

Internet in Nuclear Medicine

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INTRODUCTION

Recently, the Internet has been widely used in nuclear medicine. Development of the Internet has brought a new communication tool for us. With this tool, we can easily and quickly exchange a large amount of information, regardless time and distance. The Internet is anticipated to have a great impact on clinical practice, education and research in nuclear medicine.

In this paper, we, first, describe the outline and function of the Internet, and then introduce its applications in the various fields of nuclear medicine.

OVERVIEW OF THE INTERNET¹⁻³

The Internet is a world-wide network of computer networks that communicate with each other using the Transmission Control Protocol/Internet Protocol (TCP/IP). It has the following functions: electronic mail, electronic news, file transfer protocol, remote login, and hypertext transfer protocol (World-Wide Web).

1. Electronic Mail

Electronic mail (e-mail) provides a private communication between individuals. The basic concepts behind e-mail parallel those of regular or snail mail. You send mail to people at their particular addresses. In turn, they write to you at your e-mail address.

For example, "ysuzuki@is.icc.u-tokai.ac.jp" is the e-mail address of one of the authors. The e-mail address is generally composed by user name (ysuzuki), machine name (is) and domain name (icc.u-tokai.ac.jp). Mail messages are composed of two portions: the header and body.

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The header lists information about the sender of the message, the recipient, the posting date of the message, and a subject field. The body holds the text of the message itself, usually in ASCII format. The advantages of e-mail are that it provides very rapid communication; of the order of seconds to hour to reach the destination. It allows to send large volume of data such as source code. The confidence of the mail can not always be warranted, but is much better than those of other communication methods.

Via e-mail we can also send a message to groups of individuals. In this case, the mail first sends to the computer, called "listserv," or "mailing lists" and then it is distributed to large number of individuals on the list. With this system individuals on the list can exchange opinions with each other on the particular topics. The advantages of mailing lists are that they provide for sharing of information to large groups of individuals and facilitate the online discussion of topics of interest.

2. Electronic News

Electronic news is different from news on other media, in which news runs in one way direction from the media to individuals. In electronic news, information runs interactively among the individuals who are interested in that information. Electronic news is divided into newsgroups, which covers specific areas of interest. There are a large number of newsgroups in the world. The news groups are arranged in a hierarchical or tree fashion, with each root of the tree devoted to a major topic (Fig. 1). Like a tree, each of these roots has many branches, with each branch further defining subject area. There are many programs that can be used to read news and upload a news into the newsgroups.

3. File Transfer Protocol

The file transfer protocol (FTP) makes it possible to move a file from one computer to another, even if each computer has a different operating system and file storage format.

Files may be data, programs, and texts; anything that can be stored. Users are required to log in to each computer and to have permission to access the files you wish

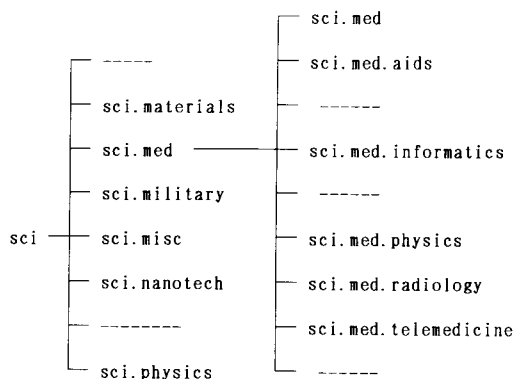


Fig. 1 Arrangement of newsgroups.

to retrieve or transfer. File transfer across the Internet is reliable because the machines involved can communicate directly, without relying on intermediate machines to make copies of the file along the way. With using FTP, large files can be transferred in short time.

Several hosts provide the username anonymous for ftp retrieval of files from their system. This service called "anonymous FTP." The hosts that allow anonymous login do so by establishing a special anonymous login account, which works only with FTP, and can not be accessed for general use of that host. The anonymous account is a special one with access limited to the FTP archives offered by that host. In anonymous FTP, the login name for remote host will always be anonymous. The remote FTP program will often request the user's e-mail address as the password.

