An Introduction to the Internet, Part 4: Medical Resources

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In this article, the last in a four-part series on the Internet, medical resources on the Internet and the means of locating them are described. In addition, a discussion is also provided on how clients and servers, primarily those on the World Wide Web (WWW), interact to retrieve and display information. After reading this article, a technologist should be able to: understand why different programs for a given Internet service can produce different results; describe methods for locating information on the Internet; and name the most important nuclear medicine sites on the Internet.
Key Words: Internet; computers; network; World Wide Web; nuclear medicine sites

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In the early 1990s, the Internet was used primarily as a means of communication between individuals. Electronic mail could be used for one-to-one communications or for one-to-many through mailing lists. More widespread communication on particular topics could be achieved through USENET. While email and USENET continue to grow, the most rapid growth of Internet has been in information resources.

Most of the information on the Internet is found at ftp, gopher and World Wide Web (WWW) sites. An ftp site is basically an archive of computer files that can range from simple text files to complex computer programs. The only purpose of ftp sites is to serve as a repository from which a user can download files, though some servers also allow uploading of files from users. Each ftp site functions as a stand-alone unit with no connections to other ftp sites. Gopher and the WWW are distributed document systems that link together information on remote computers in a way that is transparent to the user. Gopher achieves this by linking computers together through a menu format. Choosing a menu item either downloads a file to a user's computer or returns another menu. The WWW has a more flexible format. Files can contain internal links to other files that can be accessed by choosing highlighted text or images. Both gopher and the WWW have evolved from simple document delivery systems to services which can perform other functions, some of which are described below. The WWW has developed much more rapidly than gopher in this regard. As with any information resource, the greater the amount of information, the greater the need for indexing and search methods. In this article, methods for finding information on the Internet will be described. Specific medical resources will be listed with an emphasis on those related to nuclear medicine. The amount and types of information available from a given source, however, are dependent upon the type of software used to access the site. The speed at which material can be retrieved from a remote site, an important consideration when using the WWW, is a function of the method used to connect to the Internet. A brief discussion of these topics will be given with an emphasis on the WWW.

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ACCESSING INTERNET RESOURCES

One of the most surprising aspects of the Internet is that computers, from Macintoshes to mainframe IBMs connected through a variety of networks, can communicate seamlessly. This diversity can create numerous problems and even knowledgeable users can experience frustration using the Internet. Knowing how different systems communicate may allow a user to solve some problems and to understand what the source of others may be. It is far beyond the scope of this article to discuss all situations that may arise, but a discussion of the more common problems will be presented.

As discussed in Parts 2 and 3 of this series, there are two general methods of connecting to the Internet. The simpler method is for a user to access a central computer (for example, a shell account through a commercial Internet access provider) that runs the Internet application programs and networking software (the TCP/IP software). Alternatively, the user can run these programs on his local computer and connect to the Internet through a local network or by a modem to a commercial Internet access provider. In the former case, if the user can establish a working connection with the central computer, any problems accessing the Internet are almost always due to a problem with the central computer, the Internet itself or the remote computer being accessed. If the user can connect to some remote sites but not others, the difficulty usually resides at the remote site. If no Internet sites can be accessed, the

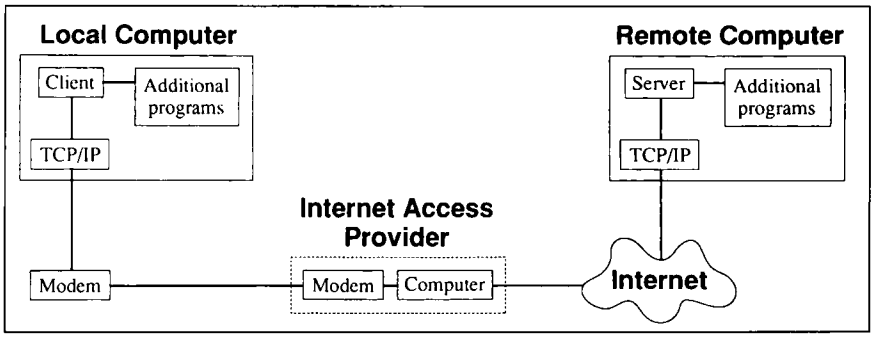

FIGURE 1. Simplified scheme of a personal computer communicating with a server across the Internet by means of a modem. With the type of access shown, the personal computer runs the Internet application program (the client) and TCP/IP software and connects to the Internet through an Internet access provider. With some types of Internet services, primarily gopher and the World Wide Web, the client and server can access programs on their respective computers to perform additional functions. On the World Wide Web, the additional programs used by clients (Web browsers) are called viewers while the additional programs used by servers are accessed through the Common Gateway Interface (CGI) Protocol.

difficulty resides on the central computer. A user who runs Internet application programs and networking software on his own computer will generally encounter more problems because he will have to install and configure his own software. If the individual is not on a local network, he will also need to set up access with an Internet access provider. In the following discussion, I will describe a common situation: accessing the Internet from a personal computer that is running the Internet application and networking programs using a modem to connect to an Internet access provider. Figure 1 shows the general setup. Every component in this scheme must function properly in order to use the Internet. Each will be discussed below.

