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Application service providers in dentistry Titus Schleyer, DMD, PhD

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Computerized practice management can constitute a significant portion of the overhead in maintaining a dental practice. Currently, more than 79% of all dentists use computers in the office [1]. Although many use computers predominantly for billing and insurance processing, more and more dentists use it for additional functions, such as scheduling, charting, providing digital radiography, and using intraoral cameras. New and innovative products present a broad range of choices for technology use in dental practice.

As a result, managing the computing infrastructure itself is becoming more difficult. It is also a challenge for which most dentists are ill equipped. Graduating dental students consistently rate practice management as one of the areas they do not learn enough about in dental school [2]. Many students do not receive formal education in computing, because few schools offer courses in dental informatics or computer-related topics [3–5]. Rapid innovation challenges busy practitioners who would like to keep current with information technologies. Most of them do not have the time or the motivation to spend significant energy on the many possibilities and opportunities that computers offer for dental practice.

Implementing and maintaining the computing infrastructure necessary even for basic computing applications in the office are significant challenges. Unless the practice relies on a single workstation, a client/server configuration (see later discussion) with a central server and two or more workstations is necessary. Although the direct costs for such a set-up can be significant (usually \$5000 and more for a basic set-up, including practice management software), the hidden costs tend to be much greater. System installation, software implementation, daily operation (such as back-up, virus protection, and firewall maintenance), troubleshooting, and software upgrades can consume significant time and resources. Dentists often assign these functions to office staff or external consultants. Some dentists, however, perform such functions themselves.

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During the last 2 to 3 years, a new model for managing some aspects of the computing infrastructure in practice emerged: the application service provider (ASP) model [6,7]. In the ASP scenario, a computing application (such as an accounting software package) is run over the Internet. On the client side, only a simple computer with a Web browser and an Internet connection is required. The server is maintained by the vendor and is accessible over the Internet. The model has the potential to reduce some of the effort and cost associated with managing computer systems; however, advantages and disadvantages should be analyzed carefully before committing to an ASP system. An ASP system may be appropriate for some practices, but not for others. The purpose of this article is to contrast the ASP model to its older cousin, the client/server model, to enable readers to understand functional differences and commonalties. The article also discusses advantages and disadvantages of the ASP model and concludes with a brief survey of commercially available products.

Many, if not all, computing applications can be delivered through the ASP model. Although this article only discusses ASP services for practice management and clinical record keeping, ASP functions are not limited to this area. For instance, many small businesses use ASP solutions for personnel management and accounting.

Traditional office computer systems

The traditional configuration for dental office systems with two or more users at one or more locations is the client/server architecture. In this set-up, a central computer (the server) maintains all data and client workstations distributed in the office interact with the server (Fig. 1). Typically, the database on the server is accessible to other computers through a communication interface. This interface allows the server to send data to and receive data from the client. A corresponding interface performs the same function for the client. Most of the information processing (such as calculations and data validation) is performed on the client. Sometimes, the database itself contains part of the application logic.

The database on the server is one of the most crucial parts of the infrastructure. If the database is not available, none of the clients can access, modify, or store information. Typically, industrial-strength database systems, such as Oracle (Oracle Corp, Redwood Shores, CA) or Microsoft SQL Server (Microsoft Corp, Redmond, WA), are used for the database. These systems incorporate advanced features that can reduce the likelihood of a database failure. The central database also ensures that users access data in an organized fashion, for instance by preventing them from overwriting each other's changes.

Setting up and configuring the server requires multiple, complex steps. Although the vendor of the practice management system typically performs most of those steps, the time and effort required contribute to the total cost of



Fig. 1. Client/server architecture for practice management systems. All components of the system (server, clients, network) are located in the dental office. An Internet connection to the server is optional.

the system. Necessary steps include installing the operating system, the database system, antivirus software, back-up software, and any necessary drivers or software libraries; preloading the database with the database structure, initial datasets, and general, practice-specific information; testing; and installing. Whereas most servers come preinstalled with an operating system, many vendors elect to reinstall it to optimize the server for database performance.

The workstations (or clients) that access the information on the server, on the other hand, are less crucial to ongoing operations. Although the failure of a client prevents access for its particular user, it does not otherwise impact the operation of the complete system. Set-up and configuration are simpler for the client than for the server. Typically, the practice management software is installed and the needed database connections are configured. Then the client is ready for use. When a new version of the practice management software is released, however, the client must be upgraded manually. Although automated solutions for upgrading the client are available, they often are not used in settings with a limited number of workstations.

