting organizations, and related groups to assess current policies for the admission, education, graduation, and licensure of graduates of foreign dental schools and to eliminate admissions policies or other practices that may exploit these students or threaten the quality of patient care." This recommendation has yet to be implemented.

A special case regarding licensure of foreign-trained dentists recently has surfaced in the State of California and may provide insight for other states, as well as for the globalization of dental education. In 1998, a new law changed the manner in which foreign-trained dentists must qualify for admission to the California dental licensure examination. Prior to 1998, a foreign-trained dentist could apply to take the California restorative technique examination (a prerequisite for admission to this examination was passing National Boards Part I & II). If successful, the foreign-trained dentist was eligible to apply for the clinical examination. The new law eliminates the restorative technique examination effective 2003. After 2003, the only foreign-trained

dentists eligible for California clinical licensure examination will be graduates of non-U.S. dental schools approved by the California Dental Board. A hearing was held in November 2000 for comments on the proposed regulations. The regulations must be approved by the Office of Administrative Law and if approved, are subsequently enforceable after 30 days. The decision is expected to be made by August 31, 2001 (Georgetta Coleman, Executive Officer, Dental Board of California, Personal Communications, November 16, 2000 and July 11, 2001).

International Need for Well-Trained Faculty

The demand for well-trained faculty members in non-U.S. dental schools is equal to, if not greater than, in the United States. Many non-U.S. schools look to the United States as the preferred location for their dental faculty to receive training. Although there has been a gradual increase in the numbers of non-U.S. citizens who receive graduate education in the United States, many applicants are turned down because a method does not exist to evaluate dental schools in most countries.

GLOBALIZATION OF DENTAL AND CRANIOFACIAL RESEARCH

Solutions to many global oral health issues will rely increasingly on scientific and technological knowledge developed through research. Opportunities to expand knowledge depend in large measure on the availability of appropriately qualified scientific talent to address needed research questions and the availability of research cases. Both conditions lend themselves to more international involvement. The United States oral science workforce is among the best in the world, but has shortfalls in a number of critical areas, particularly in clinical research capacity (National Research Council, 1994 and 2000). The United States population experiences some oral diseases and conditions that are severe but are not prevalent and, therefore, provide only a limited research base. For example, head and neck cancers, and cleft lip and cleft palate exist in this country, but there are higher incidences in Southeast Asia and in Brazil. Rare infectious diseases, such as noma, have been observed in the United States and in Western Europe, but are more prevalent in Africa. Even questions about the optimal level of fluoride for humans can no longer be

researched only in the United States because of the confounding effects of multiple vehicles containing fluoride.

Science in the 21st century, whether in the biomedical domain encompassing understanding of the human genome or in the social science domain—providing insights into orofacial pain or behavior, social, and health services research—can advance knowledge of the determinants of dental caries, periodontal diseases and their associations with systemic diseases. Both biomedical and behavioral research will depend on international alliances of scientists and research sponsors. To enhance international collaboration to address these key research areas, in March 1998 the National Institute on Dental and Craniofacial Research (NIDCR) created an Office of International Health. Building on NIDCR's history of collaboration, the new office supports strategies to advance dental, oral, and craniofacial health globally by focusing on research issues that must be addressed by international teams of researchers. NIDCR works with partner organizations to develop global oral health research agendas that continue to be refined, expanded, and adjusted. NIDCR also works to facilitate collaborative partnerships to leverage scarce research funding.

Networks of researchers are currently addressing noma, cleft lip and cleft palate, oral cancers, temporomandibular joint disorders, dental caries in children, periodontal pathogens and vascular risk, and measurement of the quality of life of children. New efforts are underway to stimulate research on fluoride issues, HIV/AIDS and the correlates of oral manifestations, biomaterials, and salivary disorders such as Sjögren's syndrome.

While the United States government has neither the budget nor the mandate to support all needed international collaborative research, the United States dental profession does have the opportunity to advocate for such research and training, providing critical leadership through its existing strength in science and technology.

INTERNATIONAL PRODUCTS

Standardization of Dental Products

Global standardization of products and their increased availability in the global marketplace could affect dental manufacturers and dentists in the United States both positively and negatively.

The advantages to U.S. dental manufacturers of standardizing products include:

- ◆ Minimization of antitrust and product liability exposure;
- ◆ Assistance in developing new markets;
- ◆ Access to and influence on global markets;
- ◆ Lower product costs;
- ◆ Contribution to the regulatory process; and,
- ◆ Useful and cost-effective standards.

