



Journal of the American College of Dentists

A Publication Presenting Ideas, Advancements, and Opinions in Dentistry

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Mission

HE JOURNAL OF THE AMERICAN COLLEGE OF DENTISTS shall identify and place before the Fellows, the profession, and other parties of interest those issues that affect dentistry and oral health. All readers should be challenged by the Journal to remain informed, inquire actively, and participate in the formulation of public policy and personal leadership to advance the purposes and objectives of the College. The Journal is not a political vehicle and does not intentionally promote specific views at the expense of others. The views and opinions expressed herein do not necessarily represent those of the American College of Dentists or its Fellows.

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HE AMERICAN COLLEGE OF DENTISTS, in order to promote the highest ideals in health care, advance the standards and efficiency of dentistry, develop good human relations and understanding, and extend the benefits of dental health to the greatest number, declares and adopts the following principles and ideals as ways and means for the attainment of these goals.

- A. To urge the extension and improvement of measures for the control and prevention of oral disorders;
- B. To encourage qualified persons to consider a career in dentistry so that dental health services will be available to all and to urge broad preparation for such a career at all educational levels;
- C. To encourage graduate studies and continuing educational efforts by dentists and auxiliaries;
- D. To encourage, stimulate and promote research;
- E. To improve the public understanding and appreciation of oral health service and its importance to the optimum health of the patient;
- F. To encourage the free exchange of ideas and experiences in the interest of better service to the patient;
- G. To cooperate with other groups for the advancement of interprofessional relationships in the interest of the public;
- H. To make visible to professional persons the extent of their responsibilities to the community as well as to the field of health service and to urge the acceptance of them;
- I. To encourage individuals to further these objectives, and to recognize meritorious achievements and the potentials for contributions to dental science, art, education, literature, human relations or other areas which contribute to human welfare—by conferring Fellowship in the College on those persons properly selected for such honor.

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FROM THE EDITOR

An Honest Broker

e are obviously entering the Information Age. It may not be so obvious, however, that information itself has no value. It's a little like that misleading "brightness" button on the television. As far as I know, it is never made anyone smarter to fiddle with it. Real results might be possible if the button were on the viewer. And so it is with information.

The amount of information generated each year and preserved in books and journals, blabbed at meetings and courses, and engorging the Internet is increasing at ever-increasing rates. There's no need to quote the statistics in this regard since they would become inaccurate between the time I write this and the time you read it.

But here is a useful question: Has the dizzving increase in the amount of information available been matched by a dizzying growth in knowledge the typical person possesses? I rather think not. The fact that information is growing much faster than is the collective capacity of humans to store it in any personally useful fashion has created two structural changes that are important to journalism. Although the professional in the new millennium cannot be expected to know more than his

or her counterpart did one hundred years ago or even a thousand, it is expected that today's professional will have the current information and will change his or her information on a more regular basis.

All of this creates a new role for professional journals: offer an array of information from which a diverse professional community can refresh its personal repertoires. Editors become brokers. They make the newest useful material available to replace stale knowledge.

The second structural change resulting from information growing function of an editor is to create community, a sense of connectedness in an increasingly specialized world.

Information and knowledge are not the same thing. The difference is essentially personal. Information can exist unconnected to any caring human being; knowledge cannot. You might ask the front desk staff for certain information and get an answer such as, "I have that somewhere, I can't put my hands on it right now." But if you asked the question, "Do you know how to reschedule broken appointments?" that kind of answer will never do. Knowledge is always

E ffective journalism gives the reader a sampling of information with high potential for knowledge conversion.

faster than the capacity of individuals to get their brains around it is the inevitability of specialization. Each professional must know enough about an area to function effectively, and the smart strategy for getting this done is to build deep knowledge in a specific field and build networks reaching out to others who have related knowledge. Thus the second the possession of someone. To get more knowledge means to change one's self in potentially useful ways.

This means that knowledge has value even if information does not. Think of the massive amounts of information a typical professional receives under the cover of bulk and presorted first class mail. There is actually a cost in getting rid of it. The truth of the matter can be discovered by realizing who pays to disseminate information. Infomercials, newsletters, public service announcements, and the like are of value to those who pay to thrust them under our noses.

Because professional journals are becoming more expensive for both those who publish them and those who read them at the same time the fraction of available information published rapidly shrinks, there must be some standard for determining what to publish. When the young Adolph Ochs left Tennessee a hundred years ago to purchase the struggling New York Times, he proudly proclaimed on his masthead his rule for content selection: "All the news that's fit to print." That will hardly do as an editorial policy these days and it was probably puffery even then. Peer re-view is a "fools' gold standard" because so many manuscripts are published after peers review them but disagree about their merits. Even the "truth" isn't enough, though it cer-tainly is expected. The truer something is, the more likely that it will be dull-take, for example, tables of statistical probabilities. It requires judgment to detect emerging truth.

We will never get a clear answer about what to publish by looking hard at the available copy. The other side of the relationship is the reader. It is only in the reader's hands, that information is converted into knowledge. Effective journalism gives the reader a sampling of information with high potential for knowledge conversion. This is why the editor and the result of dividing the pie smaller and smaller so that each can have a piece that pleases him or her is a fragmentation that the profession and society as a whole cannot afford. Years ago, Alfred Toffler connected the rise of the Information Age with superna-

The worst thing an editor can do it to distort the balance in what is presented and thus try to do the readers' thinking for them.

editorial board must read their readers just as avidly as they read potential content.

As folks in the middle, trying to arrange a useful exchange, editors must be careful to provide the best information at a reasonable cost and to maintain a reputation for honesty.

The information explosion has made us uneasy about remaining current and the costs of doing so. There is a flight to headlines, sound bites, and bullet journalism. One cannot help being sympathetic with the modern professional drowning in information and starving for knowledge. Journalism's response has often been a proliferation of publications, each more tightly niched. But some sort of balance must be maintained. The final tionalism and ethnic isolation. Universal television and desktop publishing probably did as much as anything to dissolve the Soviet Union and then the breakaway of Chechnia from Russia or what we are seeing in the former Yugoslavia. One has only to look at medicine to see what kind of risks specialization carries.

Any small group of like-minded dentists with an Internet connection and some commercial backing can produce a peer-reviewed publication and thus avoid the larger test of sustained service to the public which is the ultimate test of any profession. An editor who caters too much to the focused needs of the readership sacrifices the forum of public discussion that is the foundation of democracy.

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Editorial

How do we know then when a journal is doing a satisfactory job of bridging between an exploding information base and a limited knowledge capacity among the journal's readers? Part of the answer is balance-balance between the familiar and emerging truth, balance among alternative perspectives. Dentists are quite capable doing their own thinking. The worst thing an editor can do is to distort the balance in what is presented and thus try to do the readers' thinking for them.

In addition to balance, editors must be honest. Brokered relationships are based on trust, and journal ism is no exception. Editors cannot guarantee that every article will be of interest to every reader nor even that everything published will be true (think of the editor who first published the notion that caries is an irreversibly process -- an innocent enough mistake given the evidence at the time).

To build trust, the journal's editorial policy must be clearly stated (as ours is on the masthead of every issue) and adhered to. Both readers and contributors what to know what the rules of exchange are. In the Winter 1995 issue of this journal, a paper was published describing how reviewers are to judge the quality of submissions for potential publication. That article is worth reviewing from time to time, especially by potential contributors. The three criteria, in order of importance, are that the contents of this publication must be of interest to Fellows and opinion leaders in dentistry, be free of misleading statements, and be clearly written out of respect for readers.

It is the intent of the *Journal American College of Dentists* to be an honest broker between those who have something to say and those who are interested in knowing more about excellence, ethics, and professionalism in dentistry.

MAMBER

David W. Chambers, EdM, MBA, PhD, FACD Editor

Letters



Letters to the Editor

Dear Dr. Chambers,

Dr. Fred Aurbach's article on evidence-based dentistry was lucid, logical, and thought-provoking. His concerns were clearly articulated. I concur almost entirely with his viewpoint.

I would alter the last sentence of his article to read, "It is very unlikely that evidence-based dentistry can be used to enhance and not interfere with the professional judgment of the attending dentist—if that evidence-based judgment call is made by anyone other than the attending dentist." Dental practice parameters—yes; mandatory continuing education—yes; evidence-based dentistry—no.

Charles E. Purph

Charles E. Pugh, DDS, FACD Fort Worth, TX

Dear Dr. Chambers,

As a former editor of both my state dental association as well as my local dental society, I appreciate your editorial in the Spring 1999 Journal. Your editorial describes some of the serious ethical problems facing a conscientious dental editor.

An editor is answerable to both the reader and the publisher. If he or she fails the reader, inaccurate or distorted information is disseminated to the audience. If the editor fails the publisher, the person is chastised or even dismissed, as the recent episode involving the *Journal of the American Medical Association* demonstrates.

Added to this is the unfortunate tendency of readers, even dental professionals, to give unwarranted credence to scientific or clinical data as long as the essay is presented in neatlooking print. Questions of validity of an article endorsing a new technique or gadget are often ignored by those looking for quick solutions to old problems.

I believe it is imperative that ethical dental publications regularly publish their mission and goals as well as article review and editorial policies. In other words. "Spell it out!" If scientific articles are peer reviewed, explain the process. If a dental society publication refuses articles from non-members, state this and declare why. With this guide the reader would have a better perception of the inherent biases of the publication they are examining.

The American Association of Dental Editors should incorporate this policy of disclosure into their code of ethics so that member dental publications displaying the AADE seal will have even greater value to the dental reader. Admittedly, some dental tabloids would complain, but readership might be less inclined to take at face value articles underwritten by dental manufacturers or distributors.

By this means I would hope that this would be another step to raise the quality and ethics of dental publications to a level that those of us who read this Journal have become so accustomed.

Charles E. Owens, DDS, FACD Southgate, MI

Internet Basics

Heiko Spallek, DMD, PhD; and Titus K.L. Schleyer, DMD, PhD

Abstract

This is a primer on the internet, intended for those making a first-time acquaintance with how the system works. Topics include a brief history and discussion of access and basic services. The World Wide Web and information about finding material are also presented. Emphasis is placed on defining basic terms and providing addresses, resources, and help.

ew technical developments are more significant than the Internet. As of June 1999, about 179 million people worldwide are using the Internet (NUA, 1996). According to the Department of Education, more than half of the instructional rooms in the U.S. are wired for Internet access (CyberAtlas, 1999). The Internet currently contributes more than \$300 billion a year to the U.S. GNP and accounts for more than 1.2 million jobs (Bridis, 1999). Given the Internet's impact on society, it is reasonable to explore its effects on dentistry. This article provides definitions and concepts to help readers understand the other articles in this issue. Beginning with a brief history of the Internet, it continues with an explanation of how to access it. A brief description of the many services of the Internet is followed by a discussion of how to search it for information. The article concludes with a look at online education in dentistry.

History of the Internet

Over a period of about thirty years, the Internet developed, almost by accident, from a special-purpose military project into a global, ubiquitous information network. During the cold war, the U.S. military reasoned that it needed a specially designed communications network that would continue working while sustaining partial damage. Such a network had to have multiple redundant pathways of communication, many of which could fail before the total system broke down (Schleyer, Spallek, & Spallek, 1998). Today's Internet is based on an architecture that fulfills these requirements.

Over the same period, powerful desktop computers developed. Inicomputers tially, those were standalone workstations fulfilling a limited range of tasks. However, it soon became evident that it made sense to connect the computers to each other since many of the tasks were interrelated (such as billing and accounting). Thus, many organiza-tions implemented local area networks to share information within their confines. With the increasing geographic coverage of the Internet (see Figure 1), it was only a small step to connect individual workstations to this worldwide network of computers. As of January 1999, the Internet connected more than 43 million computers in 171 countries (Zakon, 1999). Twenty-six years after the first international connection from the U.S. to the University College of London (England), it has reached global dimensions.

The World Wide Web, invented by Tim Berners-Lee, a CERN (European Laboratory for Particle Physics) computer scientist, in 1990, reshaped the Internet significantly. The socalled "Web" was originally conceived to allow scientists all over the world to share information (CERN, 1998). Now, the Web has become a medium that allows anyone to share information-from a hobby entomologist to Internet giants such as Amazon.com and eBay. The Web is so ubiquitous that it is often used as a synonym for the Internet.



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Dentistry and the Internet

After this brief historical review of the Internet, we now discuss how to connect a computer to the Internet.

Accessing the Internet

We first review how computers transmit information over the Internet. We then discuss different methods to establish a connection to the Internet, such as modems, the Integrated Digital Services Network, and Digital Subscriber Lines. The section concludes with a description of Internet Service Providers, who provide access to the services of the Internet (such as e-mail and the Web).

How Do Computers Communicate with the Internet? Just as humans do, computers use a common language to communicate with each other. These computer languages are known as protocols. In the case of the Internet, it is the Transmission Communication Protocol/Internet Protocol (TCP/IP). For transmission, the TCP/IP protocol divides information into small units called packets that are reassembled at the destination. All commonly available computer platforms understand this protocol and thus can transmit data using TCP/IP.

Wires (such as telephone cables) connect computers physically. If computers are part of a local area Figure 1: Geographic overview. Worldwide Internet connectivity as of June 1997.



high-capacity lines which link regions in the US). In offices, most computers have a live connection to the Internet at all times.

Modems. At home, computer users often establish a temporary connection through a modem and a phone line or a satellite dish. Phone lines were designed to transmit analog data, such as human voices. However,

The Internet currently contributes more than \$300 billion a year to the U.S. GNP and accounts for more than 1.2 million jobs

network (for instance in a university or company), they are directly attached to the Internet through a system of connections resembling our national road system. The driveway (wire coming out of the back of the computer) connects to a country road (the local area network), which in turn connects to a main road (a high-speed backbone connection) or an Interstate highway (extremely

computers transmit information in digital format (strings of ones and zeros). So-called modems convert information from digital into analog form and back.

Currently, modems cannot transmit information faster than 56,000 bytes (56 KBps; about 20 pages of text) per second. While this speed may be adequate for text alone, pictures, movies, and audio tracks require transmission of much more information. Thus, modem connections can be rather slow, for instance when browsing the Web. Nevertheless, the majority of the 25% of U.S. homes connected to the Internet are using modems (NUA, 1999b). While modems are sufficient for occasional Internet usage, other methods of connecting to the Internet provide much higher transmission speeds and better reliability.

Integrated Service Digital Network (ISDN). An Integrated Service Digital Network (ISDN) connection is a digital connection with two 64 KBps channels. Used together, these channels are more than twice as fast than a 56KBps modem. Since they are digital, ISDN connections gain an additional speed advantage by eliminating the digital/analog conversion that modems must perform. ISDN is a well-established technology that has proven its reliability since its introduction in 1990.

Digital Subscriber Line (DSL). Digital Subscriber Line (DSL) provides high-speed, two-way data com-

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munication over phone lines. A DSL line can be used to handle both Internet connections and phone calls simultaneously. The most frequently used form of DSL is ADSL (asymmetric DSL) which transmits data to the Internet at 200 KBps and receives data at 8,100 KBps. Since DSL is always connected to the Internet, there is no need to dial. The technology is currently not standardized, and phone companies must invest in expensive hardware to implement DSL. Yankee Group estimates that 1.44 million business customers will subscribe to DSL services by 2002 [http:/ /www.yankeegroup.com].

Cable Modems. Cable modems use existing TV cables for an Internet connection, provided the local cable operator offers the service. The connection speed is up to 4,000 KBps for transmissions in both directions. Cable modems were introduced in 1998 and are used by about 425,000 people in the U.S. (Freed & Derfler, 1999).

Computers, modems, and cables provide the physical infrastructure necessary to connect to the Internet. However, to use Internet services (such as e-mail or the Web), an Internet Service Provider (ISP) is required. ISPs provide the "dial-tone" of the Internet.

Internet Service Providers (ISPs). An ISP provides the point to which a home computer connects when it establishes an Internet connection. ISPs dors operate on the same principle. They buy bulk capacity for long distance calls from a telephone company and resell this capacity on phone cards or on the local telephone market.

No matter how you connect to the Internet, you often find it jammed. The bandwidth, which is the amount

While modems are sufficient for occasional Internet usage, other methods of connecting to the Internet provide much higher transmission speeds and better reliability.

work like subscription services. Individuals often pay a flat monthly rate for basic services and a variable fee based on utilization. Many ISPs offer e-mail and Web access as part of their basic package.

Internet providers maintain special computer equipment and lease a permanent line to the Internet from a telecommunications company. Then, they resell this access in small portions to end-users. Prepaid phone-card venof data that can be transmitted in a fixed amount of time, currently does not keep pace with the increasing number of Internet users and resource-hungry applications. Internet service providers are using several approaches to mitigate this problem, ranging from faster connections to more efficient ways of delivering Web pages. For instance, MCI has upgraded the bandwidth of their main communication lines by over 50 times over last year. Their new main line transmits 2.5 GBit/sec, equivalent to the speed of 47,000 modems (Zakon, 1999).

Basic Internet Services

E-Mail. Electronic mail, abbreviated email, allows computer users to exchange messages. Sending and receiving e-mail messages is similar to sending and receiving handwritten letters, but conceptual differences exist. Although e-mail has become part of everyday life, even well-versed Internet users often do not understand these differences clearly. Table 1 compares communication by e-mail, letter, and fax.

Due to its advantages, e-mail has been widely accepted. Now, even clinicians use it to support their patient care activities (Schleyer et al, in press; Schleyer, Spallek, & Torres-Urquidy, 1998; Worth, Patrick, Klimczak, & Ried, 1995). While this article describes the use of e-mail as a communication tool, it can not provide de-

Figure 2: The number of Websites increased from 130 in June 1993 to 4,389,131 in March 1999



Dentistry and the Internet

Table 1. Comparison between e-mail, letter, and fax transmissions					
	E-Mail	Letter	Fax		
Transmission time	Very short (milliseconds- minute), relatively independent of the distance	Days-weeks, dependent of distance	Minutes, independent of the distance		
Cost	Free (with Internet access)	Dependent of weight, distance, and class	Dependent of length and distance (toll-call)		
Distribution of documents to more than one recipient	Easily accomplished, one-step procedure	Time-consuming copy process, production of mailing labels, individual envelopes, etc.	Time-consuming transmission process, blocks the fax line for other communication		
Storage of messages	Electronically on computer	Folders and file cabinets	Folders and file cabinets		
Search capability	Full text search for any term or given criteria, such as time received	Manual time- consuming search using only a predefined ordering system	Manual time- consuming search using only a predefined ordering system		
Addition of files in binary format (e.g. MS Word documents or digitized images)	Easy	Add floppy disk with file, size limitations, compatibility problems	Not possible		
Copying all or part of message into another document	Easy copy-and-paste	Retyping	Retyping		
Type of conversation	Almost real time	Delayed	Delayed (closer to real time than letter)		
Intrusiveness to the recipient	Limited (less than a phone call)	None	None/limited		

tailed technical help on how to set up an e-mail account and on how particular e-mail programs work. Most ISPs provide assistance on setup and use of e-mail accounts.

Clinicians must consider several issues when using e-mail with patients and colleagues. A clear policy should govern any communication involving patients. First and foremost, it must assure patients' privacy and the confidentiality of medical records. In 1998, the American Medical Informatics Association

(AMIA) drafted "Guidelines on the Use of Electronic Mail with Patients" (Kane & Sands, 1998). While these guidelines include obvious points, such as "Never forward patient-identifiable information to a third party without the patient's ex-

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pressed permission," they also provide guidance in the general areas of communication, technology, and administration. The AMIA guidelines also cover mediocolegal aspects of electronic communication.

Finding Someone's E-mail Address. As more and more people use e-mail in everyday life, we often find ourselves looking for people's e-mail addresses. Most e-mail users avoid distributing their address to the public because they are afraid of spam mail, the electronic form of junk mail. However, a few e-mail directories provide services comparable to phone directory assistance. Bigfoot International [http://www.bigfoot.com] and InfoSpace.com [http://www.infospace. com] have compiled Web-based White Pages of e-mail addresses. Users can search those by name, city, and state. The entries may include personal details, such as affiliation, specialty, education, and military service.

Advanced E-Mail Communication. The latest generation of e-mail software products expands electronic communication to include so-called group collaboration. For instance, products such as Microsoft Outlook 98 allow users not only to exchange e-mail messages, but also to share task lists, calendars, notes, and address

 Phone Lines

 Image: Computer of the Provider

Figure 3: Schematic of accessing the Internet via modem and Internet Service Provider.

groups of people. In this sense, discussion groups and newsgroups offer a broadcast function on the Internet. In a recent survey, dentists indicated that electronic discussion groups provided a convenient way to access information and reduced professional isolation (Schleyer et al, in press).

Discussion Lists (Mailing Lists). Messages sent to discussion lists, also called mailing lists, are only distributed to people who have subscribed to

The latest generation of e-mail software products expands electronic communication to include so-called group collaboration.

books. For instance, a departmental secretary may access the calendar of all department members to check their availability prior to scheduling a meeting or assign items on a personal task list to co-workers.

Discussion Lists and Newsgroups. Email is primarily used to exchange information between two people or a small group. Discussion groups and newsgroups, on the other hand, enable users to communicate with large the particular list. Since participants have to subscribe to receive messages, mailing lists offer a relatively private, controlled discussion (see the Appendix for a list of selected dental mailing lists). The number of subscribers can vary from a few people to tens of thousands. Once a user is subscribed, the computer program that manages the list sends a copy of every message sent to the list to the user. Subscribers cannot access previous messages quickly as in newsgroups (see below). Instead, they must retrieve them from the list's archive.

Prior to participating in newsgroups and mailing lists, users should review general guidelines about how to communicate electronically with a large audience. In addition, subscribing successfully requires some technical expertise. Such issues are covered in detail in our recent book "The Global Village of Dentistry" (Schleyer, Spallek, & Spallek, 1998).

Usenet (Newsgroups). Usenet is a collection of about 60,000 bulletin boards distributed worldwide, also called [http://www.deja.com/ newsgroups help/newusers_2s.html]. Messages are added to newsgroups through e-mail and published on news servers. Newsgroups cover a huge variety of subjects. Almost all current Web browsers, such as Netscape Communicator or Internet Explorer, include an application for reading newsgroups. Because newsgroups serve as open discussion forums with relatively few restrictions, messages can be retrieved not only by the recipient but by anyone with Internet access. This makes it possible to search newsgroups for particular information (see below).

After reviewing the Internet's person-to-person communication services, we now turn to the primary mechanism for sharing information on the Internet, the World Wide Web.

World Wide Web

The Web is currently the most advanced and sophisticated method for accessing information resources on the Internet. About four million Websites (http://www.netcraft.com) worldwide offer about 320 million documents (Lawrence & Giles, 1998). The following sections discuss the main concepts behind Web pages.