4. Remote Login

In remote login, the Telnet protocol is used. This protocol allows an Internet user to log in to a remote host from his or her local host. Once connected and logged in to the remote host, a user can do any operation just as if he or she were logged in directly to the remote host. Every keystroke on the user's local computer is sent directly to the remote system. Telnet is a powerful tool in resource sharing. Telnet protocol some times require that you arrange for access in advance. Such arrangements usually include the assignment of an account name and password on the remote host.

5. World-Wide-Web

World-Wide-Web (WWW) is constructed by the following three components; Uniform Resource Locator (URL), Hypertext Markup Language (HTML) and Hypertext Transfer Protocol (HTTP).

1) URL

An URL is basically an expression of specifying the location of resources on the Internet.

URLs can be used to describe just about any kind of connection on the Internet, including WWW, FTP, and e-mail, as shown in the following examples:

Table 1 Applications of the Internet in the Nuclear Medicine Community

1. Open forums for discussion.
2. Construction of teaching files.
3. Construction of data base of nuclear medicine.
4. Exchange of the information between the academic organization and its members.
5. Provided by the companies related to nuclear medicine.

<http://mfs.med.u-tokai.ac.jp>

ftp://mfs.med.u-tokai.ac.jp/pub_jpns/workshop/README

2) HTML

HTML is language to describe hypertext or tag documents for electronic format and structural uses. The fundamental concept behind hypertext is that information can be stored and retrieved in a nonhierarchical structure. So instead of moving through directories of information, you can jump from one place to the next through a series of links created by some one. The hypermedia is the extended concept of the hypertext which includes images, movies and sounds.

3) HTTP

HTTP is the description how to transfer the documents described by HTML between a computer to a computer. An access to a WWW usually can be done on user's personal computer by using a software, termed a "browser." Netscape Navigator and Internet Explorer are the commonly used browsers. Running on the client's computer, the browsers retrieve HTML documents from the server and interpret markup commands embedded in the documents. The interpretation and execution of these markup commands result in the display of the documents. The user browses or navigates through hypermedia screens containing links to information located around the world. The user does not have to be concerned with the network address or geographical locations. With the browser, navigation is entirely accomplished through mouse clicks.

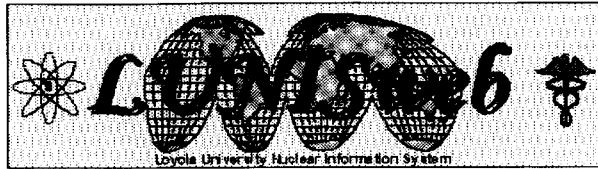
Recently the functions of the browsers have been greatly expanded and e-mail, FTP, and electronic news can be handled on WWW by the browsers.

INTERNET IN NUCLEAR MEDICINE⁴⁻¹³

The applications of the Internet in nuclear medicine, can be divided in two categories: one is use in nuclear medicine community and the other is use for communication with outside of the nuclear medicine community. In this section, these two applications will be described separately.

1. Use in Nuclear Medicine Community

In nuclear medicine community, 5 different applications can be mentioned as shown in the Table 1.



LUNISweb is an electronic information service provided by the Section on Nuclear Medicine, Department of Radiology, Loyola University Chicago, and is designed for exchange of information among medical professionals that have an expressed interest in Nuclear Medicine.

[[Top of WWW Server](#)]

Information Services

- [LUNIS eXchange](#) offers various bulletin boards for interactive exchanges among registered users. Username and password is required. Send email to ihalama@lunis.luc.edu for more information on access.
- [Telnet](#) offers access to a LUNIS BBS terminal session.
 - ★ **Registered Users of LUNIS!** Use Telnet to get your password to the LUNIS Exchange Home Page. Your password will be activated within 5 minutes.
- [Public Access Image Case Library](#)
- SNM 1996 Internet Tutorial Program - [[Introduction to the Internet](#)] [[Publishing on the World Wide Web](#)]
- [HBBX Master Index](#) of many other bulletin boards.