Figure 1 shows client and TCP/IP software programs running on the local computer, and server and TCP/IP software running on the remote computer. As explained in Part 3, the client and server communicate through ports on each computer with the TCP/IP software, but this has been left out of Figure 1 for simplicity. In addition, the details of how the messages are sent across Internet are unimportant, and the Internet is represented simply as a cloud. Clients, servers and TCP/IP software, as with any software programs, must be specific for the computer and/or operating systems on which they run. If for example, the local system is a Macintosh and the remote system is running UNIX[1], the local system must run Apple-compatible client and TCP/IP software while the remote system must use UNIX-based server and TCP/IP software. For widely-used services such as the WWW, there may be many different client and server programs that can be used with a given operating system (see Appendix B in Part 3). WWW clients (more commonly referred to as Web browsers) are the most complex client programs a user will normally have access to and they, as well as Web servers, will be discussed in more detail below. Client software can differ considerably between different vendors. As an example, an email program that cannot read MIME[2] messages, will be unable to accept some messages from MIME-compatible mailers. The protocols for the more common Internet services, such as email, gopher and the WWW, are continuously being upgraded and expanded. Clients and servers written for older versions of a protocol may not be able to handle messages from servers or clients using new versions of a protocol. Figure 1 also shows that some clients and servers can be linked to other programs on their respective systems that can perform additional functions. Gopher and the WWW use these methods, but the capability is much more widely employed with the WWW.

The modem is often the slowest link in an Internet connection. For transferring small files, a modem operating at 9600 bps is usually adequate. For transferring large amounts of data, as can occur with ftp file transfers or with many Web pages, even modems operating at 28,800 bps can require very long transfer times. Note that in Figure 1, a user's modem is connected to a corresponding modem of an Internet access provider. Since data transfer cannot occur faster than the slowest link to a remote computer, a user cannot receive data faster than the speed of the provider's modem. Some of the most popular online services had maximum modem speeds of 9600 bps well into 1995. Eventually, as high-speed digital technology, such as ISDN (Integrated Services Digital Network, see Part 2) becomes less expensive, users will be able to send and receive data much more rapidly than is possible with standard modems and analog telephone lines. Prices for ISDN service and equipment are falling continuously, and more local phone companies are offering ISDN to individual subscribers.

The next thing to consider is the Internet access provider. A provider incurs expenses through the purchase of equipment and connections to the Internet. These expenses are relatively fixed and there is usually only a small incremental cost for providing service to a new customer. A provider, therefore, maximizes profits by signing up as many customers as possible and purchasing as little equipment as possible. Since every connection to the provider must take place through a separate phone line and modem, the service provider handles multiple simultaneous connections by using multiple phone lines and modems. For a service provider to be able to handle 200 simultaneous connections through standard phone lines, the provider must have at least 200 phone lines and modems

[1] UNIX, as used in this article, refers to a group of closely related, mostly proprietary operating systems that can run on Macintosh computers, IBM or IBM compatible PCs, workstations or mainframe computers. The most common UNIX systems are SunOS, Ultrix, HP-UX, AIX, Solaris and Linux.

[2] MIME stands for Multipurpose Internet Mail Extensions, an extension of the standard Internet mail protocol, SMTP, Simple Mail Transfer Protocol, see Part 3.

available. If the subscriber base is too large, a user may not be able to access the provider at peak times because all the available phone lines and modems are in use. If a user experiences this problem, switching to another access provider may be the solution. The tradeoff is that another vendor who provides better access may charge higher rates.

Access problems that occur beyond the Internet access provider's computer are rarely under the user's control and are due primarily to the amount of traffic on the Internet and the number of users accessing the remote site. Telnet and ftp sites in particular are prone to becoming overloaded because once a connection is established to these sites, it is often maintained until the user disconnects.[3] Gopher and WWW servers, on the other hand, maintain a connection with a client only for the amount of time it takes to transfer a file or menu. As soon as the transfer is completed, the connection is automatically terminated. This permits many more users to access these sites. Nevertheless, at times of peak usage, especially in the eastern U.S., data transfer can slow to a crawl.

THE WORLD WIDE WEB

The rapid growth of the Internet in the last two years is largely the result of the increased use of the World Wide Web. This explosive growth was caused by the introduction of the graphical Web browser, Mosaic, which was made freely available to the general public in November 1993. The success of Mosaic spurred not only the development of many proprietary versions of Mosaic (most notably Netscape from Netscape Communications Corporation), but also the evolution of the Hypertext Markup Language (HTML) and the Hypertext Transfer Protocol (HTTP) on which the WWW is based. HTTP is a protocol describing how documents and images are transferred between WWW clients and servers. The original protocol, officially known as version 0.9, was quite simple. It specified the method that a client used to request a file from a WWW server and how the server would transfer the file. The entire protocol was comprised only of a few pages of text. The most distinctive feature of the WWW, however, was not the HTTP protocol, but the hypertext (HTML) document and how a WWW client handled this document. As explained in Part 3 of this series, hypertext documents contain special formatting codes (tags) that the Web browser uses to display the Web page.[4] These codes and the rules for using them form the hypertext markup language.

The original hypertext markup language, now referred to as HTML 0, consisted of codes that linked text in a document to other documents. A major change in HTML occurred when formatting codes were defined that permitted HTML documents to have links to image files. This expanded language, called HTML 1.0, allowed the stunning visual effects that are now so common on Web pages. The next major version of HTML, version 2.0, added codes that allowed a client to display forms that had been incorporated in a Web page. Forms are templates on which a user inputs data or menus from which options can be selected. The Web browser passes user input from a form to the Web server that uses this information to perform some function, such as searching a database or executing a program on the remote computer. It would be highly impractical, however, for the Web server to perform any of these functions itself. Any new program or function made available on the remote computer would require rewriting the server software. Instead, these functions are written as separate programs and linked to the server in a manner somewhat similar to how helper applications are linked to a browser. This is illustrated in Figure 1.

