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TELEMEDICINE APPLICATIONS IN PEDIATRIC CARDIOLOGY

By Craig Sable, MD

Utilization of telemedicine has increased significantly over the last five years and telecardiology is growing faster than any other field in telemedicine. Access to teleechocardiography, the primary form of telecardiology, can provide crucial information in the management of patients with suspected or known heart disease. In community hospitals without immediate access to pediatric cardiologists, echocardiograms may be performed by sonographers with limited pediatric experience and sent by mail or courier to pediatric cardiologists for interpretation. This practice can result in suboptimal echocardiogram quality, delay in initiation of medical intervention, unnecessary patient transport, and increased medical expenditures. This article will review telemedicine technology, clinical applications of telecardiology, and obstacles to widespread acceptance of telemedicine.

The two primary types of telemedicine are "store and forward" and "real-time". A technician or physician at one site acquires and stores data on a telemedicine computer and transmits the data over a telemedicine connection to a similar computer at a remote site for later review in a "store and forward" model. The file at the receiving site is identical to the sending site. Alternatively, both sender and receiver can view telemedicine data simultaneously through live or "real-time" videoconferencing. The advantages and disadvantages of both modalities are depicted in Table 1. Adult cardiology lends itself to a "store and forward" model. "Real-time" telemedicine may be more appropriate

	Real Time	Store and Forward
Live Interaction: sonographer feedback and physician/family interaction	Yes	No
Cost	Inexpensive $8,000 - $25,000 per site	Moderately expensive $20,000 - $100,000 per site
Image Quality	Acceptable/diagnostic	Optimal (equivalent to sending end)
Hard copy at receiving end	No	Yes
Required bandwidth	At least 384 Kbps: For acceptable frame rate	No minimum: Higher bandwidth ——> decreased transmission time
Reliance on intelligent compression	No	Yes
Electronic compression algorithm	H.320 or H.323 videoconferencing	Lossless, JPEG, or MPEG
Time commitment by physician at receiving end	Availability at time of transmission required	Can review study any time
Limited by location at sending site	Yes	No
Most common application	Pediatric/neonatal cardiology	Adult cardiology

Table 1. Comparison of Real Time and Store and Forward Modalities in TeleEchocardiography

	Bandwidth	Costs	Availability
POTS **Plain Old Telephone Systems**	14.4 Kbps	Low	Universal
ISDN **Integrated Service Digital Network**	128 Kbps (3 lines commonly bonded)	Low	Wide
T1 **Terrestrial 1**	1.54 Mbps	Low to Moderate	Wide
SDSL/ADSL Synchronous/ Asynchronous Digital Subscriber Lines	Variable 128 Kbps to 1 Mbps	Low	Variable Increasing
ATM **Asynchronous Transfer Mode**	Very high	High	Variable
Satellite	Very high	High	
Internet	Variable	Low	Universal Software/ bandwidth/ security limitations
Wireless	Low	Unknown	Limited/Increasing

Table 2. Telemedicine Bandwidth Options

for pediatric cardiology when inexperienced sonographers are asked to study neonates with suspected congenital heart disease.

Any telemedicine network consists of three basic components: the telemedicine computers themselves, telemedicine inputs, and some type of connection (often high bandwidth telephone lines) between the sending and receiving site. Coordination between computer hardware and software manufacturers, local and long distance telephone companies, and echocardiography machine vendors is necessary to ensure that these components function together.

"Utilization of telemedicine has increased significantly over the last five years and telecardiology is growing faster than any other field in telemedicine."

Several inputs can be attached to a telemedicine computer. The most basic systems consist of a video camera and microphone that transmits the audio and video data simultaneously in a "real-time" videoconference. The S-Video and RGB-Video outputs of a echocardiography unit can easily be connected into the telemedicine system with the only additional cost being the cable (under $10) required for the connection. This makes echocardiography and ultrasound ideal choices for telemedicine. Other telemedicine inputs on the market include radiology scanners, distance learning devices, high quality dermatology video cameras, stethoscopes, endoscopes, ophthalmoscopes, and otoscopes.

