13. COMPUTERS AND DENTISTRY

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Computers are becoming as much a part of the dental office as any earlier technology. They are an essential part of office management and are becoming more common in clinical dentistry as well. Dental office computer programs are referred to as dental management information systems (DMIS)—a term that reflects the true nature of their function. This chapter addresses the following topics: fundamentals of computers, selection of computer systems, the computer as a dental management information system, dentistry and the Internet, and dental informatics.

FUNDAMENTALS OF COMPUTERS

1. What are the basic components of a computer system?

1. System board or motherboard
2. Monitor
3. Input devices
4. Storage devices
5. Peripheral devices
6. Connectors and ports
7. Communication devices

2. Describe the motherboard and its components.

The system board or motherboard is the large electronic circuit board containing most of the computer's essential components, including:

1. **Central processor unit (CPU)** implements all basic system instructions, performs calculations, and controls peripheral devices at the rate of billions of instructions per second. Common CPUs are the Intel Pentium, Power PC from Motorola used in the newest Macintosh OS computers, and the K.6 series from AMD. CPUs are generally in quick change sockets for easy upgrading.

2. **Random access memory (RAM)** refers to computer memory chips that hold programs and data only as long as the computer is powered. When the power is turned off, all contents of RAM are lost unless previously saved to disk. When programs are run, they are stored in RAM along with any associated document; the more RAM, the more tasks that can be run simultaneously and the larger a document can be. Typical requirements are in the range of 32—128 megabytes, which will run most current office software. RAM is usually available on small circuit boards called a single inline memory module (SIMM) in units of 4, 8, 16, and 32 megabytes that plug into memory expansion slots on the system board.

3. **Read-only memory (ROM)** refers to computer memory chips that contain the permanent operating instructions. This memory is a permanent feature of the chip and can be only read—not written to.

4. **Bus** is a parallel pathway for the transmission of information between parts of the computer, especially the CPU and support circuits, memory, and expansion cards. Bus speed has a major impact on the overall speed of the computer and is governeLl by both the system clock and the data path (number of bits that can be carried at one time).

5. **Expansion slots** are connectors on the system board that can hold expansion cards. These cards are printed circuits and add increased functionality to the computer. Expansion slots are
often designated by their architecture as PCI or ISA.

6. **The power supply** converts line voltage to the DC voltages required by the computer.

3. List and describe typical expansion cards.

1. **Modem/fax card**—allows receiving and sending faxes directly from a word processor or other programs. The modem allows dial-up connections to other computers and networks.

2. **Video accelerator card**—converts computer signals into signals that a computer monitor can display. Video RAM is the memory of an expansion card that affects the speed of the display, the number of colors that can be seen (from 256 to millions), and the resolution (how fine the detail is on the screen measured in pixels across and down). Typical cards have 4—8 megabytes of video RAM.

3. **Sound card**—allows sound input and output. Cards can record and play back digital audio and usually have a musical instrument digital interface (MIDI) synthesizer to play MIDI files.

4. **Network cards**—connect a computer to the cables of a network and transmit the type of signal used throughout the network (e.g., Ethernet card).

5. **Controller cards**—let devices such as disk drives communicate with the computer.

4. What are the major specifications of the computer monitor?

A computer monitor is the display screen connected to the video-out port of the computer. Computer monitors receive **digital** signals from the computer, whereas the television monitor receives **analog** composite video signals. The digital signals provide more detail than possible in a TV receiver. These signals can be modified for display on a TV monitor, although considerable detail is lost. Sharpness and resolution rate are monitor quality. The sharpness or fine detail is expressed as **dot pitch** (the space between pixels—the smallest element that a computer can address on a screen) and has typical values of 0.26—0.28 for a high-quality monitor. Resolution is measured as pixels across, pixels down, and the number of colors. A standard resolution of 800 x 600 is acceptable quality. **Screen sizes** range from 9—21 inches, depending on the use and location of the

monitor. For viewing by several people at once, a 17—21-inch monitor is appropriate, whereas for data input in a treatment room a 12-inch monitor may be adequate. It is best to get the largest monitor possible for the available space to minimize eye fatigue and enhance resolution, particularly for graphics.

5. What are the common input devices?

The basic input device is a keyboard, but the mouse, light pen, and touch pad are common additions. Special devices (see question 25) are digital x-rays, microphones, video and digital cameras, scanners, and electronic periodontal probes.

1. The **keyboard** is the most common input device. UNIX systems and DOS systems depend primarily on the keyboard for input, whereas Mac and Windows systems require a mouse.

2. The **mouse** allows a user to move an arrow around the screen and to perform tasks by clicking the mouse button when the arrow is on the proper portion of the screen. The mouse buttons can be used in several ways (e.g., single clicks, double clicks, click and drag). Consult the software for the different actions in each case. A **trackball** is like an inverted mouse. The ball is rotated, whereas the mouse is slid over a surface.

3. **Light pens** are becoming more popular input devices. These penlike instruments allow the user to touch the screen instead of moving a mouse arrow to the correct part of the screen. A light pen allows faster input than the mouse arrow.

4. A **touch pad** is built in to some keyboards. It is a pressure sensitive pad that records the arrow position by detecting changes in its capacitance as the finger moves across the surface. It replaces the mouse.

6. What are the common storage devices?

Storage devices include any device that can store data. They are commonly hard drives, floppy drives, CD-ROM drives, or tape drives. They may be internal or externally connected through cables and used as sources of data or for backup.

1. **Hard drives** may be internal or external and have fixed or removable media. They are much faster than floppy drives and have much higher storage capacities, ranging from several hundred megabytes to over 12 gigabytes (1 gigabyte = 1000 megabytes). The storage medium is one or more aluminum disks with magnetizable coatings sealed in a dust-proof housing. There are two common types of hard disks: small computer system interface (SCSI) and expanded integrated device interface (EIDI). The former is faster at accessing data. Hard disks store all of the application software as well as all of the data files produced by any program or downloaded from other computers.

2. **Floppy drives** make use of a small 3.5-inch disk protected by a hard case. Their capacity is 1.4 megabytes of data, and they are useful for copying individual files for quick backup or transfer between computers.

3. **CD-ROM** (compact disk—read-only memory) drives are are much slower than a conventional hard disk, but they can be randomly selected like any hard disk. With a storage capacity of 650 megabytes, a CD-ROM disk can contain entire reference books or libraries (such as the Physicians' Desk Reference) as on-line data. The newest units can record once to CDs (CD-R) or rewrite multiple times to CDs (CD-RW).

4. **DVD-ROM** (digital Versatile disk—read-only memory) is the newest disk technology. Not yet widely available, it may replace conventional CD-ROM drives. The major advantages are storage capacity (4—16 gigabytes), backward CD-ROM compatibility, and unequaled fidelity. DVD-ROM promises to be better than laserdisc video with multichannel sound far better than current audio CD.

5. **Tape drives** use media similar to audiocassette tape and can record large amounts of data rapidly but are much slower in retrieval because tape can be searched only sequentially from beginning to end.