The original HTTP protocol was simply a method of requesting and transferring files between a WWW client and server. The client was responsible for reading the formatting codes in the HTML document and creating the display of the Web page. The introduction of forms in HTML 2.0 required an extension of the HTTP protocol that allowed a WWW server to access other programs that would perform the search functions and other services that could be requested from a Web page. This extended HTTP protocol is known as version 1.0. It uses a standard method of accessing other programs, generically called gateways,[5] on the remote computer that can perform a large variety of functions, thus markedly expanding the services available on the WWW. The standard access method is described by the Common Gateway Interface (CGI) Protocol. Programs on the remote computer that can be accessed using CGI are often kept in a directory labeled cgi-bin. The latest standard, HTML 3.0, includes codes for more elaborate display and organization of Web pages.

HTML continues to evolve and a new set of codes is being developed that goes beyond HTML 3.0 and will add a new level of functionality to the WWW. One such extension is called the Virtual Reality Modeling Language (VRML). Browsers capable of handling documents written in VRML will allow a user to navigate through an image and manipulate objects within the image in three dimensions. A Web site that describes the VRML language is at http://vrml.wired.com. Another programming language that is in the early stages of development is Java by Sun Microsystems. The main feature of this language is the applet, a small program that is part of the HTML document. When a Java Web page is downloaded, the applet is run on the local computer by a Java-compatible browser. Applets allow a large number of new capabilities to be added to an HTML document. Since Java allows programs to be run on the local computer rather than the remote system as required by the CGI Protocol, processing can be done much more quickly. Java browsers, Web sites and the language itself are described at http://java.sun.com.

[3] Some ftp programs will automatically terminate a connection if there is no user activity for a specified time period, such as 15 min.

[4] In this article, a document refers to any type of computer file though it usually refers to a text file, especially an HTML file. A Web page refers to the display of an HTML file along with its inline images.

[5] As mentioned in previous articles, the term gateway has several different meanings but generally refers to a means, usually some type of computer program, by which networks, computers, processes or other programs communicate.

In order for a Web browser to display Web pages written with the newer HTML codes, the browser must contain software that can decipher the new codes. New Web browsers are continually being developed, and older ones updated, that can read the codes. Older browsers that cannot understand the new HTML codes can still display Web pages written in the extended HTML languages; they simply ignore codes they don't understand. New Web servers are also being introduced that use the latest versions of the HTTP, CGI and other protocols. Different Web browsers can produce considerably different displays of Web documents and use different functions within the documents depending on what types of codes the browser recognizes. In addition, a browser can be configured by the user to display a given Web page in a variety of different ways.

A user should be aware that Web servers can download nearly any type of file if it is linked to a Web document. Web browsers, however, can only handle a limited number of file types. For example, Web browsers by themselves cannot play most types of audio or video files. In order to do this, browsers access helper application programs that handle the particular file type if the helper application is properly linked to the browser. This is illustrated in Figure 1.

While Web pages have marked visual appeal, they require considerably more time to download than text. One of the greatest frustrations a user experiences when accessing the WWW, especially through a modem, is the considerable time it can take to download a Web page. There are several ways to get around this problem. Web pages have two basic parts: the HTML file associated with the Web page which is a simple text file and a variable number of inline images. The inline images are referenced within the HTML file but are separate files on the remote computer. When a browser receives an HTML document, it reads the document looking for inline image tags (the ⟨img src="file"⟩ tags). For each such tag in the document, a separate request must be made to the WWW server for the image file. Thus, for a Web page that contains 9 inline images, 10 files must be downloaded from the server: the HTML document and the 9 image files. Since the inline image files are often considerably larger than the HTML file, most of the time required to download a Web page can be spent transferring the images. Some browsers, such as Mosaic and Netscape, allow a user to disable downloading of inline images. A small icon is inserted where the image would reside on the Web page. Clicking on the icon causes the image file to be downloaded and displayed. Netscape speeds the downloading of inline images by making multiple simultaneous connections to the server for downloading several images at once. All browsers have stop buttons for canceling the downloading of documents or images if the transfer is taking too long.

It should be emphasized that a user does not need a graphical browser, such as Netscape or Mosaic, or a computer or terminal that can display graphics in order to access the WWW. There are text-oriented (line-mode) browsers that can download and display the text portion of Web pages and their hyperlinks. These browsers are available for all the common types of operating systems. The best known program is the lynx browser for UNIX systems. A user who has a UNIX account can type "lynx" at the system prompt to see if the program is installed or call the system administrator to see if some other text-based browser is available. If a user has access to such a program, he can create bookmark lists and save files on the local computer. Specific URLs can be entered by typing "g" (without a carriage return); lynx then asks the user for a URL. If the local system does not have a text-oriented browser, there are public browsers that can be reached by telnet. One such browser is at the University of North Carolina at sunsite.unc.edu. The login is lynx. A terminal type is requested, which is usually vt100 (alternatively, the user can enter a carriage return twice). Public browsers do not allow a user to create bookmark lists or to save files. Several public text-based Web browsers are listed in the appendix.

FINDING INTERNET RESOURCES

In order to use the vast resources of the Internet, a user must have some means of locating them. As the size of the Internet, and the WWW in particular, grew to include hundreds of thousands of documents, the need for indexing and searching this material became ever more important. In Part 3 of this series, two search methods, archie and veronica, were described that allowed a user to locate files and menu items on ftp and gopher servers, respectively. Since the WWW is a more heterogeneous service than ftp and gopher, a variety of search and retrieval programs have been developed. Programs differ in the type of indexing and searching methods used, and different programs will, in general, return different results. Perhaps the most important difference between these programs and archie and veronica is that the more comprehensive WWW search programs will search documents for content. A few of the more useful programs are described below. All of these programs create Web pages displaying the search results with hyperlinks to the sites or documents found.