Various conditions can cause a practice management system to malfunction or reduce its capacity for service. These conditions are discussed as follows.

Operator error

One of the most common causes for server failure is operator error. Operator errors range from simple (such as powering down a server by mistake or accidentally deleting a file) to complex (such as installing a software program that conflicts with the practice management system). Although operator errors are sometimes the easiest to remedy, they may not be immediately apparent, especially if some time has elapsed between the error and its consequence(s).

Power failures

Power failures or fluctuations can affect server and client workstation operations negatively, especially if an uninterruptible power system or power-conditioning system is not used. Typically, the benefits of an uninterruptible power system far outweigh the investment and effort needed to implement it. With an uninterruptible power system, a server continues to operate until the battery runs out. Before this happens, the uninterruptible power system initiates an orderly shutdown of the server.

Hardware failures (disk, power supply)

The failure of one or more server components, such as hard drive, power supply, or network card, makes it unavailable. Clients can suffer from similar problems. Various preventive measures, such as redundant components (eg, multiple central processing unit fans or power supplies), are available to reduce the chance of a hardware failure that affects users. For instance, the redundant array of inexpensive disks system on a server continues to operate as long as only one of the disks malfunctions; however, the defective disk must be replaced as soon as possible.

Software failures

Software failures, such as viruses, Trojan horses, worms, bugs, and data corruption, also can render computers nonfunctional. One of the most common causes of software failures is bugs in the application software. Often, software upgrades provide new features and functions but also an increased risk of bugs. Viruses, Trojan horses, and worms are small software programs that impede or interrupt a computer's functioning. They often are introduced when software is installed or data files or e-mail attachments are opened. These programs can travel through the network or on disks, CD-ROMs, and other storage media. If a server is connected to the Internet, it also can malfunction because of a hacker attack. Installation and proper configuration of a firewall typically prevent this situation.

Network failures in the office

Failure in one or more of the networking components (such as network interface cards or hubs and routers) also can affect the functioning of a practice management system. Again, failure at the server has the most consequences and failure at the workstation has the fewest consequences.

Many readers have experienced one or more of these problems. The consequences range from annoying (eg, temporary malfunctions) to catastrophic (eg, extended downtime of a system with serious consequences for practice operations). Many users learn from experience and take a more systematic approach to the management of office computers after a negative incident.

The ASP model provides the opportunity to shift some of the burden in operating the practice management system to someone else: the vendor. In the ASP model, the server for the practice management system is maintained remotely, which frees the dentist and office staff from the necessity of keeping the server operating. The next section discusses the architectural differences between client/server and ASP systems.

Application service providers

According to the PC Webopedia [8], ASPs are "third-party entities that manage and distribute software-based services and solutions to customers across a wide area network from a central data center." ASPs in dentistry are often termed "vertical market ASPs," which provide support to a specific industry.

With the ASP model, the server is located remotely and accessed through the Internet (Fig. 2). The server, analogous to the client/server model, runs the database. It also performs most, if not all, information processing through the practice management application. In addition to performing database and application functions, the server is configured as a Web server. As a Web server, it can communicate over the Internet with any computer equipped with a Web browser.

The configuration of the clients that access the Web-based ASP server is simple. A client requires only a connection to the Internet (such as through an analog modem, cable modem, digital subscriber line [DSL] connection, Ethernet port, or wireless modem) and a Web browser. Despite the fact that most of the Internet is accessible to Web browsers from several vendors (such as Netscape, Microsoft or Opera), ASP applications are typically geared toward a single browser. This is not a problem because all major browsers are available easily and at no cost.

The Web-based practice management application works entirely within the framework of the browser. Often, the Web server generates hypertext markup language (HTML) pages, which the browser can interpret easily and require little bandwidth and processing capability [9]. Sometimes, the application incorporates JavaScript or Java for advanced functionality [9].

Because all transactions in the ASP scenario are transmitted over the Internet, designers of ASP systems pay special attention to security. Web servers are typically protected with multiple security mechanisms to prevent data corruption and break-ins by hackers [10,11]. Data transmitted between the server and the client are encrypted with strong encryption protocols (usually with encryption keys of 128 bits or larger). Web servers also can be configured to communicate only with specific client computers. For instance, the traffic to and from an ASP Web server can be restricted to the

Application Service Provider Model



Fig. 2. Application service provider architecture for practice management systems. Although the clients and local network are located in the office, the server is remote and accessible through the Internet.

customers for the practice management system only. Then, no other computer can communicate with the Web server. Good security infrastructure design can reduce the risk of a security compromise to a negligible probability, which renders commonly held fears about the risk of transactions over the Internet inconsequential [12].