7. What are the most common peripheral devices?

A peripheral device is any device connected to a computer via cables, such as printers, modems, scanners, CD-ROM drives, cameras, audio speakers, and microphones.

8. What are Serial , Parallel, USB, and PCMCIA Ports?

Serial ports are connections through which data passes one bit at a time. Often used for modems, they are designated as COM 1, COM2, and so on, in IBM-compatible computers. They are more reliable than parallel ports over long distances.

Parallel ports transmit data several bits at a time. An 8-bit connection passes packets of 8 bits of data simultaneously. Parallel ports, designated as LPTI, LPT2, and so on, are faster than serial ports over shorter distances and are typically used for printers in IBM-compatible systems. Mac systems do not use parallel ports for Mac applications.

USB ports (Universal Serial Bus) are external ports that will allow a single port to be used to connect up to 127 peripheral devices while supporting automatic configuration and changing devices without turning off power. It is anticipated that they will replace conventional serial and parallel ports.

PCMCIA ports and slots (Personal Computer Memory Card International Association) are external connectors found on compact computer notebooks, digital cameras, and hand-held computers that allow connection of peripheral devices. Classified as Type I (for adding RAM or ROM), Type II (for modern/fax devices), and Type III (for portable disk drives).

9. How are computers connected to each other?

Computers are connected either directly with cables or indirectly via modems. Connecting appropriate cables between the expansion cards (e.g.,

Ethernet) of the computers makes direct connections. Computers connected in this way must run a networking software program such as NetWare by Novell.

Usually one computer is designated as the server and contains the data files accessed by other computers, called clients or workstations. Any changes to data are saved to the server so that all workstations have access to the same data at all times. For a single facility this is a local area network (LAN). Facilities connected over a large area, perhaps several buildings, form a wide area network (WAN) and require more sophisticated cabling.

10. What is a modem?

A modem is a device for connecting a computer to the telephone system. The modem modulates the computer's signals so that they can be transmitted in the same way as analog telephone signals over conventional phone lines and demodulates the incoming analog signals so that the computer can interpret them. Modem speed is measured in bauds, or the number of voltage transitions per second (currently limited by telephone lines to 2400), although the actual transmission rate, bits per second (bps), can be much higher because of data compression. Fiberoptic cables, when universally available, will allow an enormous increase in transmission speeds. Typical transfer rates of current dial-up modems are 33.6 K—56 K bps.

11. How are data stored and protected?

Data are stored most commonly on a computer's hard disk. In a networked system, the hard disk may be on the server. Protecting data implies copying files or backing-up onto safe storage media and should be performed as often as data are changed—usually daily in the dental office.

12. What are the common backup methods?

1. **Tape drives**. Tape systems are fast, reliable, and relatively inexpensive and have high capacity. The tape cassette, similar in appearance to audiotape, is inserted into a tape drive often mounted directly in the computer case. Using a different tape for each day is the safest practice. Thus, for the average office that backs up once per day, six tapes should be sufficient. The tape backup should be kept off site overnight for additional safety.

2. **Removable drives**. Zip, Jazz, and Syquest drives are basically hard drives that use removable media. Although not much larger than conventional floppies, they have high capacities. The Zip Drive has 100 megabytes per cartridge and the Jazz and Syquest have over 1 gigabyte per cartridge. They are fast and often can be used as a temporary hard drive in the event that the system's internal drive is faulty. They should be taken off site overnight for safekeeping.

3. **Optical drive**. Optical drives are similar to CD-ROM drives but can also be written upon. They have enormous capacity but are too slow to be practical for daily backups. The optical drive is suitable for true archiving, however. The other storage media can degrade over time, especially tape. For that reason current

backups must be done on a daily basis, rotating the tapes or cartridges so that they are always current.

13. **Describe the common devices that protect against power fluctuations**.

Slight voltage fluctuations occur frequently and may have a harmful effect on data files.

I. **Surge protectors** are inexpensive devices that filter small-to-medium voltage surges; however, they do not protect against voltage drops.

2. **Backup power supplies** protect against both major voltage surges and drops and are an excellent investment, at least for the main server. These devices instantly switch to alternative power if there is an electrical drop or complete failure, allowing several minutes of backup power to turn the computer off safely. Higher-capacity systems have enough reserve power to allow backing up of files before shutdown.

3. **Antistatic mats** are available both for the floor and under the keyboard to reduce the possibility of a static discharge to the keyboard. This problem is particularly significant in the winter and may corrupt data, cause keyboard freezes, or actually crash a system.

14. **Describe the types of printers and their specifications**.

Printer types are **laser**, **inkjet**, and **dot matrix**. The right choice depends on the job to be done; several different types may be necessary for the typical dental facility. Printers are used among other things, for schedules, patient statements, receipts, correspondence, reports, insurance forms, various lists, newsletters, patient information notices, and photographs. Typical resolutions are from 300 x 30 dots per inch (dpi) for noncritical printing to 12 x 1200 dpi for photo-quality images. **Networked printers** are shared by several workstations, whereas **local printers** are connected to each individual workstation and accept print jobs only from that station. The capabilities of the different types of printers vary significantly (see table below).

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Laser printers generally produce the best-looking output. Although the most expensive, they are cost-effective on a per-page basis. The ink cartridges can process thousand,s of pages before needing a refill. They are capable of high-speed output. They cannot be used o print multipart forms but can print data as well as the forms themselves on plain paper. Color-laser printers are available at a much higher cost.

Inkjet printers produce good-looking output at lower initial cost than lasers. They are generally slower, and the replacement inks are more costly over time. Nevertheless, for personal use as a local printer for occasional correspondence, they may be the best choice. They cannot be used for multipart forms. The relatively costly replacement cartridges make these printers less suitable for high-volume use. Recently significant advances in color output from

several inkjet printer models have rivaled the color laser printers at a small fraction of the cost. They can be used for color prints of captured video images in the dental setting.

Dot matrix printers were once the standard computer printer but are being replaced by inkjet and laser printers. They are the least costly, vary in speed from moderate to very fast, and may be fairly noisy. However, they are the only devices that will print multipart forms. The output quality of the lower-priced units is only fair for correspondence but quite adequate for reports and insurance forms.

15. What is an operating system?

An operating system, or platform, is the underlying software that the computer uses to govern such elements as hard disk access, floppy drives, video display, and interaction with peripheral devices such as keyboards, CD-ROMs, and printers.

1. **Windows 95** is perhaps the most commonly found platform for DMIS software. Relying on a mouse, it can provide multiple workstations via networking software. There is probably more software available for this platform than any other.

2. **Windows/NT** is a more robust platform for networked computers. It can accommodate a greater variety of CPUs, such as PowerPC, MIPS, and DEC Alpha-based RISC systems. It is most practical in installations with more than 10 workstations.

3. **Mac OS** is the original mouse-based operating system. It allows easy and predictable connection of peripheral devices. Printers and other peripherals need Mac cables to operate with the Mac.