One of the easiest methods for searching the WWW is Yahoo at http://www.yahoo.com. Originally, Yahoo was just a list of interesting Web sites that was compiled by two Stanford graduate students. As the list grew, it was organized by subject and made available on the WWW. The project was so successful, that eventually it became commercialized, and sophisticated search and retrieval functions were added to its Web pages. Figure 2 shows Yahoo's home page. The home page and its immediate links are arranged as subject-oriented menus that can be scanned easily. Medicine related topics can be found under the main heading "Health." Yahoo also allows keyword searching and returns a list of sites that match the keywords. Using the keywords "nuclear medicine," the Web page shown in Figure 3 was returned. Notice that although some major nuclear sites on the WWW such as LUNIS (Loyola University Nuclear Information System) and Mallinckrodt Medical, Inc. are shown, many other important sites were not found. This is not uncommon. A user should try several programs if relevant information is not found by a given method.

Another useful search engine (a name commonly applied to a search program) is Lycos developed at Carnegie Mellon University that can be accessed at http://www.lycos.com. This is

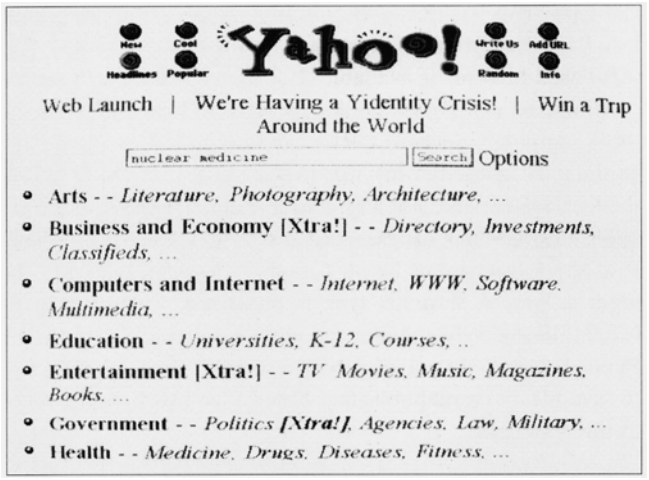

FIGURE 2. The home page of Yahoo, one of the more popular search programs on the World Wide Web. The term "nuclear medicine" has been entered as a search term. Yahoo also allows a user to search for material using a menu format with Web sites arranged by subject matter. Medical subjects are under the main heading "health" on the home page.

one of the most popular search engines on the Internet. The program has several settings which can be altered by the user, the most important of which are the number of items which can be returned and the method of searching. The default method is to find any document with one or more of the search terms a user enters. To find topics related to nuclear medicine, the search method has to be changed to "AND" which means only documents with the words "nuclear" and "medicine" will be returned. Unlike Yahoo, Lycos returns all Web pages with the search term and text (an abstract) about the Web pages. Lycos returned a list of over 100 Web pages and other sites that contained the term "nuclear medicine." All the major nuclear medicine sites were found. While the search is extensive, it also tends to be redundant. Since each occurrence of the term "nuclear medicine" is counted independently, several items in the list were the same Web pages, sometimes occurring numerous times in the list. This list also included some gopher sites.

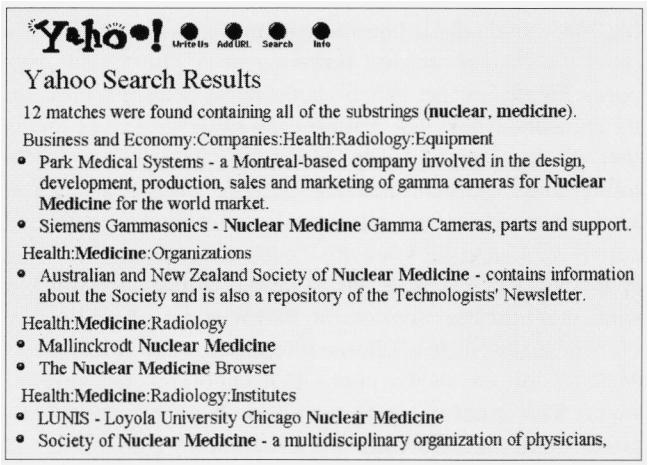

FIGURE 3. The results of a search on Yahoo using "nuclear medicine" as a keyword. Twelve sites were found. All of the items in the list are linked to their corresponding sites on the World Wide Web.

The Webcrawler (http://webcrawler.com), a program developed at the University of Washington, performs an even more exhaustive search than Lycos. This site returned nearly 500 documents when searched for "nuclear medicine." Unlike Lycos, only a list of documents is returned. Though the list is less informative than that from Lycos, it is easier to scan. Many of the sites, however, deal primarily with nuclear energy, nuclear physics and medical physics. These sites were located because the search terms "nuclear" and "medicine" appeared somewhere on the Web page. Most of these sites have little or no material related to clinical nuclear medicine. Fortunately, the search method ranks the sites for relevance, so the most useful documents are usually found at the top of the list.

Infoseek is another extensive search engine that allows highly tailored searches of material on the WWW. The main Web page at http://www.infoseek.com gives information on Infoseek and how to do free searches. There is also a description of a commercial version of the service that offers more options and searching capabilities.

A useful telnet, gopher and WWW site for searching the Internet is the Netlink service at Washington and Lee University in Lexington, Virginia (see Appendix). This site has an extensive listing of telnet, gopher and WWW sites. While this site does not search for document contents, it can give listings of sites arranged by access method, subject or geographic location or a combination of these parameters. In addition, it can perform archie, veronica and WAIS searches.