Many options for bandwidth connectivity are commercially available (Table 2). The speed of a connection (bandwidth) will impact the speed of transmission when utilizing store and forward telemedicine. A "store and forward" file may take hours to go over a low-speed connection and seconds to go over a high-speed connection. The bandwidth of a telemedicine connection impacts the quality of live videoconferencing through its interaction with frame rate (number of frames or images sent each second). Bandwidths of 384 Kbps and higher provide acceptable frame rates (20 – 30/second) for live videoconferencing and has been shown to be diagnostic for teleechocardiography.

"Over 2000 studies have been performed from eight hospitals since our telemedicine program began in 1998."

The earliest clinical publications on utilization of telecardiology were reported in pediatric populations in 1989 and 1993.(1) Several studies have convincingly shown that live transmission of neonatal echocardiograms is accurate, impacts patient management including transport of critically ill children with heart disease, prevents unnecessary transport of patients without heart disease, is cost-effective, does not increase utilization of echocardiography, and reduces the length of hospital stay.(2-5) Live transmission of fetal echocardiograms has also been shown to be diagnostic at bandwidths of 384 Kbps.(6) Use of "store and forward" telemedicine for emergency echocardiography consultation during

	Telemedicine (n = 338)	Control (n = 338)	*p value*
Transported to tertiary care hospital	5% (n = 15)	10% (n = 32)	*0.01*
Total length of stay	1.0 ± 6.8 days Range: 0 – 102 days	2.6 ± 11 days Range: 0 – 96 days	*0.005*

Table 3. American Society of Echocardiography Multicenter Study: Patients with Mild or no Heart Disease

weekend, evening and overnight hours to assess ventricular function, ischemia, pericardial effusions, valvular disease, and heart donor status in adult patients was reported in 1996.

Teleechocardiography has the potential to prevent unnecessary transports, resulting in decreased morbidity and direct financial savings. (2,4) Additional monetary benefits of telemedicine that are more difficult to quantify, include cost savings from prevention of delayed or incorrect management, shorter hospital stays, and avoidance of the financial burden of travel and lost wages on the patient's family.(3) A multicenter study, supported by an American Society of Echocardiography grant (Table 3), found that patients with access to telemedicine were transported less often, had shorter hospital stays, and were less likely to receive unnecessary invasive management than diagnosed-matched control patients. (7)

One of the most important benefits of "real-time" telemedicine is increased echocardiography quality and sonographer proficiency and efficiency, especially when adult sonographers are asked to image children. These interactions add to expertise gained from previous instruction in congenital heart disease. Ultimately, this will improve the quality of studies performed when telemedicine is not available.

In our pediatric telecardiology program at Children's National Medical Center in Washington, DC, we utilize dial-up live videoconferencing over three bonded ISDN lines (384 Kbps). Over 2000 studies have been performed from eight hospitals since our telemedicine program began in 1998 (Figure 1). The average time from request of a study to having a faxed report at the referring site is under 30 minutes.(3) Telemedicine has significantly benefited our pediatric cardiology practice including an average saving of 4.2 person-hours each week from avoidance of unnecessary consultations.(3) The cardiologist also records a digitized version of the study on the telemedicine computer (Figure 2) using MPEG technology that is of diagnostic quality and allows for "bookmarking" of images and offline measurements. We create a report on our telemedicine system that can be transmitted or faxed immediately to the referring physician. These reports and images form a digital medical record and database.

Much of the success of our program is attributable to a close working relationship with our telemedicine vendor (VitelNet; McLean, Virginia). They have provided our telemedicine software and hardware (MedVizor Teleechocardiography) since our program began. VitelNet (www.vitelnet.com) has successfully combined real-time videoconferencing, digital reporting using pediatric cardiology nomenclature, image storage and management, data base integration, prompt technical support, and easy implementation of customized software updates.

Despite the numerous reports of diagnostic accuracy, positive impact on patient care, and cost-effectiveness of telecardiology, there are many obstacles to more routine implementation.