4. **UNIX** is the most widely used system in larger corporations with wide-ranging networks. The UNIX system has been evolving over the past 25 years and is the primary system used by major airlines, department stores, catalog houses, and other companies needing a wide range of networked computers. The operating system provides much more secure data protection and networking without reliance on extra networking software. It also allows workstations to be "dumb" terminals rather than independent computers, a much more economical hardware requirement thaii systems.

5. **DOS systems** are IBM-compatible, menu-driven, and similar in appearance to UNIX systems. The DOS systems, however, require networking software to allow multiple workstations, each of which must be a computer. Although some may find the screens less esthetic, the systems are stable and have been around for many years.

The choice of DMIS often determines the hardware configuration that is required because most operate under only one operating system. The quality and reliability are equal, and remote access to most any office system can be accomplished in most cases by either Mac-compatible or IBM-compatible computers with appropriate communications software.

16. **What is the difference between a graphical and menu interface?**

Graphical user interface (GUI). A GUI is a way for people to communicate with a computer using graphics and a mouse instead of a menu and text commands. Most functions are performed by making selections with a mouse from drop-down menus or icons representing different system functions. A well-designed system is intuitive and rapidly learned. The screens are visually attractive, and frequently one can figure out what to do without consulting a manual. The downside is that one has to move the mouse and click, a process that puts a physical limit on the speed of use. In addition, one often must switch between the mouse and the keyboard during data entry. Most Windows 95, Windows/NT, and Mac systems are mouse-based.

Menu-driven interface. Menu systems typically are found on DOS and UNIX systems. They are much less intuitive, requiring the user to select choices from menus and to learn shortcut key combinations (function. control, option, alt) to accomplish various tasks. Their advantage is that once the commands are learned, most users find that they are much faster to operate. There is no switching back and forth from the keyboard, and the user can work just as fast as he or she can type. The screens sometimes are not as esthetic, often having a more functional appearance.

SELECTING A COMPUTER SYSTEM

17. **What are the major considerations for a computer system purchase?**

Software is the first and most important choice. A careful analysis of the facility must be made to help in choosing the correct system. Factors to consider:

• **Practice size**. Are there multiple office sites to be networked? How many providers?

• **Practice type**. Hospital- or health center-based, group practice, specialty, or solo practice?

• **Practice model**. Fee for service, HMO, PPO, capitation?

• **Desired features**. Clinical workstations that provide charting, imaging capturing, and digital x-rays; electronic claims processing; dial-up network connection?

Hardware. The software determines most of the hardware requirements, but certain other factors may have an effect on hardware choices:

• How many workstations will be used?
• How many clinical operators will the system have to support?
• What is the annual volume of treatment performed?
• How far apart are the workstations?
• Will remote access be required?
• Will video storage be required?

18. What are the elements of a good DMIS?

Although the following criteria are desirable features for any DMIS, this list is not complete—nor will everything be available or implemented in exactly this fashion in every system.

• Easy patient registration with capability for recording demographic, health, clinical, and social information

• Comprehensive transaction and payment processing with integrated credit card billing

• Appointment scheduling procedures and recall systems

• Development of comprehensive treatment planning, insurance and copayments tracking, and tracking of case completion

• Comprehensive insurance claims processing with provision for electronic claims submission

• Comprehensive report generation of practice data in user-definable formats

• Tracking of referrals and merging of data with form letters

• Laboratory case tracking and inventory control

• Integration of video and digital x-ray information with patient records

• Easy merging of data with word-processing files

• Office payroll management

• Modular expansion and easy upgrading

19. What is a turnkey software application?

There are basically two types of software systems: turnkey systems, which attempt to provide all of the necessary functions of a DMIS, and modular systems, which allow the addition of functions as the needs demand. Dentrix, Softdent, and PracticeWorks are examples of popular turnkey systems. Modular systems depend on the interaction with commercially software to provide the desirable functions of a DMIS. This approach saves initial software cost but requires learning several different programs.

20. What are the major guidelines for choosing a software vendor?

• How long has the company been in business?

• How long has the software been in use?

• How many installations are there?

• Can it integrate with commercial software?

• Is technical support responsive? How long is the response time?

• Does the vendor offer installation, training, and data conversion?

• How often are updates provided, and will the vendor make changes on an individual basis?

• Will the vendor supply a list of current users?

• Are service contracts available?

THE COMPUTER AS A DENTAL MANAGEMENT INFORMATION SYSTEM

21. **How can a DMIS benefit a dental practice?**

- Daily office management
- Business planning resource
- Chairside clinical support system
- Quality assurance management
- Risk management assessment
- Research tool for clinical studies

22. **How can a computer help in daily office management?**

1. **Scheduling and appointment control**. The appointment book is the heart of any dental office. With a computer, it is always accurate, legible, and easily modified. Appointments can be made at chairside, which means less transfer of information to the front desk and much faster patient processing. Appropriate appointments can be searched and offered, satisfying criteria such as operator, length of appointment, time or day of the week, and treatment. The computer can also display medical history data that help to ensure proper treatment and scheduling. The daily schedule printout for each treatment area can display the same data. Special circumstances can be flagged, such as overdue balances, premedication needs, and allergies.

2. **Recall**. An effective recall is essential for the welfare of both the office and the patient. By computerizing the recall data, one can tell when patients are due and generate reports, lists, or mailing labels for preprinted reminder cards. This process can be done automatically each month or at any chosen interval. It is much less likely that patients will be lost to a computerized recall system.

3. **Laboratory control**. Laboratory cases can be tracked and coordinated with the scheduling program to create alerts for the staff to be sure that reports are back when needed. These alerts can appear on the schedule or screen, depending on the software.

4. **Inventory control and equipment maintenance**. Inventory databases offer many advantages. One has immediate and accurate information about what materials are on hand, when to reorder, name of supplier, phone number, and best price. Cost savings can be substantial when one orders on a timely basis, eliminating unnecessary inventory. Reports of consumable usage and equipment maintenance are readily available. Many supply houses even allow electronic ordering and provide updated product information databases. Complete repair logs can be maintained so that timely service intervals are performed and cost analyses are available.

5. **Insurance processing**. Computer systems, besides ensuring that data are complete and legible, allow electronic submission of insurance claims. The American Dental Association (ADA) has established the Electronics Commerce Company (ECC0), which has contracts with NEIC as the clearinghouse and Trojan Professional Services for software support. The ECCo does not interfere with any state-sponsored clearinghouses. Submission is done via modem to the clearinghouse, which inspects for completeness of data and forwards the claims to the carrier. If the data are incomplete or incorrect, they are returned for correction

before being forwarded. Turnaround time is said to be much faster than with paper submission. The office also saves time because submission can be scheduled after office hours when the computer is idle and no paper handling is required. Postage savings can be substantial and should be considered in evaluating the costs of electronic claims submission.