The advantages to United States dentists include:

- ◆ Products of better and consistent quality;
- ◆ Greater choice of products;
- ◆ Confidence in the assessment of products; and,
- ◆ Enhanced safety and health.

Not participating in international standards activities would incur risks, including:

- ◆ Fragmented markets;
- ◆ Competitive disadvantage from international competitors;
- ◆ Higher product costs;
- ◆ Imposition of a regulatory process; and,
- ◆ Bottom line decisions made by others.

International Standards Programs, such as ISO 9000 and the CE Mark, already in place, are actually toughening United States standards. Companies have improved their Good Manufacturing Practices because of the tougher international standards.

International Distribution of Dental Products

Access to the Internet is rapidly affecting the distribution of and access to dental products by the dental manufacturer, the dental distributor, the lab-

oratory, and the dentist. For example, many manufacturers who have sold through distributors are now creating websites and are selling products to dentists and laboratories through the Internet.

The Internet also has the potential to globalize the distribution of dental products. Traditionally, two-thirds of the products manufactured in the United States have been distributed to dentists through dental supply houses. At the present time, there are approximately 300 small- to medium-size urban and regional distributors of dental supplies in the United States. The volumes of their business generally range from \$2 million to \$20 million. Additionally, there are several national chains whose retail volumes might be between \$750 million and \$1.5 billion. About one-third of the dental manufacturers sell directly to the dentists, rather than through distributors. Moreover, certain dental manufacturers will sell products only to laboratories (9,000 in the United States) through dental supply houses, while other manufacturers will sell laboratory products only directly to laboratories.

Within the past few years, a new breed of dental Internet company has come on the scene, some calling themselves manufacturers, others calling themselves distributors. Some of these new companies are located in the United States, but many are based in Europe and Asia, and will be taking more and more orders from United States dentists.

There may be risks involved in the broadening Internet market: ignorance or avoidance of important elements of public health, safety, and efficacy; lack of quality assurance; and price dislocation, among others. Many new Internet companies may not have a background in public health, and may not comply with FDA safety records and regulations. For example, under the Dental Device Acts, distributors must report to the FDA adverse events that come to their attention through their customers, the dentists. Moreover, product identification may disappear, as several entrepreneurial entities take title quickly from branded and unbranded products, and resell these products to others, who are selling them on the Internet. It is important that the identification of the product be very clear and that compliance with state and federal laws occur.

Product Approval

Medical devices, including dental devices, must be cleared by the Food and Drug Administration (FDA), generally through the 510(k) process to be imported into the United States. This requirement applies to products manufactured throughout the world and includes products manufactured in the United States that are exported to international markets and subsequently imported back to the United States.

II. GLOBAL ORAL HEALTH IN THE FUTURE

FUTURE CHANGES IN ORAL HEALTH AND DISEASES

Dental Caries

While it was reported at the first International Conference on the Declining Prevalence of Dental Caries (Glass, 1982) that dental caries experience among children and young adults has decreased in industrialized countries, dental caries may be rising again in areas in which preventive interventions have been neglected or removed. For example, where water fluoridation has been stopped as a result of political issues, the incidence of dental caries has increased (Attwood and Blinkhorn, 1988; and Kunzel and Fischer, 1997).

The prevalence of dental caries may increase as urbanization increases, especially in developing

countries. Not only might populations in these countries adopt more cariogenic diets, but they might also be affected by bacterial infection and the unknown effects on the immunologic system associated with the stress of rapid social and economic change.

Periodontal Diseases

Although reports from several countries indicate a decrease in the prevalence of periodontal diseases, the emerging association between periodontal diseases and systemic conditions (Compendium, 1999) will require continued monitoring of these diseases and their health effects. Lifestyle, especially the widespread use of tobacco, will ensure that periodontal disease will continue to be a major oral disease. In addition, as the economies of many nations improve, there will be a greater demand for periodontal care.

It might be reasonable to speculate that the availability of oral hygiene products, both mechanical and chemotherapeutic, in industrialized countries might improve periodontal health in industrialized countries and possibly, by association, certain systemic health conditions. Progress in lower-income or in emerging-market economies would be slower. In the latter, availability of affordable products for prevention would be a real issue.