There are a few sites on the Internet that give listings of many of the Internet search engines. The Internet Meta Index is the most comprehensive collection of search programs on the Internet and includes archie, veronica, Lycos, the Webcrawler, Infoseek and a number of other WWW and non-WWW search engines. The Meta Index can be found at two locations, CERN (the European Laboratory for Particle Physics) and NCSA (National Center for Supercomputing Applications) (See Appendix.). The MetaCrawler (http://metacrawler.cs.washington.edu:8080) maintains a list of WWW search programs and accepts requests for searches. The Metacrawler sends the requests to each of the search programs, organizes the results in a uniform format and displays them.

GENERAL MEDICAL RESOURCES ON THE INTERNET

There are a large number of sites on the Internet that are related to the medical field. The types of sites range from academic medical centers and research institutes to government agencies and commercial organizations. One of the main reasons for the increasing number of medical sites on the Internet, an increase that has paralleled the growth of the rest of the Internet, has been the ease with which Web pages can be created and the greater number of services available through the WWW.

The most comprehensive list of medical resources on the Internet has been compiled by Gary Malet and Lee Hancock at

the University of Kansas. A description of this project can be found at the Medical Matrix, http://www.slackinc.com/matrix. This web page contains links to medical resources arranged by categories. The complete list of medical resources can be found at the University of Michigan and can be reached by gopher at una.hh.lib.umich.edu from the inetdirsstacks directory on the main menu. The file is named Medical Resources–Clinical by G. Malet and L. Hancock, version 2.10, last updated 10/9/95. Many gopher clients allow a user to email gopher documents or save them on the local computer which allows a user to download a copy of the list. Although this list strives to be comprehensive, it is difficult to keep up-to-date. Hancock has published a book about medical resources on the Internet that is current to about June, 1995 (*1*).

One of the most informative sites for medical resources on the Internet is the National Institutes of Health. Most of the institutes can be reached individually by gopher or the WWW. A complete listing of the individual institutes can be found at http://www.nih.gov on the WWW or gopher.nih.gov by gopher. Search programs are found on several menus and Web pages. One important service available at this site is CANCERNET that offers a wide range of topics on all aspects of cancer. There are listings of cancer by organ systems and types of cancer with extensive information for both physicians and patients. This service can also be accessed by email by sending a message to cancernet@icicb.nci.nih.gov. To get information on how to use the system, send email to the above address with an arbitrary subject and the single word "help" as the entire message. There are about two dozen databases that can be accessed through the NIH. Some, such as MEDLINE, require a personal account.

There are many sites on the Internet that have catalogs of medical resources. A partial list of these sites has been published (*2*). Medical centers and even individual hospitals have Web pages that can be accessed from a Web page called Hospital Net at http://dem0nmac.mgh.harvard.edu/hospitalweb.html. The Department of Veterans Affairs has an extensive listing of its services and medical facilities at its main Web site, http://www.va.gov. Included is a list of VA hospitals that can be reached through the Internet. Several medical centers, such as the VA hospitals in San Francisco, Long Beach and Honolulu, have Web pages. The entire VA mail system has been on the Internet for several years.

Increasingly, medical journals are offering information and services through the Internet. Some medical journals, such as the *New England Journal of Medicine* and the *Journal of Nuclear Medicine*, have email addresses for submitting letters to the editor or communicating with the editorial staff. The American Medical Association, which sponsors 9 specialty journals, has an extensive list of services including tables of contents to all its journals and the ability to search these journals by topic and retrieve abstracts. The home page is at http://www.ama-assn.org. Another medical journal on the WWW that has extensive information is the *British Medical Journal* (http://www.bmj.com/bmj).

Two particularly interesting medical Web sites are Oncolink and the Virtual Hospital. Oncolink is the most comprehensive site for cancer information on the Internet. Oncolink (http://cancer.med.upenn.edu) is located at the University of Pennsylvania, created and maintained by E. Loren Buhle and J. Goldwein. This site has Web pages for physicians, patients and families whose members have cancer. Patients have created Web pages describing their personal experiences with cancer, and children who had cancer have artwork displayed here. The Virtual Hospital is located at the University of Iowa (http://indy.radiology.uiowa.edu). Physicians can post questions to this site and earn CME credits by viewing material and answering questions. One interesting feature is the multimedia textbook which includes extensive case discussions on multiple topics. A search form on the home page using "nuclear medicine" as keywords brings up the document ElectricGINucs created by HelenAnne D'Alessandro, from the Department of Nuclear Medicine, William Beaumont Hospital, Royal Oak, Michigan. This Web page, http://indy.radiology.uiowa.edu/Providers/Textbooks/nucs/ElectricGiNucs/GiNucs.html, has links to cases and discussions of hepatobiliary scintigraphy, GI bleeding, Meckel's diverticulum and biliary atresia. Interspersed in the text of the Web pages are small icons that are linked to images and full dynamics displays such as complete hepatobiliary studies (one such study is 5.4 million bytes long, however, and would take more than half an hour to download by a 28,800 bps modem operating under the best conditions).

In addition to the resources listed in this section, a few medical sites are listed in the appendix that have extensive links to other medical resources that can be reached through the WWW or gopher.

NUCLEAR MEDICINE RESOURCES

The majority of nuclear medicine sites on the Internet are on the WWW. As explained above, anyone with access to a telnet client can reach these and other WWW sites through programs such as lynx. There are too many nuclear medicine sites to describe in detail in this article, but the more well-known sites will be discussed and others are listed in the Appendix. Some of the better known sites such as LUNIS, the Mallinckrodt Institute and Harvard's Joint Program in Nuclear Medicine, have extensive links to other nuclear medicine sites and serve as a good starting point to locate other resources.