6. **Accounts payable and receivable**. Simplified bookkeeping applications such as Quicken or Quickbooks provide efficient and organized records of all expenses. They are customizable by the user and integrate into most popular DMIS software. They also allow full electronic banking and detailed reports for year-end accounting. Computerized patient billing allows aged reporting, addition of installment billing, collated insurance and patient balances, inclusion of messages for patient communication, and programmed cycle billing.

7. **Payroll**. Payroll can be processed swiftly with software that calculates all federal, FICA, and state deductions and prints employee checks automatically. This software may be a commercial product or, if integrated with the DMIS, password-protected so that only certain personnel have access. These applications typically can keep track of vacation times as well as create W-2 forms for employees.

8. **Marketing**. Communication with patients and colleagues can provide an effective means of internal marketing. Patients' birthdays can be acknowledged, referring patients and doctors thanked, and newsletters produced with targeted mail-merging from the system database. In-office patient education can be offered using CD-ROM software in the waiting or consultation room. The interactivity between computer and patient enhances the exposure process compared with more passive videotapes.

23. How can a computer function as an analytical tool for practice analysis and business planning?

As an analytical tool the computer is unsurpassed. The DMIS software builds databases in a variety of categories:

1. Registration data (e.g., name, address, phone numbers, date of birth, insurance plans, Social Security number)

2. Patient medical history data (e.g., all significant positive elements, medications)

3. Production data by category (e.g., provider, ADA code, insurance plan)

4. Laboratory fee data by laboratory, patient, and provider

5. Inventory usage data

6. Equipment maintenance logs

By allowing rapid retrieval of data in a meaningful way, the computer helps with management decisions, business planning, and quality assurance assessments and analyzes treatment outcomes and morbidity. Often a report can be generated by category or key word searching to allow solving a variety of interesting problems. Consider answering the following questions:

• How should a fee schedule be adjusted to account for a 5% increase in laboratory costs and a 7.5% increase in consumables? How will this affect net production?

• How many patients have insurance plan B? What is the income from this group? What would be the impact on production figures if they left the practice?

• How does the productivity of each practice hygienist compare? How should their fees be adjusted to allow a 7.5% salary increase?

• What is the cancellation (broken appointment) rate for each of the operators? What time of day has the highest rates?

Such data are difficult and time-consuming to retrieve and calculate manually. If the DMIS is properly designed, such data are retrievable at will, with no extra effort, because the relevant data are entered routinely for every patient and continually updated. Projections can be easily made by applying the data received to a spreadsheet analysis.

24. What are the common chairside applications of a DMIS?

The clinical workstation concept places computer terminals in each operatory area. Current applications allow a host of tasks to be processed chairside:

1. **Clinical charting**. Several charting programs (SoftChart and Chart It) are available for both Mac and PC platforms. Data relating to existing conditions, both hard and soft tissue, and necessary treatments can be input. Some applications (Voice Pilot, Kurzweil Voice Pad) allow voice recognition, thus permitting hands-free recording. Periodontal probing also can be recorded electronically with a special probe providing a graphic printout of all periodontal measurements. Complete medical histories, clinical photographs, and digital x-rays can be stored as part of the patient record and recalled any time the patient record is accessed.

2. **Image capturing**. Intraoral cameras and digital cameras can be used as input devices to allow clinicians and patients to observe oral conditions. Still images can be selected and modified on a monitor to illustrate possible treatment outcomes and enhance case presentations. Images can be saved to the hard disk or printed in color for a patient to take home or to accompany an insurance claim form.

3. **Digital x-rays**. Several systems (Trojan, Schick) currently available use up to 50% lower doses of x-radiation to provide an image. A special sensor is used in place of film; it is computer-enhanced to produce a visible image on a computer monitor. The advantages are speed, a modifiable image to emphasize different conditions, easy storage, and environmental reduction of chemical waste. The resolution of the image is not quite equal to conventional film, but it is still highly useful for emergencies and endodontic verification films. The image can be printed or transmitted electronically to insurance carriers as well as stored as part of a patient record.

25. What special input devices are of dental interest?

1. **Periodontal probe**. There are several manufacturers of electronic periodontal probes. An electronic probe is inserted into a pocket and, when activated, measures each pocket depth by applying a predetermined force to ensure consistent readings. Data are transmitted automatically to the computer program, and a record is made of all readings. Reports can be printed out graphically or viewed on the screen as part of the patient chart.

2. **Microphone headsets**. Voice recognition software is becoming more and more reliable so that commands can be executed and text recorded verbally rather than by more traditional methods.

3. **CAD-CAM** software is available to produce indirect restorations in one visit. Computer-driven milling machines can carve restorations from ceramic blocks with marginal adaptation rivaling traditional casting methods. One such device duplicates internal and external contours of a wax pattern to produce a chairside restoration. Another system uses an optical impression to carve the tissue side of a restoration. External contours are produced using more traditional means, either in the mouth or on a die. The ceramic material has none of the stresses caused by traditional heat firing and is therefore claimed to be more durable.

4. **T-scan** is a device for precisely measuring all of the occlusal contacts of natural and artificial dentitions. It can record the exact order, velocity, and force of each contact and display the data on a computer system running Windows. It uses the parallel port of any computer, according to the manufacturer.

26. How can a computer help in clinical consulting?

This relatively new application for dentistry has been used in medicine for several years. Through a modem connection to another clinical facility one can transmit data and images that can be seen by a consultant. If a video camera is connected to the computers as well, true realtime video conferencing is possible. The benefits for the patient and doctor are obvious.

27. How can a computer be helpful in clinical diagnosis?

Expert systems are software applications that provide a logical process for establishment of a differential and clinical diagnosis. Using data supplied by a clinician in a carefully ordered sequence, the system analyzes the data, branching to the appropriate next series of questions until a differential diagnosis can be established and, eventually, a most likely diagnosis with an estimated percentage of reliability. Once a diagnosis has been established, treatment recommendations can be offered with consideration for the patient's medical history and clinical status. In addition, the computer can provide access to the Internet, giving nearly unlimited access to research material worldwide.

28. How can a DMIS improve quality assurance?

An analysis of key subject themes can be addressed by organized database reports. Using category and key word searching, patients can be selected by

topics of interest. For example, in a review of compliance with office protocol for patients with a medical hi of heart murmur, one may find all patients in this group, determine the percent that received follow-up letters to their physicians about the need for prophylactic coverage, and evaluate the percent that received premedication. Such timely evaluations can greatly enhance quality assurance studies. Another example is the frequency of full-mouth and bitewing x-ray exams based on clinical diagnosis, age group, or other clinical variables.

29. How can risk management analysis improve with a DMIS?

A computer database can provide easy reporting of adverse events and thus help to collate types of events, methods of resolution, and analysis outcomes. Such reports may help to identify opportunities to prevent future events and thus improve the quality of care.

30. How can the DMIS benefit in clinical research studies?

As years of clinical procedures accumulate in a practice database, interesting analysis can be performed to shed light on treatment outcomes and product performance, incidence of disease, and other clinical inquiries. Consider answering the following questions:

• What is the length of service in this practice of full-coverage crowns, indirect porcelain onlays, posterior composite restorations vs. amalgams?