As is clear from the preceding explanation, the ASP practice management applications have an architecture that is different from traditional client/ server systems. The following section discusses the benefits and drawbacks of ASP systems in more detail.

Benefits and drawbacks of ASP systems

Some benefits and drawbacks of ASP systems are immediately obvious, whereas others may be somewhat more obscure. Choosing an ASP system over a traditional practice management system is currently a matter of weighing the risks and rewards. There is no decisive advantage of one over the other; however, this situation may change over time. Developments in computing and the Internet in general determine the acceptance of ASPs more so than specific innovations in dental ASP applications.

The major benefit of ASPs is that the server management is completely outsourced. As is evident from the preceding discussion, installing, configuring, and maintaining a server requires significant expertise and effort. Professional service organizations, such as ASPs and Internet service providers, often manage a large number of servers in so-called data centers. Data centers are climate-controlled, secure facilities with their own back-up power source. Servers are typically configured for high availability and reliability and contain multiple redundant components. The redundant array of inexpensive disks systems serve as disk storage, almost eliminating the chance that a hard disk crash affects server operations. (In most of these systems, two or more disks must fail to render the system inoperable.) Highend ASPs mirror server operations at a remote site, so that even complete destruction of one data center does not affect operation for the end user.

The geographic separation of the server and the practice also may be beneficial. In the case of a catastrophic event that affects only the practice, the server is secure in the ASP model. In a client/server configuration, the whole infrastructure, including the server, would have to be rebuilt.

In ASP systems, software upgrades are performed exclusively on the server. Once a change has been made, the changed application is immediately available to the users. No action is required on client workstations. This feature stands in marked contrast to the client/server model, in which the upgraded software must be installed on each client workstation and sometimes on the server. This installation requires additional work, can be prone to error, and results in forced downtime for users. (Downtime for users of ASP systems is usually not noticeable because it is so short. On an ASP server, usually only the software component to be upgraded must be recompiled or installed [not the whole application]. This installation results in a delay of several seconds at most.)

Problems with a client workstation are also easy to remedy with an ASP system. Because a client only needs a Web browser, most computers can be connected to the network "out of the box" (ie, without any software installation). Practices with several workstations may want to consider having an older or low-end workstation on hand for such a contingency. With a client/ server system, the practice management software must be installed on a new client at minimum, which results in additional work.

An ASP system also may provide a low-cost entry to a practice management system. It obviates the need to purchase and maintain a server, and the customer only must establish the client infrastructure. Empirically, fees for renting an ASP service currently range between \$100 and \$200 per month. A high-quality server, including accessories (such as an uninterruptible power system), costs at least \$3000 to \$5000 and has a typical life span of 3 to 5 years. Maintenance and upgrading also require significant ongoing effort and expense. Thus, an ASP system may be more cost effective. At least it reduces the up-front investment required to implement a practice management system.

An ASP system also may be an attractive choice for dentists who have offices in more than one location. Although it is possible to connect several practices to a central server in a client/server configuration, designing and implementing such a wide area network infrastructure is difficult. With an ASP system, additional offices access the central server using standard and widely available Internet connections.

Another advantage of an ASP system is that it can be accessible to authorized users from any computer connected to the Internet and equipped with a browser. For instance, a dentist can access his or her complete practice records from home should that be necessary. Anytime, anywhere access also potentially extends to wireless computing devices, such as personal digital assistants [13]. Currently no ASP vendor offers this capability, however. Interacting with Web pages on small screens (such as those of personal digital assistants) and without a keyboard and mouse presents difficult design challenges that are not easily solved.

Despite their many advantages, ASP systems also have potential disadvantages. In the case of client/server systems, the most important component is the server. In the case of ASP systems, it is the network connection. Without a functioning network connection, clients cannot access data on the server. Currently, the reliability of Internet connections, although improving, is not 100%, especially for high-speed connections such as DSL and cable connections. This situation does not reflect an underlying weakness of the respective technologies, however, but rather excessive demand for bandwidth, configuration problems of routers and network servers, and lack of or inadequate training of network engineers and service personnel. As the Internet infrastructure matures, such problems will diminish. In general, the situation mirrors the early days of the telephone. Currently, we hardly ever think about reliability problems associated with landline phones.

A cheap and easy way to ensure the availability of the network connection at the client end is to configure two separate types of Internet access. The main type of access could be provided through a DSL or cable connection, which is made available to all client workstations in an office through a hub or router. An analog modem at each client workstation could serve as the secondary (back-up) access. In case of failure of the DSL or cable access, a workstation could dial up to an Internet service provider and establish a connection. This connection would be slower, but system functions could be maintained to some degree during an outage rather than not be available at all.