The Society of Nuclear Medicine

The Society of Nuclear Medicine has a Web site at http://www.snm.org. This site is primarily concerned with information about the society and its functions. Included on its home page are links to documents describing the organization, membership and publications of the society along with some ancillary material such as a calendar of nuclear medicine meetings. Figure 4 shows a portion of the home page.

Teaching Material

There are two major sites on the Internet dedicated to nuclear medicine teaching files. One of these sites is the Joint Program in Nuclear Medicine located at http://www.med.harvard.edu/JPNM that is largely the work of J. Anthony Parker, at the Beth Israel Hospital, Boston, Massachusetts.

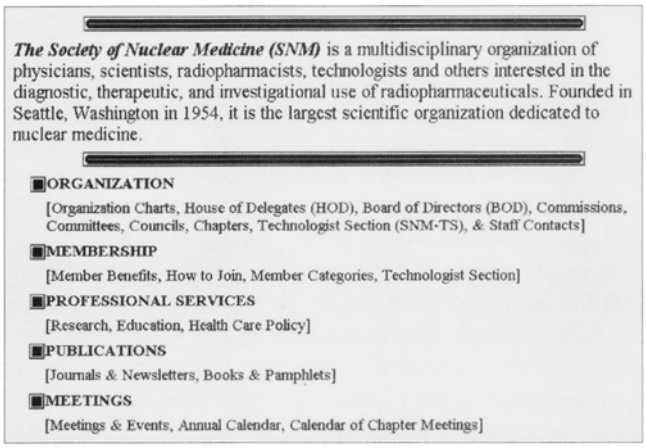

FIGURE 4. A portion of the Society of Nuclear Medicine's home page.

FIGURE 5. The top of the home page of the Nuclear Medicine Digital Teaching File by Jerold Wallis at the Mallinckrodt Institute of Radiology, St. Louis, Mo.

This site has a large collection of nuclear medicine and other radiological images organized into teaching files. These cases can be accessed as interesting images or as unknowns. Other materials available at this site include Web pages on pediatric nuclear medicine, medical physics and physical characteristics of nuclear medicine images. The rest of the home page is dedicated to extensive cross-references to other WWW nuclear medicine and radiology sites.

The other site with extensive nuclear medicine teaching material is the Mallinckrodt Institute of Radiology at Washington University Medical Center in St. Louis, Missouri created by Jerold Wallis (http://gamma.wustl.edu). The main feature at this site is the Nuclear Medicine Digital Teaching File. A user can choose from a list of cases to view images and discussions pertinent to the cases. There are links for adding comments to a case and a user can view other user's comments on the case. Figure 5 shows a portion of the Digital Teaching File home page. A fairly thorough discussion of this and other teaching files was recently published (*3,4*). The other important resource at this site is the Computer and Instrumentation Council page, http://gamma.wustl.edu/caic.html, that contains council newsletters, bylaws and a syllabus of the "The Nuclear Medicine Information Superhighway," a program about nuclear medicine and the Internet presented at the 1995 midwinter meeting of the Society Nuclear Medicine.

LUNIS

LUNIS is a nuclear medicine bulletin board service at Loyola University at Chicago run by James Halama (*5*). LUNIS can be reached by modem through a regular dialup (non-Internet) connection, telnet or the WWW. LUNIS has an active bulletin board where users can post messages, ask questions or browse through a library of nuclear medicine images that can be downloaded. A login and password are required to access the bulletin board service, but general information about LUNIS can be obtained at http://www.lunis.luc.edu. For information on obtaining access to LUNIS, send email to James Halama at jhalama@lunis.luc.edu. Instructions for joining LUNIS are also available on its home page http://wwwd.lunis.luc.edu/lunis. There are separate areas for announcements, email (each user gets an email address), conferences, job postings and forums of special interest. A Web page at this site describes the American College of Nuclear Physicians, its activities and the programs it sponsors. The latter includes the Proficiency Testing Program. Nuclear medicine departments that subscribe to this program receive phantoms twice a year for assessment of practice efficiency. Results from this program can be used to satisfy some FDA, JCAHO and NRC requirements.

Nuclear Regulatory Commission

One WWW site that all nuclear medicine practitioners should be aware of is the home page for the Nuclear Regulatory Commission on the WWW at http://www.nrc.gov. New regulations are announced here as well as general information for the nuclear medicine community. A hyperlink is available for sending email to the NRC.

The Nuclear Medicine Browser

The Nuclear Medicine Browser is an extensively cross-referenced site of nuclear medicine resources at the Dr. Dan. den Hoed Cancer Centre, Rotterdam, the Netherlands (http://www.xs4all.nl/~dschonf). This site is maintained by D.H.W. Schonfeld and has links to all the other major nuclear medicine sites. There are lists of PET facilities, cancer related sites, radiation and health physics topics, and links to USENET newsgroups related to nuclear medicine.

Mailing Lists

There are several mailing lists that have rather well-defined areas of interest. Anyone who can send and receive email can join these lists. To subscribe or unsubscribe to these lists, messages are sent to an administrative address. Messages to the members on the list are sent to another address where a mailing list manager (see Part 3) distributes the messages to all members on the list. Instructions for subscribing and posting information to the mailing lists below are given in the Appendix. To get general information about a mailing list, a user sends a message to the administrative address with the single

word "help" (without the quotes). No subject is necessary, although an arbitrary subject can be entered if required by the user's mail program.

The nucmed mailing list at the University of Western Ontario is oriented toward nuclear medicine physics and instrumentation. Another mailing list is the PET list at Bowman Gray in North Carolina that is devoted to a discussion of positron emission tomography. DOSENET, a mailing list about radiation dosimetry, is run by James B. Stubbins at the Radiation Dose Information Center, Oak Ridge Institute for Science and Education, Oak Ridge, Tennessee.