• How does postoperative sensitivity compare using zinc phosphate cement vs. resin-modified glassionomer cement?

• What types of complications arise after implant placement? How does Branemark compare with other manufacturers?

DENTISTRY AND THE INTERNET

31. What components are needed to create a network?

The basic components are cables, an adapter card for each computer, and the networking software installed on both servers and clients. Networks can be made up of more than one type of computer: Mac, PC, or UNIX.

32. What hardware is needed to connect to a network?

A network expansion card (built into most Macs) and appropriate cables. The network software running on all computers allows the transmission of the signals used on the network. Representative cards are Ethernet, Token Ring, or NetWare.

33. What is the Internet?

Any two networks connected together is technically an internet. The real Internet, often called the Information Super Highway, is a worldwide network that links thousands of other computer networks at universities, business corporations, government agencies, and organizations, enabling the exchange of information in

the form of text, sound files, video images, and application programs among users. The "highway" metaphor is quite accurate in that the Internet is a two-way path for digital signals to travel between countries, states, cities and towns, and eventually to individual computers in all types of facilities. Anyone with the appropriate hardware and software utilities may tap into the Internet and participate in cyberspace.

34. How are Internet networks connected?

The large regional and national networks are connected physically by fiberoptic cables and microwave links called Ti and T3 digital carriers. These connections are able to carry digital signals at 1.54 and 44.74 megabits per second, respectively. This backbone is operated by American Network Services. Everyone else is connected to the central core by various connections of different speeds. The respective users typically lease the lines from local carriers such as Bell Atlantic, AT&T, or MCI.

35. How did the Internet start?

In the 1960s, under an initiative of the U.S: Defense Department, the Advanced Research Projects Agency (ARPA) network was conceived to allow military and scientific information transfers through universities. This first network involved four sites, the University of California at Los Angeles, the University of California at Santa Barbara, the University of Utah, and Stanford University, which were able to unite their computers with special telephone lines at speeds of 56,000 bps. By 1980, over 200 computers were connected, and in 1986 the National Science Foundation (NSF) assumed operation of this transmission backbone at speeds 1.54 M bps. The NSF fostered rapid university connectivity. By 1988 this NSF network became known as the Internet. Eventually other users were allowed to connect to the 1.54 M-bps transmission backbone, and by 1994 there were over 2.2 million available servers on the Internet. Today the Internet backbone runs at nearly 45 M baud and is administered by the North American Network Operators Group (NANOG). The National Research and Educational Network (NREN) project is developing a transmission line capable of 622 M baud, and technology exists for fiberoptic lines to operate at nearly 2.4 billion bps.

36. Define the following terms:

1. **Bit**—the smallest unit in computer functions; a binary digit, 0 or 1. Electrically this is a transition from +5 to —5 volts in a transistor circuit or a change in the polarity of a point on a magnetic disk.

2. **Byte**—8 bits; the basic unit of information storage in a computer. One letter of the alphabet in program code (ASCII) takes one byte.

3. **Band width**—a measure of how much electric signal information a cable can carry. Band width = data path x frequency. Thus a typical computer bus connector (electric conduit or ISA bus) that sends 16 bits at a time and operates at 9.33 MHz has a band width of 133.28 megabits per second.

4. **MB**—megabyte; a million bytes and a unit of memory and data storage size. Two issues of Scienaflc American equal about 1 MB.

5. **Mb**—megabit; one million bits.

6. **Router**—an electronic switching box that can connect two or more networks. A router is like a railroad switching yard where information packets come in from one network and are handed off to another. Packets range in size from 100—1000 bytes each, and millions of packets can be shipped at any moment. Routers can be either software or hardware implementations.

7. **Gateway**—software or hardware that enables networks of different protocols to communicate with each other.

8. **ISDN line**—a fiberoptic telephone line capable of transmission speeds of up to 128,000 bps. A special ISDN modem is needed to use this connection. It refers actualty Integrated Services Digital Network, which enables multiple services on the same line (i.e., telephone, television, and computers).

9. **Internet service provider (ISP)**—a commercial provider of Internet access. It allows dial-up connection via modem or with direct router connections for LANs. A national provider, such as NetCom, MCI, or AT&T, allows connection with a laptop even when traveling because of the multiple local access numbers to log onto your account.

10. **Commercial on-line service**—America Online, CompuServe, and Prodigy offer a wealth of information and communication options with one connection: e-mail, newspapers, chat groups, shopping, and complete Internet access. They are probably the easiest way to access the information on the Internet.

11. **Modem connection**—most single users or small offices connect via a modem to a local telephone line to an ISP, or commercial on-line service. If greater speed is required, an ISDN phone line may be leased from the phone company. These are termed dial-up services.

12. **Cable modem**—although not available in all areas, television cable companies now offer direct connection to the Internet via the same cable used for their television service. Because the connection is always on, there is no need to dial up.

13. **Service provider connection**—larger LANs connect via a router to the ISP, which then connects to the Internet.

14. **Direct connection**—large companies, universities, and hospitals with heavy usage lease Ti or T3 lines from the phone companies for direct connections.

15. **PC satellite**—newly introduced competitor to cable modems; small satellite dishes that access the Internet through a satellite ISP. They offer speeds up to 400 bps and may be suitable for some sites without cable access. All downloads (Internet to computer) occur via the satellite, whereas uploads (from computer to the Internet) are still by modem.

Relative Transmission Speeds	
Standard modem	56 K bps
PC satellite	400 K bps
ISDN line modem	128 K bps
Frame relay router	784 K bps
T1 router	1.5 M bps
Cable modem	3—10 M bps
T3 route	45 M bps

37. What types of information are found on computer servers connected to the Internet?

The Intertiet is the transmission line for information stored on computers around the world. The major categories of these servers are as follows:

• **Electronic mail**—servers that send and receive e-mail.

• **Telnet**—servers that allow your computer to log onto another computer and use it as though you were at that computer.

• **File transfer protocol (FTP)**—servers that allow your computer to retrieve files from a remote computer and view or save them on your computer's hard disk.

• **Gopher**—servers with a text-only method for gaining access to Internet documents. Although largely supplanted by the Web, this was the vast storage site for Internet informa tion for the past 20 years.

• **World Wide Web**—servers that have text, graphics, sound, and links to other documents within their pages or to other websites. This is the fastest growing Internet service, approximately doubling in size every 2 months. Documents on the Web feature hypertext, which is the ability to link highlighted text to other documents and sites worldwide. The Web also includes access to much of the material on gopher, telnet, FTP, and e-mail.

• **Listserv and Usenet**—servers that deliver forum discussion groups on over 20,000 topics via e-mail and the Web, respectively.

38. How do individual servers communicate on the Internet?

The servers respond to a specific set of communication rules or protocols, known as the Transmission Control Protocol/Internet Protocol (TCP/IP), that determine how the data packets are sent. This protocol is built into all computer software for Internet communication.