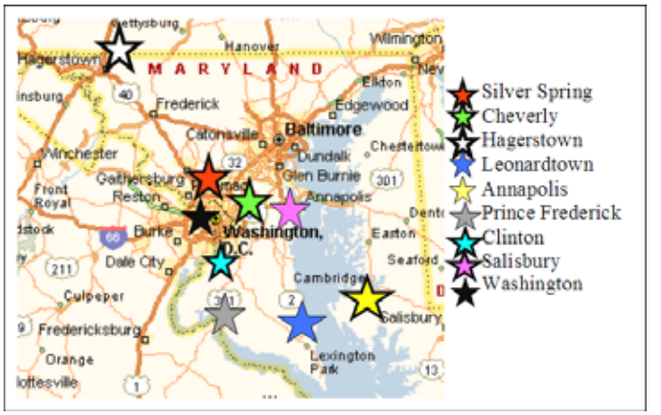

Figure 1. Washington, DC Pediatric Telecardiology Network.

There are many different software, hardware, and telephone line options available, but none are specifically designed for cardiology. When technical problems arise it may be difficult to pinpoint which component is malfunctioning. Primary care providers and specialists may be resistant to acceptance of new technology and practice models. The legal ramifications and licensure requirements of using telemedicine for echocardiography diagnoses are still evolving. Finally, reimbursement for telemedicine consultation is limited in the United States and may discourage many physicians from participating.

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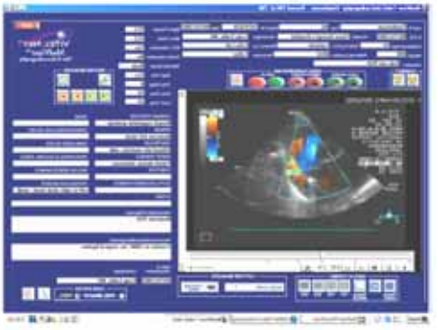

Figure 2. MPEG Digitization and Medical Record Options.

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SELECTED TELECARDIOLOGY LINKS

AMD Telemedicine
www.amdtelemedicine.com/index.cfm

CHILI
http://mbi.dkfz-heidelberg.de/chili/Cardio/

HeartLab
www.heartlab.com

iCardiogram
www.icardiogram.com

Medcon
www.medcon.com

VitelNet
www.vitelnet.com

VMI Medical
www.vmimedical.com

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USEFUL WEBSITES

The Royal Society of Medicine
www.rsm.ac.uk

The Society for the Internet in Medicine
www.internet-in-medicine.org

European Union of Medical Specialists (UEMS) Specialist Section Cardiology
www.uems.be/cardio.htm

United Network for Organ Sharing (UNOS)
www.unos.org

VascularWeb
www.vascularweb.org

American Medical Informatics Association (AMIA)
www.amia.org

The Internet Healthcare Coalition
www.ihealthcoalition.org

The Medical Records Institute
www.medrecinst.com/

Western Society of Pediatric Cardiology
www.wsopc.org

The World Medical Association
www.wma.net/e/

World Heart Federation
www.worldheart.org

The International Network of Agencies for Health Technology Assessment (INAHTA)
www.inahta.org

South African Heart Association
www.saheart.org

NEW GUIDELINES FOR PROPHYLAXIS OF RESPIRATORY SYNCYTIAL VIRUS INFECTION IN INFANTS WITH CONGENITAL HEART DISEASE

By Daniel Bernstein, MD

Respiratory syncytial virus (RSV) infection is the leading cause of hospitalization for children less than one year of age, accounting for over 90,000 hospital discharges annually in the United States and an estimated 2% mortality rate for hospitalized infants. Those infants at highest risk for serious RSV infection include those with premature birth, bronchopulmonary dysplasia or other forms of chronic lung disease, cardiac disease, neuromuscular disease, and immune deficiency. Congenital heart disease represents the second leading co-morbidity responsible for RSV-related hospitalization, second only to bronchopulmonary dysplasia. The risk of RSV hospitalization for children with cardiac disease less than 1 year of age is 92 per 1000, compared to that for infants with chronic lung disease (388 per 1000), and for premature infants (between 57 and 70 per 1000, depending on gestational age). This increased risk persists at least until 12 months, and to a lesser degree up to 24 months of age (1). The mortality rate for congenital heart disease patients hospitalized with RSV infection is considerably higher than for other high-risk patients, reported as high as 3.4%. (2)