The ASP systems require fast network connections. Although most qualified designers of Internet resources take the highly variable download speeds into account, ASP systems can transmit relatively large quantities of information. Some ASP systems currently offer storage and retrieval of digital images, radiographs, and videos, which results in significant bandwidth consumption. For such systems, relatively fast network connections (eg, integrated services digital network [ISDN], cable, or DSL) to the client are essential [14]. As broadband network services become increasingly available throughout the country, high-speed Internet access will be more accessible and cheaper.

In addition to the necessity of transmitting relatively large volumes of the data, ASP systems also can incur other performance penalties. For instance, using Java for all or part of the application logic on the client requires a more powerful client workstation than if only HTML was used [9]. Most designers of ASP systems, however, attempt to minimize the requirements for client workstations to allow dentists to use inexpensive and widely available equipment.

Many dentists are reluctant to give up control of "their" data (ie, have data physically located anywhere but in the dental office). In the ASP scenario, the dentist does not have direct control of the storage media that contains the patient data. Many dentists believe that this is less safe than maintaining direct control; however, this is a spurious concern. In many real-life situations, we happily relinquish control of important data to others. Given the suboptimal back-up and data management procedures in many dental offices, the data are actually safer with qualified vendors. All ASP vendors currently offer clients the option of receiving an archival copy of their patient database upon request.

A final concern could be that ASP vendors could prevent access to a dental practice's data at will. For instance, a dentist who is in arrears paying the subscription fee for an ASP service could find himself or herself without access to patient data. A recent proposed amendment to the Uniform Commercial Code—called the Uniform Computer Information Transactions Act [15]—could make such a situation more likely than before. It must be acknowledged, however, that ASPs function like utilities. Eventually, even the telephone or electric company suspends service after prolonged nonpayment of bills. Most dental practices simply avoid this situation.

Security is not a drawback for ASP systems from qualified vendors. Designers of Web-based computing applications must implement a security infrastructure much more sophisticated than that of the average client/server system. Typically, security of computer systems is compromised by simple means, such as password theft, social engineering, and carelessness. Even highly publicized contests to crack messages encrypted with strong security mechanisms require enormous computational power to solve the cipher [16]. It is highly unlikely that a well-designed and well-managed ASP system can be compromised by less than a determined attack from highly trained hackers.

In terms of the Health Insurance Portability and Accountability Act (HIPAA) [17], ASP vendors are "business associates." As such, they are required to comply with certain HIPAA provisions regarding privacy and security. For instance, they must agree to use protected health information only for the purposes for which they were engaged by a dental office,

safeguard the information from misuse, and help the dental office comply with duties to provide individuals with access to health care information about them and a history of certain disclosures.

To illustrate commercial ASP offerings, the following section discusses products from two companies: dentalxchange.com and PackOnline. The descriptions are only provided as examples, not as an endorsement of any of the products.

ASP examples: dentalxchange.com and PackOnline

As of this writing, two major vendors are offering ASP services: dentalxchange.com and PackOnline. Because the dental ASP industry is new, the market for ASP services is expected to remain somewhat volatile until this business model has proved viable for dental practitioners and providers. The two vendors profiled herein are only emblematic for the types of available services.

Dentalxchange.com began offering ASP services in early 2001. The product, PracticeConnect (Dentalexchange.com, Irvine, CA), is billed as delivering comprehensive practice management features via a Web browser with complete data security and no system administration headaches. The application provides restricted online access to patients through the dental practice's Web site and is designed as a multi-office application.

Fig. 3 shows the PracticeConnect main screen after logging in and selecting a patient. Patient-related functions, visible as horizontal tabs above the patient data area, include patient demographic information, medical, dental, and medication histories, visits, varied financial information, and an intraoral chart. The program also allows the storage of images, such as radiographs, for each patient. The vertical row of buttons on the left-hand side of the screen provides access to patient data, fees and carriers, appointments, reports, the contact manager, and utilities. An interesting feature is found under "tutorials," where users can access "how-to" instructions on various features of the program. It is obvious how the "tutorials" section can be used to train employees on new features after a software upgrade.

PracticeConnect allows new patients to register and provide their medical and dental histories and financial information remotely. Patients on record can check their individual histories and upcoming appointments and recall dates and current balances. PracticeConnect users also allow colleagues (such as specialists) to access limited portions of a patient's record (for instance images).