39. How are individual servers and locations found?

Two kinds of addresses locate all computers on the Internet: IP addresses and domain names. Each computer on a network has a unique IP address in the form of numbers separated by dots; for example, 140.147.2.12 is the IP address for the Library of Congress. This number is read primarily by computers and is composed of 4 octets totalling 32 bits. It functions like a telephone number to

identify a region, network, and server computer. A more manageable address scheme is the domain name system (DNS).

40. How does the DNS work?

A domain name is a unique address that parallels the IP address. Computers called "name-servers" match or translate domain names into IP addresses and establish connections. Domain names are organized into hierarchies describing the country of the network, what kind of organization owns it, and other information. A domain name has a number of geographical and nongeographical categories and is usually read right to left and separated by dots. Thus, rubens.anu.edu.au is the name of a computer in Australia (geographically based domain is .au) in the educational category (.edu) at the Australian National University (anu) and on the computer named "rubens." The domain name bics.bwh.harvard.edu is the server at Harvard University (harvard.edu) for Brigham and Women's Hospital (bwh) and the computer named "bics."

There are presently six top-level domain categories:

.com—a commercial user .gov—a government user
.org—an organization, often nonprofit .mil—military user
.edu—an educational institution .net—a network

In addition, two-letter geographical domain designations are appended to the name. Because the system began in the United States, it is common to omit the .us for U.S-based names. Other country designations include:

.uk—United Kingdom .fr—France .it—Italy
.ca—Canada .jp—Japan .su—Sweden
.ae—United Arab Emirates .de—Gerrnany .ar—Argentina

All domain names worldwide are registered by InterNiC (http://dsl.internic.net), run by Network Services of Henderson, Virginia. If a name is not already in the database, a new domain name application may be registered for 2 years for $100. The rate of new registrations is over 85,000 per month.

41. What is the enhanced domain name system?

As of April 1, 1997, seven new categories were created by the International Ad Hoc Committee (IAHC) to meet the demand for more domain names. Applications to register new names and their distribution will be made by eDNS (http://www.edns.com). The new categories are as follows:

.firm—businesses or firms
.store—businesses offering goods to purchase
.web—entities emphasizing activities related to the WWW
.arts—entities emphasizing cultural and entertainment activities .info— entities providing information services
.rec—recreationIentertainment activities
.nom—those wishing personal or individual nomenclature

42. How can one create a domain name?

Any name not exceeding 24 characters of letters, numbers, and the dash(—) is valid as long as it is not already registered. Registration is made to one of the preceding administrators. The owner of a domain name may make subdomains separated by dots (.). Subdomains give greater flexibility to create variations to any domain name base. Imagine the possibilities:

clean.perio.com
straight.ortho.com
file.endo.com

43. What is a URL?

Each server or computer document has a unique address called a uniform resource locator (URL). Thus, to get to a specific site, one simply enters a URL into the software program (Browser) to initiate the connection. The URL has imbedded in it a domain name that will identify the computer, server, and network designated in the address and also the Internet tool used to read that document. Using a URL greatly simplifies locating documents via the Internet, because complicated numbers and addresses are grouped into one path statement.

44. Define the elements in the following URL: http://www.ada.org

I. The first part of the URL (**http://**) defines the Internet protocol or tool used to read the document. In this case, it is a document in Hypertext transfer protocol, unique to the World Wide Web. Other server protocols appear as fttp:!/ (file transfer protocol), gopher:!! (Gopher transfer protocol), or news:!! (Network News tran protocol used to browse through a newsgroup).

2. The information following the double forward slashes indicates the name of the server on the Internet to which you are connecting—in this example, the American Dental Association server on the World Wide Web (**www**). The server computer is recognized with a domain name and identifying category; thus we have **ada.org**.

3. The slash following the domain identifier indicates a specific file, directory, or path on that computer server. In this example, we are looking in a file or directory called **lib**. Many directory names may be listed, separated by slashes.

4. The end of the URL (**amalgam.html**) is the name of the document itself. The html extension identifies the type of document; in this example, it is in hypertext. This particular URL finds a document at the American Dental Association on the safety of amalgam.

45. What is the World Wide Web? What software is necessary to begin using this Internet service?

The World Wide Web (WWW) is the name of a body of information on the Internet that incorporates Gopher, FTP, Telnet, and e-mail. It allows viewing of images, text, sound, and video and functions using Hypertext Markup Language

(HTML), a set of computer code and formatting instructions for viewing the content of documents. These documents are often called web pages, HTML pages, websites, or home pages. Because of Hypertext, words or phrases are highlighted, allowing the user to move from one document or site to another intuitively; as such, pages are termed "linked." Each of these pages and links is uniquely identified by a URL. To view these pages on a computer screen, one uses a software application called a browser. These programs allow WWW information written in HTML to be properly displayed on a computer screen. Netscape and Internet Explorer are the two most popular graphics browsers. Lynx is a WWW browser that allows access to all of the text on the Web but not to sound or images.

46. How is e-mail used?

Electronic mail (e-mail) is probably the most used tool of the Internet. With the software integrated into all on-line service providers' proprietary software or that embodied into operating systems (e.g., Microsoft Exchange, Outlook in Windows 95), sending a text document from a word processor is but a click away. Similarly, receiving mail from anywhere in the world is possible. Furthermore, one may attach files to any e-mail text. Thus photo images, voice, and audio as well as large information packages may be sent. The format for an e-mail address is generally someone@somewhere Thus, to reach the authors of this chapter, you may send mail to evfeldbau@bics.bwh.harvard.com or hwaxman@edgenet.net. Similarly, one may send a batch file of insurance claims to an electronic processor or a set of digital radiographs to a consultant for a second opinion. Privacy cannot be assured because your electronic package is traveling on many networked computers.

47. What is a mailing list? How does one subscribe?

One also may use e-mail to access mailing lists (reflectors), which are special e-mail addresses that redistribute mail to people who have subscribed to a specific discussion group or topic. When one sends mail to the list, it is redistributed via e-mail to all of the list's subscribers. There are literally thousands of free mailing lists on as many topics. One of the most popular e-mail reflectors is Listserv. By subscribing to a list, one receives e-mail written by other subscribers on the chosen topic. Often an individual administrator moderates the lists so that inappropriate mail may be excluded. An excellent source of electronic discussion groups in dentistry may be found at the website of the University of Iowa College of Dentistry: http://vh.radiology.uiowa.edufBeyondlDentistrylleslie.html. Topics include calcified tissue discussions, oral pathology, periodontology, cosmetic dentistry, and many others.