Accessing Documents on the Web. Specialized software, called a Web browser, is required to access information on the Web or Web pages. Browsers are available for all types of computers and operating systems and make retrieving information as easy as pointing and clicking. Three preconditions must be met before a browser can display a document from the Web. First, the document must be stored on a computer that is permanently connected to the Internet, called a Web server. Second, the local ment is titled "curr.htm." Thus, the URL of the document is http:// www.temple.edu/dentistry/di/ curric/curr.htm. To access this document, the user types the URL into the "open location" dialog box of a Web browser. The Web browser then retrieves the document from the hyperlinks allow readers to explore additional information if needed. Hyperlinks are underlined and/or colored words in Web pages that link to another Web page. For instance, a document about various forms of periodontitis may contain the word "fenestration." Clicking on

Hyperlinks are underlined and/or colored words in Web pages that link to another Web page.

Web server, in this case a computer at Temple University in Philadelphia.

Hypertext. The desire to retrieve information flexibly in a variety of ways has existed for a long time. Chronological ordering of textual information, the traditional method of organization, allows only one-dimensional navigation, and is limited in its flexibility in supporting different information needs. In his seminal article "As we may think," (Bush, 1945) Vannevar Bush stated the problem as follows: "Professionally our methods of transmitting and reviewing the re-

A bout four million Websites worldwide offer about 320 million documents

computer must successfully retrieve the document from the server. And third, the document must be encoded in a format that the Web browser can interpret. Most Web pages are formatted in the Hypertext Markup Language (HTML), the standard language for Web pages.

Addresses of Web Pages. To retrieve a document from the Web, the local computer must know its address. This address is called a Uniform Resource Locators (URL) and must be unique. For instance, a document about "basic predoctoral dental informatics curriculum" is stored on a Web server named "www.temple.edu" in the directory "/dentistry/di/curric/". The docusults of research are generations old and by now are totally inadequate for their purpose."

Traditional methods of information delivery, such as books or videos, force users to process information primarily sequentially. While readers may move freely between passages in a book, they have no opportunity to access the background information that may underlie the statements in the book. Detailed information is often only available through secondary sources that are not easily accessible.

A step towards solving this problem was the development of the hypertext principle (Berners-Lee, 1989). In hypertext, so-called the hyperlink may display a document with further information about fenestration. This system provides new freedom for exploring information. Readers can decide whether they need additional information about a term, and thus follow a hyperlink. Secondary documents, in turn, can link to other related documents. These links form a network of documents-a web-that readers can explore as they wish.

Text, Images, Sound, and Video on the Web. Hyperlinks are only one innovation on the Web. Another is the ability of Web documents to display information in more than one type of media, such as images, color illustrations, audio and video clips, or three-dimensional models. Such documents are called multimedia documents. This puts Web documents on par with medical textbooks and even adds several enhancements, such as auscultatory sounds.

Applied to clinical settings, Web documents can also display information about patients. Newer systems use the Web to implement Web-based computer-based patient records (Schleyer & Dasari, 1999). Such Webbased patient records can contain links to various types of clinical records, such as digital radiographs. This technology allows practitioners to share patient-related information freely. However, substantial political and legal groundwork is needed to make such systems a reality on a national and international basis. The Web makes sharing information easy, but only when one can find it. The next section discusses various strategies to do so.

Finding Information on the Web Imagine a huge library that is growing constantly and that has no catalog. Finding a single book would be nearly impossible. In a real library, every book that is added to the collection is cataloged first. On the Web, thousands of new "books" (=Web pages) are added daily, but they are cataloged only after the fact-often weeks later. A lack of structure, not the amount of material, is the reason for our growing inability to cope with information today (Koniger & Janowitz, 1995). "Drowning in information, but thirsty for knowledge" is a phrase especially appropriate for Web users. While many methods to locate information on the Web have developed, none of them is failsafe and efficient.

Unstructured Search. Because of the lack of structure on the Web, many companies and organizations have developed indices of Web pages. Excite, Yahoo, Altavista, and others have compiled large databases of Web pages. Specialized computer programs extract indexing information from each Web page. Users can then query and efficiency. Reliability is limited because search engines use different strategies to index pages and various means to identify new pages. In addition, the databases built by search engines are not totally up-to-date because of the sheer volume of Web ing healthcare. MEDLINE contains bibliographic citations and author abstracts from over 3,800 biomedical journals published in the United States and 70 foreign countries—a total of over 8.6 million records dating back to 1965. The MEDLINE data-

Having access to all previous contributions to newsgroups is like having access to all discussions ever held at scientific conferences.

pages that have to be indexed and updated continuously. Usability suffers because most search engines can only be queried with keywords and not with natural language. Most searches are not efficient because thousands of matches cannot be reviewed with reasonable effort. On the other hand, searches that result in no match are no guarantee that the information does not exist.

To aid interested readers, the Appendix lists some of the major sites of interest for dentists. These sites can serve as starting points for further exploration.

Structured Search. A structured search is possible when information is stored in structured form. To do so, each item must be divided into data

EDLINE contains bibliographic citations and author abstracts from over 3,800 biomedical journals published in the United States and 70 foreign countries—a total of over 8.6 million records dating back to 1965.

the index to look for a particular document. If a user's keyword matches an entry in the database, the URL of the Web page is displayed, providing direct access to the page.

However, indexing documents on the Internet and subsequent searching lacks reliability, usability, fields, such as author, title, etc. In addition, each document must be tagged with keywords from a set of terms known to both authors and users.

One example of a structured search system is MEDLINE, the National Library of Medicine's (NLM) premier bibliographic database coverbase is continually updated by subject specialists in various areas [http:// www.ncbi.nih.gov/pubmed].

Since 1996, NLM has been offering free access to MEDLINE over the Web. Compared to an Internet search, MEDLINE provides advanced search capabilities. Keyword searches are based on a standard vocabulary, called MeSH–Medical Subject Headings. MeSH organizes 250,000 terms in a hierarchical structure. The MeSH terminology provides a consistent way to retrieve information. For instance, a search for "Parotitis, Epidemic" will bring up the same set of matches as a search for "Infectious parotitis".

Other examples of structured searches are online journals that allow readers to query entire article databases using various options, including a full-text search. For instance, the British Medical Journal (BMJ) provides access not only to its abstracts, but also to the full text of articles. It enhances this approach by offering additional features, such as the capability to retrieve other related articles from the BMJ, to retrieve abstracts of related articles from other MEDLINE, to initiate an e-mail alert when other articles cite the selected article, to search in MEDLINE for other articles by the same authors, and to send responses to the author.

Searching for electronic publications on the Internet can be compared to a traditional library search. However, searching people's conversations has no equivalent in the world of printed books and journals.

Searching People's Conversations. The Internet is not only a place to publish electronic material but also to exchange ideas in discussions. Because of the sheer number of people who participate, the likelihood that any given topic, no matter how specific, has already been discussed is very high. Having access to all previous contributions to newsgroups is like having access to all discussions ever held at scientific conferences. But again, the user must be able to find the information for it to be of value. Several search engines have specialized in storing every message sent to any newsgroup worldwide. For instance, Deja.com allows users to search for, read, and participate in discussions on more than 60,000 subjects.

The last aspect of the Internet to be discussed in this article is learning on the Internet. Johnson's article in this issue illuminates some of the future possibilities of online education. We provide a brief overview of its current status.

Learning on the Internet

For dental practitioners, learning on the Internet most often takes the form of online continuing dental education (CDE) courses. Online courses have several advantages. They usually can be accessed at the convenience of the user, are independent of geographic location, allow providers to offer up-to-date material at all times, and may save money over traditional courses. Disadvantages include the inability to network with other professionals in most courses, the limitation to didactic material, the absence of direct and immediate interaction with the teacher, and the technical limitations of preparing educational content on the computer.

A relatively large number of CDE courses are available today. In a recent study, we reviewed 157 courses from 32 providers (Schleyer & Pham, 1999). The courses covered a wide range of topics, and most were relatively short (five screens or shorter). Courses were offered in a variety of forms, such as slide shows, online books, case reports, and composite reports. Credit hours per screen ranged from 0.05 to two, and cost per credit hour ranged from no charge to \$25.

A related study examined the instructional quality of the online courses (Schleyer, Johnson, & Pham, in press). Unfortunately, on average the instructional quality of courses was poor. Most courses scored 4 to 5 points out of a maximum of 18 points. Basic information that was missing on many courses included the authors (29%); the intended audience (81%); goals and objectives (77%); and references (85%). In 47% of the courses, there was no opportunity to provide feedback either to the author or the provider. Most for-credit courses contained self-assessment questions, but only 28% of courses scored the questions online. Very few courses used advanced media such as video clips.

While dentistry has begun to adopt the Internet as a medium for continuing education, these findings show that current offerings have significant deficiencies.

Conclusion

This article provides a general overview of the Internet and the World Wide Web to help readers understand the other articles in this issue. Several of the areas that this article touched upon are explored more fully in the other papers. As Dan Gillmor stated, "As we surge towards a new millennium, the Internet has become more than the overwhelming reality...It is the foundation for the Information Age, the environment in which we will all be living before long." (Gillmor, 1998) Dentistry is only at the very beginning of exploiting the power of the Internet. In the coming years, the Internet will revolutionize how we practice dentistry as much as it already has revolutionized our daily lives.

Recommended Literature

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Dental Supply Companies

http://www.henryschein.com/

http://www.dentalxchange.com/

Bookstores, e.g. Quintessence Co, Inc.

Henry Schein, Inc.

Dental X Change

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Appendix

E-Mail Addresses Important to Dentists

Professional Organizations

ADA

http://www.ada.org/

AADS

http://www.aads.jhu.edu/ IADR/AADR

http://www.iadr.com/

NIDCR

http://www.nidr.nih.gov/

Dental Schools

University of California, Los Angeles http://www.dent.ucla.edu/ Harvard School of Dental Medicine

http://www.hsdm.med.harvard.edu/ Temple University School of Dentistry, Philadelphia http://www.temple.edu/dentistry/

Practitioners Index

The Dental Site - Practice Directory http://www.dentalsite.com/directory

Journals

Journals by Quintessence Co, Inc. http://www.quintpub.com/journals.htm Journal of the American College of Dentists http://www.acdentists.org/publications.htm British Journal of Orthodontics Online http://www.oup.co.uk/jnls/list/bortho/ Journal of Dental Technology Online Edition http://nadl.org/jdt/ British Medical Journal http://www.bmj.com/

http://www.quintpub.com/ Dental ResourceNet by Procter & Gamble http://www.dentalcare.com/ **Dental Indices** Electronic Discussion Groups in Dentistry, by U. of Iowa College of Dentistry http://www.vh.org/Beyond/Dentistry/leslie.htm Internet Dentistry Resources, by U. of Iowa College of Dentistry http://www.vh.org/Beyond/Dentistry/sites.htm Yahoo – Dentistry http://dir.yahoo.com/Health/Medicine/Dentistry/ Web Sites for Dental Students http://www.dentalsite.com/dentists/denstu.htm **Dental Mailing Lists** Internet Dental Forum Moderator: David Dodell Subscription: http://idf.stat.com/idf subscription.htm Periodont Moderator: Heiko Spallek Address: periodont@spallek.com Discussion list for dental students unmoderated Archive: http://listserv.temple.edu/archives/dentst-l.htm Address: dentst-l@listserv.temple.edu

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Oral Microbiology/Immunology Interest Group Moderator: Dennis Mangan Address: listserv@list.nih.gov Practice Management in Dentistry Moderator: Mert Landay Archive: http://listserv.temple.edu/archivesprctmgt.htm Address: prctmgt@listserv.temple.edu

Dental Newsgroups SCI.MED.DENTISTRY news:sci.med.dentistry ALT.SUPPORT.JAW-DISORDERS news:alt.support.jaw-disorders All newsgroups at: http://www.deja.com

Medical Websites			
The Internet Pathology Laboratory for Medical Education			
http://www-medlib.med.utah.edu/WebPath/webpath.html			
NLM-Medline Plus			
http://www.nlm.nih.gov/medlineplus/			
Virtual Hospital by U. of Iowa			
http://www.vh.org			
Websites to learn more about the Internet			
Explanations about computer terms			
PC Webopaedia: http://www.pcwebopaedia.com			
History of the Internet			
Hobbes' Internet Timeline http://info.isoc.org/guest/zakon/			
Internet/History/HIT.htm			
Frequently Asked Questions documents			
FAQ Finder: http://ps.superb.net/FAQ			
About the Web by World Wide Web Consortium			
http://www.w3.org/WWW			

Editors Note: There some problems with establishing consistency regarding references to Internet sites. I personally signed on to many of the sites mentioned in this and other articles in the issue-sometimes encountering difficulty. Some search engines are tolerant of minor variations; others are not. Some sites seem to be highly sensitive and others forgiving. In this issue, we have attempted to designate web sites with the prefix http://www. (although some or all of this might be omitted in use) and to indicate hypertext masking (?) language with the suffix .html (although .htm will often work and has been given by the authors). It may be useful to recall that there are never spaces in an Internet address. Addresses are not case sensitive on the computer; upper and lower case can be interchanged. The sometimes convention of referencing a date for a web site (the date of last revision for the version the author looked at) is not followed here. A reference that self-destructs with the new update is not a reference in the same sense that the first edition of a book is.

The Internet—Approaching a Ubiquitous Tool for Dental Education

Lynn A. Johnson, PhD

Abstract

The Internet holds promise of addressing some of dentists' and dental students' needs caused by the rapid expansion of knowledge. The Internet is used primarily for communication and for courses, but the quality of Internet courses is uneven. The Internet holds potential in formal dental education for supporting information and instructional databases and as an educational administrative tool. The use of the Internet for educational purposes raises issues such as locating resources on line, ensuring information guality, and incorporation of emerging computer architecture. Some projections are offered for the future: increased instructional quality, replacement of textbooks, creating "courses" out of modules of instructional material, faculty becoming coaches, increased use of trained instructional technologists, intelligent tutoring systems, and the merging of information, instruction, and practice systems. Numerous web sites are given.

omputers are a part of the entire educational experience from kindergarten, through college [http:// www.educause.edu], into dental school (Johnson & Schleyer, in press), and now into continued dental education (Schleyer, Johnson, & Pham, in press; Weisman, 1999). It is difficult to find a student, practitioner, or education institution who has invested in computers and communication technology, including the Internet, who would now choose to abandon it. The explosive growth of information and educational products found on the Internet (Schleyer, Spallek, & Spallek, 1998) are rapidly pervading education at all levels. What is not understood is the need for educational software, the various forms in which it is offered, and the quality of available products. Even more nebulous is an understanding of the future direction of computers in dental and continuing dental education. This manuscript will examine the stimulus behind the growth of the Internet-based education, discuss related issues, and give one set of predictions for the future directions of Internet-based education. Whenever possible, concrete examples will be provided to illustrate points.

Why Internet-Based Education?

Instructional computing began over thirty years ago on large mainframe computers. It then moved to personal computers and presently a large number of educational applications (also known as *courseware*) can be found on the Internet. Although it is difficult to accurately measure the number of educational products on the Internet, sold-out crowds at technology events at the annual sessions of the American Association of Dental Schools combined with the recent growth of continuing dental education courses (CDE) on the World Wide Web suggest an extreme interest in instructional computing. The reasons for the growth are numerous. One is the ongoing and rapid increase in the quantity of knowledge that must now be used during patient care. The dental practitioner's knowledge base is too large for a dental student to learn in a traditional four-year program; and once graduated, busy practitioners find it difficult to keep up with all of the new findings in dental research. It is this information explosion that a number of states cite as a prime reason for requiring practitioners to complete continuing education courses on a regular basis.



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et al, 1998). Unlike CD-ROMs or other technologies, the Internet is easily updated. Thus, content changes can occur in a few moments and at a reasonable cost.

The report *Dental Education at the Crossroads: Challenges and Change* (Field, 1995) and a corresponding background paper (Tedesco, 1995) suggest that computer-based instruction could help teach problem solving skills and, in certain select situations, potentially replace faculty, thereby

The explosive growth of information and educational products found on the Internet are rapidly pervading education at all levels.

National Institutes of Health, 1987, 1989; White & Formicola 1990). As a further complication, the nation's population is aging. The elderly, who as a group have chronic diseases, now live longer and are no longer edentulous. Thus, they require regular dental care. However, their drug treatments are more complex and ever changing. The dental professional requires enhanced problem-solving skills in order to care for these patients. Dental education and continuing education are obligated to provide opportunities for students and practitioners to develop the ability to deliver services to diverse populations. However, limitations such as patient availability and practitioner practice constraints may limit the impact of traditional education methods.

Contemporary teaching methodologies, such as Internet-based instruction, can be employed to address this possible limitation (Saliterman, 1990). Internet-based education solves a number of problems for dental education and for continuing dental education. It combines the visual, textual, and audio information that are used in educational settings in a form that is easily accessible to students and practitioners at their convenience (Fresnel, freeing them for other activities. A number of courseware products have been developed using videodisc and CD-ROM technology (Abbey, 1991; Eisner, Tedesco, & Vullo, 1992; Johnson, Cunningham, Finkelstein & Hand, 1997). However, highly specialized expertise was required to design and develop these products. Accompanying the expansion of the World Wide Web has been the development of produce the proliferation of instructional software now found on the World Wide Web (Schleyer, Spallek, & Spallek, 1998).

In the United States continuing dental education, is a requirement for dental practitioners in forty-three states and for dental hygienists in forty-six states (Dental Interactive Simulation Corporation, 1997). Despite the need and value of continued education, there are associated costs to participants. The office is shut down. but the overhead costs remain. Also, there are the travel costs and the actual expenses of the course. Lastly, there is the inconvenience of time spent away from home. CDE courses offered on the World Wide Web can be completed at the practitioner's convenience and without the costs of shutting down the office or travel. Increased and convenient access combined with reduced costs are two powerful reasons for the boon in Internet-based CDE.

However, as with other new educational technologies, Internet-based education is not the panacea it may appear to be at first glance. A recent study found that CDE courses are difficult to locate and are generally of substandard quality (Schleyer,

The Internet easily permits the transfer of the highly visual information that is critical to teaching and practicing dentistry.

powerful new software tools such as Web page editors (e.g. *Microsoft Frontpage 98* [http:\\www.microsoft. com/frontpage/default.htm] or *Adobe PageMill* [http:\\www.adobe.com/prodindex/ pagemill/main.htm] that enable anyone familiar with the basic operations of a computer to develop instructional products that can be delivered via the Internet. These powerful new tools combined with the mindset that computer-based instruction might free faculty for other activities have helped to Johnson, & Pham, in press). Thus, while Internet-based education can ideally solve the problem of ease-of-access to recent and relevant information at a reduced cost, the emerging issue of locating high-quality instructional products remains (Johnson & Schleyer, in press). The issue of locating instructional material is addressed in the next section while the issue of measuring quality is addressed throughout the manuscript. As with all other instructional products, it is becoming clear that it is not the technology that teaches, but the quality of the education behind the instructional product that determines its value (Clark, 1983).

The Internet and Continuing Dental Education

Continuing dental education is the lifelong education of dental practitioners after they have completed their formal dental school education. Internet-based continuing education activities tend to take two forms—communication between two or more professionals and completion of CDE courses. This section will first discuss the communication capabilities of the Internet and how they relate to CDE followed by a discussion of online courses.

Communication. It is the connecting power of the Internet, not the computer behind it, that enables the Internet to enhance communication and raise the bar on disseminating information. The end of the Twentieth Century finds that students and practitioners routinely use e-mail to communicate. This recent form of communication is probably the biggest change brought about by the Internet for both students and practitioners alike [iccel.wfu.edu/publications/dbrown. htm]. Instead of intermittent interactions interspersed with phone calls, electronic messages can be conveniently exchanged between two individuals of describing these communication forms, a few examples of how professionals use them are given. Australia offers an example of how health care professionals use the Internet to enhance patient care and improve their knowledge. Like many other parts of the world, Australia has the problem of attracting and retaining health care professionals to rural regions. The about new products, converse with other practitioners, and find additional continuing education courses.

Numerous listservs are available for discussion on almost all topics relevant to dentistry [http://www.vh.org/beyond/dentistry/leslie.htm]. For practitioners interested in highly focused topics such as CAD/CAM a specialized listserv such as the Cerec mailing

S tudents can search across an entire curriculum's worth of materials and find the information that answers a specific question whether is be textual, video or still image information.

problem is compounded by the need of providing high quality, cost-effective educational and clinical support to professionals located in these remote areas. In Australia the Internet supports isolated health professionals through communication and educational programs including a discussion forum (Walker, Thompson, & Smith, 1998). An interactive bulletin board enables remote clinicians to discuss clinical issues with numerous other professionals around the country in a timely manner. In addition, these same practitioners access the information archives found on the World

nternet-based education solves a number of problems for dental education and for continuing dental education.

(between faculty and student; between two practitioners) or one message can be broadcast to an entire class or group of practitioners through a listserv.

A companion article in this issue by Spallek and Schleyer summarizes the various forms of communication that take place on the Internet–e-mail, listservs, and newsgroups. So, instead Wide Web as they manage patient problems. These same remote practitioners in Australia, or any other location, can join virtual study clubs throughout the world. The Study Club [http:// www.dentist.ch/index.cfm] in Switzerland offers portions of its site in four languages (German, French, Italian, and English) where you can read list [http://www.devigus.dentist.ch/informations/cerecmail.htm] may prove informative. Other practitioners who are interested in general topics may subscribe to (join) listservs such as the Internet Dental Forum where dentists from around the world pose problems and challenges they encounter in patient care [idf/stat.com]. (Membership in the Internet Dental Forum is free for the first thirty days and for dental students. The cost to practitioners is \$60/year and for corporations \$180/year.) A few testimonials from practitioners who participate in a listserv provide insight into their value. A practitioner in the United States says, "...The international network of dentists that makes up the [listserv] gives me nearly immediate access to answers for questions on any aspect of dentistry and patient care. It is the best resource a modern dentist has available to them (sic)." A dentist from the United Kingdom says, "This [listserv] has made a tremendous difference to my attitude to my work, new ways of doing things have come to light and made work easier and more satisfying. When you run into a problem, one of my on-line friends nearly always has the answer. It is like having a thousand friends who you can call on for help and support. It has really made work

more fun" [http://www.idf/stat.com/ idftestimonials.html; June 13, 1999].

While testimonials provide anecdotal stories about the wealth of information available on the Internet. little has been done to change the way continuing dental education is structured to include this information. Jeff Galvin and Michael D'Alessandro, two of the three founders of the Virtual Hospital [http://www.vh.org], have spoken about the need to award continuing education credit based on the time spent using the Internet to search for, find, and synthesize information relevant for patient care. This is termed "just-in-time learning" (D'Alessandro, et al, 1994). A number of reasons prevent just-in-time learning from being adopted as a means of earning CDE credit. Some of these reasons include: information is difficult to find on the Internet, the bulk of the information on the Internet is not peer reviewed and thus may be of questionable quality, and new forms of practitioner education are slow to be adopted.

