

## Review Articles

# Uses of internet technology in clinical practice

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### ABSTRACT

The practice of medicine has extended itself to vast areas and requires active clinicians to systematize and organize their workload through the use of the most up-to-date digital and computer communication technologies. Computerization and worldwide accessibility of information has especially provided great assistance in this regard. The explosive growth of medical information increases the need for the use of these new methods of organizing and accessing data. This article briefly summarizes a few of the vital tools that internet technology has provided clinical practice, with the aid of basic concepts of internet, database systems, hospital systems and data security and reliability.

**Keywords:** World wide web, medical information.

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Like a fast whirling hurricane, computers and the internet have swept over every nook and corner of medicine. Their role in clinical practice is especially widespread, ranging from web-based record keeping, web-based decision assistance, rapid review of detailed information and relevant cases, electronic web-based consultations, report dispatching systems, handling and manipulating microscopic electronic images for pathology and radiology to better doctor-patient communication, personal collections, research purposes and publications and even for teaching and educational purposes. The practice of medicine increasingly requires handling and managing large amounts of information, particularly in hospital settings. If we look at a typical physicians daily workload of laboratory results, request forms, reports, and pending discharge summaries, it is a sufficient reminder of this fact. In the past, hard work and good organization could usually deal with this paper trail, but there is now increasing evidence that important information is lost or misinterpreted even in the best hospitals.<sup>1</sup> In addition, the rapid growth in medical knowledge, particularly within biomedical literature,

is further taxing our ability to provide optimum care.<sup>2</sup> However, we are starting to see real clinical benefits from computerization of clinical data.<sup>3,4</sup> The Internet is a network of networks that connects millions of computers, people, software programs, databases and files. Though it is comprised of various sections from news groups through email services, by far the most popular and fastest growing component is the World Wide Web ("W.W.W." or just "Web") which contains most of the information, and which is cited as most important by two-thirds of the users, followed by electronic mail.<sup>5</sup> The web has accelerated the growth of the internet by giving it an easy to use, point and click, graphical interface and it contains a universe of network accessible information. In February 1999, the Web contained approximately 800 million pages of information, increased up from 320 million in December 1997.<sup>5,6</sup> The rapid increase in medical information requires such new methods of accessing and organizing data. The technologies of the web are increasingly being used to manage clinical information within organizations and hospitals. Another way the internet can be beneficial in medical practice is through the

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use of web sites, which can be quickly set up to display text, images, and even video clips that can become immediately available for worldwide access and can be used as a reference. Diagnosis programs linked to web sites can be effectively integrated into clinical settings and can assist patients and even clinicians in minor matters such as in calculating INR and other values, adjusting drug doses, hemodynamic dysfunctions, heart failures, and so forth. Web technologies provide us open standards for developing comprehensive medical information systems with easy and economical access.<sup>7</sup>

***The Internet and the world wide web for clinical medicine.*** It should be no surprise that the internet and the web have important potential for clinical medicine. The internet is above all a communication system, and hospitals have made great use of innovative communication systems over the years such as pagers, internal telephones, air tubes, and fax machines. However, text has stubbornly remained paper based in most hospitals. As a result, problems of legibility and loss of patient notes are daily occurrences.<sup>8</sup> The internet was developed to link together computers of different makes and operating systems, which suits the situation in many hospitals. A central design principle of internet based programs is its separation into clients and servers. A server is a program or programs that runs on a computer that stores information and processes requests from users. A client is a computer program that runs on the users machine and communicates with servers to access or provide data. A typical example of this arrangement is the use of a program like Netscape (a web client or browser) to collect information from a web site a (web server).

***Benefits of putting documents on a web site.*** 1. Information becomes available globally, and with easy, click on access. 2. Publishing is instantaneous, it is carried out by just saving the file. 3. Immediately published information can be used as reference. 4. Information from various sources local, regional, and international can be linked together to form an organized body of knowledge, with better, expanded coverage and giving good insight and understanding. 5. Access to documents can be restricted to one institution, or even to a small subgroup, by means of password protection. 6. With modern computers, high quality, full color reproduction of images, animation, and sound are possible at minimal cost. 7. Print outs of forms for clinical data and guidelines or instruction sheets for patients are immediately available anywhere there is a printer. 8. Difficult cases available on the web for discussion can provide web-based clinical seminars to allow for better diagnosis and consultations among physicians, pathologists and radiologists. The web provides the additional benefit of displaying formatted text and images. Documents are organized with "hyperlinks." These are highlighted areas of text or images on web

pages that allow users to jump to other documents at the click of the mouse, providing an intuitive way of accessing information. Finally, programming languages that can run in web pages and on most makes of computers are now available such as Java and hypertext mark-up language (HTML).<sup>9</sup> This allows calculations and other processing to be performed in web pages and simplifies the process of exchanging useful programs. Web technologies are increasingly used on private networks inside organizations as local area networks (LAN) and wide area networks (WAN<sub>2</sub>). These "intranets" bypass many of the concerns regarding data security on the web but retain its flexibility and potential for rapid development. These web technologies provide standards and common languages for communication between computers and their specifications and construction have been published. Therefore, data and programs can be freely shared, avoiding constant duplication of effort and simplifying upgrading.