To subscribe to a mailing list, send an e-mail to the Listserv address. Leave the subject area blank, and in the body of the text type: subscribe { listname } { your first name } { your last name } without the brackets. E-mail software automatically includes your return address. For example, to subscribe to the

Buffalo Board of Oral Pathology, send e-mail to Listserv@ubvm.cc.buffalo.edu. In the body of the message, type subscribe bboplist elliot feldbau to begin receiving the author's e-mail on topics of oral pathology. To terminate the subscription, type the word "unsubscribe" without quotes in place of subscribe. Other mailing lists may be addresses such as Listproc or Majordomo. A summary of common Listserv commands follows:

- Subscribe <listname> <your first name> <your last name>
- Subscribe digest <listname> causes the program to send all of the day's messages in one mailing per day rather than individual messages as they are written throughout the day.
- Unsubscribe <listname>
- Set nomail <listname> discontinues all mail.
- Set mail <listname> resumes mail delivery.
- Set conceal <listname> hides your name on the subscription list.
- Info Refcard <listname> causes the Listserv program to send a list of commands.

48. How does one send attached files with e-mail or a browser?

All browsers and on-line service software allow sending of any type of file, text, image, sound, or video by pressing the "Attach" button. Some files may be very large, and simply using compression software may reduce transmission time. WinZip (PC) or Stuffit (Mac) are excellent software applications for working with compressed files (commonly with a .zip or sit extension).

49. Discuss major differences between searching for information via the Internet and at a library.

Because of the immense size and rapid growth of offerings on the Internet, there is no single complete guide to the material. Furthermore, because there is no central control or standard of organization, it is hard to know if any search is complete or even if material will be available in a particular field. A library, on the other hand, is a statement of organization, collecting, and planning. National standards exist for cataloging the contents of every library (e.g., Library of Congress, Dewey system), and each university library usually has complete collections for its specialty schools. The library also supports reference professionals to guide you in a literature search.

However, as unorganized as the collections of information may be on the WWW, there are important areas in which Internet research may provide an advantage. The Internet is both a storage resource and a communication tool. Subscribing to discussion groups on topics of interest provides a wealth of opinions, comments, and suggestions for finding answer and professional problems. Both Listservs and Usenet Newsgroups fulfill these inquiries.

As more and more libraries, museums, government agencies. and commercial entities begin to digitize their archives and collections, the volume and quality of offerings will grow, resulting in much greater accessibility. Health

resource data from the National Institute of Dental Research, World Health Organization, and National Institutes of Health are readily available online. Access to medical journal databases, such as Medline on Paperchase, allows the convenience of searching from one's office, and graphical collections are readily downloadable. Electronic journals also have appeared. Many library catalogs are available on-line, so that locating specific reference works is convenient. To use the Internet for searching the World Wide Web, a working knowledge of search tools is essential.

50. What makes a productive WWW search?

With millions of documents available and no standard of organization, finding documents of specific interest requires knowing how to use what are commonly termed **searchable indexes**. These tools (search engines) use some standard but slightly different criteria to search key text words in web pages or titles. The ability to create close matches between terms of interest and words or phrases used in web pages determines how closely you get to your chosen subject.

51. How do search engines work?

Web search services find documents matching the user criteria by searching their database of URLs, texts, and descriptions selected fro the whole WWW. Their robot computers scan the Web 24 hours a day, updating databases where the resource information is stored. Thus each search tool may be different, depending on the organization of its database. Some search engine yields are first edited or reviewed, whereas others are a mere gathering of the robotlike computers, which transfer data directly onto the database. The search engine allows the user to enter requests to the database for sites of interest. A search generates from the engine's database a list of Hypertext links to documents that fulfill the user's search criteria. Clicking on a link sends one to that document on the Web. Every search tool's list will vary based on the features of its search mode, the size of the database, and the selectivity of the organization of the database.

52. What are the two major search criteria?

There are two major categories of search engine organization: subject indexes and keyword indexes. To ensure comprehensive searches, the keyword search tools are advantageous because they search the full title and all text of a document. To limit a search in volume and to ensure high-quality sites, a subject search may prove more profitable initially.

53. List four strategies for successful Web searching.
1. Analyze your topic before you begin.
2. Learn search tool features to help refine your topic.
3. Choose databases with the size and features that you need.

4. Learn about each of these tools: Infoseek, Yahoo, Excite, Magellan, Lycos, and Open Text.

54. How does one begin to analyze the topic? What search tool features are available?

Phrase searching. If one is looking for a proper name or distinct phrase, using double quotation marks (") or capitalizing initial letters will require an exact match. Examples: "American Dental Association" with or without quotation marks, "bullous lesions,""G. V. Black:"dental education."

Boolean operators. Using AND, OR, NOT will refine searching. Examples: Common words with many meanings: law AND dentistry AND ethics. Searching for computers AND dentistry AND "digital cameras" OR "intraoral cameras" allows variations in name: Dentistry OR dental AND software. An alternative is use of + and — for AND and NOT. For example, office management + software + dental — Mac limits the search to non-Mac applications.

Limit search to title field. Searches may be limited to home pages about a subject. For example, the title "American Association of Dental Schools" yields its home page, whereas the title "dental malpractice" yields primarily pages about dental malpractice. Other field limitors may be URL:, link:, or text:.

Case sensitivity. Usually lower case retrieves upper case. If one keys capitals, only capitals may be retrieved.

Truncation. If there are many different endings to the term (e.g., dentist, dentistry), dentist* retrieves both terms. The asterisk is called a "wild card."

55. What search engines are available?

• **Alta Vista** (www.altavista.digital.com) 30 million; general web database of pages rather than sites. No subject categories or reviews. Has advance search capability. Includes Usenet discussion group search.

• **Infoseek** (www.infoseek.com): 50 million; general web databases. Subject directory. Smart searching of pages and related categories. Includes Usenet, e-mail, and news.

• Excite (www.excite.com): 50 million; reviews website and displays reviews, subject directory.

• **Yahoo** (www.yahoo.com): I million; subject directory. Displays both summary of site and related category. Defaults to Alta Vista if subject not in database.

• **Lycos** (www.lycos.com): 66 million; general web database. Catalogs web page rather than entire site; outline and abstract for each matching page.

• **Magellan** (www.magellan.com): 30 million; subject directory. Review and ratings with links to full review for each site.

• **Hotbot** (www.hotbot.com): 54 million; general web databases. No subject categodies or reviews.

As an example, when we searched the key word "compomer," we got the following number of sites for each search engine:

Hotbot: 114   Infoseek: 20
Yahoo (defaulted to Alta Vista): 222   Lycos: 19
Excite: 49

These results compare with 27 references from a journal search of Medline on Paperchase. Remember that dental supply manufacturers often have web pages for their products, allowing one to keep up to date on new products and specifications. An excellent source for all web-related searching utilities and tools can be found at the Internet Scout Project at the University of Wisconsin: http:llscout.cs.wisc.edu/scoutltoolkit.

56. What is a meta-search engine?

A meta-searcher is able to take simple inquiries and search many indexes at once. **Meta Crawler** (http://www.metacrawler.com) searches six search engines at once and integrates the results. **SavySearch** (http://cs.colostate.edu:2000) searches over 20 search engines with one command in multiple languages and can include the Web, software, e-mail addresses, and more. **Search.com** (http://www.search.com) has access to hundreds of engines in over 25 subject categories. Finally, Inforia's Quest98 (www.inforia.com) and NetMetrics' WebTurbo (www.webturbo.com) search hundreds of search engines at once and allow custom searching and organization of topics. The latter two functions actually integrate into a browser's basic function buttons.