Given the difficulty in treating high risk patients once they have developed severe RSV infection, prophylaxis of RSV infection was a major focus of research efforts in the early 1990s. The first successful immunoprophylaxis of RSV infection was achieved with RSV intravenous immunoglobulin (RSV-IVIG, RespiGam). However, this preparation required monthly intravenous administration of a fluid volume totaling 15 ml/kg. Furthermore, a large clinical trail in the mid-1990s found an increased risk of serious adverse events in patients with cyanotic congenital heart disease (3), preventing the use of RSV-IVIG in this high risk group of patients.

The development of palivizumab (Synagis), an RSV-neutralizing humanized monoclonal antibody, has reopened the possibility of prophylaxis for cardiac patients. This anti-RSV antibody binds to an RSV cell surface glycoprotein (the F protein) which enables the virus to recognize and penetrate human cells. The F protein is also expressed on the surface of infected cells, leading to cell fusion and the formation of the typical pathologic finding of syncytia. Humanization of the antibody involves grafting the variable regions of a murine-derived anti-F protein

Recommendations of the Committee on Infectious Diseases of the American Academy of Pediatrics Regarding RSV Prophylaxis for Infants with Congenital Heart Disease

- Children who are 24 months of age or younger with hemodynamically significant cyanotic and acyanotic congenital heart disease will benefit from 5 monthly intramuscular injections of palivizumab (15 mg/kg).

Children most likely to benefit from prophylaxis include:

- Infants who are being treated with anti-congestive medications
- Infants with moderate to severe pulmonary hypertension
- Infants with cyanotic congenital heart disease

Infants and children who should not receive prophylaxis include:

- Those with hemodynamically insignificant heart disease (e.g. secundum ASD, small VSD, pulmonic stenosis, uncomplicated aortic stenosis, mild coarctation of the aorta, PDA)
- Patients with lesions adequately corrected by surgery unless continued use of anti-congestive medications is required
- Infants with mild cardiomyopathy who are not receiving pharmacologic therapy

Table 1. Adapted from Pickering, LK, ed. Red Book: 2003 Report of the Committee on Infectious Diseases. 26th ed. (9)

antibody to the constant regions of a human IgG molecule. The advantages of a humanized antibody are its increased efficacy and greater safety due to markedly decreased antigenicity.

"Given the difficulty in treating high risk patients once they have developed severe RSV infection, prophylaxis of RSV infection was a major focus of research efforts in the early 1990s. "

In the Impact-RSV trial, Palivizumab was shown to be safe and efficacious in patients with prematurity or chronic lung disease, reducing the incidence of hospitalization by 55%.(4) This led to the Palivizumab CHD Study, designed as a phase 3 trial to assess the safety and efficacy of RSV prophylaxis in children with hemodynamically significant congenital heart disease.

The Palivizumab CHD Study (5) was a multicenter (76 international sites), randomized, double-blind, placebo-controlled study, with patients stratified by heart defect (cyanotic vs. acyanotic). The definition of hemodynamically significant heart disease was left to the judgment of the participating cardiologist, and included pulmonary hypertension, congestive heart failure, failure to thrive, recurrent pneumonia, cyanosis, and developmental delay. Patients received monthly doses of palivizumab (15 mg/kg) or placebo for 5 months during the RSV season. The primary endpoint of the study was RSV hospitalization. Secondary endpoints included total days of RSV-associated hospitalization, total days of increased oxygen requirement, total days of RSV-associated ICU care, and total days of mechanical ventilation. A total of 1,287 patients were randomly and approximately equally divided between cyanotic and acyanotic subgroups. Common cyanotic congenital heart diseases represented included single ventricle (both hypoplastic left and right heart varieties), tetralogy of Fallot, pulmonary atresia (with intact septum or with ventricular septal defect), d-transposition, and Ebstein's anomaly. Common acyanotic diseases included atrial and ventricular septal defects, atrioventricular septal defect and left heart obstructive lesions.