Oral Manifestations of Systemic Diseases

Infectious systemic diseases, such as HIV, which have oral manifestations, could increase. Middle-income and emerging-market countries that experience rapid dislocations of traditional institutions and cultural practices might undergo changes in diet, housing, sanitation, and income, and may exhibit disease patterns associated with the resulting reduced immunologic resistance. For example, the anticipated increase in the number of HIV cases in the United States and elsewhere in the world will affect oral health and treatment requirements.

As populations age throughout the world, they will experience multiple chronic debilitating diseases, as well as more complex oral conditions, multiplying the challenges for the dental professional familiar with the prevention, diagnosis, and treatment of caries and periodontal diseases in individuals with no other health concerns. The management of oral health and systemic health will be more closely aligned and dentists worldwide will need to work with physicians and other health care practitioners to meet these challenges.

Oral Cancers

Oral cancers will continue to be a major and growing public health problem where using tobacco, chewing betel nuts, and consuming alcohol or other carcinogens are risk behaviors of sizable proportion. Whether in the United States or in countries from which the United States receives immigrants, the delivery of prevention, early diagnosis and management of oral and nasopharyngeal cancers will remain an issue.

FUTURE CHANGES IN ORAL HEALTH CARE DELIVERY

Countries, including the United States, with large population segments that have unique health care

needs, such as the elderly, uninsured adults, young children, and recent immigrants, may find solutions to oral health problems by studying models and policies in societies that have comparable trends. The challenge is to understand the significance of these demographic and disease trends and to develop strategies to meet these needs. As the population ages, the systems by which health care is delivered, the sites for service delivery, and the mechanisms of payment may require options already found in countries with large populations of elderly. For example, solving the problem of how to reimburse the elderly in the United States for oral health care or health care having oral complications might be facilitated by examining solutions and options in countries that have already come to terms with this demographic phenomenon.

In 1996, the United States Bureau of the Census (U.S. Bureau of the Census, Economics and Statistics Administration) reported that 16.5% of the United States population was age 60 and over. Twenty-four countries had even higher proportions in that age group. Italy, Greece, and Sweden topped the list, followed by Belgium and Spain. In 1996, the estimated number of persons in the world 60 years of age and older was 550 million; by 2025 there will be 1.2 billion persons 60 and older in the world. Older populations in the least developed countries are growing much more rapidly than those in the more developed countries.

Similarly, countries, including the United States, with large proportions of uninsured adults or young children, may find solutions by studying models and policies in societies that may have comparable trends. The challenge is to understand how significant these demographic and disease trends might be and to develop a strategy to meet these needs.

It has been asserted by the International Summit on the Private Health Sector that the private health care sector outside the United States will double in the next 5 years (Academy for International Health Studies, 2000). In the interest of profit making, the private sector may abandon or ignore the economically disenfranchised, the elderly, the poor, the unemployed, and the less fortunate. Towards responding to these issues, the international summit will facilitate a number of globalized efforts fostering public/private partnerships across national borders, providing a forum for information-sharing about health reforms, globalization of health care services and trade, health investor information, and

the like. This may not be the only organization of its kind but its very existence portends that globalization of health systems is a trend that is likely to affect oral health.

Large segments of the world's population live in developing countries that have few professionally trained health providers of any kind, and little access to oral health care. These populations in particular need the industrialized world to provide them affordable prevention products and to help them develop treatment services that can be delivered by health workers already in the communities in need.

Teledentistry for remote site care should parallel and augment the trend for telemedicine and telehealth, which is also applicable for delivery of home health care and geriatric services.

FUTURE CHANGES IN DENTAL EDUCATION

Dental Curricula

- ◆ The European Union DentEd project has resulted in dental school visitations by international teams of educators, which in turn pull together intellectual resources across nations to focus on issues of dental curricula. This trend toward purposeful sharing of materials may lead to electronic access to curricula. Joint visitations also seem to be considering strategic planning and outcome assessment tools that can be used universally (see www.dented-global.org).

- ◆ Use of problem-based learning in dental school curricula is increasing, though it will be many years before the evidence validating this approach will be available. Comparative analysis of the effectiveness of these approaches to learning will provide valuable insights for United States educators as dental curricular materials continue to be updated.

- ◆ Extensions in the lifespan globally will require that curricula incorporate material on the special needs of the aging patient presented with several diseases/conditions, and that graduates of dental professional schools be prepared for multiple career options given that the length of active work life is likely to increase.

Dental Personnel

- ◆ Accreditation of non-U.S. dental schools by the State of California might be viewed as a precedent

that will enable graduates of those accredited institutions to circumvent the requirement to matriculate in a United States dental school for 2 years prior to licensure examination.