LUNIS Contributors & Supporters

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Fig. 2 Home page of the LUNISweb.

Welcome to Tokai University School of Medicine Biomedical Engineering

Click [here](#) in Japanese

(Since December, 1994. Last updated: Nov. 1, 1996)



The School of Medicine is located in [Isehara](#), Kanagawa, JAPAN.

The Founder of the Tokai University: [Dr. Shigeyoshi Matsumae \(1901-1991\)](#)

- [Welcome to Tokai University School of Medicine](#)
- [Radiology and Allied Practice](#)
- [Nephrology and Metabolism](#)
- [Psychiatry and Behavioral Science](#)
- [Thoracic Surgery\(in Japanese\)](#)
- [Pediatric Surgery](#)
- [Plastic Surgery](#)
- [Clinical Examination and Pharmaceutics](#)
- [Malaria \(in Japanese\)](#)
- [Guide to the Internet: An Interactive Workshop \(in Japanese\)](#)
- [The Tokai Medical Association](#)
- [Medical Students' Plaza](#)
- [Medical Doctors for Out Patients at the Tokai University Hospital \(in Japanese\) \(Last updated: Nov. 1, 1996\)](#)
- [WWW servers related to the medical fields](#)
- [Other WWW Servers](#)

We also have [Anonymous FTP server](#) and [Anonymous FTP server \(in Japanese\)](#).

Fig. 3 Home page of Biomedical Engineering, Tokai University Medical School.

1) Forums for discussion
For establishing forums, mailing lists, WWW and newsgroups are now used. One of the most active listserv in nuclear medicine is "nucmed@largnet.uwo.

ca" which has been established by Prof. Craddock TD in the Department of Nuclear Medicine, University of West Ontario, London Ontario Canada. In this server, the topics about basic aspects of nuclear medicine are

Weight loss and gastric abnormalities: A 73-year-old male

A 73-year-old man was admitted to a hospital because of gastric tumor. He had vague discomfort in the epigastrium 6 months before admission. He lost his appetite and had a weight loss of 5kg during past 6 months. He had a upper GI series elsewhere and a submucosal gastric tumor was suspected. He was transferred to the hospital for further examination.

On physical examination the patient appeared chronically ill. No lymphadenopathy was found. Epigastric tenderness was found, but mass was not palpable, and liver and spleen were not enlarged.

Laboratory data on admission were as following: WBC 10,800/microl, Hb 16.2g/dl, platelet count 250,000/microl, total protein 5.8g/dl, albumin 3.4g/dl, GOT 21U/l, GPT 12U/l and LDH 557U/l.

An upper GI series, and ultrasound and CT of the upper abdomen were obtained. Whole body images with Ga-67 citrate and Tc-99m methylene diphosphonate were carried out. A radiograph of the right femur was obtained

What is your diagnosis?

Fig. 4 a: Brief history, and clinical and laboratory data of the case uploaded.

Whole body image with Ga-67 citrate

Anterior and posterior whole body images were obtained 72 hours after injection of 111MBq of Ga-67 citrate. The anterior image reveals a large localized hot area in the epigastrium corresponding to the stomach. Lung activity is diffusely increased with several localized hot spots, corresponded to the abnormal shadows on the chest radiograph. There is an area of mildly increased activity in the right inguinal region. Colonic activity is a normal finding.

The posterior image shows an intense hot area in the left upper abdomen. Three hot spots are demonstrated in the right lung.

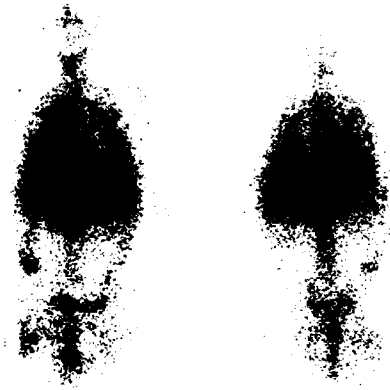


Fig. 4 b: Images and description along them.

mainly discussed. A mailing list for individuals interested in PET nuclear medicine has been established and managed by Beth A Harkness, MS at the Department of Radiology, Bowman Gray School of Medicine, Winston Salem, North Carolina, USA. This mailing list covers broad aspects of the PET nuclear medicine such as basic technology and reimbursement policy.