***Concepts of web-sites for clinical data.*** The was developed to display such things as research papers, electronic journals with online peer reviewing system, E-mail discussion groups, and online clinical associations, and hence is a natural medium for clinical articles, reviews, discussions and guidelines. Text can now be prepared with a conventional word processor such as Microsoft Word or WordPerfect or with an HTML editor such as Microsoft Front Page, Netscape Gold, Net object fusion or micro media flash. Images can be scanned into files or created with a drawing program. Animations and sound effects can be integrated into the information in a very user friendly manner. More sophisticated programs allow whole lectures to be linked to a web page such as Real Audio and video recordings to be converted to a computer format such as QuickTime. Slide making programs now allow slides to be converted to web pages, which can be useful for previewing lectures and other teaching material. Online live clinical seminars and lectures can be broadcasted with active discussions. With the use of this Internet communication technology, even the burden of conducting clinical exams has been solved. Most of the exams are now conducted online, decreasing the man power load, invigilators, flexibility with and immediate availability of results.

***Web sites and forms for clinical consultations and decision assistance.*** There are web sites available which allow the users to feed in clinical data, information for analysis, advise or consultations. Static web documents become more powerful tools when users can enter data and receive specific data or advice. Hypertext mark-up language forms allow entry of data that is then processed by the server. Programs on the server can allow users to search for names or keywords such as in a hospital physician directory. Patients can be registered in the system with these forms and tests can be ordered,

with the request being sent to the laboratory either by e-mail or as a direct entry in the laboratory database. Finally, patients can be given specific advice by means of diagnostic or decision support programs linked to the web server.<sup>10</sup> All these interactive functions require some kind of program on the web server or in the web page. While these are usually written by experienced programmers, it has recently become possible to create search programs, send e-mail messages, and even store patient details in a database without real programming skills such as with FrontPage, Net Object Fusion or even through HTML supported Microsoft Office). Decision assistance is to provide relevant information to help in decision-making. Textbooks, journal articles, specific case reviews, online image databases, atlas' and other guidelines are all examples of decision assistance, but it usually means more specific advice such as clinical decision trees, calculators for clinical parameters, or expert systems. All these methods can easily be connected to web pages, which provide a uniquely powerful way of combining this information in an organized and accessible form. As an example, many web sites are available as workstations to assist in the management of heart diseases and hemodynamic diseases (www.healthgate.com)<sup>11</sup> drug doses and calculations, drug side effects and interactions, laboratory results interpretation and many other clinical parameters.<sup>10-13</sup> To complete the workstation it is necessary to keep records of patients entered into the system. This allows users to refer back to specific patients and for checks to be made and feedback given on the quality of advice. A link to a standard database can allow collection of the relevant data, but the real benefits can be seen by integrating programs into a comprehensive clinical information system. Then information has to be entered only once and cross-checks can be made between different types of data such as plasma creatinine concentration and drug dosing. The above functions can now be implemented in a few weeks or less (apart from full integration into the hospital system).

**Linking of information and databases through the internet.** Many useful and flexible hospital electronic medical record systems are available that provide a common communication system and overcome the problem of connecting multiple systems of varying ages written in different programming languages.<sup>14,15</sup> Different databases such as those for patient registration or laboratory tests typically organize data differently, use different vocabularies, and run on different management systems. Each database is linked to a program, the site server, which converts the data to a common format or code for medical information called Health Level 7.<sup>16</sup> The data is then linked together by another program and displayed as web pages. The beauty of

this system is that each database needs only one translation program. Just as importantly, the users need only a web browser such as Netscape and Internet Explorer, which runs on most modern computers. The hospital can combine information from the old and new systems, which may be in different sites, but users have only to learn the one web display. The latest available hospital systems contain 3 layers: the database, the programs for translation and formatting of data, and the web browser. This design is an extension of the "client-server" approach described above, which allows each part of the system to be designed and written separately and then united and compiled together in the end. As long as each component can pass information to the other parts, it does not matter how they are written, or which programming language was used. Our main intention in providing this basic information to clinicians is to help them develop some concepts of what is going on behind the screen.