- ◆ The high cost of dental education in some countries has precipitated the training of other less costly personnel, such as dental nurses, to provide needed preventive and restorative services in some countries in the South Pacific, Asia, Africa, and the Caribbean.

- ◆ Because of the severe shortage of faculty in United States dental schools, the search for clinical and research faculty has increasingly looked to the global market, a trend likely to continue because of difficulties in recruiting United States dental students to advanced academic training (Haden et al, 2000). Legislative initiatives in Congress are pushing to exempt highly skilled professionals working in universities from current limitations on the number of visas available. While some of these efforts are driven by shortages in personnel with highly technical computer skills, it is conceivable that similar legislative initiatives might permit more flexible visa policies for university faculty in the health sciences.

Distance Education

- ◆ Dental education and continuing competency education should be well positioned to take advantage of the technology revolution. Distance should no longer be an impediment to students, faculty, or clinicians in any location. Individual schools will be able to provide certain courses directly, based on availability of expertise. When direct provision is not possible, they will be able to fill in voids through electronic communication. Faculty members of the more advanced dental schools can be available to less advantaged schools via televised sessions, CD-ROMs, and other electronic methods. It should not be necessary to recreate each time a course is developed. Use of these technologies not only will improve the quality of education in schools throughout the world but also will enable faster development of new schools and will facilitate access to continuing education.

- ◆ Technology also will benefit international dental education in the area of information storage and access. Many non-U.S. dental schools, hospitals,

and dental societies, especially those in less-developed countries, do not have well-stocked libraries and information retrieval services available.

FUTURE CHANGES IN DENTAL AND CRANIOFACIAL RESEARCH

The trend towards creating a high-level focus for international collaborative oral health research within the United States demonstrates a willingness to work with global partners to achieve common humanitarian and scientific objectives. The trends in most areas of dental research indicate a need to draw expertise from wherever in the world that expertise exists. Networking of scientists in the United States with colleagues around the world will be the normative model for research in the 21st century. The following early trends hold promise for sustaining and increasing international collaboration in research:

- ◆ Expanded investment in biomedical, behavioral, and health services research addressing global health problems, particularly those infectious disease problems where there is a growing burden of dental, oral, and craniofacial diseases/disorders.
- ◆ Expanded research support to finance international teams of scientists as they seek to address these global research questions. Cost-sharing by international funders in the public and private sector is essential for maintaining these networks, and United States leadership is needed to spearhead the science as these teams develop and pursue such questions of global significance.
- ◆ Advocacy for the development of sustainable scientific and oral health care infrastructures in developing countries. Unless these are in place, such lack of infrastructure will thwart the progress of knowledge developments applicable to the United States as well as to other countries.
- ◆ Providing training for researchers from developing countries in United States dental and other related graduate schools to strengthen the links among researchers from other countries and to enhance the likelihood of future collaborative research initiatives. A side benefit is that United States dental products and technologies might gain entry into overseas markets, thus serving both to enhance global health and to advance United States economic markets.

FUTURE CHANGES IN THE INTERNET AND INTERNATIONAL COMMUNICATION

The Internet is an important mechanism that will influence how we communicate and share knowledge in the future. Although the costs of electronic communication will continue to be a major factor, especially for poorer nations, the Internet will continue to expand rapidly and will be utilized extensively throughout the world. The following are advantages of international communication:

- ◆ Dentists will be able to easily access publications internationally. This will enable all dentists to share in learning, even from parts of the world where they currently do not have access to information.
- ◆ Worldwide teleconferencing will facilitate problem solving and knowledge-sharing.
- ◆ Satellite transmission of information to small hand-held computers will mean almost instantaneous communication, complete with pictures. This means that in many countries, dentists will be able to share information, and participate in continuing education, without leaving home.
- ◆ Real-time, simultaneous translation will overcome any language barriers, and a true *community* of professionals will exist.
- ◆ Continuing education will become worldwide in scope. Clinical procedures performed will be viewed in real time via the Internet or saved for viewing at a more convenient time.
- ◆ Within the context of dental education, communication will take on many new changes on a worldwide basis. Many clinical procedures are being taught via computer simulation. The opportunities for education and communication through technology are unlimited.