57. What is an FAQ?

"Frequently Asked Questions" (FAQ) is a document containing information about a subject in the format of questions and answers. It is similar in style to this text. Product manufacturers, newsgroups, and organizations list FAQs to answer questions about a topic.

58. How does Gopher work? Who are Veronica and Jughead?

Gopher is a set of servers on the Internet that allows searches of information much like the Web. The information is presented in a point-and-click text menu that is arranged in a hierarchy of subtopics. Access to a single Gopher client allows a link to any worldwide Gopher server. Gopher was started at the University of Minnesota, and their Mother Gopher site registers most of the Gopher servers in the world. Gopher servers are often arranged geographically. Gopher is commonly accessed via a browser. Typing gopher:// on Netscape allows entry into "Gopherspace." On-line service providers (e.g., America Online) make use of Gopher as easy as use of the Web.

Veronica (Very Easy Rodent-Oriented Net-wide Index to Computer Archives) and Jughead are Gopher services that construct menus based on keyword searches. The information retrieved may be any of the following:

- Another menu (folder icon)
- A document, graphic file, or text file (document icon)
- A search entry (magnifying glass icon)

- A pointer to a text-based remote log-in (Telnet)
- A pointer to a software gateway to another service (Usenet or F1'P)

59. What are Usenet newsgroups?

NewsgroupS, also known as Usenet news or News, are a category of information-sharing mechanisms on the Internet. Second only to e-mail in volume usage, they are basically a discussion forum or electronic bulletin board on which one can post messages and read responses. The Usenet network administers all groups. Over 20,000 topics are arranged in hierarchies and subhierarchies by subjects. Top levels include Comp (computer topics), news (news about the Usenet network), rec (recreational subjects such as music, collecting art), sci (science and engineering), soc (social groups and society talk—random discussions), alt (new groups), and misc (miscellaneous topics). These subject hierarchies are separated by periods to create a unique address. Many of the web search engines allow Usenet topical searches. Entering the following examples into your browser URL line will bring up the newsgroups:

- news:sci.med.dentistry (a newsgroup about dental issues)
- news:alt.support.jaw_disorders (a newsgroup support group for sufferers of temporomandibular joint disorders)

60. What are the basics of FTP? How are files saved?

FTP allows the transfer of large files to (upload) and from (download) other computers by TCP/IP on the Internet. Anonymous FTP allows public access to many computer files. One just types "anonymous" at the user name prompt and one's e-mail address for a password. An easy way to explore FTP is via the Web using Yahoo's topic Internet, then FTP. This method shows many FTP sites on the Web. File formats are important to understand, because most files are compressed to minimize storage and transfer times. Compression programs must be used to see these files. Common file extensions include the following:

- .hqx—compreSsed Macintosh files; retrieved in binary mode and processed with a Mac decompression utility Stuffit expander
- .sit—Mac files compressed with the Stuffit program
- .sea—self-extracting Mac files
- zip—DOS file compressed with pkZip program; decompresses with pkZip or Winzip
- .exe—compressed DOS files that are executable or self-extracting upon clicking on them
- .gif—Graphics Interchange File format
- mpeg—video files
- .jpg—compressed graphics files
- .txt—plain text files that need no special utility to view or print

61. What is Telnet?

Telnet is a Unix program that allows one to connect to a remote computer and search its database via the Internet. Netscape and Internet Explorer have Telnet applications that launch when a Telnet address is entered in the URL line (generally an IP address or text address). For example, if one types 160.19001 in the "Go To" line of Netscape, the connection to the National Cancer Center in Japan is retrieved. Using the address gopher.ncc.go.ip gives the same connection. Once connected to the remote computer, there is a "log-in" and "password" formality that may be satisfied by "new" or "guest" entries if one does not have an account. To use a web browser for Telnet access, write telnet://internet.address in the "Go To" box.

DENTAL INFORMATION MANAGEMENT

62. What is the definition of dental informatics?

The term is a subset of health care or medical informatics and is the application of new information technologies to dental practice, education, and research. It is allied to the field of artificial intelligence, which relates biomedical information, data, and knowledge into computer-applied management. Dental informatics includes all forms of practice management information systems as well as applied clinical and research systems.

63. What are the differences among data, information, and knowledge?

Data are a collection of facts in the form of measurements or observations without implication of organization or conclusions. Thus, a patient's vital signs or symptoms or the descriptors of firm mass, pulsating pain, or periodontal pocket depths represent a raw collection of data for a database.

Information implies some method of collection, organization, and classification of a pool of data with some intended format of communication. Descriptions of different disease entities, such as gingivitis, pulpitis, or cracked tooth syndrome, represent elements of an information base.

Knowledge implies knowing or decision-making through experience, reasoning, or association. It is a complete understanding of one's information. Thus, correlation of the raw data of a patient's physical signs and symptoms with an information base of possible diseases to form a differential diagnosis and reach an ultimate diagnosis requires the application of knowledge.

64. What are the components of a decision support system?

1. The user interface, or collection module, at which the clinician enters the physical signs and symptoms or other collected data descriptors required by the program.

2. The database module that constitutes the computer's clinical knowledge base.

3. An inference module to operate on the knowledge base data in light of the clinician's input information to arrive at a diagnosis or treatment plan.

65. What analytical mechanisms are used by the decision support systems?

1. **Decision trees or algorithms** use a form of logical classifications to lead the user to a desired end point.

2. **Statistical systems** compare information about a patient's signs and symptoms with a database and calculate a diagnosis based on the probability of occurrence. They are often referred to as Bayesian classification methods because they use Bayes' theorem to calculate the probabilities associated with signs, symptoms or laboratory value descriptors and arrive at a particular diagnosis.

3. **Rule-based systems** are based on "if... then" statements to arrive at a diagnosis. The knowledge base is stored as production rules, heuristics, or rules of thumb. By using these rules the program can create associations and correlation between pieces of information. For example:

If a tooth has a draining fistula
And the tooth tests nonvital to an electric pulp tester
And there is a radiographic apical lucency,
Then the tooth is likely to have a necrotic pulp.

66. What dental decision support software is currently available?

DART is a decision support system for diagnosis of oral pathology based on algorithmic design.

ORAD is a statistically designed program for support in diagnosis of osseous lesions. URL: http://www-scf.usc.edu/

RaPiD is a rule-based partial denture framework design program.

Hammond P, et al: Knowledge based design of removable partial dentures using direct manipulation and critiquing. J Oral Rehabil 20:115—123, 1993.

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67. What future roles may decision support systems play in dentistry?

If standard formats of data reporting become established within dental management information systems, one may envision national databases that can assemble quality assurance information and morbidity statistics for different treatments. An example may be the longevity of different restorative materials, situations surrounding implant failures, or success of different periodontal treatment protocols. These data may even be electronically transferred to analytical review centers for standardized research reporting analogous to the reporting of adverse complications of drugs.

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