**Privacy, security, confidentiality and validity of medical data.** This is one of hot issues in the internet world. Internet users need an environment of mutual trust and openness, which will help to make the internet a free, comfortable and richly diverse community for everyone. As an internet user, one has the right to expect online privacy and the responsibility to exercise choice over how one's personal information is collected, used and shared by the web sites. Medical web sites should ensure its users that their privacy is protected. Various "trust marks" are provided to sites that adhere to established privacy principles by different privacy maintaining sites such as [truste.com](http://truste.com). Privacy principles embody fair information practices approved by the United States Department of Commerce, and by various organizations and associations include:<sup>17</sup>

1. Adaptation and implementation of a privacy policy that takes into account consumer anxiety over sharing personal information online,
2. Notice and disclosure of information collection and use practices,
3. Choice and consent, giving users the opportunity to exercise control over their information and
4. Data security, quality and access measures to help protect the security and accuracy of personally identifiable information. All websites must disclose their personal information collections and privacy practices in a straight forward statement, generally carried out through a link from the home page. More than one page may be displayed if personal information privacy practices vary within the sites. Users should be assured that websites will disclose:

1. What personal information is being gathered.
2. How the information will be used.
3. Who the information will be shared with, if any one.
4. Choices available in regards to how the collected information is used.
5. Safeguards in place to protect information misuse or alteration.
6. How one can update or correct inaccuracies in information.

**Personalize tracking.** Preferably, the site should be tailor made to meet the individuals interests and concerns with appropriate consent and options. The site should have precautions safe measures for personal and health information that should not breach individual personal privacy and reveal individuals health data in safe mode. More strict and stringent standards are required for this.

**Confidentiality.** Confidentiality is defined as "the right of an individual not to have personally identifiable medical or other information disclosed to others without that individuals expressed informed consent." Patients have a right to privacy that should not be infringed upon without express informed consent. Identifying patient information should not be published in print or online description, photographs, or pedigrees, unless the information is essential for scientific purposes and patients give informed consent. Patient confidentiality is of great importance, especially with regard to clinical databases and the internet. At present, few systems send data over the internet, almost all systems operate only within the private hospital network (intranet) such as LAN, multiple area network (MAN) or WAN<sub>2</sub>, possibly with telephone connections for doctors at home. Those systems that do have Internet connections use a "firewall," a computer that screens all connections to the Internet and prevents inappropriate transfer of data.<sup>7</sup> There is a strong drive from commercial Internet users to provide secure data transfer for credit card numbers and other personal data, leading to the creation of several secure systems and the use of encryption. These approaches should soon provide adequate security to transmit confidential clinical data, but until then great caution must be exercised.

**Reliability and validity of data.** The internet has become one of the most widely used communication mediums. It is also allows for unprecedented freedom of expression. It ignores national and cultural boundaries. Internet technology is developing with bewildering speed. A single web site can cover a vast array of unrelated subjects. Conventional print and audio-visual media leave a physical record, while net content is volatile: "here today, gone tomorrow." With the free availability of web server software, anyone can set up a web site and publish any kind of data, which is then accessible to all. There is no common legal framework for the provision of healthcare information on the internet and other on-line services. So a code of conduct for medical and health web sites has become one of the internets main healthcare issues, to verify the reliability, validity and credibility of information provided. The problem now is not just finding medical information but also assessing the credibility of the publisher as well as the relevance and accuracy of a document retrieved from the Net. In many cases, a given web site

provides no appropriate documentation regarding the scientific design of a medical study, nor are studies made available that support given claims. This requires the need of evaluating web based medical information sites to assess their reliability and validity. There are no defined set of rules, principles or regulations to be followed for evaluation and rating of web sites, but some of the important ones are listed below so that the viewers may feel confident in obtaining information and using resources on the site. All site visitors should be able to opt out of personal tracking information. Viewers should know who is tracking and what is being tracked.

**Basic points to be looked at when evaluating medical web sites.<sup>18-23</sup>**

1. Information from IP addresses. 2. Quality of contents. 3. Quality of editorial content. 4. Specifications regarding site ownership, sponsorship and currency. 5. Authority of source and easiness in use. 6. Maintenance of links, contacts, feedbacks. 7. Maintenance of privacy, personalized tracking and confidentiality.

In conclusion, this article describes a few concepts of Internet uses in clinical practice, data base systems and data security and reliability on the Internet. Internet technology has revolutionized the world of science including the clinical sciences. We should adopt these advances as soon as possible as they are going to be standards of practice very soon.

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