Online Continuing Education. Traditionally, most continuing dental education credit is earned by attending lectures. Self-study courses that may include reading journal articles, viewing videotapes, and completing computer-assisted instruction courses also qualify for continuing education credit under certain circumstances. courses can be selected, paid for (using a credit card over a secure connection), and completed all in the convenience of your home using your computer and Internet connection. The courses tend to present textual information supported by images and graphics to illustrate a point. Most of them end with a quiz that can either be printed out and mailed with a check or taken online and paid for with a credit card.

While the convenience of online courses may sound appealing initially, they must be approached with caution. The state of on-line continuing keeping current with advances in dentistry, currently most online courses do not meet even minimal instructional quality standards.

A review of the literature in continuing education and distance learning hints at the direction that effective online instruction may go. Research in traditional continuing educational settings has shown that merely providing research findings is unlikely to be effective in modifying health practitioners' behavior and prompting them to adopt new techniques. An effective dissemination experience must involve interaction with credible

ncreased and convenient access combined with reduced costs are two powerful reasons for the boon in Internet-based CDE.

dental education is embryonic. A recent survey evaluated 157 World Wide Web CDE courses offered by 32 providers using 34 criteria (Schleyer, Johnson, & Pham, in press). The relationship between credit hours and course length was extremely variable. Additionally, most courses consisted of text and a few still images. Almost no video was used. Measured against the study's index of instructional quality, the courses were

There is no inherent structure or standard for describing the instructional strategy or the quality of an instructional product.

Usually upon completing a self-study course, a short multiple-choice quiz is completed and submitted to the sponsoring institution for scoring and the award of credit. Now many of these same forms of instruction can be completed using the Internet, but with added benefits. At the convenience of the practitioner, continuing education generally of poor educational quality with very limited interactivity. Most for-credit courses contained self-assessment questions, but only one-third of the courses scored the questions online, and feedback to the authors was limited. While Internet-based continuing dental education courses may potentially provide a method for opinion leaders and peers (Stross & Bole, 1980; Stross, et al, 1983; Sumerai & Avorn, 1990). The bulk of distance education research indicates that it is equally as effective as traditional methods (Hanson & Maushak, 1996; Moore, 1989). Some studies have even found that remote participants are more motivated and self-directed and show higher achievement than participants who receive traditional instruction (Biner, Bink, Huffman, & Dean, 1995; Souder, 1993; Whittington, 1987). Distance education researchers agree that the key to effective distance education is to make it highly interactive (Barker, Frisbie, & Patrick, 1989).

Interactive Distance Learning. This research suggests that online education/continuing education should not be limited to independent study courses. Let's look at what a medical education/continuing program is doing as an example that approaches what high-quality online education may become. The ophthalmology residents at the University of West Virginia and practicing ophthalmologists in the area receive advanced instruction in ocular pathology from Dr. Robert Folberg at the University of Iowa [http:// www.webeye.ophth.uiowa.edu/dept/ den_omfp/telecom.htm]. Using a video-equipped microscope and computer graphics, Dr. Folberg displays eye pathology sections and CD-ROM programs. He and the participants view each other on TV screens. This particular example of distance education happens to use compressed audio and video and is delivered over teleparalleled amounts of information in more formats and at a low cost and (b) by allowing a single student or practitioner to be more actively involved with more colleagues over time and geographic distance. The uses of the Internet for instruction vary widely. Its uses currently can be categorized as information and instructional databases, administrative support tools, and the integration of

nternet applications which incorporate design innovations with advances in client-server technology have been termed "third generation" web sites.

phone lines, however, the exact same instruction can happen over the Internet. The only difference is that participants can be in separate locations such as their homes or offices. During a live Internet-based course, an instructor would not necessarily be able to view all of the students at one time, but the instructor and participants could view a student who electronically signaled that he or she wanted to ask a question. The author anticipates that this type of interactive online education is going to increase. The future will see a blending of electronic lectures being delivered over the Internet, with accompanying resources that parallel current online courses. Participants will receive credit when they submit their answers to an online quiz and apply the information as they solve online case studies. The quiz would be scored instantaneously and an electronic award certificate e-mailed to the participant. In addition, for a limited amount of time after the lecture, participants will be able to e-mail the instructor questions.

The Internet and Dental Education

Like textbooks before it, the Internet increases our instructional options in two ways: (a) by giving all students or practitioners increased access to unthese functions plus communication into integrated course support tools. Its use can occur singly or combined with other media. Some healthcare institutions are even being progressive enough to put complete graduate programs online, such as the nursing doctoral program at Duquesne University in Pittsburgh (Milstead & Nelson, 1998).

Information Databases. Originally, libraries were private collections. Over time, Ben Franklin's idea of the public library took hold. Now few communities and no universities are students would only have access to these images as slides in the lecture hall. Occasionally faculty would make the slides available outside of class, but the slides were easily re-arranged and lost. Now with the World Wide Web, high-quality images and motion segments are easily distributed to large numbers of students. As a result, a number of dental related sites can be found with useful images. (One note of caution: It is a violation of copyright regulations to copy the images and post them on your web site without permission. It is permissible to link to them.) Some sites, such as the Oral Pathology [http://www.uiowa.edu/ Imagebase ~oprm/atlashome.htm], have lists from which a selection can be made and others such as DERWeb have searchable databases [www.derwed.ac.uk]. Because web sites with imagebases (Liepins, Curren, Renshaw, & Maisey, 1998) (databases of images) have proven so useful, many faculty are putting their electronic presentation slides on a course web site for students to review at their convenience. These usually accompany course syllabi and other course documents. However, presentation slides are meant to serve as prompts for discussion points. They are not intended to thoroughly deliver the content. Through their verbal elaboration a faculty member de-

Thus, both students and faculty should remember that an electronic presentation on the course web site is not a substitute for the lecture.

without them. Just as the Internet is helping to reshape the definition of the library from being the purveyor of large chunks of information (books and journals), it is changing the shape of information dissemination to students and practitioners. The Internet easily permits the transfer of the highly visual information that is critical to teaching and practicing dentistry (Wurdack, 1997). Traditionally, livers the content. Thus, both students and faculty should remember that an electronic presentation on the course web site is not a substitute for the lecture.

Instructional Databases. Desktop publishing and the Internet allow universities to meet the specific information needs of the students without relying on the publishing industry. The advantage is that the materials can be individualized to the needs of the student at each point in their instruction. However, these materials are usually not indexed, nor have they been through the peer review process offered in journals. Vital Source Technologies, Inc. [vitalviewer.com] has developed an answer to the issues of shrinking numbers of textbooks and course specific web sites which are not indexed or peer reviewed. On a single DVD (Digital Video/Versatile Disc) they place textbooks, faculty slide collections, and other course materials which are properly indexed, and thus easily searched. Using one strategy students can search across an entire curriculum's worth of materials and find the information that answers a

Approved summaries are then automatically made available for public use. Additionally, each summary is catalogued using the key words of the journal article, thus allowing the summary to be searched. This project goes beyond summarizing and commenting on published literature. Because it is catalogued and peer reviewed, practitioners and students at other universities can find the summaries and know that they are guaranteed to be of high quality.

Administrative Support Tools. The Internet can be used to support many of the traditional and routine administrative functions of instruction. It provides a central location for course materials that are easily accessed at

ncreased interactivity in Internet courseware will be accompanied by standardized measures of instructional courseware quality.

specific question whether it be textual, video, or still image information. Vital Sources Technologies uses SGML (Standard Generalized Markup Language) which permits metadata to be attached to each piece of content, thus permitting each content chunk to be searched and shared. Vital Source's ability to combine highly focused searches across textbooks and customized course materials makes it one of the most powerful tools currently available to dental educators.

A second example of an instructional database is the *Summaries of Published Literature* [http://www.research.dentistry.uiowa.edu/summaries/index.htm] web site being developed by the University of Iowa College of Dentistry. Graduate students enrolled in a literature review course summarize published research articles, including their commentary about the manuscript, in a web-based database. Faculty, using a separate web interface, review the summaries and either approve them or ask the students to make revisions.

each student's convenience. An item bank of test questions can be built and individual tests constructed, administered, and graded. Customized reports for a course, an instructional module, an exam, or a single student can be generated. Class lists can be easily updated and distributed. All of these functions are able to operate as Internet-based database applications.

An administration product that a number of dental schools have found useful is the local-area network based *Curriculum Analysis Tools* (CATs) from the University at Buffalo School of Dental Medicine [http://www.tasc. sdm.buffalo.edu/cats]. This tool is used for curriculum planning and analysis, and a number of dental education institutions have used it in preparation for accreditation. Faculty can now enter their course information into the CATs database using their web browser instead of the database [http:// www.tasc.sdm.buffalo.edu/ index.html].

Certain dental educators are going beyond using the Internet as a means

of upgrading their administrative functions. The University of Indiana School of Dentistry has developed the *PBL-Evaluator* to support an administrative aspect of their problem-based learning program (Chaves, Chaves, & Lantz, 1998). *PBL-Evaluator* permits students to enter peer and self-evaluations of a PBL session and enables faculty (tutors) to view and enter their evaluation of each student. Narrative comments can also be entered. This feedback is immediately collated so that any student can then view his or her evaluations.

Integrated Course Support Tools. Internet-based communication tools, administrative support tools, and databases have been combined into suites of course tools. (The website www.outreach.utk.edu/weblearning contains information for educators interested in learning about developing web-based courses, including a comparison of various packages. An additional comparison of ten off-the-shelf packages can be found at http://www. syllabus.com/sep98_magfea2.html.) A few of these products are Blackboard CourseInfo[™] by Blackboard, Inc. [product.blackboard.net/courseinfo], FirstClass by SoftArc [http://www. softarc.com], LearningSpace by Lotus Development Corporation [http:// www. lotus.com/home.nsf/welcome/ learnspace], TopClass by WBT Systems [http://www.wbtsystems.com/ solutions/products.html], and WebCT by the University of British Columbia [http://www.webct.com]. Whether an institution decides to use a package of course tools or builds their own product, careful planning is required to order to ensure successful implementation. (See sidebar.)

The Internet and Educational Issues

While the Internet brings to education and continuing education new solutions to instructional problems, it is not a panacea. Two of the most critical problems that need to be addressed the location and quality of instructional materials—are briefly discussed. Locating Instructional Software on the Internet. As mentioned above it is difficult to locate courseware on the Internet. Three approaches are currently being taken to solve this problem: the creation of instructional resources lists, the use of on-line databases, and the use of metadata. These approaches also serve to demonstrate the evolving sophistication of the Internet.

Resource Lists: Resource lists such as Internet Dentistry Resources [http://www.vh.org/beyond/dentistry/sites.hmtl] (Schleyer, Spallek, & Spallek, in press) are dedicated to indexing dental information that is available on the Internet. Some resource lists focus strictly on education applications (Lowe, Lomax, & Polonkey, 1996; Pallen, 1995). They are the Internet's initial attempt at solving the location problem. However, resource lists vary in their effectiveness and longevity because volunteers for whom this is a hobby versus a professional responsibility, frequently manually maintain them [http://www.bubl.ac.uk/archive/subiect/about].

As Internet-based software gains sophistication, some of these resource lists move from being "hard-coded" and updated manually to being databases that permit developers to add their product to the website. In Europe, the European Association of Dental Schools (ADEE) hosts Courseware in Dentistry [linux.odont.ku.dk/adee/scot/ courseware] and allows any user from throughout the world to add new courses on-line. In the United States, ADDSoft [http://tasc.sdm.buffalo.edu/ aadsoft] serves a similar function. Additionally, AADSoft summarizes the hardware and software capabilities of dental schools. Both sites allow an individual to enter information about a course, including evaluation information. The ability to add evaluation information allows the potential user to make a judgement about the quality of the product. However, because the developer supplies the evaluation versus a third party, it has

Two Examples of Using Integrated Course Support Tools

First, the success story. In January 1998 Kennesaw State University used a course tools package to expand the scope of its executive MBA program into new markets and new geographical areas [http://www.lotus.com/news.nsf/public2/ D89C35EE43F2310A8525675F00600902]. Through careful up-front planning Kennesaw was able to reduce the number of face-to-face meetings required of its MBA students, thus making it more attractive; and also expand the program without a proportionate expansion in the teaching staff. In additional to careful up-front planning, Kennesaw State University provided faculty with training that allowed them to develop, augment, and update their courses. Students now meet every other weekend for lectures and discussions. All course assignments, media, and case studies are presented electronically. Assignments are turned in and graded electronically, and tests and schedules are also handled electronically. Using the Internet and the course tools suite allows the same number of faculty to instruct an increased number of students.

Now for the second story. The University Hospital of Rennes built a pedagogical network for its medical students, which contained both patient information and educational programs. It was unique in that it could be accessed from the clinics. Students had access to e-mail, the Internet, multimedia databases, and instructional programs including clinical cases and guizzes. While a very ambitious project, it was not designed based on instructional outcomes or goals. Technologists mostly working in isolation built the project. While they worked in good faith thinking that they knew what was needed, now that the program is implemented they are finding it difficult to get faculty participation. They made a classic mistake that has been repeated over and over in technology circles. They did not involve the users in a needs analysis at the beginning. If faculty had been involved at the early stages and set the goals and directions for the project, it would have met their needs and faculty involvement would most likely have been higher.

not been peer reviewed and should be viewed with caution.

Online Databases: The second solution to the location problem is online databases. Once again, you are referred to the accompanying article by Spallek and Schleyer. The *Information Retrieval* section in their article briefly describes online databases and the associated issues. This manuscript will focus strictly on instructional issues. While online databases are clearly an improvement over resource lists, they do not solve the problem of content quality.

Educators want to use the Internet to increase student access, but they do not want to sacrifice the quality of instruction. For education, the quality issue needs to be addressed on two levels—the quality of information that students and practitioners may access during instruction and the quality of online instructional courses. First, vice from the users' perspective, (b) evaluation criteria, and (c) indexing issues. This ongoing attempt to improve the quality of its service to the biomedical community ensures that OMNI will continue to offer a valuable service that will grow in size and scope.

Ensuring Information Quality. While projects such as OMNI are working to ensure easy access to high quality biomedical information, they do not address the issues associated with instructional software. There is

nstructional courseware will be increasingly subjected to peer review and other third party quality measures.

let's take a brief look at a project that is addressing the issues of information quality then one that is examining the quality of instructional modules.

Online database projects such as Organizing Medical Networked Information (OMNI) (Norman, 1998) add a quality review to information that is used for instruction. OMNI uses a process of locating information resources that are of interest to the broad-based biomedical community, evaluating the quality of a specific resource (image, textual description, etc.), and then indexing those resources for easy retrieval by the OMNI database engine. This thorough process ensures consistent highquality biomedical information. The DERWeb (Dental Education Resources on the Web) site [http:// www.derweb.ac.uk] is the largest dental component with over 2,300 images representing most areas of dentistry. A single search on a term yields results from the DERWeb as well as other biomedical sites. The OMNI project must be applauded for ensuring that its final product meets the needs of its users, and thus, is used. Instead of the technical staff working in isolation, the project calls upon three advisory groups to give input and feedback regarding (a) serno inherent structure or standard for describing the instructional strategy or the quality of an instructional product. Databases are valuable for the primary use of the Web as an information repository. They are not designed to view the Internet as an interactive space supporting the collaborative and dynamic nature of learning. EDUCAUSE is attempting solve this

wide number of organizations at the national and international level. A few examples will demonstrate the scope of the project. One collaborator, the Advanced Distributed Learning Initiative, sponsored by the U.S. Department of Defense and the White House Office of Science and Technology Policy, is interested in guidelines for large-scale development and implementation of effective and efficient online learning systems [http://www.adlnet.org]. At the international level, IMS is collaborating with the Alliance of Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE) [ariadne.unil.ch], project sponsored by the European Union, and the Dublin Core [purl.oclc.org/dc] to build indexing specifications. Lastly, to ensure that the standards they develop will be adopted nationally and around the world, IMS is collaborating with a number of international standards setting organizations including the European Committee for Standardization/ Information Society Standardization System [http://www.cenorm.be/isss] (an information technology standards setting organization for the European

M etadata will result in reviewed dental education courseware that is indexed in a standardized manner and will be guaranteed to be located by search engines as soon as it is published on the Internet.

problem through the development of the Instructional Management System (IMS) [http://www.imsproject.org].

IMS is attempting to address three obstacles faced by providers of high quality online instructional materials: (a) lack of standards for locating materials, (b) lack of support for the collaborative and dynamic nature of learning, and (c) lack of incentives for developing and sharing content and programs. IMS is collaborating with a Union), the Institute of Electrical and Electronics Engineers (IEEE) [http:// www.ieee.org], and the National Institute of Standards and Technology [http://www.nist.gov]. Metadata is such a central component to work being performed by IMS that it is discussed in the next section.

Metadata. Automatic methods applying user-specific review criteria to information are being developed. This entails labeling Internet infor-

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mation with "metadata" in a standardized format that allows software to search and check for content that suits the learner. The concept of metadata applied to healthcare information on the Internet is not new (Appleyard & Marlet, 1997). Metadata can be provided on two levels-the authors can describe the contents and context of the information and users can request expanded ner and will be guaranteed to be located by search engines as soon as it is published on the Internet.

Anticipating the Future

While computers are not likely to go away, they will continue to become faster, cheaper, and smaller. Some users are starting to question how much more powerful computers will become. By contrast, experts are starting

The role of the faculty member will shift from being the disseminator of information to coaching.

information from third party rating services. Also, users can customize their browser to filter out any information that does not meet their quality requirements or interests. Because both types of metadata (authors' and third parties') can be indexed by search engines, this approach helps users find appropriate high quality information.

The World Wide Web Consortium [http://www.w3.org] has developed a set of technical standards called PICS (platform for Internet content selection) (Miller, Resnick, & Singer, 1996; Resnick & Miller, 1997) that enable users to distribute descriptions or ratings across the Internet. Originally developed to support applications filtering pornography, the same technology can enable services to review and rate websites with electronic labels. When properly customized, the user's computer will check with the label service and compare website labels against the user's specific requirements. A warning may then appear if the information is aimed at a different audience or if a disclaimer needs to be reviewed. A prototype vocabulary for health care, called med-PICS, has already been developed (Eysenbach & Diepgen, 1998). Once adopted, the combined metadata work of med-PICS and of IMS will result in reviewed dental education courseware that is indexed in a standardized manto predict that more and more computer tasks will be taken over by smaller single-purpose machines connected to the Internet (Levy, 1999). In this world of increased connectivity and portability—ubiquitous computing—what will be the effects on dental education and continuing dental education? A few projections are offered.

Increased Instructional Quality. Until recently, the evolution of Internet-based instructional applications has been driven by technological advances in technology and translating the traditional strategies and matequality of the Internet in dental education. These applications have the potential of eliminating the myriad of interfaces associated with instructional courseware. Currently, for dental education and continuing education, the Internet is a source of static screens of text interspersed with images. In the future, users will operate highly interactive applications such as patient simulations over the Internet. Currently, multimedia CD-ROMs offer this high level of interactivity, each program with a different interface. In the future, these programs will all operate through a single interface-the World Wide Web browser.

Increased interactivity in Internet courseware will be accompanied by standardized measures of instructional courseware quality. Just as faculty are increasingly being peer reviewed for the quality of their classroom and clinical teaching (Carrotte, 1994), instructional courseware will be increasingly subjected to peer review and other third party quality measures. Students and practitioners will be able use metadata to search throughout the world for the best possible course in a topic. Currently, Working Group 5 (Educational Software and Research Systems) of the

E xperts are starting to predict that more and more computer tasks will be taken over by smaller single-purpose machines connected to the Internet

rials of dental education (voice, presence, print, video) into Internet applications. Many applications, while technologically advanced, lack the focused development of interface and interactivity design that have proven to enhance learning experiences in other multimedia environments. Internet applications which incorporate design innovations with advances in client-server technology have been termed "third generation" web sites and have the potential to improve the Standards Committee for Dental Informatics (accredited by American National Standards Institute) has published an initial set of guidelines to help course designers develop high quality instructional materials (Johnson & Schleyer, in press). Proposed guidelines have been written and feedback is being gathered through the website [http:// www.temple.edu/dentistry/di/ edswstd]. In the future, these guidelines will evolve into standards.

Replacement of the Textbook. While the textbook will not be completely eliminated, universities will increasingly publish instructional information on the Internet. Modules of text, images, video, and interactive conversations with experts will replace textbooks. Some of these modules will be complete courses. Other modules will be built by a collaboration of faculty and students during the course [http://www.research.dentistry. uiowa.edu/summaries/index.html]. Through a peer review process, an institution will become a leader in a topic and market that module (including the interactive conversations) to other institutions. Colleagues at geographically diverse institutions will divide the responsibility for teaching a single class (Chen, et al, 1998). This will allow each faculty member to spend more time preparing his or her module that will be shared with students at other universities. This crossinstitutional sharing of teaching expertise will allow students greater access to more specialists in each dental discipline.

Education Object Economy (EOE). With institutions gathering instructional units from numerous sources and combining them into complete courses new online commerce solutions will be developed for compensation of instructional content and programs. Thus, the education object economy (Sutton, 1999) (EOE) is emerging. The private sector is attempting to have a major role in online education. EDUCAUSE's National Learning Infrastructure Initiative [http://www.educause.edu/nlii] (NLII) and the EU's ARIADNE project are partnerships between the private sector education providers, universities, and professional organizations to develop the EOE. These organizations demonstrate a significant shift away from the culture of cooperation and sharing of educational materials that has existed on the Internet towards one that is profit-based. The recent Digital Millennium Copyright [http://www.hrrc.org/dmca-leg-Act

hist.html] supports the EOE by providing legal protections for digital intellectual property. Legislation such as this will allow the marketing of Internet-based materials knowing that intellectual property is safeguarded.

Faculty as Coach. The doubling of knowledge every several years combined with the increased access by students to databases will result in the confusion associated with information overload. The role of the faculty member will shift from being the disseminator of information to coaching. Class time will be spent more intensively reacting to information stueffectiveness of instructional programs will also improve, but only when the programs use techniques proven to be effective. Contrary to known research, the technical ability to author a Web page is too often equated with the ability to design effective computer-based instructional materials. One safe predication is that online continuing dental education providers and dental education institutions will find themselves hiring specialists in interactive instruction (Barnes, 1998).

Intelligent Tutoring Systems. Individual courseware products will merge into a single system that helps

Not only will instructional courseware merge into intelligent tutoring systems, but dental education, continuing dental education, and practice will merge into a single practice-learning environment with a focus on patient care.

dents gain prior to class rather than receiving information. This new role is already emerging as current dental faculty take on coaching roles in problem-based learning sessions. Faculty serve as coaches as they guide students through the evaluation of a patient problem, identification of learning issues, and the review of the associated learning reports (Matlin, Libert, McArdle, & Howell, 1998).