Commercial Sites

There are several commercial organizations directly related to nuclear medicine on the WWW. The main sites are Picker, Mallinckrodt Medical, Inc., ADAC Laboratories and Toshiba. General Electric, Sopha and Siemens are less extensive, but have some relevant material on the WWW.

Picker (http://www.picker.com) has separate Web pages describing their line of gamma cameras. A useful discussion is given on DICOM (Digital Imaging Communications in Medicine), a proposed standard for formatting images that would allow the exchange of images between systems from different manufacturers and from different imaging modalities. Mallinckrodt Medical's Web page is located in the Netherlands at http://www.mallinckrodt.nl/nuclear. There are updates on its products including Octreoscan and Re-186 HEDP, a bone-seeking beta emitter that is being developed for the treatment of painful bony metastases. Toshiba has an extensive amount of material on nuclear medicine. A search function on the home page (http://www.toshiba.com) allows a user to find material related to nuclear medicine (search term: nuclear medicine). An example of some of the material at this site are Web pages on attenuation and scatter correction in SPECT imaging and the use of 511 keV collimators for SPECT imaging with PET radiopharmaceuticals.

Other Nuclear Medicine Resources

The State University of New York at Buffalo, Department of Nuclear Medicine has a Web page at http://www.nucmed.buffalo.edu. There is a link on the home page to a document describing their nuclear medicine technology program. Another document at this site, http://www.nucmed.buffalo.edu/petctrs.htm, is a list of about two dozen PET centers with links to these centers. A useful link is to the PET center at UCLA that has an online tutorial called "Let's Play Pet" (http://www.nuc.ucla.edu/lpp/lpphome.html). This page and its accompanying links cover all aspects of PET imaging from basic chemistry to clinical PET imaging.

Other nuclear medicine Web sites deal with specific topics in nuclear medicine. A counterpart to the nucmed mailing list at the University of Western Ontario is LARG*net (London and Region Global network) at http://johns.largnet.uwo.ca/nucmed/index.html, general manager Trevor Cradduck. As with the mailing list, most of the topics here deal with physics and instrumentation including computers and networking. There is, for example, an extensive review by Piotr Slomka of gamma cameras and computer systems displayed at the 1995 Society of Nuclear Medicine's annual meeting in Minneapolis, Minnesota. Another useful feature at this site is a calendar of nuclear medicine meetings and events (ftp://ftp.largnet.uwo.ca/pub/nucmed/calendar.nucmed).

There are several sites around the Internet where individuals can submit resumes and CVs and search for jobs. One such site is STACKRAY: Medical Radiography Home Page (http://web.wn.net/user1/ricter/web/medradhome.html). In the Employment Opportunities section on the home page is a link to America's Job Bank (http://www.ajb.dni.us) where a search can be performed on the Job Search menu. To find nuclear medicine related positions, a user chooses the Search Nationwide link to the Self Directed link (http://www.ajb.dni.us/job.search/job.search.html) and follows a series of Web pages that present menus with various choices. The menu items to choose on successive pages are: (a) professional, paraprofessional and technical; (b) health practitioners, technologists, technicians and related health; and (c) other health professional, paraprofessional and technical. The list that is returned from the last Web page has specific categories for nuclear medicine and radiology technologist positions.

RADIOLOGY SITES

There are more sites on the WWW dedicated to radiology than to nuclear medicine. Some of these sites have material pertaining to nuclear medicine. One of the best-known radiology teaching files on the WWW is at the University of Washington (http://www.rad.washington.edu) created and maintained by Michael L. Richardson. The teaching material at this site is indexed by anatomic area, organ systems and pathologic diagnosis. Teaching cases are weighted toward musculoskeletal radiology, trauma and sports medicine. Other interesting features at this site are anatomy teaching modules, online textbooks and an image analysis program, called Dr. Razz written by Thurman Gillespy III. As with several other Web sites with teaching files, CME credits can be earned by viewing files and answering self-assessment questions.

The Radiological Society of North America (RSNA) has a Web site at http://www.rsna.org. This site has an extensive amount of material related to radiology that can be accessed through a hyperlinked index (http://www.rsna.org/outline.html) or through a search program (http://www.rsna.org/edu/internet/launchpad.html). The server has a list of radiology Web sites that can be used as a starting point for locating other radiology sites on the Internet.

Another site with extensive listing of radiology resources is the Department of Radiology, Hershey Medical Center, Penn State University. The URL for this site is http://www.xray.hmc.psu.edu. There are useful subcategorizations of radiology sites that facilitate finding resources. Some other radiology Web sites are listed in the Appendix.

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APPENDIX

This listing of resources is current to January 1996. The reader should be aware that information changes rapidly on the Internet and file names, paths to files or site names can change or become unavailable. If a user has trouble locating a file at a given site, accessing the site's home page or main menu by entering the access method and computer name alone may allow a user to find information about the file.