Palivizumab administration reduced the rate of hospitalization (primary endpoint) by 45%, from 9.7% in the placebo group to 5.3% in the treatment group ($p<0.003$). Palivizumab also reduced the total number of RSV hospital days (574.0 vs. 129.0, $P<0.003$) and total days with oxygen requirement (27.9 vs. 101.5, $p<0.02$). Total ICU days, days on a mechanical ventilator, and mortality rates for those patients who were hospitalized were not significantly different between the two groups. There were no significant differences in adverse events between the treatment and placebo groups and no serious adverse events attributable to the drug. Thus, palivizumb is safe and well tolerated in infants with congenital heart disease. The safety profile is similar in patients with cyanotic vs. acyanotic lesions. As a result of this study, hemodynamically significant congenital heart disease is now listed as one of the indications for palivizumab administration (6-8) and the Red Book: 2003 Report of the Committee on Infectious Diseases of the American Academy of Pediatrics now recommends Palivizumab prophylaxis for infants with hemodynamically significant congenital heart disease (Table). (9)

Palivizumab prophylaxis should be administered during the RSV season, as determined regionally by the National Respiratory and Enteric Virus Surveillance System (NREVSS) of the Centers for Disease Control. The start of this season varies between mid-October (in the South and West) to late November or early December (in the Northeast and Midwest respectively). There is more variability in the end of the season, sometimes coming as early as mid-March to as late as the end of May. The majority of RSV-hospitalizations occur in the months of December through March. Consultation with your local infectious disease colleagues or obtaining information from the CDC website can guide the administration protocol. Of note, palivizumab levels were found to be reduced by 58% after cardiopulmonary bypass, so that patients should receive a supplementary dose after undergoing cardiac surgery utilizing bypass.

"...the Red Book: 2003 Report of the Committee on Infectious Diseases of the American Academy of Pediatrics now recommends Palivizumab prophylaxis for infants with hemodynamically significant congenital heart disease."

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Disclosure: Dr. Bernstein has served as a consultant for MedImmune, Inc., manufacturer of palivizumab.

For comments to this article, send email to: JULDB@PediatricCardiologyToday.com

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Palivizumab (Brand Name: Synagis)

Medline Plus
www.nlm.nih.gov/medlineplus/druginfo/uspdi/203646.html

FDA Product Approval Information—Licensing Action
www.fda.gov/cder/biologics/products/palimed061998.htm

Medimmune, Inc.
www.medimunne.com

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MEDICAL CONFERENCES

American Society of Echocardiography - 15th Annual Scientific Sessions
June 26 - 30, San Diego, CA
www.asecho.org

2004 BSF Family and Scientific Conference—Barth Syndrome Foundation
July 7 - 12, Orlando, FL
www.barthsyndrome.org

The 2004 "Specialty Review in Pediatric Cardiology" Course
July 12 - 15, 2004, Chicago, IL
www.uic.edu/depts/ci/pcard04

The 31st International Congress of Electrocardiology
June 27 - July 1, Kyoto, Japan
www.congre.co.jp/ice2004/

24th International Congress of Pediatrics - The IPA World Congress of Pediatrics
August 15 - 20, Cancun, Mexico
www.icp2004.com

European Society of Cardiology ESC Congress 2004
August 28 - Sep. 1, Munich, Germany
www.escardio.org

NIH (National Heart, Lung, and Blood Institute) - Symposium on Cardiovascular Regenerative Medicine
September 13-14, Bethesda, MD
www.nhlbi.nih.gov/meetings/

8th Pediatric Interventional Cardiac Symposium (PICS-VIII) and 2nd Emerging New Technologies in Congenital Heart Surgery (ENTICHS-II)
September 19-22, Chicago, IL
www.picsymposium.com

2004 Annual Meeting - Western Society of Pediatric Cardiology (WSPC)
September 11 -1 2, Napa, CA
www.wsopc.org/webpages/

MEDICAL NEWS

New Cardiac Arrhythmia Syndrome Identified by International Team

DURHAM, N.C. - An international team led by researchers from Duke University Medical Center and the Howard Hughes Medical Institute (HHMI) have defined a previously undescribed inherited cardiac arrhythmia syndrome that can lead to sudden death and can strike young, seemingly healthy people.