Emergence of Trained Instructional Technologists. Research also demonstrates that programs developed without personnel specifically trained to develop computer-based products have lower instructional effectiveness than programs developed with specially trained personnel (Clark, 1983). As "third generation" web pages emerge with the same high level of interactivity and instructional effectiveness as current multimedia courseware, Internetbased courseware is evolving into more than a reference tool, but also a self-contained instructional package. Thus, as the technology improves, the

an individual student or practitioner to identify their strengths and weaknesses, apply information to patient care, and remediate deficits as they relate to patient care. This will require a merging of numerous systems into one large integrated "killer app" that will track a dental student's progress and continue on into his or her professional career to help improve patient care and permit seamless movement between education and patient care.

Intelligent tutoring systems (ITS) are instructional/assessment systems for developing problem-solving skills. ITS's primary use is to teach, diagnosis, and remediate deficiencies so that all students and practitioners achieve a competent level. In the arena of patient care, incompetence must be identified and eradicated. ITSs infer a student's skills, knowledge, and strategy usage through their interactions with simulated patients, i.e., what decisions they make during patient care. An ITS is developed first by conducting a cognitive task analysis such as the one conducted

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by Dental Interactive Simulations Corporation in dental hygiene (Mislevy, et al, 1999). From the cognitive task analysis a mental model is developed which approximates the skill and knowledge configurations of a dental hygiene student and practitioner (Mislevy, Steinberg, Almond, & Breyer, 1999). This model serves as a mediator between the user's actions in specific simulation events and agreed upon levels of expertise (novice, competent, and proficient) (Steinberg & provider will be alerted to track the time spent actively conducting the search. The provider will count these minutes towards the practitioner's required CDE hours. Accordingly, cost structures will evolve to cover the costs of just-intime information access. Students are already practicing searching for information, evaluating it, and applying it to the care of virtual or simulated patients as they prepare to care for live patients. Practitioners

nformation literacy, will become a competency for all students and practitioners.

Gitomer, 1996). Probability-based reasoning is then used to explain the interrelationships between the users' competencies and actions (Gitomer, Steinberg, & Mislevy, 1995; Lewis & Sheehan, 1990).

Merging of Information, Instructional, and Practice Systems. Information services (databases) will be integrated into one interface-the World Wide Web browser. Searching these databases will become an important skill and information search techniques, otherwise known as information literacy, will become a competency for all students and practitioners. Most certainly dental school accreditation standards will change to include requirements for information literacy and other technology competencies. Internet information services similar to Vital Source (Chaves, Chaves, & Lantz, 1998) will provide the knowledgebases required for students and practitioners. They will be able to access information when they need it, and in the format they prefer. Linkages between practitioners and their dental school will be extended as they continue to use the same knowledgebases they were trained with as updated resources in their practice. When practitioners conduct a literature search to solve a patient problem, their online CDE

are honing their skills by using these same information sources to answer questions about actual patents.

only will instructional Not courseware merge into intelligent tutoring systems, but dental education, continuing dental education, and practice will merge into a single practicelearning environment with a focus on patient care (Barnes, 1998). The result is that the learning system may eventually merge with the patient record system. Finally, the current distinction between learning and decision support will begin to disappear. Decision-support systems have proven to be able to provide practitioners with support (McDonald, et al, 1984). However, most of these systems fail to be incorporated into the daily care of patients (Elson & Connelly, 1995) because the system requires additional data entry is too time consuming, does not fit into the clinical routine, or ignores the clinician's intelligence (Miller, 1994). Thus, integrating instructional, information, and patient support systems may improve the likelihood of these systems being incorporated into the practitioner's daily routine (van der Lei, et al, 1993). This integration of systems will only be possible after standards such as SNODENT (American Dental Association, 1999) (dental diagnostic nomenclature) and confidentiality procedures are fully developed. Meanwhile, the Internet will continue to develop. Already XML (eXtensible Markup Language) [http:// www.sciam.com/1999/0599issue/ 0599bosak.html] is emerging as a higher level, more powerful replacement for HTML. As these standards and capabilities merge, so will the instructional, information, and patient care systems. Then the Internet will truly be a ubiquitous tool for dental education and continuing education.

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See Editor's Note on page 15 regarding formats and references to the Internet.

Clinical Decision-Making and the Internet

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Abstract

The Internet has potential to make dentists more effective decision makers. Statistics are given regarding current patterns of computer use by dentists. Use is primarily for communication rather than decision support. The Internet will increasingly fulfill its promise as an information resource for practitioners as issues such as access, searching, understanding, relevance, and cost are solved. The future of the Internet includes a number of likely enhancements: technical changes, portals, meta-sites, personalization, collaborative filtering, and improved information retrieval.

any proponents view clinical decision-making as an area that could ben-Lefit significantly from the Internet. We expect today's clinicians to base their decisions on the best evidence available, achieve the desired health outcome at the lowest cost, and act quickly, efficiently, and confidently. With the half-life of medical education estimated at three to four years (Hersh, 1999), where should practitioners turn but to up-to-date information resources available through the Internet (Anderson, Moazamipour, Hudson, & Cohen, 1997)?

The reality of supporting clinical decision-making is somewhat more complex. First of all, we currently do not understand the clinical decisionmaking process very well (Diamond & Pollock, 1987; Taylor, 1990). What are the decisions that result in a favorable patient outcome? Do we always make decisions in the same sequence? How do we recognize that we have made a wrong decision? What information do we need to make correct decisions? The mere presence of upto-date information is only one factor influencing the quality of clinical decision-making.

The availability of up-to-date information does not mean that it will be used. For instance, it took more than a hundred years for an effective antidote to scurvy to be widely used (Haines & Jones, 1994). Even today, adoption of effective treatment measures may take decades. A major predictor of clinician behavior is still what was learned in professional school (Ramsey et al, 1991). Clinical decision-making varies significantly between providers (Bader & Shugars, 1995a, 1995b). Only few computer interventions, such as computer-generated reminders, have been shown to change clinician behavior (Hunt, Haynes, Hanna, & Smith, 1998; Lobach & Hammond, 1997; Shea, DuMouchel, & Bahamonde, 1996). In some studies, behavior regressed to the status quo in the absence of reminders (Gouveia-Oliveira et al, 1991). Making correct decisions may be as much based on in-depth knowledge of the domain as on knowledge of the problem-solving process (Curley, Connelly, & Rich, 1990; Gruppen, Wolf, Van Voorhees, & Stross, 1988).

We are only beginning to understand clinical decision-making and how computers can effectively support it. This circumstance, however, should not keep us from examining how the new medium "Internet" could help us make better clinical decisions. This paper discusses uses of the Internet for clinical decision-making and some of its opportunities and limitations. We first look at the process of clinical decision-making in general before we turn to the use of the Internet for clinical decision-making in dentistry. We then discuss generic properties of information resources that influence their usefulness for decision support. These properties also



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Clinical Decision-Making

The clinical decision-making process is a complex activity that is poorly understood (Diamond & Pollock, 1987; Taylor, 1990). In a landmark investigation, Elstein (1978) found that diagnostic medical decision-making often conformed to a hypothetico-deductive model. Deriving from this theory, Gruppen (1990) presents a conceptual model of the clinical reasoning process (see Figure) in which the clinician generates a hypothesis based on the initial input of context and patient information.

The initial hypothesis is evaluated and may be revised after gathering additional information before arriving at a course of action. Elson's model (Elson & Connelly, 1995a) is based more directly on the model for an information processing system, in which both long term memory (domain knowledge, experience, etc.) and external memory (knowledge from textbooks, articles, etc., patient data) are combined through an inferencing process. Sumner identified concepts and relations that underlie decision-making processes in family medicine (Sumner, Truszcynski, & Marek, 1996).

Intuitively, we assume that the decision-making process is similar across healthcare disciplines. While that may be true in a larger context, it differs significantly in the types of decisions,



ment options. Then, they may render one or more treatments, monitor clinical parameters over time, and address deviations. We must understand this decision-making process, and at a more superficial level, information needs, to develop useful decision-support resources. Currently, researchers are beginning to define empirical

We currently do not understand the clinical decision-making process very well.

the information needed, the information resources, and the impact of decisions. In dentistry, clinicians routinely collect large amounts of information about a patient initially and choose among a relatively limited number of dental diagnoses, some of which may have a substantial number of treatmodels for decision-making in dentistry (Mislevy et al, 1999).

Computer systems that support the clinical decision-making process are commonly called decision support systems. Such systems fall into two categories. Active decision support systems perform some or all aspects of a reasoning process, while passive decision support systems simply provide information that helps the clinician make a decision (Elson & Connelly, 1995a).

Much attention has been focused on aspects of designing and evaluating active decision support systems (Adelman & Riedel, 1997; Elson & Connelly, 1995a; Haug, et al, 1994; Hunt, Haynes, Hanna, & Smith, 1998; Johnson, Langton, Haynes, & Mathieu, 1994; Taylor, 1990; Warner, Sorenson, & Bouhaddou, 1997). Often, computer-based patient record systems supply active decision support systems with patient-specific data. Clinicians tend to adopt such systems more easily because they require little data entry (Miller, 1994). Unfortunately, this circumstance impedes the development of active decision support systems in dentistry. The sheer number of different practice management systems makes it im-

Figure. Conceptual Model of Clinical Decision Making

possible to develop decision support systems for general use unless standards for such systems are defined. Most dentists store only a limited amount of patient-specific information on computers because they use computers mainly for billing purposes (American Dental Association, 1998).

Currently, very few active decision support systems exist in dentistry (Brickley & Shepherd, 1997; Davenport, Hammond, & Hazlehurst, 1997; Firriolo & Levy, 1996; Hammond & Freer, 1996; Ireland, 1996; White, 1989, 1996), and almost none are available over the Internet cuss clinical cases, and communicate with patients on the Internet. Over half the respondents received between ten and one hundred e-mail messages a week and browsed the Web more than once a day. Eighty percent rated the Internet as a useful resource in dentistry. A second study showed that the Internet makes a substantial amount of clinical content available to practitioners (Schleyer, Spallek, & Arsalan, 1998). A third study investigated how dental practitioners use the Internet to support clinical practice (Schleyer et al, in press).

Dentists' access to online services and the Internet is growing. The pro-

C omputer systems that support the clinical decisionmaking process are commonly called decision support systems.

(see [http://www.dent.ucla.edu/cgibin/orad/orad.pl] for one example). Therefore, the Internet currently may be more valuable as a communication medium and a passive decision support resource. Recent studies (Schleyer et al, in press; Schleyer, Spallek, & Torres-Urquidy, 1998) suggest that the Internet may have the potential to support at least some decision-making processes in dentistry.

In the next section, we discuss Internet use and access in dentistry in general. We also describe some of the applications of the Internet in clinical decision support.

Clinical Decision Support and the Internet

We have conducted several studies on how dental professionals currently use the Internet (Schleyer et al, in press; Schleyer, Spallek, & Arsalan, 1998; Schleyer, Spallek, & Torres-Urquidy, 1998). One world-wide survey (Schleyer, Spallek, & Torres-Urquidy, 1998) with 825 respondents found that dental professionals obtain diagnostic and product information, disportion of dental practices with computers increased from 11% in 1984 to 79.5% in 1997 (American Dental Association, 1994, 1995, 1998). In 1994, dentists in a recent study began to use the Internet at home before using it in the office (Schleyer et al, in press). Anecdotal evidence indicates that physicians use the Internet more often at home than in the office (Doyle, 1999).

Dentistry is probably one of the healthcare disciplines most likely to benefit from the communications capabilities of the Internet. Similar to family practitioners (Renjford & Eagleson, 1982), dentists are highly geographically dispersed and community-based. Approximately 150,000 dentists (American Dental Association, 1994) practice in the U.S. today.

In 1993, 67.1% of dentists worked alone, 21.3% with one other dentist, and 11.6% with two or more dentists (American Dental Association, 1994). While national data about the geographic distribution of dentists do not exist, a survey in Louisiana found that 63% of respondents practiced in urban or semiurban areas

(Strother, Lancaster, & Gardiner, 1986). In addition, most dentists are not affiliated with hospitals as physicians are. Because the dental care sys-

Many organizations, such as the National Institute of Dental and Craniofacial Research, the National Oral Health Clearinghouse, and the American Dental Association offer large amounts of information relevant to clinical dentistry on their Web sites.

62% of dentists used computers with modems, and 20% of those had an account with an online service. In 1997, 69% of dentists had access to a computer with a modem (American Dental Association, 1998). While dental offices are relatively highly computerized, only between 21% and 34% of dentists have access to the Internet in the office (American Dental Association, 1998), a figure that is similar to physicians (Kripalani, Cooper, Weinberg, & Laufman, 1997). Most tem is highly distributed, access to physical information resources, such as libraries, journal collections, and seminars has historically been difficult.

Dentists can use the Internet to support clinical decision-making in several ways:

Communication With Colleagues and Others: Many studies indicate that colleagues rank first as an information resource for clinical decision-making (Covington & Craig, 1998; Gravois,

Information Design and Computers

Computers are a new medium for communicating information. They are fundamentally different from, but also retain some important characteristics of, conventional media. One research discipline, information design, looks at how we can communicate information optimally—regardless of the medium used. Clinical decision-making can be affected significantly by how information is displayed. A look at computers in light of information design helps us understand how computers can be both better and worse than other media at communicating information.

Good information design is "the clear portrayal of complexity" and allows us to reason about information by analyzing cause and effect, relationships, and trends. Good information design is a precondition for making quick, efficient, and correct clinical decisions. Yet, what we see on a computer screen (i.e., the user interface) falls far short as a method for good information design. One expert formulates the essential problem of a user interface as this: "At every screen display are two enormously powerful information-processing capabilities, the human on one side and the computer on the other. Yet communication between the two must pass through the low-resolution, low-information, narrow-band user interface of a video display terminal."

The problem begins with screen resolution. The human eye can reliably discern differences at about 300 dpi (dots per inch), which approximates the resolution of a printed page. Average computer monitors can display about 72 dots per inch. The information displayed on an average computer monitor, printed on paper, would measure approximately 3.4 by 2.6 inches, or 1/10th of the area of an 8 x 11-inch page. Thus, ten computer screens display the same amount of information as a printed page. This comparison, however, only addresses the physical representation of information, not its perceptual quality.

Because of this low information density, computer programs provide mechanisms to navigate through information. Windows, scrollbars, tabs, and next/previous buttons are non-data elements that add nothing to our ability to interact with information. Instead, they consume precious real estate on the computer screen. New methods of interacting with the computer, such as voice input, present the opportunity to reduce screen clutter, but are not widely available or used.

A third aspect of information design, following from screen resolution and navigational controls, is the user interface design. Together with the display of data, user interface design is concerned with the number and types of screen controls (such as buttons, menus, and toolbars), their function and format, and placement. User interface design offers almost infinite possibilities for a design task, depending on the operating system, programming environment, and design philosophy. On the World Wide Web, no two Web sites are exactly the same. Most differ by content and in their user interface design.

The flexibility of user interface design is both a boon and a bane. While it enables flexible and innovative interaction between humans and computers, humans spend considerable time learning new user interfaces. It is a pleasure to interact with a well-designed, intuitive, content-rich Web site. However, most sites fall far short of this ideal. Instead of reviewing and assimilating information, the user must spend time learning the idiosyncrasies and quirks of navigating a site. An information resource is only as good as the interface to it.

Bowen, Fisher, & Patrick, 1995; Renford & Eagleson, 1982). Colleagues, if they are accessible, tend to provide a convenient, trusted, and flexible source of information. Since most dentists practice in a solo practice (American Dental Association, 1994), their direct contact to colleagues is limited. Electronic mail, discussion lists, and newsgroups make communicating with other members of the oral health care profession, as well as patients and family members, easier. In a recent study (Schleyer et al, in press), dentists who were using the Internet reported interacting with an Internet discussion list or colleagues through e-mail much more frequently than obtaining information from either electronic (e.g., World Wide Web) and hardcopy sources (e.g., books, journals, etc.). Many participants also indicated that the Internet reduced their professional isolation. The Internet may also make it easier to communicate with opinion leaders, who appear to be important mediators in innovation dissemination courses serve to increase the general knowledge of participants, some courses, such as case reports, can be useful in making diagnostic or treatment decisions. While quite a large number of continuing dental education courses are available on the Internet (Schleyer & Pham, 1999),

The sheer number of different practice management systems makes it impossible to develop decision support systems for general use, unless standards for such systems are defined.

(Gruppen, 1990). A related study showed that anesthesiologists used an Internet discussion list to support a wide range of clinical decision-making (Worth, Patrick, Klimczak, & Ried, 1995), and obtained valuable information from their colleagues (Worth & Patrick, 1997). Thus, the Internet appears to mediate interpersonal and group communication for clinical decision-making effectively.

Information Materials on the Web: The World Wide Web offers a vast array of information resources for dentists. A recent study (Schleyer, Spallek, & Arsalan, 1998) reviewed a random sample of dental Web pages and found that over 40% contained content relevant to clinical dentistry. Clinical information included continuing education materials, clinical images, case studies, diagnostic aids, and treatment protocols. Many organizations, such as the National Institute of Dental and Craniofacial Research, the National Oral Health Clearinghouse, and the American Association Dental offer large amounts of information relevant to clinical dentistry on their Web sites. Authoritative information resources can be quite popular (Graber et al, 1998).

Online continuing dental education courses also can be potentially useful for clinical decision-making. While most continuing education there are significant concerns about their quality (Schleyer, Johnson, & Pham, in press).

Web-Based Databases: Web-based databases sometimes are indistinguishable from normal Web sites. However, they differ in that they provide access to information stored in databases. The PubMed [http://www. ncbi.nlm.nih.gov/pubmed] and [Internet Grateful Med http://igm.nlm.nih.gov] home pages are examples of Web sites that provide access to over nine million articles in the biomedical literaInternet. One example is ORAD (White, 1989). Users can enter characteristics of radiographic lesions, such as pain, number of lesions, location, contents, borders, and relationship to teeth. The program then lists differential diagnoses with confidence factors.

Using the Internet to help make clinical decisions is a relatively new approach. Our recent study on the use of the Internet in clinical dentistry (Schleyer et al, in press) showed that respondents used the Internet more to keep up in general and communicate with colleagues than to answer clinical questions. Respondents accessed information about products most fre-quently, followed by information about therapy, drugs, and medical conditions. Information about diagnosis or patient education was accessed less frequently. These observations are consistent with the fact that only 5% of respondents reported using the Internet at chairside or in the operatory.

The next section discusses characteristics of information resources that influence their usefulness. Those characteristics also apply to the Internet, and examining them can help us un-

The Internet may also make it easier to communicate with opinion leaders, who appear to be important mediators in innovation dissemination

ture. Two other examples for Webbased databases are the Dermatology Internet Service [http://dermis.net/ index_e.html] and the Oral Pathology Image Database [http://www.uiowa. edu/~oprm/atlashome.html]. On the Dermatology Internet Service, users can search for lesions with specific characteristics, such as location, color, and morphology. This system bridges passive and active decision support.

Decision Support Systems: Currently, very few dental decision support systems are available over the derstand the benefits and shortcomings of the Internet as an information resource.

The Internet as an Information Resource

To a large degree, the Internet follows the broadcast model of television. Information providers know their audience in general terms, but have no detailed information about their preferences, behavior, and needs. The geographic dispersion of the Internet audience makes it difficult to collect

information systematically. such Thus, providers tend to construct their sites from their own, not from their users', perspective (Nielsen, 1998). This has important implications for clinical decision support. Another important aspect is that information on the Internet is presented through computers. Computers have special properties for communicating information that make them quite different from more traditional media. Clinical decision-making can be affected significantly by how information is displayed (Elting, Martin, Cantor, & Rubenstein, 1999; Wyatt, 1999). The sidebar in this article discusses several issues in using computers for information display.

Devising a clinical decision support system should begin with the answer to the question: How do clinicians make decisions and what information do they need in the process? In dentistry, this question is currently unanswered. While many studies have provided answers for medicine (Detlefsen, 1998), information needs and information-seeking behavior of dental professionals have not been studied systematically. In 1981, Murray (1981) examined dentists' preferred sources of new drug information. Sixty-two percent of respondents preferred the Physicians' Desk Reference and 25% preferred colleagues as a source for information about drugs. In 1986,

new developments and for patient care. Two studies of dental hygienists (Covington & Craig, 1998; Gravois, Bowen, Fisher, & Patrick, 1995) did not investigate information needs, but only resource use. Our recent study of Internet use in clinical practice found that participants used the Internet more to keep up with new developments in general than to an(Curley, Connelly, & Rich, 1990) preliminary framework for physicians' use of medical knowledge resources. This framework is summarized briefly below.

Accessibility primarily determines whether and how an information resource is used. A book that has been lent out at the library, a collection of journals that is at home rather than at

Only 5% of respondents reported using the Internet at chairside or in the operatory.

swer patient-specific questions (Schleyer et al, in press). No study in dentistry has provided the type of information that observational (Covell, Uman, & Manning, 1985; Ely, Burch, & Vinson, 1992; Forsythe, Buchanan, Osheroff, & Miller, 1992; Lomax & Lowe, 1998; Osheroff et al, 1991) studies have discovered in other healthcare fields.

Thus, the question "Is the Internet useful for clinical practice?" is difficult to answer because we do not know what practitioners' information needs are. If we assume that the Internet provides at least some useful information, we need to turn to how practitioners can retrieve and use it. Gorman (1995) found that primary the office, or a defective telephone switch that prevents access to the Internet–all these are obstacles to information access. Traditionally, physical access determined availability of a resource. Accessing information on the Internet, however, requires a complex physical and logical infrastructure. Even a successful connection to the Internet is not enough. Slow connection speeds and incompatible file formats can also impede access to information.

Once a resource is accessible, a user must search through it successfully to find the relevant information. Effective searching requires that documents are indexed and that the user's query is correctly matched with the information in the index (Hersh, 1998). Finding relevant information on the Internet is very difficult (Baujard et al, 1998b; Gatlin, 1998; Hersh, 1999; Jenkins, Grey-Lloyd, & Hancock, 1998; Li, 1998; Schleyer, Spallek, & Spallek, 1998; Tay, Ke, & Lun, 1998). The extrinsic form of indexing and organization most search engines provide is marginal at best. Thus, the search for a generic term often results in a large numbers of hits. This makes it difficult to find useful information. The Web provides a basic method for indexing Web pages through meta-tags, but the vast majority of sites do not use it (Internet Economy Index, 1998).