There is a very active bulletin board, called LUNIS (Loyola University Nuclear Medicine Information Service) in the division of Nuclear Medicine, Department

of Radiology, Loyola University Medical School, Chicago Illinois, USA (Fig. 2). You can access to LUNIS via telnet or WWW (URL: <http://wwwd.lunis.luc.edu:80/lunis/>), but you have to get permission in advance to participate in the discussion.

There is no newsgroup dedicated solely to nuclear medicine, but you will find many interesting topics in the following newsgroups; sci.med.informatics, sci.med.physics, sci.med.radiology, and sci.med.telemedicine.

Diagnosis: Adult T-cell lymphoma

Gastric mucosal biopsy was carried out, and histological and histochemical diagnosis was non Hodgkin lymphoma; medium size and diffuse T-cell type. Serum anti HTLV-I antibody was demonstrated.

Comments

Adult T-cell lymphoma(ATL) is etiologically linked to the human T-cell lymphotropic virus type I(HTLV-I). HTLV-I, a retrovirus, is endemic in southern Japan and Caribbean basin. ATL occurs less than 5% of people with HTLV-I with average latency period of more than 30 years. ATL cells frequently infiltrate the GI tract. ATL is poor in prognosis and resistant to the chemotherapy. It has a tendency to involve skeletal system.

Ga-67 citrate has strong affinity to the ATL, so whole body image with Ga-67 citrate is useful for evaluating the distribution of the disease and the therapeutic effect. Bone scan is highly sensitive in detection of the skeletal involvement.

Fig. 4 c: Diagnosis of the case and brief comments about it.

Table 2 Teaching Files on WWW Sites

1. Tokai Univ. Medical School (http://mfs.med.u-tokai.ac.jp)
2. Harvard Univ. Medical School (http://www.med.harvard.edu/radiology/JPNM/TF.html)
3. Washington Univ. Medical School (http://www.gamma.wustl.edu/home.html)
4. New York Univ. Buffalo (http://www.nucmed.buffalo.edu)

Table 3 Data Base on WWW Sites

1. SNM Computer & Instrumentation Council (http://gamma.wustl.edu/tf/caic.html)
2. Univ. West Ontario, Nuc. Med. (http://johns.largnet.uwo.ca/numed.index.html)
3. Harvard Univ. Radiology (http://www.med.harvard.edu/JPNM)
4. Univ. Texas Health Science Center (http://nuc-med-read.uthscsa.edu)
5. Iowa Univ. Radiology (http://vh.radiology.uiowa.edu)

2) Teaching files

There are many WWW sites uploading nuclear medicine teaching files. Some sites are sampled in the Table 2. Figure 3 shows the English version of our home page at the Department of Biomedical Engineering, Tokai University Medical School. We have uploaded 25 cases in which nuclear medicine is useful for the diagnosis and elucidating the pathophysiology. Our teaching files are constructed of 3 components; brief clinical history and data, images, and diagnosis and comments (Fig. 4).

The WWW-based teaching files have several advantages over the film-based ones: 1, Network access

Table 4 Home Pages of the Academic Organizations

1. Society of Nuclear Medicine (http://www.snm.org)
2. SNM Computer & Instrumentation Council (http://gamma.wustl.edu/tf/caic.html)
3. British Nuclear Medicine Society (http://www.bnms.org.uk/bnms)
4. RSNA (http://www.rsna.org)
5. Institute for Clinical PET (http://www.icppet.org)
6. Spanish Nuclear Medicine Society (http://www.semm.es)

permits use at multiple sites, both within an institution and cross multiple institutions. 2, The space for keeping teaching files can be saved. 3, Loss of teaching file cases due misfiling of films is prevented, and rearrangement of files is easily carried out. 4, Because of the small size of nuclear medicine images and ready access to the imaging data in digital form, nuclear medicine is particularly well suited for creating a digital teaching file. 5, Incorporation of best cases from multiple institutions enhances the quality of teaching files. Development of teaching file material is time-consuming. By being able to link to materials developed at other institutions, the final product is multiplied number of collaborators. Each institution can invest a moderate effort but the endproduct can be very impressive.