After discovering in 2003 a mutation in a specific gene in an extended French family for the arrhythmia, the researchers have identified four other similar mutations in different families worldwide, adding further evidence that they have indeed identified a new cardiac arrhythmia syndrome. The gene in question -- ankyrin-B -- encodes a protein that coordinates ion channels and transporters and thus regulates the flow of ions in and out of heart muscle cells, which in turn controls the beating of the heart.

The researchers believe that ankyrin-B mutations are more common than previously suspected, so they advocate that all family members of patients with sudden cardiac death undergo genetic testing. However, unlike other disorders with demonstrated genetic links but with no current treatments, the researchers said that beta blockers should be quite effective in controlling the irregular heartbeats.

The results of the study were published May 31, 2004, in the Proceedings of the National Academy of Sciences.

"When taken together with the results of our earlier studies, the current findings support a new paradigm for human disease based on the abnormal coordination of these related ion channels," said HHMI investigator and Duke cell biologist Vann Bennett, MD, senior member of the research team. "We now have a new class of arrhythmias that had in the past been grouped with the Long QT Syndrome (LQTS) class of arrhythmias. We can now say that the new syndrome is completely separate and distinct."

Patients with the ankyrin-B mutation typically have varying degrees of cardiac dysfunctions including increased risk of sudden death; however, prolonged QT intervals were not a consistent feature, indicating that this is a distinct arrhythmia, the researchers said.

In their latest studies, the researchers discovered four new mutations on a specific gene that encodes for ankyrin-B, a protein within heart muscle cells. Normally, ankyrin-B acts as a biochemical choreographer, ensuring that microscopic pores known as ion channels are correctly positioned in heart muscle cells so that they can work in a coordinated fashion. These channels allow such chemicals as calcium, potassium, sodium and chloride to pass in and out of the cell with each heartbeat, thereby regulating the electrical activity of the heart.

Ankyrin-B is not only found in muscle cells of the atria and ventricles, but also in nerve cells within the heart, leading researchers to believe that the gene could play an important role in different aspects of heart function.

The research was supported by the National Institutes of Health, the Leducq Foundation (Paris, France), and Johnson & Johnson (New Brunswick, NJ). For more information:

www.dukehealth.org/news/7634

Cryolife Registry Demonstrates Positive Pediatric Long-Term Outcomes Following Heart Valve Implantation

CryoLife, Inc., a human tissue processing and bio-surgical device company, announced updated results from its registry, tracking clinical performance of its cryopreserved heart valve allografts. Data from this registry is used to project long-term performance by actuarial statistical analysis. Results indicate 100% of pediatric patients receiving human heart valves processed by the company were reported to be free from thromboembolic (blockage) events for a period of ten years following implantation. These and other patient outcomes were detailed in the company's CryoValve® Human Heart Valve Clinical Experience 2003 report, an annual publication tracking more than 2,600 patients receiving human heart valves processed by CryoLife for a period of ten years following the implant. The CryoValve Human Heart Valve Clinical Experience 2003 report is available on the company's website.

Additionally, 99% of pediatric recipients of heart valves processed by the company were reported to be free from endocarditis, an inflammation of the lining of the heart and its valves, for ten years following the implant procedure. Also, 97% of pediatric patients were free from valve-related death within the same time period. These statistics confirm the significant patient benefit conferred by human cryopreserved heart valve allografts.