FUTURE CHANGES IN ORAL HEALTH PROMOTION

There are overall national gains in oral health in the United States. Nevertheless, some population groups have more disease which goes undetected and untreated than the rest of the population. From

dental caries to oral cancer, the health of poor people, members of minorities, children in poverty, and the elderly remains at greater risk than need be. The Surgeon General's report on oral health calls for a national effort to improve oral health among all Americans (U.S. Department of Health and Human Services, 2000). Inequalities in oral health are observed in the United Kingdom as well (Watt and Fuller, 1999). Reducing these disparities in the United States, the U.K., and elsewhere requires increased collaborative efforts and resources devoted to health promotion. The Dental Health Foundation of Ireland, the British Society for Community Dentistry, and the European Association for Dental Public Health hosted an Oral Health Promotion Forum in September 2000 to share information on the evidence-base for best practices in this field. The FDI constituted a Special Committee of Council to address the same subject, and the momentum continues to build to "enable individuals and communities to increase control over the

determinants of health to thereby improve their health . . ." (Green and Krueter, 1991). Defining the meaning of health promotion to distinguish it from health education (the latter term refers to specific learning aimed at producing a health related goal [Green and Krueter, 1991]) is the substance of current trends in the oral health promotion area. Health promotion comprises health education as well as related organizational, economic, and environmental supports conducive to health (Green and Krueter, 1991). The trend is clear:

- ◆ Research on oral health promotion strategies require global collaboration; and,
- ◆ Public-private partnerships to develop sound goals and strategies for oral health promotion are developing on a global basis and may provide opportunities to share and to learn from the successes elsewhere.

III. PATHWAYS AND STRATEGIES FOR GLOBAL ORAL HEALTH IN THE FUTURE

The vision for dentistry throughout the world is that the dental profession internationally will increase its commitment to and involvement in global oral health practice and promotion. During the past 20 years, people have been increasingly interested in thinking globally and looking globally for ways to innovate and partner. Distance and language are no longer impediments to collaborations thanks to the Internet, cellular capacity for transmission of information, and increased travel. Microbes have never known geographic boundaries and today they are even more apt to travel around the world in hours, posing challenges to populations who in the past would never have been exposed. The future of dentistry and oral health demands the professional leadership think and act globally.

Dentistry in the United States must be fully involved in international organizations and activities for research, education, clinical practice, product development and distribution, and health promotion. This involvement requires a commitment to learning from other countries and cultures and creates a mandate for leadership with sensitivity.

The United States will benefit from dentistry's global involvement. As the demographics of the country continue to change and reflect multiple cul-

tures from around the world, answers to many of the disease management, disease prevention, and health promotion questions will be found through collaborations with other countries. Collaborative networks must be established to facilitate funding and to implement activities related to research, education, and practice. Also, the emergence of common markets increases the need and the opportunity to develop common standards for product development, approval, and distribution.

The profession and its leadership must develop a "global vision"—one fitting the 21st century. Dentistry in the United States cannot be separated from the rest of the world any more than the United States can be separated from the global community. Organized dentistry must provide that essential leadership in international health, for its own sake as a responsible member of the global community.

A global oral health strategy is needed to guide professional leadership toward greater international involvement. This goal will best be realized through an organizational structure that has, as its mission, the functions of promotion, coordination, and facilitation of international activities, including professional education, research, oral health care delivery, public education, and health promotion. The glob-

al health strategy must be predicated upon the development and sustenance of partnerships, defined as groups of allies sharing goals, efforts, and consequences of their joint ventures. Partnerships would form around global issues of diseases and disorders, education, research, clinical practice, and health promotion. These partnerships would be leveraged by parallel, crosscutting trends in the globalization of businesses, finances, politics, and the movement of information and people. This involvement requires an institutional commitment to learning from the experiences of other countries, and creates a mandate for leadership that is characterized by sensitivity and respect for cultural diversity. Examples of such partnerships may include: educational exchange programs of personnel and curricula; coordination of teledentistry and distance learning; development of global data banks for research and scientific resources and for educational and practice-related information.

A common thread for global partnerships must be health promotion and disease prevention as strategies are developed to deal with common risk factors for oral diseases and other health problems that have oral manifestations and affect the quality of life. Centralized data banks and regional centers of excellence, which develop information and facilitate its dissemination, could ensure sustainability of global efforts and initiatives.

As globalization evolves, issues such as the convergence of professional curricula, common standards for assessment of clinical performance and competencies, ways to facilitate international faculty exchanges and certification, and ethics and sensitivity to cultural differences will require increasing attention.

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American Dental Association
www.ada.org

211 East Chicago Avenue
Chicago, Illinois 60611-2678

ISBN: 0-910074-55-0