Most individuals use only simple keyword searches, either because they

O ur recent study of Internet use in clinical practice found that participants used the Internet more to keep up with new developments in general than to answer patient-specific questions

Strother (1986) surveyed a random sample of 500 dentists in Louisiana on what information they sought and what sources they preferred. Eightynine percent and 85% of respondents, respectively, indicated that they sought information to keep up with care physicians leave a significant number of clinical questions unanswered. This study also identified several characteristics of information resources that influence whether they are used or not. Some of these characteristics are mirrored in Curley's are unaware or unfamiliar with the "advanced search" most search engines and some Web sites provide. Even if users are familiar with the search functionality, they may not perform optimal searches because of their lack of experience (McKibbon et al, 1990; Peng, Aguirre, Johnson, & Cimino, 1994).

Once a document has been retrieved, it must be understandable to be useful. For instance, many research studies provide clinically useful information, but not in the form the clinician needs. Researchers and clinicians use different vocabularies and measures to express their worlds (Slawson, Shaughnessy, & Bennet, 1994). A document in a different language may provide the perfect solution for a clinical problem, but unless the clinician is fluent in the language, it is not useful.

Once a document is understood, it should be clinically relevant. The more the document deviates from the clinical situation at hand, the less useful it becomes. In 1994, Gorman (1993) examined how useful the biomedical literature was in answering clinical questions of primary care physicians. Participants indicated that the literature answered 46% of their These cost-oriented characteristics are balanced by the perceived benefits of a resource. Extensiveness describes the scope of knowledge that a resource has. While in general the Internet is considered a very extensive resource due to its sheer size, it may be very narrow when considering single domains. However, our reopments anticipated in the near term include:

Technical Changes: The expected technical developments of the Internet and the World Wide Web are too numerous to list. Two of them will have the most significant consequences. The first is the evolution of information representation on the Web. Currently,

Not only will the Internet's technological foundations change, but so will applications and uses.

cent content analysis of dental Web pages (Schleyer, Spallek, & Arsalan, 1998) has shown that it offers a wide range of dental information. Relevance of a resource describes how specific its information is in the problem domain at hand. In a companion article in this publication, Hersh extensively discusses credibility of information, the last quality criterion in Curley's model.

We conclude this article with a discussion of several expected developments of the Internet that will influence its usefulness as a decision sup-

A personal profile entered at the beginning allows site customization, so that information can be targeted to characteristics of the user

questions clearly. Other studies support this finding (Lindberg et al, 1993; Wallingford, Humphreys, Selinger, & Siegel, 1990). Anecdotal evidence indicates that MEDLINE may be useful for dentists (Ahluwalia & Lang, 1996), but use seems to be low (Lang et al, 1998).

Lastly, the use of a document may also be determined by the monetary cost of obtaining it. The cost of accessing the Internet, however, may not be an issue based on the evidence from a recent study (Schleyer at al, in press). port resource. We also identify some potential research issues for Internetbased clinical decision support.

Future Developments

The Internet will evolve significantly in the coming years. Not only will the Internet's technological foundations change, but so will applications and uses. As organizations and companies learn to work with the Internet, we can expect that dental Internet resources will become more tailored to the needs of their users. Some develalmost all Web pages are represented in the Hypertext Markup Language (HTML). However, developers are beginning to adopt the Extensible Markup Language (XML), a superset of HTML (Kahn & de la Cruz, 1998). XML is much more powerful than. but also very different from, HTML. Most importantly, XML will make it easier for computer programs to understand the content of documents. Thus, computers will become more efficient at finding, filtering, and organizing information. A second change will be the implementation of faster communications architecture, such as Internet 2 and vBNS. Higher speeds will allow us to use more advanced applications, such as videoconferencing.

Portals: Portals are Websites that attempt to provide "one-stop" information shopping. Mainstream examples include Netscape's Netcenter [netcenter.com], Yahoo [yahoo.com], and Microsoft Network [msn.com], which offer news, search engines, indices, e-mail, and other services from one Web page. Dental examples are GlobalDent [http://www.globaldent. com], the Dental Xchange [http:// www.dentalexchange.com], and P&G ResourceNet [http://www.dentalcare. com]. Portals can facilitate information access because users need to learn the interface only once. However, since portals can never provide access to all relevant information in a domain, they can not meet all information needs. In addition, portals often integrate advertising, which reduces the space allocated to the actual content.

Meta-Sites: Many times, related relevant content is spread over multiple Web sites. In a thorough search, a user would have to visit all these sites to obtain the desired information. Some Web pages, however, collate this information automatically. One example is comparative shopping services which list prices obtained automatically from several vendors. A dental example would be the comparison of similar dental materials from dental manufacturers. Unfortunately, such sites are not popular with vendors since they tend to make markets more transparent (e.g., by reducing information asymmetries for buyers). Another example for meta-sites are meta-search engines such as [www.search.com], which submit user queries to several search engines automatically and collate and organize the results.

Currently, implementing metasites is difficult because Web pages written in HTML do not lend them-

Collaborative Filtering: Assessment and rating of documents requires much time and effort (Shaughnessy, Slawson, & Bennett, 1994; Slawson, Shaughnessy, & Bennett, 1994). Several sites employ collaborative filtering (Borchers, Herlocker, Konstan, & Riedl, 1998; Dragan, 1997b) to characterize and rate content. Users are asked (or required) to rate certain characteristics of an item (such as a Web page or a music CD). Ratings from many individuals are aggregated into summary ratings. These ratings are then used in subsequent user que-Google [http://www.google. ries. and Direct Hit [http:// com www.directhit.com] are examples for Websites that use a collaborative filtering approach.

Information Retrieval: Significant research activity is currently focused on information retrieval (Baujard et al, 1998a, 1998b; Hersh, 1998; Hersh & Donohoe, 1998; Malet, Munoz, Appleyard, & Hersh, 1999; Tay, Ke, & Lun, 1998; Zacks & Hersh, 1998). Several different approaches to index-

The ultimate goal: to integrate the Internet into the clinician's workflow so that it becomes invisible

selves to automatic interpretation by software programs. However, Web pages written in XML will facilitate cross-sectional information retrieval.

Personalization: Sites that keep track of individual users (for example, by requiring a unique login password) can personalize content. For instance, a site could keep track of preferred documents or services of a user and subsequently present those as the first choices when the user returns. Also, a personal profile entered at the beginning allows site customization, so that information can be targeted to characteristics of the user (such as the dental specialty). Intelligent agents can perform similar functions on the user's computer (Dragan, 1997a). ing (Baujard et al, 1998b) are improving our ability to categorize documents. Several projects (Baujard, 1998b, Detmer, Barnett, & Hersh, 1997; Suarez, Hao, & Chang, 1997) have improved access to healthcare related documents already by using controlled vocabularies (such as the Unified Medical Language System developed by the National Library of Medicine).

Another area in information retrieval concentrates on making it easier for end users to query databases by using natural language [http:// www.askjeeves.com] or graphical maps [http://www.semio.com]. Lastly, researchers are developing methods to query content that could not be queried previously, such as video, audio, or images. For example, it will be possible to query clinical image databases by image content in the future.

These developments will raise the value of the Internet as a passive decision support resource. However, we should see this only as an intermediate step to the ultimate goal: to integrate the Internet into the clinician's workflow so that it becomes invisible (McGowan, Michl, O'Malley, & Parrish, 1999). Currently, retrieving information on the Internet requires substantial effort. Technology can reduce or eliminate this effort and support clinical decision-making in a natural, transparent manner (Elson & Connelly, 1995b). This goal can be achieved by focusing on underlying research and development aspects (Hersh, 1999).

Currently, we do not have a good understanding of how dental practitioners make clinical decisions and what information they need to do so. Theoretical models of decision-making in dentistry that detail when and how decisions are made during the care process are the foundation of successful decision support systems. Despite drawbacks (Covell, Uman, & Manning, 1985), systematic information needs studies can contribute to designing better information resources for clinical decision support. Research methodologies that could be used include surveys, participant-observer studies, and the critical incident technique.

In order to be able to support the clinician effectively, a decision support system needs to know as much about the patient as the clinician does. Thus, dentistry should focus on the development of systems that can store patient-specific information useful for decision support. These systems must have appropriate interfaces to decision support systems to eliminate duplicate data entry. One way to meet this challenge is to integrate Internet-based decision support systems with Web-based patient record systems. Web-based patient records systems in dentistry, however, are currently in a very early stage of development (Schleyer & Dasari, 1999).

Significant effort is required to integrate Internet-based information resources and decision support with the clinician's workflow (Barnes, 1998; D'Alessandro et al, 1996; Zielstorff, 1998). Currently, only Web-based systems hold the promise of a seamless integration of all types of applications and resources (Schleyer & Dasari, 1999). As writing programs for the World Wide Web evolves, such systems will becomes easier to build. However, significant research and development efforts (e.g., in human-computer interaction and artificial intelligence) are needed to be able to integrate computers successfully with the clinician's work.

The Internet promises to become the infrastructure for information management and communication of the dental care system. It holds significant potential, but it must evolve substantially before it becomes a compellingly useful clinical decision support tool.

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See Editor's Note on page 15 regarding formats and references to the Internet.

To Net or Not to Net: Confessions of a 'Tweener

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Abstract

A dentist who sees both the advantages and disadvantage of participation on Internet chat rooms (listservs) reflects on his own participation in this medium. Allowing for individual differences, listservs permit great flexibility and offer alternatives for remaining professionally connected that are between the passivity of reading and the risk of confrontation of face-to-face meetings. Some personal suggestions are offered for good citizenship on the Internet.

he public, and often the media, tend to view dentists generically. Dentists, undoubt edly, appreciate the range of diversity in their ranks, even as most dental organizations work hard to project a single and unified face of the profession. "Dentist," however, can not be taken as a homogeneous construct when applied to the electronic information age. While there are undoubtedly many individual exceptions, it is clear that there exists an age cohort effect for Internet participation by dentists. This likely reflects the age cohort effect among the general population for the use of computers. One would expect younger dentists, who have been reared during the information and technology explosion, to be

early and more ready adopters of such change. Among my dentist colleagues, who span an age spectrum from the early twenties to upper seventies, I have vet to meet a dentist (or dental student) younger than thirty-five years of age who is without an e-mail address. Recently a dental student provided me his business card that included an e-mail address. When I was in dental school, we had neither e-mail addresses nor business cards! Many of my more senior colleagues either have eschewed the routine use of a broad array of electronic communications in their professional activities or claim to be working up the courage to become "computerized."

Electronic communications can seem threatening from a number of perspectives. For example, they permit dental students virtually free access to professors, at least in one direction. They also expose our ideas to others where they may be challenged or criticized. If we become dependent on computers, what will we do when they fail? And for the faintest of heart, what if I mess up something big?

For me, I'm a 'tweener (read "inbetweener"). I had no choice but to become comfortable with electronic technology since I still have children of school age, I deal with a cross section of colleagues from all age cohorts, and I work predominantly out of my home. It was either be on board or stand on the shore and watch.

Many uses for electronic communications are being discussed and promoted in dental publications on a continuing basis. These include such practical matters as submitting billings, ordering supplies, looking up prices for items and materials, identifying continuing education opportunities, seeking information from a web-site, transmitting patient records, looking for scientific data on some subject, etc. One of the most practical and user-friendly aspects is the chat room or listsery. This convention allows for fairly free-ranging discussions by parties of overlapping interest. The American Dental Association has instituted such a service for its members, based on a menu of topics. I participated for over a year in what was labeled a "managed care" listserv. By participating, I mean I regularly checked to see ongoing communications that were added. Occasionally, I offered something of my own, believing that it could enhance the factual



Dr. Corbin is Director of Health Initiatives and Research at Special Olympics, Inc. in Washington, DC and a member of the Editorial Board of this journal. basis or direction when opinions sank to the monotony of verbal dueling.

Human beings are by nature social animals who thrive on interaction and communications. Knowledge is power. In the emerging electronic communications era, that power potential, or deficit, is rapidly growing. It has been estimated that 75% of the technology that we will be using in 2005 has yet to be invented. The ability to retain a fixed body of knowledge will have decreasing market value in the future, while the ability to rapidly locate and effectively use information will determine winners and losers in all walks of life and business endeavors. Thus, it would seem that developing facility with computers and computer-based communications will be a requirement for being competitive, even in the near term. While it is true that much of dentistry still depends on manual skills developed through training and dental practice, we can expect that the role of the manual side will decrease in the future, especially in light of the epidemiology of oral diseases.

The Internet Highway—Rules of the Road

I wish to offer some suggestions that may be helpful for anyone considering a drive on the Internet highway. In general, following the "golden rule," as related by the innocent rabbit Thumper in the movie *Bambi*, is a good starting point: "If you can't say something nice, don't say nothin' at all." That's not to say that everything you offer on the Internet should be blandly agreeable to everyone else, because it won't be.

My personal views on how to be a good citizen in cyberspace are shown in the side bar.

The Costs and Benefits of Taking the E-Plunge

There are both costs and benefits to participation in such activities. On the benefit side, dentistry is predominantly a "cottage industry" profession with most dentists practicing by themselves. Additionally, dentistry, Rules of the Road for Civil Participation in Listservs

Be respectful and professional, not rude or crude.* Act as if you were having a semi-private discussion with another professional in the waiting room of your office or at a meeting.

Respect rather than condemn the ideas of others. Don't be narrow minded.***

Be a good listener (to others!), rather than being self - absorbed.**

Do some quiet, patient thinking, rather than simply firing back knee-jerk responses as a standard operating procedure.*

Don't keep repeating yourself*. You may, however, seek additional information and attempt to get your point across by strengthening your argument.

Honor the agreed upon subject matter range or precepts established for a specific listserv; i.e., don't ask for recommendations about impression material on a managed care listserv.*

Be careful not to transmit computer viruses to others (OSHA rules provide little help with this!).*

Be concise and to the point. A windbag is a windbag whether in person or electronically.***

Don't discuss taking actions collectively (and don't take actions collectively!) that put yourself in harm's way with the FTC or any other entity ("Stupid is as stupid does"—Forrest Gump).*

Note: Asterisks are intended to denote author's perceived degree of difficulty for complying; the greater the number of asterisks, the greater the difficulty.

through its policies and actions, tends to focus rather narrowly on dental clinic-specific matters. While this maximizes consistency and the potential impact of group action, it does so somewhat at the expense of exposing ourselves to new and different ideas that might be beneficial to us individually and as a profession. Listservs provide an opportunity for dentists to be exposed to a broadened array of information and opinions beyond their immediate circle. Additionally, a debate format among civil individuals can be quite helpful for drawing conclusions that might be more elusive if one were left to his or her own devices. Likewise, the electronic venue can free individuals from having to save face or defend a particular personal or organizational position. One

can choose issues of interest but need not pick up every bait that is proffered on a group e-discussion and escape the face-to-face debate common in meetings. It can also be relaxing to watch others carry on a conversation while you are thinking and not have to offer an immediate conclusion, decision, or defense. One can actually walk away ("exit," "delete," or "escape" buttons), reconsider, come back at a later point, and re-enter the discussion. This is particularly appreciated by a morning person such as I.

I rely heavily on data and systematic analysis in forming my opinions. This also means that I am forced to modify my opinions as new data become available. I have been able to acquire important data through electronic dialogues-new publications, new findings, updates, etc. Further, some of the most valuable data are those that do not come from published studies. Opinions and experiences of the participants provide potentially important data for examining one's perceptions, values, and biases. In particular, I was surprised with many of the things people were willing to share over the Internet that they never would say "in public." This included reports of some activities that could provoke moral, ethical, or legal questions.

When it comes to the Internet, you have about as much privacy as when President Clinton's mother was induced to share a secret with a reporter based on the promise "It'll just be between us." You should never assume this.

The major downside to participating in electronic group discussions is that it can, at times, be frustrating. real, face-to-face life, but rarely with so many witnesses. It was encouraging that there seemed to be some self-policing of behavior on the Internet. When someone got out of line, there were usually several people who would step up and call for a higher level of courtesy and dignity.

"All the World Is A Stage"

Different listservs reflect different motifs and are quite dynamic, largely a result of the principal participants, but also the group at large. For example, there may be two hundred or more persons signed up on the listserv, but no more than a dozen participate with any regularity. Greek tragedies or television soap operas offer useful analogies as to how listservs function at the human level. Expect that there will be a principal protagonist and one or more antagonists. The protagonist's role may be to propose

The ability to rapidly locate and effectively use information will determine winners and losers in all walks of life and business endeavors.

When conversations become dominated by just a few individuals who are overly pedantic, redundant, or have their own agenda, they can be wearying. It takes some courage to politely suggest that some individuals may wish to take a break. Likewise, I have witnessed some occasions of impolite or unprofessional behavior between parties. This happens also in ideas that he or she knows will push the envelope of factual or conceptual acceptability or civility among the group. The antagonists bring to bear the collective, informal, policing norms of the group and help to flesh out the issue to be contended. The chorus generally is in the background, either observing or offering succinct refrains, such as: "Right on," "Count me in," "Well said," "You've gone too far," etc. As in Greek tragedies, listserv protagonists are occasionally subject to tragic flaws, such as being too smart for one's own good, having a personal agenda exposed, or relying too much on personal experience, rather than on a broader range of information. Where protagonists repeatedly become rebuffed, they may lose their standing or actually elect to abdicate it.

It has been said that the amount of light (insight) that is shed on a topic is usually in inverse proportion to the amount of heat (argument) being generated. It is quite useful in a listserv group to have a couple of individuals who are adept at bringing light in a timely fashion to an overheated discussion. When the temperature of such dialogue starts rising, this is a pretty good indicator that more information is needed.

All in all, I believe it is worth experimenting with "e-conversations." It certainly offers an inexpensive means of keeping in touch with the broader world. One might even engage in conversations beyond the practice of dentistry. If you have a computer linked to the Internet, all you need to do is find the address of an operating listserv and figure out how to sign on. Also, I recommend that you save the instructions as to how to sign off! You may decide to start your own listserv on a topic in which you have interest and see if anyone else has a similar interest. But beware, "e-conversations" can be so stimulating that they become addictive. At least in such cases, one can determine their own therapeutic and tolerable dose.

The Quality of Information on the World Wide Web

William Hersh, MD

Abstract

How can a healthcare provider or patient evaluate the quality of information available on the Internet? The credibility and interests of the host should be considered and a filter that screens sites might help. In the end, however, there is no substitute for the experience of a qualified practitioner.

he World Wide Web has revolutionized access to health information. While such information has always been available in book stores and public libraries, the Web makes its access easier and faster. Of course, information about health has always required perspective and skepticism on the part of the reader. Those who write about health topics do not always have the interest of the reader foremost. The Web magnifies both the good and bad about health information.

Most health care providers believe that being well-educated about health makes one a better patient. Such patients tend to take a more active role in the medical decision making process and adhere better to treatment regimens. But most health care providers have seen instances of patients led astray by information they obtain from newspaper, magazines, television, and, of late, the Web. Sometimes they are misled by misunderstanding what has been written. Other times, they have been led so purposely by those who have products to sell or axes to grind. Nonetheless, the proverbial cat is out of the bag. Over half of all Americans have Internet access, and of those who do, 30% use it to seek health information (Nammacher & Schmitt, 1998).

How does one sort out good information from bad on the Web? How good is the quality of information on the Web? Just perusing the sites listed in this journal should convince anyone that the Web is a great source of health information. But all sites are not equally good. For example, a search for information on depression may yield a practice guideline detailing the most effective known treatments or a page advertising colloidal minerals, a completely unproven therapy. How does one know whether a page found on the Web represents good information or just someone's desire to make a buck?

One approach to determining the validity of information is to look at who created it. Sites from health-related government agencies, academic health science centers, and commercial health information publishers are likely to have information of high quality. But this is not always the case, as these sites, even with good intentions, may not have the level of review necessary to ensure information of the highest accuracy. And sometimes those with products to sell have quite good Web sites that describe the treatments they sell and the conditions they treat.

Another approach is to look to "meta" sites which review, catalog, and (sometimes) rate "primary" sites. These sites are also called "portal" sites and often have associated search engines. The degree to which primary sites are reviewed is variable, from those that review the content in detail to those that just rate sites for their aesthetic qualities. Often times the meta sites will describe how they rate primary sites. A recent review of meta sites and their varying criteria for quality judgment was published in JAMA (Jadad & Gagliardi, 1998).



Dr. Hersh is Associate Professor and Chief, Division of Medical Informatics & Outcomes Research, Oregon Health Sciences University, Portland, OR. An additional technique is to give more credence to sites that adhere to voluntary codes of conduct. Probably the best known of such codes is the Health on the Net (HON) code (http://www.hon.ch) that is presented in the sidebar. Sites that adhere to the HON code can display its logo.

A final approach is for individuals to rate sites on their own based on quality criteria that have been advocated. One such set of criteria were published recently in JAMA (Silberg, Lundberg, & Musacchio, 1997). These criteria state that Web pages should contain the following:

- 1. The name, affiliation, and credentials of the author–You may or may not value the individual or his or her credentials, but they should be posted for you as the reader to assess.
- 2. References to the claims made–If health claims are made, they should contain references to legitimate scientific research documenting the claim.
- 3. Explicit listing of any perceived or real conflict of interest–A conflict of interest does not disqualify someone from posting information, but as must be done by physicians who teach continuing education courses and all perceived or real conflict of interests must be disclosed.
- 4. Date of most recent update–Even though the Web is relatively new, health information becomes outdated quickly, and the date that a page was most recently updated should be listed.

These criteria do not necessarily indicate that a page which has them is of high quality or that a page which does not have them is not of high quality. However, they can be a guide for at least starting to determine how trustworthy a page is.

How well does the Web answer health questions and how good is the quality? We assessed this by taking fifty questions that physicians had asked in the course of clinical practice and were known to contain answers Health on the Net (HON) codes of conduct (http://www.hon.ch).

- 1. Any medical/health advice provided and hosted on this site will only be given by medically/health trained and qualified professionals unless a clear statement is made that a piece of advice offered is from a non-medically/health qualified individual/organization.
- 2. The information provided on this site is designed to support, not replace, the relationship that exists between a patient/site visitor and his/her existing physician.
- 3. Confidentiality of data relating to individual patients and visitors to a medical/health Web site, including their identity, is respected by this Web site. The Web site owners undertake to honor or exceed the legal requirements of medical/health information privacy that apply in the country and state where the Web site and mirror sites are located.
- 4. Where appropriate, information contained on this site will be supported by clear references to source data and, where possible, have specific HTML links to that data. The date when a clinical page was last modified will be clearly displayed (e.g., at the bottom of the page).
- 5. Any claims relating to the benefits/performance of a specific treatment, commercial product or service will be supported by appropriate, balanced evidence in the manner outlined above in Principle 4.
- 6. The designers of this Web site will seek to provide information in the clearest possible manner and provide contact addresses for visitors that seek further information or support. The Webmaster will display his/her E-mail address clearly throughout the Web site.
- 7. Support for this Web site will be clearly identified, including the identities of commercial and non-commercial organizations that have contributed funding, services, or material for the site.
- 8. If advertising is a source of funding it will be clearly stated. A brief description of the advertising policy adopted by the Web site owners will be displayed on the site. Advertising and other promotional material will be presented to viewers in a manner and context that facilitates differentiation between it and the original material created by the institution operating the site.

in the regular medical literature (Hersh, Gorman, & Sacherek, 1998). These questions were entered into a search engine and the output judged for applicability to the question as well as quality based on the JAMA criteria above. The results were not very encouraging. Less than half the questions had any pages which answered the question. And in total, only about 10% of the pages retrieved had anything to do with the question whatsoever. The quality measures were equally abysmal, with only 30% having a listed author, 12% having sources for claims made, and 18% showing the date of most recent update. Virtually no sites indicated any conflict of interest, whether present or not. In summary, this study showed the Web has a long way to go to be a definitive source for answering health questions.