Security and availability are high priorities for PracticeConnect. The application runs on multiple Web servers. If a single server becomes unavailable, another server takes over automatically. The servers are divided between two geographic locations, which reduces the chance of failure caused by a catastrophic event. A sophisticated security infrastructure (128-bit encryption, digital certificates, and a firewall) reduces the chance

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Fig. 3. Main screen of Dentalxchange.com's PracticeConnect application.

of unwanted break-ins. The software runs on MS Internet Explorer Version 5.0 and higher. As of this writing, PracticeConnect had approximately 100 customers. The subscription to PracticeConnect (basic service) was \$199.

PackOnline also offers an ASP product. Although the program had been available to solo and small group practices, as of this writing the company was focusing on large groups of dental providers. The program provides functionality similar to that of the offering of dentalxchange.com, including patient access to the system.

PackOnline recently developed an interesting variation of the ASP model described previously. Its new product, PracticeAccess (PackOnline, Herndon, VA), mirrors the data from a traditional client/server system to a Web server on the Internet. A dentist retains the existing set-up (if a practice management system is already installed in the practice), but the data contained in it are copied periodically to the Web server. The PracticeAccess application then provides functions for managing patient recalls, giving patients online access to a portion of their dental records, and providing dentists with anytime/anywhere access to their practice records. Not only does the system provide a back-up of a practice's data but it also adds functions that may not be available in a dentist's current practice management system. As of this writing, PracticeAccess interfaced with Softdent (SoftDent, Hunt Valley, MD), Easydental (Easy Dental Systems, American Fork, UT), Computer

Age Dentist (PracticeWorks, Atlanta, GA), Dentrix (Dentrix Dental Systems, American Fork, UT), and EagleSoft (Patterson Dental Supply, Effingham, IL).

Fig. 4 shows a screen shot of the PracticeAccess application. The page provides a high-level summary of the practice status, including accounts receivable, average daily production, and collections. Functions in the center of the screen allow the user to send recall and appointment reminders and birthday cards electronically. Most functions on the left-hand side of the screen provide access to patient and practice data. The second function from the top is "synchronize desktop," which allows the provider to update the practice data on the Web server.

As of this writing, PracticeAccess had been released only recently. Subscriber figures were not available. The subscription fee for the basic service was \$39 per month.

Although dentalxchange.com and PackOnline are only two examples for dental ASPs, further maturation and development can be expected in this product category. To assist readers who are considering signing up with an ASP vendor, the author provides a brief list of issues to check.



Fig. 4. Main screen of the PracticeAccess application from PackOnline.

Type of Internet connection

The Internet connection should be at least ISDN, DSL, or cable or faster. Standard modem connections are not recommended for ASP services, except as a back-up connection modality.

Functions of the application service provider vendor

As with any software and system purchase, the functions that the ASP vendor provides should match the practitioner's requirements optimally. Feature lists, demonstrations, reviews, and references can provide useful information for this purpose.

Failsafe operation

The practitioner should obtain detailed information about the measures the ASP vendor has taken to guarantee maximum uptime and availability of the service.

Security

The practitioner should ask the vendor for detailed documentation about the security mechanisms that safeguard the practice's data. Vendors should formally assess the vulnerability of their system by contracting with a company that specializes in discovering security weaknesses and loopholes in computer systems.

Copies of the database

The ASP vendor should offer to provide periodic copies of the practice database. The practitioner should check the fee for this service.

Conversion services

Should a practitioner elect to discontinue service with an ASP, he or she must ensure a smooth transition to the subsequent system. He or she should check whether the ASP provides assistance in that process, how much it costs, and how uninterrupted service is assured.

Company viability

Current ASP vendors tend to be young, developmental companies. Practitioners should exercise due diligence in assessing whether the company is a good prospective long-term business partner.

Summary

ASP practice management systems are a new and potentially useful service for the dental profession. ASP systems have the potential to reduce the time, effort, and expense required to maintain computer-based practice management functions. ASP systems can deliver a rich array of functions at a distance, eliminate concerns about upgrades, back-ups, and server hardware, and make management of client workstations easier.

The ASP industry is young, however, and its companies and products will be in constant flux. Practitioners should exercise great caution in selecting an ASP system.

If the ASP model proves viable in dentistry over the long term, we can expect to see a growing number of services being delivered over the Internet. Many ASPs exist already that serve many needs of small businesses, such as accounting, personnel management, and supply ordering.

Application service provider systems also have the potential to improve communication between dental care providers. The ease of exchanging selected patient information between providers may result in more patient-related information exchange than is currently the case. The quality of dental care can only benefit.

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