"This unique registry of patients is maintained and managed by CryoLife for the benefit of surgeons and their patients undergoing reconstructive heart valve procedures everyday at hospitals nationwide," said Steven G. Anderson, President and CEO of CryoLife. "This is the tenth consecutive year that CryoLife has published the CryoValve Human Heart Valve Clinical Experience 2003 report which has become a recognized and valuable outcomes resource within the cardiac surgeon community." A registry is maintained on a subset of CryoLife allograft heart valves implanted in the United States to provide ongoing clinical data useful to surgeons in making informed decisions on the most appropriate surgical procedure for patients in need of a heart valve replacement, particularly for children with congenital heart defects. Seven implanting institutions throughout the United States participate in this registry. Cryopreserved human heart valve allografts do not require the use of anticoagulant drug therapy and, therefore, are considered the heart valve of choice for children under the age of 15.

The study population within the registry consists of 1,782 males (68%) and 850 females (32%). The age of the recipients at the time of implant ranged from 1 day to 87 years, with 1,244 (47%) of the patients between the ages of 0-17 years (pediatric patients) The data in the CryoValve Human Heart Valve Clinical Experience 2003 report, collected and analyzed on a yearly basis, includes patient survival and freedom from endocarditis, thromboembolism, and structural valve deterioration. The updated report is published annually and made available to surgeons and their patients.

Since the company was founded in 1984, more than 100,000 patients have received CryoLife-processed tissues in cardiac, vascular, and orthopaedic reconstruction surgical procedures. More than 44,000 cryopreserved allograft heart tissues have been implanted at over 800 institutions in the United States, Canada and Europe. For more information:

www.cryolife.com

RESEARCHING MEDICAL LITERATURE ON THE INTERNET

By Gloria Miccioli, International Librarian
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The proliferation of medical web sites is good news for the researcher with a small to non-existent medical collection. Legal researchers often have to consult medical sources, so it is fortunate that the Internet provides free access to a great deal of the medical literature, either in full text or citation/abstract format, and that it offers search capabilities good enough to fulfill most information needs. In addition, public demand for medical information on the World Wide Web is constant. Many professionally-oriented health care sites have evolved to meet consumer needs, and consumer-oriented sites often include professional literature. Journals, dictionaries, textbooks, indexes - all can be found on the Net in growing numbers. The sources are varied; they include publishers, government agencies, professional organizations, and health libraries, to name a few.(1)

With so many medical websites to search, how does a researcher know which to choose? It depends on what you are looking for. Journal articles make up an extremely important category of the medical literature because they contain the latest research. MEDLINE, one of the jewels of medical research, is the National Library of Medicine's electronic index, which provides bibliographic references to some 4,600 American and foreign biomedical journals. The database contains over 12 million citations. As such, it is a mainstay of medical research, especially for current information. It is offered at no cost on the Internet and is accessible not only from the NLM web site but also from other sites, such as those of medical libraries and medical associations. But remember: not all MEDLINE sites are the same. Some do not cover the entire MEDLINE database; some do not offer all MEDLINE search features. Read the web site's description, if there is one, to determine exactly how much MEDLINE is offered.

MEDLINE can be searched from two National Library of Medicine websites, PubMed and NLM Gateway. These web products are both similar and different.

National Library of Medicine Databases

PubMed

PubMed is also referred to on its website as Entrez PubMed. "Entrez" refers to the date that a citation is added to the database, as opposed to the actual publication date of the article.

PubMed was developed by the National Center for Biotechnology Information (NCBI) at the National Library of Medicine in conjunction with publishers of medical literature. PubMed contains only the MEDLINE database plus links to NCBI's molecular biology databases. As of September 30, 2003, OLDMEDLINE citations have been incorporated into the MEDLINE database on PubMed. OLDMEDLINE contained around 1.5 million citations predating 1966, which is when MEDLINE coverage started. These earlier citations were originally printed in hard copy indexes published from 1953 through 1965. A separate search of OLDMEDLINE was required for pre-1966 literature; now that OLDMEDLINE is part of MEDLINE, a search of MEDLINE on PubMed will include these early citations.