So what should one do to ensure that information is likely to be accurate and useful? First, one should make sure that the source of information they are reading is credible and unlikely to have a conflict of interest. Second, one should consider using a site that filters and/or catalogues information so the best sources are accessed and a better overall picture of the subject of interest is attained. And finally, we should remember that despite our highly wired world, there is no substitute for a qualified health care provider who has experience in addition to knowledge and can help apply general information to an individual's specific situation most effectively.

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Patients and the Internet: Guidance for Evidence-Based Choices

Belinda Gregory-Head, BDS, MS

Abstract

This paper discusses the uses of the Internet by the public to gather healthcare information. It reviews the types of information available and the pitfalls of random searches. It provides guidance for directed searches and advice for patients and practitioners seeking evidence-based sources. It discusses future directions and the growing responsibilities of professions to stay educated with regard to Internet technology.

he public's use of the Internet for gathering healthcare information is on the increase. There is little doubt that this will continue to be a growing resource for patients. Recent data suggests the number of adults in the U.S. with access to the Internet either at home or at work rose in the last year by 16.3% to 83.7 million Men (http://www.mediamark.com). are more frequent Internet users by a fraction. There will be an estimated 67 million interactive households across the U.S. and Europe by 2003, up from 10.3 million in 1998, according to a reby Datamonitor (http:// port www.datamonitor.com).

Patients anxious to participate in decisions about their own treatment have turned to the Internet to confirm diagnoses, validate physician-recommended treatment, or seek alternative therapies. This trend may eventually eclipse the traditional routes by which patients gather information.

The volume of health related web sites and the speed with which information can be disseminated is phenomenal. Prior to the advent of easy access to the Internet, healthcare information came to the consumer at a much slower pace. Information was gradually assimilated into the common knowledge via scientific journals and then through the popular press and television. At each step it was subjected to some kind of editorial review. The Internet, on the other hand, allows rapid dissemination of information that can quickly gain credibility by the mere fact that it is seen in print on the computer screen. There is often no formal review process and there is already so much information available that even the best efforts of the most careful watchdogs are unable to keep up with all the new sites coming online. Once the information is available on the Internet, the problem for the searcher shifts from one of quantity to quality.

There has been some research into the accuracy, completeness, and consistency of patient-orientated healthcare information available on the Internet. A recent survey checked the reliability of advice given at forty-one web sites with regards to the home management of childhood fever (Impicciatore, Pandolfini, Casella, Bonati, 1997). Only four of the web pages retrieved gave complete and accurate information according to the published guidelines. A second study evaluated the quality of information a parent could obtain from Internet sources regarding the treatment of childhood diarrhea (McClung, Murray, & Heitlinger, 1998). Sixty articles were retrieved from the first 300 sites searched. The articles were published by traditional medical sources. Only twelve (20%) conformed to current American Academy of Pediatrics recommendations for treatment of children. The source of the information, even if from a major academic medical center, did not improve the likelihood of accuracy. The authors concluded that there is an urgent need for major medical institutions, schools, and hospitals to devise ways to carefully monitor and establish quality control of their home pages.



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The reliability of information available to physicians over the Internet has also been the subject of minimal research. There are indications that doctor-orientated information does have value. A recent study compared the quality of information available to physicians on a subset of Internet mailing lists for nephrologists with that available through the specialty's peer-reviewed print journals (Hernandez-Borges, Macias, & Torres, 1998). The study reviewed the types of postings and the authors of the postings and found that while there was a slight tendency for the print journals to show higher average impact factors there was no statistical significance. Likewise, an assessment of the content and academic quality of the postings to a list for orthopedic surgeons showed that over half the postings contained at least one journal reference and over 77% of the postings were from senior orthopedic surgeons in the U.K. hospital system (McLauchlan, Cadogan, & Oliver, 1999). The authors concluded that the mailing list did provide good quality information.

Types of Information Available to the Public

The healthcare information that is available to the public falls into several categories. Firstly, there are the legitimate scientific sites such as those run by the National Library of Medicine (PubMed) which draws its data**BIOLOGICAL DENTISTRY**

http://membrane.com/philanet/dentist/biomenu.html http://www.naturalbiologics.com/Therapies/dentistry.html

CAVITATIONAL OSTEPATHOSIS http://www.hugnet.com/yourhealth/cavitations.html

CANCER CURES

http://www.curecancer.com/

MULTIPLE SCLEROSIS http://www.intergate.bc.ca/personal/sweet/index.html

press. It has necessarily been scrutinized and subjected to peer review prior to inclusion on these sites. Such resources are extensive but it is not their intent to present information in patient-centered terms. It is understandable, therefore, that other sites should be required that can present information in an easy format for the average patient to understand.

Those sites that are specifically designed to educate or inform patients and the public fall into several subcategories. There are those sites that are the home pages of accredited medical and dental institutions, along with those sites maintained by the various accredited specialties. Such sites often serve as marketing tools for the institution but generally also provide for community service needs such as directing patients to appro-

The reliability of information available to physicians over the Internet has also been the subject of minimal research.

base primarily from MEDLINE (http://www.ncbi.nlm.gov/ PubMed). These often do not require registration and they allow free access to literature and data that has been published in the scientific and medical priate programs and providing public health information (Sonnenberg, 1997). As the limited research into these sites has already shown, many of them do not convey completely accurate information, but this is an

area which can be improved over time by the institutions themselves. Along with the trend for clinical schools and hospitals to create public health information sites there lies an increasing responsibility for clinical experts to become familiar with the technology and to review the materials posted to ensure their accuracy. Care must be taken to ensure that such sites really are designed for the average reader and not the technologists and doctors that build them. A recent study has assessed the readability of fifty sequentially sampled patient-centered information pages and determined that the viewer must be reading at a little more than tenthgrade level to fully understand the information presented. Previous studies have shown that this is far above the level of the majority of patients. The authors concluded that the information presented was often not comprehensible to the healthcare consumer (Graber, Roller, & Kaeble, 1999).

Both the scientific sites and the institutional home pages offer the best hope as legitimate sources of information regarding the current standard of care in any particular field. They may also direct the reader to other sites that offer an alternative point of view but in general the information they provide is similar to that given by the position papers of the various medical and dental organizations sponsoring them. These sites, for all their faults, still remain some of the best initial resources for patients.

The unreviewed and often more confusing resources for the consumer are the sites that fall into the remaining categories. These include those add credibility to their web pages. As with the quack sites, the intent may not be to deliberately deceive but merely to present the very strongly held points of view of a few. The sites maintained by the advocates of biological dentistry and holistic dentistry

The most alarming trend is the growth in sites in the final category, those of charlatans.

run by well-meaning individuals offering personal testimonials, those run by quacks and cranks, and finally, those run by charlatans.

Many personal web pages attest to the efficacy of various treatments and therapies for the ailments of that individual. They generally act as testimonials from patients who wish to share their tales and help others in the same situation. Unfortunately, the public may be easily misled by reports of miraculous recovery. These represent the experiences of one person and whether true or not cannot be evaluated in an evidence-based manner. The authors of some of these sites may also fall under the definition of quacks in that they may boast about or promote unproven remedies. It is possible to build and maintain a web site for as little as \$100-200. It is also possible for web pages to remain unmaintained but available long after the author has succumbed to his or her disease. They can therefore, without intent, give false hope and inaccurate information regarding long term outcomes.

The next group of potentially misleading web sites are those maintained by cranks. These individuals may have some scientific background but may have become disgruntled with the scientific community. They tend to work isolated from traditional science. They develop their own plausible sounding jargon and publish in their own journals and web sites. They may even create "professional" organizations with seals and logos to may be considered to fall into this group since they present views that directly contradict those held by dentistry's governing bodies on these matters (http://www.explorepub.com/ events/dentistry.html). Some sites do acknowledge that the views presented are not those of the mainstream but most do not (http:// www.hugnet.com/yourhealth/ cavitations.html; http://www.hugnet. com/default.html).

The most alarming trend is the growth in sites in the final category, those of charlatans. The authors of these sites engage in fraudulent practices with intent to deceive. They play on the fears of patients. Those who are most vulnerable are those with chronic or terminal disease such as AIDS or cancer. There are sites that address almost any disease with a long natural history where conventional some "cure" that can be ordered over the Internet. As with the crank sites there may be an appearance of legitimacy about the site, with "professional" seals and endorsements. It may be difficult to discern that the site is actually nothing more than a marketing device for an unproven remedy, but usually as the reader wades further and further through pseudoscience and testimonials of previous patients it becomes obvious. Some suggest alternative etiologies for the disease process and then present available "cures" at many hundreds of dollars (http:// www.curecancer.com). Some take the other approach of presenting one universal "cure" and then defining the whole range of diseases that it is effective on (http://www.intergate.bc.ca/ personal/sweet/index.html).

The Need for Awareness

Practitioners will increasingly be challenged by patients clutching printouts from health related websites. Most patients will not have the scientific background to critically evaluate the information presented. Medical professionals will need to develop personal and institutional approaches to advising patients who wish to augment their knowledge using the Internet.

Initially, patients should be warned of the voluminous misinformation that is on the Internet. They can be directed to the sites maintained by

There has been some research into the accuracy, completeness, and consistency of patient-orientated healthcare information available on the Internet.

medicine can take many months to be effective, if at all. These patients have often been given a realistic diagnosis and prognosis by their physicians but are desperately seeking someone who can tell them there is a cure available. The sites are often characterized by major institutions or those of the medical or dental specialty boards that are appropriate. Secondly, they should be advised to be systematic in their approach and consider using one of the Internet guides that can direct searchers to quality, subject oriented

Dentistry and the Internet

Resources on the Internet

Patient Education Sites

http://www.dentalcare.com

Sponsored by Proctor and gamble with some excellent patient education pages

http://www.ada.org/tc-cons.html

The consumer section of the ADA web page has excellent patient information including video clips.

http://www.nidcr.nih.gov/news publica.html

The NIDCR public information page

http://www.healthfinder.gov

A government funded "gateway" site to reviewed sources

http://www.healthatoz.com

A "gateway" site with a directory of 50,000 reviewed resources

Sites for Dental Professionals

http://www.medmatrix.com

Peer-reviewed annotated resources on all aspects of healthcare

http://nccam.nih.gov

The NIH site that describes current evaluations of alternative therapies

http://healthweb.org

Evaluated resources from a collaboration by a number of health sciences libraries in the Midwest.

<u>http://www.ncbi.nlm.nih.gov/</u> <u>PubMed/</u>

Free MEDLINE from the National Libraries of Medicine

www.dentalxchange.com

A discussion forum and resource site

Sites About Quackery and Fraud

http://www.HCRC.org

Information from the National Council Against Health Fraud

http://www.quackwatch.com

Operated by Stephen Barrett M.D. as a non-profit consumer protection site. Excellent reviews of controversial topics.

http://www.skeptics.com.au

A lighthearted look at quackery in medicine and other arenas such as the paranormal.

information from evaluated resources. A good starting point would be one of the so-called "gateways" shown in the accompanying table. These sites filter, evaluate, and classify websites through a number of review processes. Some are supported by paid advertising and others such as Healthfinder are public health service sites maintained by the government. These are an excellent place to begin any search. They will generally lead the searcher to the evidence-based sites and those that inform about the current standard of care. Discussions with patients regarding their Internet sources should be open and acknowledge alternate points of view, but the need for critical evaluation of the information

can be stressed. In many cases the issues that come up may be beyond the scope of the individual practitioner's knowledge and patients can be directed to watchdog sites such as those listed to compare their findings to those of the scientific community. The site maintained by the National Council Against Health Fraud, (http://www.hcrc.org) has a searchable database on many of the alternative therapies that are presently popular. It also has a link to the Scientific Review of Alternative Medicine, a peer-reviewed journal dedicated exclusively to evaluating alternative medicine which counts several Nobel laureates on its editorial board. Another excellent watch dog site is Quackwatch which, again, has a broad

searchable database that patients can consult for advice regarding cures and therapies they find. These sites add a note of caution to any search and remind the searcher that if a "cure" sounds too good to be true it generally is.

The healthcare professions will have increasing responsibilities in helping patients make the best use of the Internet as a growing resource. Patients will use it anyway, with or without guidance.

Physicians and dentists must become familiar with the technology and what is available to patients. We must be able to help patients in directed searches; we must ensure that patients can be comfortable discussing their findings. The professional organizations should strive to create more evidence-based patient education sites. If more information is available from peer-reviewed sources then it is more likely to turn up when patients conduct a search. There should be greater efforts towards patient-centered education in regards to the scientific effort that has determined the techniques and practices used today. We should be aiming to bring balance to some of the issues that are presently the source of controversy. The monitoring efforts of the groups that already exist should be supported and further resources allocated to this important area.

Finally, clinicians should be well versed in the principles of an evidencebased approach to dentistry and medicine so that they can evaluate new information as it becomes available. Patients and providers will need to educate themselves regarding who and what to trust on the Internet.

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Healthcare in a Networked World

Mark E. Frisse, MD, MS, MBA

Abstract

In this essay a medical informatics expert reflects on what the history and future of the Internet means to the way we do business and how we relate to each other. It is not just a matter of more of the same faster; the nature of work changes, the value of services change, and participation in community becomes natural. Ironically, the informality and impersonal nature of the Internet is making it that much more important to know who one is dealing with.

n addressing the many roles the Internet may play in dentistry, this issue of the Journal of the American College of Dentists takes a courageous step; it is trying make valid predictions about the future. The pace of the Internet is accelerating. The growing use of this technology by all ages has led to massive investments in the technologic features required to allow the conduct of business in a private and secure way suggests a growing use in all health care disciplines. No field will be immune. Book stores, toy stores, and brokerage houses have already had to undergo massive changes. Universities, publishers, retailers, and manufacturers will be compelled to follow. Can we expect our own professions to be immune? If not. what should we understand about this new force so that we can improve the quality of our care and the quality of our professional and personal lives? How can we integrate our own experience with other, larger questions about this industry?

These questions cannot be answered with certainty, but I believe it is possible to see the emergence of trends and, in doing so, at least provide some idea of the forces that will effect the future of our professions. This article will attempt to do just that. We will address some of the forces that will no doubt have a major impact on the lives of our professional colleagues, their patients, and their families. We will look at the notion of "being digital" and the way in which the established "information rules" of economics can be applied to digital media. We will see how new technologies dissolve barriers of time and space, creating a "death of distance."

Being Digital: Where it Came From

Less than two decades ago, few saw the association between the newly emerging personal computer and the Internet used by the scientific and military community. The personal computer was the affair of the hobbyist or the small business. Early advocates of home computing felt the devices would somehow be useful for recipe management; they were correct about the value of home computers, but utterly inaccurate about where the value would be found. The Internet, on the other hand, was restricted to the elite researchers and graduate students who had access to powerful mainframe and mini-computers. The business of e-mail was conducted on a terminal connected with dozens or hundreds of others to a larger computer which in turn was connected to the Internet. The latter was valuable for identifying software patches and discussion groups, but only the rare pioneer really used distributed computing in a manner that is commonplace today. Even in those early stages, however, one realized that a new form of commodity was appearing-information.

With the emergence of even the early networked computers, individuals became parts of communities sharing information. Because the community was small and elite, it wasn't as rough to get things accomplished as one might imagine. One knew, for example, that a given professor could be



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The growth brought forth by the emergence of browsers brought with it a grass-roots drive to develop and disseminate content. As the content

D entistry is knowledge work, and the Internet promotes the availability and dissemination of knowledge of every kind.

ily and had easy means to share emotions with a parent. As one parent told me, "I somehow became closer to my son when he was in college because he was able to say things over email that he had never shared when he lived at home. We developed a deeper sense of trust in one another."

These one-to-one communications were complemented by the shared communications between individuals. The emergence of spontaneous newsgroups and discussion lists skyrocketed in the late 1980s and led to a dramatic increase in traffic. But even in these settings, the phenomena were more focused on the spontaneous interactions between ever-changing groups of individuals. And this was the state of affairs until the Mosaic browser took the Internet by storm.

Mosaic, and its oft forgotten nongraphical ancestors WAIS and GO-PHER, brought the Internet to the masses because they eliminated cryptic commands like "ftp" and "mail -f / usr/local/frisse/sentmail." Mosaic brought an intuitive look and feel to the media and, in doing so, made it attractive to those who wished to reach a mass audience. Scholars were among the first to pursue this media. Several increased, full-text search algorithms known since the 1960s were re-discovered by young and old entrepreneurs, often creating millionaires overnight. Just as the market in the 1980s moved from an emphasis on hardware to an emphasis on software, the market of the 1990s moved from the web browser to the Internet portal. Everyone involved in the industry tried to edge from "atoms" to "bits"–a transition well articulated in Negroponte's (1996) book entitled "Being Digital."

Along the way, real commerce developed. First, trade was limited to books and CDS in pioneering sites like Amazon.com [http://www.amazon.com] and CDNow [http://www.cdnow.com]. The model was extended next to online brokerages and to highly regulated auction sites like OnSale [http:// www.onsale.com]. Later, more vibrant communities became prevalent. Brokerages were complemented by wildly popular sites like the Motley Fool [http://www.fool.com]. The static auction model of OnSale was complemented by a more participatory model espoused by eBay [http:// www.ebay.com]. In each of the latter instances, the relationship was not between a single seller and multiple buyers, but instead a true marketplace where one could be both a seller of one item and a buyer of another at the same time. Increasingly, the Internet became characterized not just as a commerce of trade items but also as a commerce of ideas. People could find kindred spirits interested in even the most arcane subject. Increasingly, these on-line communities are being

R ather than "dumbing down" a population—a charge often made of television—the Internet seems to elevate the opinions and practice standards of the profession.

develop attractive sites with a phenomenon they call "stickiness"—the tendency for readers to return to the site again and again. This in turn became attractive to advertisers, who often pulled advertisement from print (newspapers, magazines, and professional journals) and brought these same adds to audiences targeted on the basis of their queries to Internet portals. All of this was a part of a movement of the recording of knowlformalized through firms like eGroups [http://www.egroups.com] and also in the more widely known Internet portal sites. Looking from the outside of this emerging phenomenon, one observer thought it akin to a soccer game in which there were scores of teams and dozens of balls all playing at the same time. Everyone on the field seems to be having a good time, but from the bleachers, the whole affairs seems to make little sense! Each of these businesses is an exemplar of a hive of activity. Each of these businesses will no doubt change between the time this essay is written and the time it is published. Where technology is concerned, the only certainty is change.

What does this mean to dentistry? To paraphrase one respondent to a survey on Internet use, the availability of digital information allows the dentist to leave a "monastic existence" and to learn tion was the result of the ability of technologists to double the computing power of a chip every eighteen months. But to a greater extent, the transformation occurred because of an ability to increase both the likelihood one could be connected to the Internet and the amount of information that could be sent over a network. In the world of telecommunications, the ability to push more and more information across a fiber-optic

C oncern over misrepresentation, fraud, and abuse of intellectual property will lead to stronger methods of authenticating identity.

from colleagues. It allows one to identify new products and services, and it finally recognizes the vital role information plays in complementing the manual therapeutic skills of the practitioner. When seeing a patient, the dentist first does the right thing through examination and assessment, and only then does therapy-doing the thing right-commence. Dentistry is knowledge work, and the Internet promotes the availability and dissemination of knowledge of every kind, from office hours to claims processing to information about new products to details of new and complex procedures. The dentist is not alone anymore; communities are possible and, as the communities extend to patients, new ways of promoting health and advancing the profession will be identified.

The Death of Distance

Early surveys of Internet use by dentists suggest that the profession is achieving an international consensus on quality and practice standards. Rather than "dumbing down" a population—a charge often made of television—the Internet seems to elevate the opinions and practice standards of the profession.

How did this transformation come about? In part, the transforma-

cable increases by orders of magnitude. This in turn leads to a dramatic drop in the prices charged by a telecommunications industry facing increasing competition. Indeed, since most of the cost of a long-distance call is in the cost of the local switching, there is very little difference in true cost between a call across town or a call across a continent (or an ocean). Cairncross (1997) has called this effect a "death of distance" in a recent book of the same name.

This change in the cost of communication will have striking implications. Increasingly, English will be group in Seattle can close up shop in the evening and have its work continued by a team in Bombay. A dentist requiring an urgent consultation in the middle of the night can contact a colleague across the world who is in the middle of a busy day of practice. As more and more information about oral disease prevention becomes available on a world-wide basis, expectations will increase and standards for many countries will be elevated. Popular techniques and procedures will not disseminate slowly but instead will grow and shrink rapidly as they are scrutinized by thousands and their effects are tabulated. Dentistry, in other words, will become increasingly a global profession united by common standards and techniques. Telemedicineand teledentistry-will not be a significant part of the vocabulary. These technologies will someday be so commonplace that they will be integral to many practices.

Webonomics

The Internet is changing the way we work and explore the world, but it is not changing the basic rules of supply and demand. In a recent and popular book entitled "Information Rules," Shapiro and Varian (1998) describe how simple economic rules still apply. In the realm of popular publishing, for example, the introduction of a

n general, practitioners underestimate the total cost of ownership of computers in their offices.

a universal second language simply because so much popular and professional content is written in this language. As the cost of communication decreases, much knowledge work can be done "over night" in one country by actually performing the task on the other side of the world during daylight hours. For example, a popular CD ROM-based encyclopedia by Microsoft had a serious impact on the sales of traditional, high-end print encyclopedias. As the lowerpriced digital products became more widely available and complemented by Internet-based sites, the higher-end print publications have not been able to make up for lost revenues by raising their prices to a shrinking audience. Instead, most have chosen to complement their print products with subscription-based services made available through the Internet.

Recognizing the impact the Internet was having on popular publishing, traditional publishers of biomedical information realized a threat to their hegemony. But threats are nothing new to this industry. In the 1960s, the introduction of the photothe recorded music world is now facing a similar battle.