Public Text-Oriented WWW Browsers Reachable by Telnet

Site	Login	Location
sunsite.unc.edu	lynx	University of North Carolina
info.cs.yale.edu	none	Yale University
pubinfo.ucsd.edu	infopath	University of California, San Diego

World Wide Web Search Programs

Yahoo http://www.yahoo.com
Lycos WWW search engine http://www.lycos.com
Open Text http://www.opentext.com:8080
The Web Crawler http://webcrawler.com
Infoseek http://www.infoseek.com
The MetaCrawler http://metacrawler.cs.washington.edu:8080
Netlink
Telnet: liberty.uc.wlu.edu; login: lawlib; password:lawlib
gopher: netlink.wlu.edu 1020
WWW: http://netlink.wlu.edu:1020

Catalogs of WWW Searching Tools

CERN–European Laboratory for Particle Physics
http://cuiwww.unige.ch/meta-index.html
EINet Galaxy http://galaxy.einet.net/search.html
National Center for Supercomputing Applications
http://www.ncsa.uiuc.edu/SDG/Software/Mosaic/MetaIndex.html

Medical Information and Resources

National Institutes of Health (NIH)

Gopher access

gopher.nih.gov	Main NIH gopher
gopher.niaid.nih.gov	National Institute of Allergy and Infectious disease
gopher.nlm.nih.gov	National Library of Medicine

World Wide Web access

http://www.nlm.nih.gov	National Library of Medicine
http://www.nih.gov	Main NIH WWW entry point

Medical Sites

The following sites have extensive links to general medical resources:

Global Network Navigator–Medical table of health resources
http://gnn.com/wic/wics/med.new.html
University of California at San Francisco
gopher://itsa.ucsf.edu–Choose the "Bio and Medical Gophers and Info. Sites" item from the main menu
World Health Organization
http://www.who.ch
Hospital Net
http://dem0nmac.mgh.harvard.edu/hospitalweb.html
Oncolink, University of Pennsylvania
http://cancer.med.upenn.edu
The Virtual Hospital, University of Iowa
http://indy.radiology.uiowa.edu
The American Medical Association http://www.ama-assn.org

Nuclear Medicine Resources

The Society of Nuclear Medicine http://www.snm.org

Teaching Files

Joint Program in Nuclear Medicine, Beth Israel Hospital, Boston, MA
http://www.med.harvard.edu/JPNM
Mallinckrodt Institute of Radiology, Washington University Medical Center, St. Louis, MO
http://gamma.wustl.edu
http://gamma.wustl.edu/caic.html–Computer and Instrumentation Council home page.

The Nuclear Medicine Browser

The Nuclear Medicine Browser, Rotterdam, the Netherlands
http://www.xs4all.nl/~dschonf

Oak Ridge National Laboratory

http://www.ornl.gov
http://www.ornl.gov/library/index.html–Main information index

Mailing Lists

When sending a message to each of the mailing lists below, do not include the quotation marks. To unsubscribe to a list, send a message to the same address as for subscribing, and replace "subscribe" with "unsubscribe". No other text except that shown in quotes should be in the body of the message.

DOSENET
administrative address: mailserv@orau.gov
mailing list: DOSE-NET@orau.gov
To subscribe, send email to mailserv@orau.gov with message "subscribe DOSE-NET".

NUCMED
administrative address: listserv@largnet.uwo.ca
mailing list: nucmed@largnet.uwo.ca
To subscribe, send email to listserv@largnet.uwo.ca with message "subscribe nucmed ⟨user's name⟩" where ⟨user's name⟩ is the user's first and last name.

PET MAIL
administrative address:
pet_mail-REQUEST@ncbapsun2.pet.wfu.edu
mailing list: pet_mail@ncbapsun2.pet.wfu.edu

To subscribe, send email to pet_mail@ncbapsun2.pet.wfu.edu with message "subscribe".

Miscellaneous Nuclear Medicine Sites and Resources

American College of Nuclear Physicians (ACNP)
http://www.lunis.luc.edu/acnp/acnp.html

New York University Medical Center, Department of Radiology, Division of Nuclear Medicine
http://nucmed.nyu.edu

University of British Columbia, Division of Nuclear Medicine,
http://www.triumf.ca/ubcnucmed/default.html

Nuclear Regulatory Commission http://www.nrc.gov

State University of New York, Health Science Center, Syracuse Nuclear Medicine Technology Training Program
http://www.hscsyr.edu/~hellwigb/nucs.html

Commercial Organizations

Picker http::/www.picker.com

Mallinckrodt Medical http://www.mallinckrodt.nl/nuclear

Toshiba http://www.toshiba.com

ADAC http://www.pi.net/~adacbv

General Electric http://www.ge.com

Siemens Gammasonics http://scendtek.com/smi

Park Medical Systems
http://www.parkmed.com–A company specializing in gamma cameras.

Radiation and Health Physics

University of Michigan http://www.umich.edu/~bbusby

GI Nuclear Medicine

http://indy.radiology.uiowa.edu/Providers/Textbooks/nucs/ElectricGiNucs/GiNucs.html

PET Centers

Paul Scherrer Institute PET Program, Switzerland
http://pss023.psi.ch
http://pss023.psi.ch/paul/pet-centers.html–A list of links to over two dozen PET centers.

Veterans Affairs Medical Center, PET imaging service, Minneapolis, MN
http://pet.med.va.gov:8080

UCLA Pharmacology Web page
http://www.nuc.ucla.edu
http://www.nuc.ucla.edu/lpp/lpphome.html—Let's Play Pet

Job Opportunities

America's Job Bank http://www.ajb.dni.us

MedSearch America http://www.medsearch.com

Selected Radiology Resources

Department of Radiology, Brigham and Women's Hospital, Harvard Medical School
http://www.med.harvard.edu/BWHRad/
http://www.med.harvard.edu/AANLIB/home.html—The Whole Brain Atlas

University of North Carolina Radiology Web Site
http://sunsite.unc.edu/jksmith/UNC-Radiology-Webserver/UNCRadTeachingFile.html–Contains a short section on nuclear medicine

Northwestern University Department of Radiology
http://pubweb.acns.nwu.edu/~dbk675/netsites.html–One of the most complete lists of radiology related Web sites on the Internet.

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