3) Data base of nuclear medicine

When you want to get the information related to the basic science of nuclear medicine, nuclear medicine procedures and softwares, you can find the specific information on the many WWW sites. Some such sites are tabulated in the Table 3. For example, if you access to the Texas Health Science Center, there are many

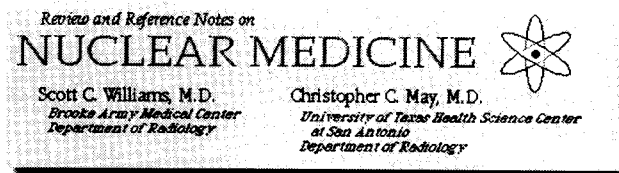


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<u>Central Nervous System</u> Marc G. Cote, D.O., F.A.C.F. Robert Ward, M.D.	<u>Endocrine:</u> Thyroid & Parathyroid Ralph Blumhardt, M.D., F.A.C.R. Chief, Division of Nuclear Medicine U.T. Health Science Center at San Antonio Harry L. Uy, M.D. Department of Internal Medicine, Division of Endocrinology U.T. Health Science Center at San Antonio
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<u>Tumor Imaging</u> John Bauman, M.D.	<u>Radioscintigraphic Assay and Volumetry</u> John Miliziano, M.D.

Fig. 5 Table of contents of the review and reference notes on nuclear medicine uploaded on the web site at University of Health Science Center at San Antonio.

Table 5 Home Pages of the Companies Related to Nuclear Medicine

1. Toshiba U.S.A.
(<http://www.toshiba.com:80/rproducts/home/home.html>)
2. Siemens
(<http://www.siemens.com/nmg>)
3. ADAC
(<http://www.adaclabs.com>)
4. Picker
(<http://www.picker.com/picker-Home.html>)
5. Mallinckrodt
(<http://www.mallinckrodt.nl/nuclear>)

useful review manuals covering the entire field of nuclear medicine (Fig. 5).

4) Home pages of the academic organizations
Now many academic organizations in nuclear medicine and related fields have their own home pages (Table 4). These home pages contribute to enhancement of communications between the organization and its members, and among the members. Each home page is expected to be useful for promotion of nuclear medicine toward the outside of the nuclear medicine community.

5) Home pages of the companies related to nuclear medicine

In the Table 5, a couple of the homepages of the companies related to nuclear medicine are listed. These home pages give us useful information about the products of each company.

2. Use for Communication with Outsides of Nuclear Medicine Community

Using the Internet, we can send a messages to the professionals in medicine as well as to lay person. WWW is a very powerful method for this purpose. As for the professionals in medicine, we can teach them the indications, contraindications, advantages and disadvantages of each study, and have a discussion about the specific case with them. Uploading the study protocol will be convenient to all professionals in medicine. Introduction of new method and new developed indications of the old methods to the doctors in other specialties are our important duties. WWW is suitable for all of these purposes.

The big problem in nuclear medicine is that we nuclear physicians play a great role in clinical practice, but lay person does not know anything about nuclear medicine, our role in medicine and its benefit to them. We always have to continue sending clear messages to them.

In the home pages of the Society of Nuclear Medicine,

there are messages to lay person. Here people can learn many things about nuclear medicine from its history to characteristics. They can get information about radiation dose of each examination in nuclear medicine compared with the other modalities. The home page of Mallinckrodt has also useful documents for lay person. They can get general information about nuclear medicine and also how to do each examination. They can get knowledge of nuclear medicine procedures in comparison with other method.

CONCLUSION

The internet has various functions which are very useful for the clinicians and scientists in nuclear medicine. With the Internet we can exchange opinions very conveniently and transfer any type of information very quickly, regardless time and distance. The Internet will greatly contribute to promote the international collaboration among the personnel in nuclear medicine.

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