In the biomedical arena, the E-Biomed proposal advanced by the U.S. Director of the National Institutes of Health is advancing the discussion on how these new technologies can be used to resolve a crisis in biomedical publishing [http://www.nih.gov/welcome/director/ebiomed/ebiomed. html]. Varmus proposes a centralized repository for biomedical publications

One can ultimately imagine a system in which employers contract with dental plans through the Internet.

copy machine led to similar threats and concluded with a landmark Supreme Court Decision that limited the scope of copying that could be done without paying royalties to the owners of intellectual property. But in contrast to digital media, the photocopy machine did not pose a lethal threat. Although one could make multiple copies of the same work, the degradation in quality produced by photocopying prevented one from making copies of copies.

In the digital world, however, one can produce a theoretically infinite amount of copies identical in every respect to the original document. Like a virus, everyone downloading a copy of a work could in turn make a perfect copy for others and these readers in turn could make copies indistinguishable from the original. In principle, an individual unencumbered by conscience and copyright law could post a book on the Internet and have most of the world read it-without the author ever selling a legitimate copy (Goldstein, 1996). The "market failure" induced by such a phenomena is still the focus of much of the print publishing world, and with the more recent ascendance of the MP3 music format,

which, to this writer, appears a bit akin to the SEC's EDGAR database for financial reporting. The intent of the proposal is to find new ways of addressing better accessibility, lower cost, rapid access to quality publications, and a "heightened sense of community." The intent of the proposal is to stimulate discussion, not to create a government monopoly for biomedical print. In one sense, it could allow publishers and professional societies to devote more of their resources to establishing better relationships with their clients along the lines of the spirit of "Webonomics." While a sucmight have a broader readership through a parallel Web site. Dues paid to professional societies might be spent on additional services. All will be possible if organizations can know the identity of those whom they are dealing with and members can be sure of the identity of individuals providing services.

Concern over misrepresentation, fraud, and abuse of intellectual property will lead to stronger methods of authenticating identity. In essence, if one subscribes to a costly electronic journal, means will be found to limit "reading" this journal to specific computers or, perhaps limiting readership to a person with a "smart card" that validates his or her identity. The alternatives to these technical solutions are not pleasant; some journals may maintain their readership through sponsorship by professional societies; some may maintain their readership through additional on-line advertising; but many journals will fold.

The move to more formalized means of authenticating identity may have many benefits, however. With a valid means of authentication-be it smart card, finger scan, retinal scan, or some even newer technique-one can provide new data about how our patients are using information by borrowing techniques employed in other Web industries (Schwartz,

ndeed, it is quite easy to imagine that the word Internet disappears from our vocabulary because it is so ubiquitous.

cessful implementation would definitely change the finances of publishing as much as Wal-Mart changed retailing and Amazon changed e-Commerce, this proposal does not necessarily spell a death-knell to print publishing. Indeed, print may thrive and professional publications like this 1998). Equally important, these technologies can ensure trust and security of confidential information. Currently, the security of our health care information is only as good as the weakest link in the system. Often, the Internet is viewed as this weak link, either because of the ability to capture messages as they travel through networks or because of the possibility of impersonating the identity of someone who is legitimately entrusted with the information. The issue of computer security and information privacy is critical to all of us both in our role as providers of health care and—equally important—as patients within an increasingly digital health care delivery environment. Because publishing, entertainment, and other forms of commercial activity depend on highly renance and support. In a corporate environment, network-based computers can incur an annual cost of ownership in excess of three thousand dollars. Practitioners wishing to scale up from a relatively inexpensive solitary personal computer to a highly networked office should expect to incur similar costs.

In fact, it is fairly easy to make a case that dental practitioners do not need the Internet for any of their current professional activities. Benefits to individuals are clear in some instances,

Itimately, it is not the technology that is of concern so much as it is the people who will use it.

liable trusted information systems, it is reasonable to conclude that the price of adopting similarly rigid security standards in the health professions will decrease rapidly over time.

How are Dentists Using the Internet Today

The articles in this issue describe in some detail both the current state of Internet use in dentistry and the issues that will affect its future adoption by the profession. Hopefully, readers of these articles will have a greater degree of enthusiasm for the potential of this technology in the profession. But in these early days of Internet use, practitioners should view the current stage of the technology as only a hint of the potential that is to come. Clearly one can derive much benefit from Internet use as a consumer and as a professional, but the cost-benefit to dental practice is not universally demonstrable. In general, practitioners underestimate the total cost of ownership of computers in their offices (Strassmann, 1997). All too quickly, the uninitiated realize that the cost of ownership of networked systems is not in their purchase but in their ongoing mainte-

but most of these benefits are of such a profound impact that a practitioner could not conduct business without them. Before taking this somewhat nihilistic view, however, one might reflect on a more pressing question: how are current and potential patients using the Internet and how can the practitioner use the Internet to enhance these relationships? Here may be the ultimate value of the Internet. In principle, the technology can be used to streamline the making (and canceling) of appointments, of ensuring adequate inventories, of reducing accounts receivables, and of adjudicating claims. Numerous established claims processors and many new companies are entering this arena. Information vital to patient care-in particular medication informationmight be made available to the practitioner with the patient's permission, ensuring that adverse drug reactions are minimized. Pharmaceutical benefits management companies and Internet pharmacies will no doubt engage in collaborations with others to provide these services. One can ultimately imagine a system in which employers contract with dental plans through the Internet, patients identify

providers through the Internet, they make appointments through the Internet, they pay their bills through the Internet, and even receive their medications through Internet pharmacies. What is promising about this scenario is the real potential to minimize overhead and to protect one of the most valuable commodities of a patient and their provider-their time.

Long ago in computer time (i.e., about twenty years ago) visionaries predicted that personal computers would be found in many homes. Their claims were greeted with jeers and skepticism, but they were correct in their prediction. But if one reviews these claims, one sees that these prophets were only partially right. They envisioned the computer as a useful vehicle for maintaining home recipes. In my twenty years with information technology this writer has yet to see someone use a computer for this purpose.

Given the uncertainty around past predictions, it is equally apparent that the only valid prediction one can make about Internet use is that it will be different than we currently envision. Indeed, it is quite easy to imagine that the word Internet disappears from our vocabulary because it is so ubiquitous. As communications technologies extend to all parts of the air and earth one will expect Internet access every bit as much as one expects electricity and the word "Internet" will be used no more frequently than the term "power grid."

Through this uncertainty, however, professional standards will be the central area of concern in our relationship with our patients. Ultimately, it is not the technology that is of concern so much as it is the people who will use it. If the past is any predictor, the dental profession will find new and innovative means of using the Internet to enhance the quality of care for their patients. It is hoped the articles in this issue will advance this debate. References

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History

Controversies in the History of Dentistry

Eric K. Curtis, DDS, FACD

Abstract

Controversy appears to be inescapable in the retelling of history. Three examples from dentistry are no exception: who invented anesthesia, why was the first U. S. dental school separate from a medical school, and what is the difference between the DDS and the DMD degrees?

ecounting the past is always a game and a gamble. History has been described as something that didn't happen written by someone who wasn't there. Events gone by are reconstructed and interpreted through filters of circumstantial evidence, cultural bias, and even guesswork. As a result, reporting history comes to resemble gossip more than simple disclosure. Such uncertainties prompted Thomas Carlyle to call history "a distillation of rumor" and led Phillip Guedala to observe that history may repeat itself, but historians repeat each other. History engages not unbleached facts but lively imagination, however sincere. And since understanding is not a prerequisite for argument, history is full of ongoing debates. Dentistry's own nineteenth century beginnings, in fact, harbor several important developments greased by rumor and wrapped in dispute.

For example, who really invented anesthesia? Why is dentistry separate from medicine, or more specifically, why did Horace Hayden and Chapin Harris found the first dental school instead of starting up a dental department in the medical school where they already taught? And why are there two dental degrees? In the following I offer my bets on some short answers.

Who Invented Anesthesia?

Bill Gates was asked recently whether success comes from invention or refinement of the ideas of others. His answer, of course, was yes. The pattern of progress is tangled, and nothing is invented in a vacuum. Anesthesia's story begins with nitrous oxide and ether, which had been around and used for entertainment since the late 1700s. All of the claimants to anesthesia fame in the 1840s seized on existing ideas—and materials—and in some context adapted them to help solve one of the knottiest problems in medicine.

Êvery dental student hears the story of Connecticut dentist Horace Wells, who attended Gardner Quincy Colton's nitrous oxide lecture in 1844 and was amazed to observe that a volunteer who sniffed the newly-discovered laughing gas was still happy even after falling off the stage under the influence and injuring a leg. The next morning Wells invited Colton to his office, where he took the gas and had dental student John Riggs extract a tooth. Wells was elated to realize he had experienced no sensation. In a month Wells had used nitrous oxide on more than a dozen patients. At the request of Wells's partner William Morton, Harvard anatomy professor John Warren allowed the dentists to demonstrate painless dentistry in a surgery class. Warren was skeptical and the students hostile. When the medical student who volunteered to have a tooth removed groaned under the procedure, Wells was ridiculed– even though the patient admitted he had felt no pain.

Wells lost his sanity over the humiliation, but won the accolades of dental history. Both the American Dental Association and American Medical Association gave Wells the credit for ushering in the era of surgical anesthesia. But there are three other contenders. Morton, who went on to study medicine under Charles Jackson, continued to be on the lookout for pain relieving agents. Morton was intrigued when Jackson recommended ether as toothache drops and



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History



began testing inhalation ether on animals. In 1846 he bravely returned to Warren's surgical arena and convincingly demonstrated inhalation anesthesia. Wildly jealous of Morton's success, Jackson denounced his protégé and took credit himself. In the midst of the argument, a rural Georgia doctor named Crawford Long announced he had already used anesthesia for surgery. He published an account in 1849 describing his use of inhalation ether to remove a neck tumor in 1842.

So who gets the glory for bringing the world anesthesia? In 1847 the U.S. Congress began a sixteen-year investiHayden and Chapin Harris launched the Baltimore College of Dental Surgery in 1840. The real question is why. To answer that requires a glance back to the previous century. The French surgeon Pierre Fauchard settled in Paris after a hitch in the navy and devoted himself to dental surgery. His landmark work, The Surgeon Dentist, published in 1728, presented dentistry for the first time as a coherent discipline. Fauchard created the modern concept of dentistry when he identified three problems: (1) inadequate dental literature; there were neither books nor journals to share information, (2) the scarce op-

H istory may repeat itself, but historians repeat each other.

gation of the "Ether Controversy," and finally couldn't decide whether to offer congratulations to Jackson or Long. Charles Jackson had mentored Morton, but made no effort to advance the anesthesia concept himself. The first to apply anesthesia in a medical situation was Crawford Long, whom the U.S. Postal Service honored with a stamp for his trouble. But Long, who was only mildly interested in the possibilities, didn't bother to tell anyone about his success for years after. The first to demonstrate anesthesia publicly was clearly Horace Wells. And the first to win the medical establishment's support for anesthesia and encourage its widespread use was William Morton, who gets the nod from many medical historians. As William Osler said, "In science the credit goes to the man who convinces the world, not to the man to whom the idea first occurs."

Why Did American Dentistry Identify With Surgery Rather than Medicine?

There is no argument as to who established the first dental school. Horace portunities for instruction, and (3) the lack of regulation of practice across France; no mechanisms existed to set or measure standards of competence.

The French Revolution, however, brought a jarring setback. For dentistry the revolutionary ideals of liberty, equality, and fraternity were a disaster, smashing Fauchard's vision of an autonomous, disciplined, educated body of practitioners. Fauchard's ideals of systematic training for dentists,

and cost control. The rapidly expanding population and coming of the Industrial Revolution caused a rise in expectations of better living. The resulting upswing in consumption encouraged the experiments of inventors, many of whom applied their ingenuity to dentistry. Charles Goodyear's mid-19th century invention of hardened vulcanite rubber, for instance, meant that denture bases could be made cheaply and easily. Suddenly, false teeth, which had been previously reserved for the rich, were available to the masses. Wells's and Morton's anesthesia demonstrations at Massachusetts General Hospital showed that pain control was possible. The introduction of the dental engine, which cut hard tissue much faster than could hand instruments, led to sharply increased treatment efficiencies.

America also fostered an educational philosophy that promoted free public school education, which in turn produced an expanded audience of readers, resulting in the rapid growth of books and newspapers. The increased printing and circulation of books and pamphlets for patient education may well have increased the patronage of dentists and presaged the development of professional publications to encourage better training.

And the United States had highminded Horace Hayden and Chapin Harris. Hayden taught dental surgery

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nevertheless, would be embraced in America. The United States had the right demographics, in the shift from a rural to an urban emphasis in western civilization. The rise of cities fostered education and communication and supported a growing demand for such luxuries as formally trained dentists.

The U.S. was also developing the technology to encourage both comfort

to medical students at the University of Maryland. Harris, already trained in medicine by his brother John, apprenticed himself to Hayden to study dentistry. In 1833, following his mentor's footsteps, Harris won a license from the medical school to practice dentistry. Three years later the country fell into depression. Banks failed, mercantile houses collapsed,





and unemployment skyrocketed. Many of the newly jobless turned to dentistry, which was widely thought of as a vocation requiring little preparation for its successful pursuit. Hayden and Harris formed a partnership to counteract the growing numbers of untrained dentists.

In 1840, when Hayden turned seventy and had been practicing in Baltimore thirty-eight years, the University of Maryland awarded him an honorary MD degree. Hayden approached the school about integrating dentistry into the medical school curriculum.

He intended to develop dentistry into a specialty of medicine. But the school refused his proposal. Some ter to establish a dental school, may have been an influence.

Whatever the impetus, the two advocates of dentistry went their own way. Hayden and Harris fulfilled Pierre Fauchard's mandate, organizing the original dental society, the American Society of Dental Surgeons (which may have been the first professional organization in the world-the American Medical Association would not be formed until 1846) and the world's premier dental periodical, the American Journal of Dental Science. Hayden and Harris were responsible for the founding of the Baltimore College of Dental Surgery, the first school dedicated to educating dentists.

D octors looked, surgeons cut, and apothecaries poisoned.

conjecture that Hayden was rebuffed because of dentistry's status. Surgery, originally a trade several social notches below medicine, had become medicine's competitor. Only relatively recently had surgery's threat to medicine been neutralized by re-integration with medicine. But dentistry-the first specialty of medicine-may have been just too specific and specialized to be likewise accepted; besides, it still was not a proper activity for gentlemen.

Others conclude that Hayden, whom the local medical society accepted as both a physician and a dentist, only approached the medical school out of convenience. The university, for its part, couldn't afford the expansion. In this scenario Hayden's ultimate intention all along was to found an independent dental school. Chapin Harris's physician brother John, who had his own interest in dentistry and had tried unsuccessfully a year earlier to persuade the Kentucky legislature to grant a charThe curriculum covered a two-year span, which included four months of formal instruction and the rest of the year spent pursuing practical experience in a dental office, which was equivalent to that of the old University of Maryland medical school. Hayden and Harris created the school's degree, "Chirirgia Dentium Doctoris," the initials of whose translation became the familiar DDS.

What is the Correct Degree Designation—DDS or DMD?

Dentistry is not the only profession with two different degrees. Medicine has MDs and DOs. But while that dichotomy represents diverging philosophies, training, and politics, dentistry's degrees are identical. The DDS-DMD duality arose from disagreements over what dentistry should be. From the middle ages European health care separated into three tiers, which were both occupational and social. Doctors looked, surgeons cut, and apothecaries poisoned. The ancient divisions weighed heavily on the nineteenth century debate over dentistry's maturing identity. Some leaders argued for a merger with medicine, while others envisioned an autonomous profession.

The Baltimore College awarded the first formal dental degree, and the designation it chose-doctor of dental surgery-reflected dentistry's deep affiliation with surgery over medicine. Great admirers of Fauchard, Havden and Harris took their inspiration from the French, who had developed several dental designations. Influenced by the legendary surgeon Ambroise Pare, in 1619 France passed an ordinance granting equal rank to three surgical specialists: dentists, bone setters, and lithotomists. On passing examinations before a commission of three Masters in Surgery, each specialist would be considered "expert" in his branch of surgery. Later on, after completing a two-year course of study, a student could earn the title of "surgeon dentist" in France.

Twenty-seven years passed before the second dental school appeared. Harvard embraced dentistry in 1867 with the expectation of treating it as a specialty of medicine. But because dentistry had already manifested its politiindependence in Baltimore. cal Harvard's dental students were not admitted to the medical school, but to a new, parallel school of dental medicine. Its degree, doctor of dental medicine, or DMD, reflected a rival attitude to that in Baltimore. The line in the sand was drawn and new dental schools thereafter chose one degree or the other. But under the unifying influence of a single dental association, by the twentieth century any differences between the degrees were semantic. Still, presumably in search of a sharper, more cohesive image, longtime ADA general secretary and executive director Harold Hillenbrand suggested that the profession accept just one degree, the DMD. Hillenbrand retired in 1969. There are still two dental degrees.



The Roles of Evidence and the Baseline in Dental Decision Making

David W. Chambers, EdM, MBA, PhD, FACD

Abstract

Decisions are courses of action that exclude other actions and are based on information that is subject to error. Sometimes that information is evidence gathered about a particular situation; sometimes it is general knowledge about similar situations. A very simple example is used to show that the best decision making strategy is to consistently favor the most likely outcome based on previous experience if one is using baseline information. This is more effective than probability matching or dividing resources evenly. The same advantage of "sticking with the winner" applies when one is making a decision based on evidence. When both baseline information and evidence are available.

entistry is having a little trouble deciding where it stands on evidence-based practice. Systematic and shared inquiry, grounded in the conventions of one's peers is the bedrock of all professions. Good dentistry depends on good science. But that does not mean that dentists should be scientists and it certainly does not mean only one should be used-the one with the highest accuracy. They cannot be combined. The evidence-based dentistry controversy is analyzed from this perspective. It is shown that evidence has the highest accuracy for the controlled circumstances that researchers investigate and that the baseline has the highest accuracy for the natural circumstances that dentists encounter. The relative roles of the baseline and of evidence in decision making are applied to investing in the stock market and for showing that both examination-based relicensure and the current practice of testing for initial licensure are indefensible because they ignore the baseline.

that dentists should turn over their decision making to biomedical or policy researchers. There have been recent calls to change curricula in dental schools so that dentists become wise consumers of research. Strangely, there are no complementary calls that researchers should be trained to understand the logic intrinsic to dental practice. Although evidence-based dentistry is theoretically defensible, it often seems a bit impractical. Every case of recurrent caries is not a research project. Most of dental practice, including diagnosis, is the reflexive application of learned connections. That is true of all human behavior, and scientists who study human performance use the term "forward thinking" to describe the way we normally proceed in life. Effective people have large repertoires of "If condition C, then action A..." that have become habit and are appropriate to the circumstances.

It is only when forward thinking rules produce surprising results or when intuition borne of experience counsels caution that we begin to problem solve. Human performance researchers call this "backwards thinking." Competent individuals are usually as effective at forward thinking (rule following) as experts are. The difference becomes apparent when the context is complex and likely to require some problem solving as well. That is where the experience of expertise shines—especially in the part about recognizing that there is a problem.

Evidence costs. There is a hope among those who embrace evidencebased practice that improved technology will reduce these expenses to a point that justifies their benefits. But even sound evidence may be superfluous. Caries must be removed under amalgam restorations. A computer search for meta-analysis research data supporting this view will have absolutely no impact on the daily practice of dentistry.

There is a sense in which the dental literature systematically misrepresents dental practice. Case studies are selected for publication because they are unusual and not because they represent what dentists typically encounter. Research articles involve artificial assignment of patients and control of circumstances that would normally be inappropriate in practice. The custom that research articles begin with a review of the literature in order to establish a scientific context cannot be generalized as appropriate to typical dental treatment. In a word, the scientific literature in dentistry contains an inherent sampling bias. Precisely because it is science-an investigation of the unknown-the role of evidence will be greater in research than in practice.

Besides the costs of getting evidence, all of the interesting stuff has some probability of being wrong and therefore misleading. Decision making in dentistry, as in all other areas of human activity, is effected by both the quality of available evidence and the underlying distribution of events. Our recent preoccupation with the quality of evidence has drawn attention away from the baseline realities of dental practice. This column offers practical advice about when it is best to ignore the evidence, regardless of its quality.

The Basic Concept

The roles that evidence and the baseline play in decision making can be determined with considerable pre-



cision, even mathematical precision. Understanding this relationship often creates a challenge to fundamentally held beliefs regarding such issues as evidence-based dentistry, investment in the stock market, in-office audits for continuing licensure, and the initial licensure examination—all of which will be discussed in this column. Because of the numbers in-

E very case of recurrent caries is not a research project.

volved and the counter-intuitive conclusions that are sometimes reached, the basic relationship between evidence and the baseline will first be explained using a straightforward and unemotional example. If mathematics are put-off-ish, one can skip this section and take my word for the applications that will begin in the subsection entitled "The Combined Contribution of Baseline and Evidence" or take five minutes to learn this simple and powerful tool for decision making developed in the following ten paragraphs.

The Contribution of the Baseline. Assume that a dentist has purchased a special piece of equipment which he uses for many of his patients-perhaps an intraoral camera. He has two operatories that are approximately 20 feet apart. When the equipment is in the operatory where it is needed, there is no delay; but if the equipment is in the other operatory and must be retrieved, the round trip costs the dentist (or more realistically the chairside assistant) 40 steps. It has been worked out over time that the baseline-the proportion of times patients who need this equipment are in Operatory A-is 80%. Here is the question: Assuming that it requires none of the dentist's time to set up the equipment in either operatory, where should the equipment be placed before each appointment in order to minimize the number of steps or the lost productivity bringing the equipment into use?

The first strategy is to ignore the baseline and place the equipment in Operatory A 50% of the time and in



Operatory B 50% of the time. If this strategy is adopted, the dentist will take an average of 20 steps for every appointment. Here is how that 20 step estimate is determined. There are four possible outcomes: (a) Equipment in A and needed in A, (b) in B and needed in B, (c) in A but needed in B, and (d) in B but needed in A. The outcome of the first two cases is the same—no steps. The outcome of the last two cases is also the same—40 steps each. Now all we have to do is figure out the probability of each of these four outcomes. The total expected value for the strategy of even distribution of the equipment between operatories is the sum of the expected values for each outcome that could result from the strategy: 0 + 0 + 4 + 16 = 20 steps. If records are kept for a period of time, the average number of steps per appointment will be 20 using this strategy. The same result would be expects if the equipment were alternated between operatories or if a coin were flipped. It is even the case that the same expected value of 20 steps would

The scientific literature in dentistry contains an inherent sampling bias.

That is given by multiplying the probable location of the equipment by the baseline probability of its need.

In case (a) the equipment is in A half of the time (.50) and is needed there 80% of the time (.80). That means there is .40 chance of its being where it should be. The probabilities of the other outcomes are (b) .50 * .20 = .10; (c) .50 * .20 = .10; and (d) .50 * .80 = .40. The combined probability of all outcomes is 1.00 (.40 + .10 + .10 + .40) showing that all outcomes have been considered.

We now have all the numbers required to solve the problem. We know the results of each of the four possible outcomes and we know the probabilities that each will occur. All that remains to be done is to combine them correctly. This is simply a matter of multiplying the result of each outcome by its likelihood. The resulting number is called an "expected value"-it is the result you can expect to achieve by following this strategy over the long haul. The expected value for outcome (a) is .40 * 0 = 0; for (b) .10 * 0 = 0; for (c) .10 * 40 = 4; and for (d) .40 * 40 = 16.

obtain if the equipment were placed in the hall equidistant between the operatories (different numbers are plugged into the formulas, but the result is the same). In all cases of even distribution strategies, the baseline is ignored.

A second strategy is to leave the equipment in the operatory where it was last used. This might have some advantages since patients who need the equipment are more likely to be appointed in Operatory A and the equipment is more likely to be left in that operatory. Again there are four outcomes and their results are the same as those enumerated before: 40 steps for (c) and (d) and none for (a) and (d). But now the likelihood of each outcome has been altered. Consider (a)-equipment in A and needed there. Instead of the former probability of .40 (.50 * .80), now we can expect that combination almost twothirds of the time (.80 * .80 = .64). The likelihood of other results is (b) .20 * .20 = .04; (c) .80 * .20 = .16; and (d) .20 * .80 = 16. The combined probability of the results that would require movement, (b) and (c), are .16

+ .16 = .32. The expected value of steps to be taken with this strategy is .32 * 40 = 12.8.

The strategy of probability matching-allocating choices proportional to the baseline probability-is an improvement over the strategy of even distribution. This is true whether probability is matched with some random number generator, by hunch, through assigning the first X% of cases in a period to the most likely outcome, or by letting nature do the distributing by leaving things where they fall.

The third strategy for assigning resources when the baseline probability is known is the simplest; it is also the best. The strategy is called "stick with the winner." In this example of equipment in operatories, nothing can beat leaving the equipment in Operatory A all the time. Eighty percent of the time, the equipment will be where it is needed and no steps will be required; 20% of the appointments will result in travel and the expected value is 8 steps (.80 * 0 + .20 * 40). The full expected value calculation will confirm this shortcut reckoning.

When meaningful baseline data are available, the wise strategy is "stick with the winner" and the expected payoff is the same as the baseline probability.

The accompanying table shows the general relationship among the three strategies for using baseline information. To make this principle general, an arbitrary prize of 100 is set as the desired result so that high values in the graph represent hoped-for consequences. In all cases the best strategy is "stick with the winner," followed by baseline probability matching, and then by even distribution of choices. The greater the amount of usable baseline information (the farther away the baseline is from a 50:50 split), the greater the advantage of using the correct strategy. For baseline probabilities less that .50, just flip the outcome con-



sidered—if the probability of the equipment being needed in Operatory A is .20, the probability that it will be needed in Operatory B is .80.)

The Contribution from Evidence. But what of the role of evidence in such cases? For the moment, let's ignore baseline information and concentrate on the accuracy of some sort of external information to aid in decision making (evidence). In our hypothetical example from the dental office, the evidence may come from front desk staff who use information about the treatment needs of patients who are scheduled in order to place the equipment in either Operatory A or B. This strategy would certainly have much to recommend it if the evidence used by the front desk staff was free of errors. For the sake of reality let's assume that a combination of no shows, poor information collecting, and variability in patient treatment result in an error rate of conclusion one draws in either case are exactly the same-stick with the winner, especially if the winner has a good track record.

The Combined Contributions of Baseline and Evidence. Now we come to the issue of using both evidence and baseline information in the same situation. The appropriate strategy in this situation is also very simple, although the reasoning behind it is complex and it is sometimes resisted. The rule is "Base your decision on either the baseline alone or the evidence alone, depending on which one contains the most information." If the baseline distribution of patients between operatories in our example is 80% for Operatory A, always assign the equipment to Operatory A if the front desk personal makes 20% or more mistakes on average guessing where to assign the patient. If the front desk is more accurate than 80%, always use that evidence. The reason

B as your decision on either the baseline alone or the evidence alone, depending on which one contains the most information.

20%. In other words, the front desk is assigning the equipment based on evidence that is accurate in 80% of the cases. There are three strategies that can be used to make the assignments when such evidence is available: (a) ignore the evidence and assign the equipment evenly to both operatories, (b) match the distribution 80:20 to match the probable accuracy of the evidence, or (c) always assign the equipment based on the most likely outcome given the evidence.

The analysis of decision making based on evidence is exactly the same as the analysis of decision making based on baseline information. The this rule holds where decisions are involved comes from the symmetry of baseline and evidence when one course of action precludes others.

The example we are considering up to this point involves decision making-the commitment of resources to a course of action under conditions of risk (estimated probability). Many times, both the baseline and the evidence will support the same correct course of action; occasionally they will both support the same incorrect one. Where they disagree, however, they force a choice between one or the other incompatible courses of action. The three alternative decision rules we have discussed before apply in this case as well. Where evidence and baseline conflict the decision maker can ignore both and alternate between actions, engage in random probability matching, or always go with the long-term, most informative information.

Decisions vs Descriptions. The situation is different when a situation is being described as opposed to a decision being made. When an orthodontist does a space analysis, he or she considers the physical measures taken from the model as evidence and norms from the Michigan studies and personal experience as baseline. These are combined in the practitioner's mind, with more credence given to the physical measures. Although it is common to record in the chart only the physical measures from the models, experienced orthodontists make mental allowances for measurements that might be flawed or that deviate unexpectedly from norms.

This practice of combining sources of information weighted for their relative accuracy is called Kelley's Rule and is named after Truman Kelley, the developer of the modern IQ test and an advocate of using common sense in interpreting test scores. It is possible and even appropriate, to combine information from the baseline and from evidence when describing a situation. It is not appropriate to make these combinations when choosing a course of action. There is a difference between diagnosis (a decision) and the information that diagnosis is based on (a description). The role of evidence is different in these two cases

Evidence in Research and Evidence in Practice. This extended discussion may help explain some of the tension that now exists in the profession surrounding evidence-based dentistry. Researchers for the most part are concerned with making accurate descriptions involving situations where there



is no baseline information or where the situation has been manipulated to equalize the baselines (randomization and control). Under these circumstances, evidence is always of value for description and if decisions are made under circumstances that mimic the research, the evidence from any significant study will be better than the baseline. By contrast, practitioners are ultimately concerned with the category decisions of diagnosis and treatment. Unusual cases truly are rare and dentists have a rich foundation of experience which make it unlikely that evidence will alter established practice patterns. Thus "stick with the winner" baseline strategies will probably be the best course of action.

Two corollary points must be made before preceding with other illustrations of the relationship between evidence and baseline. First, although the theoretical explanation in the preceding paragraphs may seem overly detailed, human nature has this logic wired into it. Scientists who study human performance are in agreement that our lives-from how we maintain our body posture to the most sophisticated esthetic decisions-are controlled automatically by following the baseline. It is only when surprises occur that we look around for evidence. The second corollary point is that some advocates of evidence-based dentistry will find the reasoning in the preceding paragraphs awkward. They might even say that I have confused term for this approach is protocolbased dentistry, and advocating that all dentists practice standard protocols should really raise some red flags. This is certainly not evidence-based dentistry, however, though practitioners who fear that it is tend to lash out at insurance companies on the belief that it is. A more promising alternative might be termed outcomes-based dentistry. In this model, dentists would keep track of their own treatment outcomes for various patient types, They move them toward those that have out-performed the market in the same period. Later, they will move their funds again and so forth, always chasing the best in the past. This is a form of random probability matching and has the specific name "random walk" because of the meandering path it produces. As was demonstrated previously, this strategy is better than complete even assignment but is inferior in the long run to picking an established winner and staying with it.

The smart money has always said don't "play" the stock market.

diagnostic categories or symptom clusters, and treatments. The goal would be to build baseline data personalized to the practice to increase diagnostic accuracy and treatment predictability.

Three Applications

The Stock Market. The stock market is an excellent example of the kind of thinking we have been analyzing. There are only three courses of action possible: buy, sell, or refrain from either. These decisions are made based on baseline, historical performance and on evidence such as the opinions of experts, leading indicators and other indexes, and personal analysis.

Considering the baseline and the evidence, ex-

the meanings of evidence and baseline. Some of the advocates of this new thinking are actually advancing predetermined treatment plans or diagnoses based on best evidence and are advocating that such "pre-thought" treatments be used in all situations—as the "baseline" action. A more accurate A common strategy among market "players" is to follow the market. This is a focus on the baseline side of the equation but a misapplication of rules. Players move their holdings out of stocks, bonds, or funds when they see those investments under-perform the market in a particular time period. A second form of error is to place too much reliance on evidence (newsletters, annual reports, and even newspaper headlines) because that information is novel and especially if that novel information coincides by accident with any deviation from baseline expectations. The rule is always the same. Go with the baseline and ignore the evidence if the baseline has an overall long term higher probability of success: go with the evidence if the evidence has an overall higher probability of success. Switching back and forth is just another random walk.

Of course the stock market is more complicated than the simplified example of stationing equipment in a dental operatory. Both baseline and evidence information change over time and there are a huge number of alternative investments. It is also true of market situations that the large amount of money available and the large amount of intelligence that is chasing it will lead to a parity between baseline and evidence. The smart money has always said don't "play" the stock market. The strategy should be to study and understand the economy as a whole and to predict its future performance. Stocks, bonds, funds, and other investments are then chosen which match your un-



derstanding of the economy (not the market) and your own personal needs.

Examination for Licensure Re-newal. The profession has long debated whether there should be performance requirements associated with periodic relicensure. Potential requirements fall into two categories: (a) participation in continuing education or other professional development programs intended to change what practitioners are *capable* of doing and (b) written or practical examinations, case presentations, or office audits that provide evidence of the actual level of performance. Participation in educational experiences is a different kind of issue than the one being discussed here. But examinations for relicensure do meet our criteria: the decision involves mutually exclusive courses of action (relicense or deny relicensure or perhaps probationary status) based on a combination of baseline information (practice competence in the profession generally) and evidence (tests or audits for a particular dentist).

Considering the baseline and the evidence, examination for relicensure makes no sense. To my knowledge there are no studies which would allow us to estimate the accuracy of reexamination evidence in predicting which dentists should be relicensed and which should not. (There have never been any programs that test dentists to determine whether they should continue practicing and then let those who failed the test remain active just to find out how accurate the test is.) But there is a fall-back position that allows us to place an upper limit on such estimates. It is possible to calculate the reliability of tests with multiple questions, examinations with multiple evaluators, in office audits with multiple records pulled, or any situation where multiple patients are used or could have been used. Although reliability (consistency of decisions) does not determine validity (accuracy of decisions), it does place a limit on it. (The mathematics of this

relationship are somewhat complex but I have published a table which allows for direct visual determination of the relationship-see Recommended Reading.) If the reliability of evidence is measured at .20, the predicted validity must be in the range of .00 to .45 for example. While it could be anywhere in this area, depending on the representativeness of the test, it could never be higher than .45. If the reliability of the evaluation evidence is .70 or .80. as is common on written examinations, the validity could never be higher than .90, but could in fact be as low as zero if the test is consistently measuring the wrong thing.

Even with this much imprecision in estimating the accuracy of evidence for evaluating relicensure, we can draw useful conclusions. The proportion of practitioners who are so incompetent they should not be relicensed is a very small number. Published estimates of those who are technically incompetent range from 1% to 3% and those who are incoming on the proper decision. The amount of development time and testing costs required to bring evaluation for relicensure evidence to parity with the baseline would represent an unrealistic expense. It is not just charity to assume that dentists are competent professionals unless they show otherwise, it is also hard-headed logic to do so.

Let's consider another example along these lines that shows how even valid evidence can be damaging. There is a difference between saying that 20% of incompetent dentists will fail an examination and saying that of those who failed, 20% are incompetent. Although the two statements look similar, there is no way of concluding one from the other. If 20% of the phone calls received during the dinner hour are solicitations, it does not follow that 20% of the solicitations will disrupt our dinners.

Each time we make a conclusion from test information, we are making a hidden assumption about the underlying distribution. We can untangle

F ewer mistakes will be made in initial licensure by granting all graduates of accredited schools their license than are now made with an expensive and contentious system.

petent for any reason have never been estimated at more than 10%. Applying the basic rule, it is entirely safe to ignore evaluation information for relicensure, even when that information exists. The baseline competence for relicensure is reasonably 90% and probably much higher, while the accuracy of available information can be no more than 90% and is probably much less. Any efforts to develop betevaluation mechanisms for ter relicensure are a waste of valuable resources. An improvement in accuracy of such evidence from 20% to 40% or even 80% will have no defensible bearthis relationship by using a formula known as Bayes theorem, named after an English clergymen who several centuries ago became preoccupied with probabilities. The computations are not particularly difficult and the formula can be found in any intermediate statistical text book.

A practical example of how to use evaluation evidence in drawing a conclusion might be the following. Assume that a state institutes a practice of randomly sampling dental offices through an in-office audit requiring half a day and pulling about a dozen patient charts. Because such a sam-



pling is a tiny percentage of dentists' actual work we will assume that the audit has 20% accuracy, meaning that 20% of the incompetent practitioners will be identified as substandard using this process. But we do not know which ones they are. We also assume that 20% of those who are competent will fail the test because of an unlucky case, a score showing incompetence would still be wrong 15% of the time.

Those in the profession who have argued against relicensure based on any form of examination have traditionally pointed to cost and to unproven need for such a program. It is reasonable to add to these concerns a significant fear that a large number of competent prac-

A dvocating that all dentists practice standard protocols should really raise some red flags.

draw of charts or incomplete date. The final assumption is that 95% of the dentists in the state are competent. The question is when a dentist fails the audit, how likely is it that he or she is truly incompetent? The answer given these assumptions and Bayes theorem is .05. In other words, nineteen out of twenty dentists who fail this examination are in fact competent and would unreasonably be deprived of a license to practice or be subject to unjust scrutiny or probation. Perhaps, these numbers are not realistic and some method of in-office audit could be created that would be conducted in a reasonable period of time and be reasonably unobtrusive but yield a better estimate. Let's make the outrageous assumption that visitors remained in an office long enough to be 99% certain of the results. In this

titioners will be mislabeled as incompetent despite the best efforts of those developing evaluation systems.

Of course the logic of these arguments applies only to random evaluation or to evaluating all dentists. If there is reasonable suspicion of a dentist's incompetence the baseline changes. Let's assume that the state board has some grounds on which to judge that a particular dentist is not competent, perhaps there is an estimate in the range of an 80% likelihood that he or she should not be practicing without appropriate remediation. Under these circumstances an in-office visit that found the dentist was not competent would be accurate 50% of the time even when the overall accuracy of the evidence is 20%. If the evidence has an accuracy factor of 70%, a conclusion that the dentist is not competent will be correct 90% of the time. Of course, this is exactly the system we have now. State boards investigate dentists against whom there are allegations of incompetent practice, using a judicious combination of appropriate baseline and evaluation evidence to both save resources and improve the accuracy of decisions. As a general rule, probable cause is a more accurate guide to policy in determining qualification to practice dentistry than is any effort in the direction of test construction.

Initial Licensure Examination. We draw the same conclusions regarding evidence and baseline for initial licensure examinations as the one for evidence and baseline on examination for relicensure of practicing dentists. Such examinations are indefensible for exactly the same reasons. American Dental Association and American Association of Dental Schools data place the percentage of students graduating from accredited dental schools and being licensed to practice within one year of graduation in the 90% to 95% range. Boards do not publish or otherwise make available their reliability statistics although it is reasonable to conclude that they are no better than similar kinds of a data from dental schools, and no board has ever published data refuting the assertion that their reliability is any higher than .50. (Of course it is illegal to conduct any study which would validate the accuracy of board decisions since those who do not pass the boards are pre-

vented from practicing whether they are competent to do so or not.) It is possible, however, to use the rules relating reliability to maximum possible validity as mentioned above to show that under the best of circumstances no amount of evidence from the initial licensure examination would be more useful that the baseline criterion. Fewer mistakes will be made in initial licensure by granting all graduates of accredited schools their license than are now made with an expensive and contentious system.

Initial licensure examinations are often defended on the grounds that they are administered as fairly as possible and that efforts are made to ensure the calibration of examiners. Anyone would be alarmed to hear otherwise, but none of these efforts addresses the validity of the examination, and it is unlikely that any practical improvements in the psychometric properties of such tests could override the substantial baseline effect. As Algina has observed (see Recommended Reading), this is true even when the costs of passing an incompetent dentist are greater than the costs of failing a competent one. No data have been presented that bear on the relative costs, although examiners sometimes say such a difference exists for recent graduates, if not for practicing dentists.

The major source of unreliability in the initial licensure exam, however, is not the calibration of raters; it is the variability from patient to patient. The fact that this source of variability is not measured on licensing examinations does not diminish the impact of this factor any more than one can avoid being late by not looking at his or her watch. In a study that paralleled the structure of initial licensure exams using a dental school mock board situation, the inclusion of variability from patient to patient and testing time to testing time decreased the measured reliability well under .20. The great inaccuracy of drawing a conclusion that a person who fails an examination with 20% accuracy and 95% baseline has already been demonstrated several paragraphs above in the discussion of in-office audit visits for relicensure of practicing dentists. The numbers are identical and the conclusion must be the same in both cases. A confirmation of this conclusion can be found in the fact that the pass rate on re-examination for initial licensure examination often is as high as 80% or 90%.

A final comment must be made on written examinations as part of initial licensure. There are a number of jurisdictions that add their own written examinations to those already required in every licensure jurisdiction and given under the auspices of the Joint Commission on National Board Examinations. The National Boards happen to have internal reliability coefficients above .90 because of the psychometric expertise used in their construction and the very large number of questions asked. Locally developed tests tend to be considerably less reliable.

A case that demonstrates concern over the validity of special-purpose, locally-developed written tests for initial licensure involves one concerning ethics in a jurisdiction to be unnamed. I was able to analyze that examination and determine that its accuracy was 85%. In other words, based on this examination 15% of candidates would be misclassified on average-although we do not know which ones they are. It seems unreasonable to me that 15% of graduating students are unethical. So I can only conclude that it would be unethical to label them as such based on a short examination that has a significant chance of mislabeling graduates. If the number is indeed 15% or higher of graduates or practitioners who are unethical, massive educational intervention is a wiser strategy than is testing.

To be absolutely fair concerning the test on ethics, its authors point out that most of the questions are on terminology in ethical theory and on understanding of the dental practice act. To call this a test of ethics raises an ethical question regarding misrepresentation. Further, the principal architect of this examination is a board member with considerable experience and has told me that the practitioners in his state who know the practice act by heart and can give multiple interpretations for each section are those who have actions against them by the board.



Recommended Reading

* Algina, J. (1978). On the validity of examinations for making promotions decisions in medical education. *Medical Education, 12,* 82-87. Very technical paper on the accuracy of decisions made from test scores and baselines in the context of medical school passing

rates. Argues that the best strategy is to pass all students. Also presents an argument that content validity (efforts to make certain that tests cover a representative set of material) are insufficient protection from weak predictive validity.

Chambers, D. W. (1988). How good is my test? Journal of Dental Education, 52, 479-485. A readable introduction to ways of measuring the effectiveness of examinations. The basics of reliability and validity are presented. The graph showing the relationship between a test's reliability and its maximum possible validity is contained in this article.

Chambers, D. W. (1988). How good are my grades? Journal of Dental Education, 52, 579-583. Here the general method for calculating the proportion of students receiving the wrong grade on a test is developed. This is a general solution that extends beyond the two-category (pass-fail) type of decisions considered in this article.

Chambers, D. W., & Loos, L. (1997). Analyzing the sources of unreliability in fixed prosthodontics mock board examinations. Journal of Dental Education, 61, 346-353.

Study of a simulation of the fixed prosthodontics section of an initial licensure examination comparing four sources of variance: (a) examiners, (b) type of restoration, (c) experience of the operator, and (d) patient variability. Only the patient factor plays a significant role in overall reliability of scores. This is a source of variance that initial licensure examinations are blind to because they ask that the candidate perform each procedure only once. The overall reliability of scores in this simulation are in the .10 to .15 range.

Kelley, T. L. (1924). Statistical method. New York, NY: Macmillan.

This book was published seventy-five years ago; it is still as clear an elucidation of the way humans should think about data as one can find. In particular, Kelley lays out the rules for combining evidence and baseline information in estimating a score-describing a value (not to be confused with making a decision). An observed score (say a child's IQ to use the case Kelley was most famous for) should be weighted by its reliability and the baseline (the average score for children of that age) should be weighted by 1 minus the reliability of the test. The best estimate for the true score will be a compromise between the observed score and the baseline based on their weights.

Malkiel, B. G. (1999). A random walk down Wall Street. (Revised Edition). New York, NY: W. W. Nostron. Sound investment advice-don't "play" the market. Following the trends (random walks) is less effective in the long run than sticking with proven stocks.

* Reason, James (1990). Human Error. Cambridge, England: Cambridge University Press. ISBN 0-521-31419-4; 302 pages; about \$20.

A blend of the formal research literature in psychology and technical reports from industry, mostly case studies of accidents at nuclear power plants. The author argues that there are different kinds of errors which occur for different reasons and can be mitigated in different ways. Error results from a mismatch between the expected pattern of behavior and the requirements of the environment. Although this mismatch can be understood from an analysis of the patterns of human response (based largely on familiarity and similarity), the best forms of prevention are in systems design.

* Shapira, Zur (1995). *Risk Taking: A Managerial Perspective*. New York, NY: Russell Sage Foundation. ISBN 0-87154-766-X; 175 pages; about \$24. Managers approach decisions involving risk in predicable ways that differ from the classical rational approaches suggested by theorists. For example, they separate assessment of probability and outcomes and focus heavily on outcomes, especially negative ones. They reject the notion that they are gambling by defining gambling as one-time trials of pure luck. By contrast, executives feel they have special expertise and control, even after a decision has been made. They prefer to see decision making as sequential nego-tistion or duration with they can gat to a project on the special experimental special expertise. tiation and reframing until they can get to a position of acceptable risk (potential cost).

Editor's Note

Summaries are available for the three recommended readings preceded by an asterisk (*). Each is about four pages long and conveys both the tone and content of the book through extensive quotations. These summaries are designed for busy readers who want the essence of these references in fifteen minutes rather than five hours. Summaries are available from the ACD Executive Office in Gaithersburg. A donation to the ACD Foundation of \$15 is suggested for the set of summaries on decision making; a donation of \$50 would bring you summaries of all the 1999 leadership topics.

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