A wonderful trend in medical literature is the growing availability of full text information. NLM is certainly in the forefront of this trend. The problem with medical research from my point of view has been the need to get the articles once you have a list of citations or abstracts. Document retrieval has not always been easy nor has it been inexpensive. PubMed, however, provides the full text of articles of participating journals. Access to the full text depends on the publisher; some require a fee or subscription. PubMed makes it clear when a fee is required. The LinkOut feature of Entrez PubMed takes users from citations in the PubMed and Entrez databases to various web resources, such as full-text publications, consumer health information, research tools and more. You can see a list of the approximately 4,000 journals (out of 4,600) that offer full-text links as well as a list of the approximately 1,100 LinkOut providers. You can also review the 396 journals that offer free full-text articles. Note: these are not complete lists of all free, full-text journals on the web, just of those that participate in the LinkOut program. In addition, the National Library of Medicine's digital archives of life sciences journal literature is available for free from PubMedCentral. At this time PMC covers around 130 titles; coverage dates vary by title.

In addition to full text articles, NCBI has a growing collection of biomedical textbooks available for search and retrieval. As of this writing, Twenty-seven books can be viewed and searched; see the Bookshelf home page. Or, you can select "Books" from the PubMed home page pull-down menu next to the search button. There are also links to these texts from PubMed abstracts and summary documents.

PubMed offers powerful searching and may seem somewhat complicated to the novice. I recommend that new users click on the Help screen for detailed information on PubMed or take the online Tutorial. Links are on the left sidebar of the home page. Both are easy to understand and explain the many features available to medical researchers. To search PubMed, you can enter terms in a simple query box on the PubMed home page, or you can click on Preview/Index for more advanced searches. You can also search by author and journal title. To narrow your search parameters, click on Limits and use pull-down menus to restrict the search by field (such as title, title word, abstract word, MeSH heading, issue, page number, and so on) and by language, age, gender, publication type, date range, and more. PubMed allows for Boolean searching and the use of a command language to designate search fields.

Because not everyone who uses MEDLINE is familiar with medical vocabulary, the system is programmed to help you find precise terminol-

ogy by leading you to MeSH subject headings. The National Library of Medicine has developed an extensive controlled vocabulary called Medical Subject Headings (MeSH); using MeSH terms in a search will lead to greater accuracy and relevancy in search results. You can browse through a ranked list of terms by clicking on MeSh Database on the left sidebar of the home page. Here you will find MeSH terms and hierarchies and relevant co-terms. Enter a term and the system will respond with the correct MeSH heading(s), which can then be selected. When I entered "Norplant", I got the MeSH heading "levornorgestrel" and a short definition. Clicking on levornorgestrel led me to the term hierarchy, from which more terms could be selected and added to the search. You can also designate main headings. Terms will also be automatically "exploded" unless you indicate otherwise; that is, subheadings of a term will be searched along with the main heading. I can't stress enough the importance of using the MeSH function; your results will be more accurate when you use the terms assigned to the article by the indexer. And the non-medical searcher may not be able to guess the correct terms: how many of us know that "mad cow disease" is represented in MEDLINE as "encephalopathy, bovine spongiform"? Be aware, however, that very new citations that are still being processed may not have been assigned MeSH headings yet.

Using a system called Automatic Term Mapping, the PubMed search engine automatically tries to match search terms, author names, and journal titles against established lists. Phrases, however, bypass ATM and are searched in the index of searchable terms, which can be viewed by clicking on Preview/ Index on the home page. Search terms must be designated as a phrase in order for them to be searched as such: the searcher can use double quotes or a phrase search tag. If there is no match the terms will be ANDed together.

Search results can be displayed in different formats. Very old and very new articles will probably only appear as citations. The summary format may include authors, title, journal, publication type, and citation status. It also displays icon links to indicate whether or not the citation includes an abstract or if the full text is available free in PubMed Central or elsewhere. In addition, PubMed allows you to retrieve related articles for most citations, because most records in MEDLINE are linked to other records by a matching algorithm. The citation format will include MeSH terms, so you can check to see what terms were assigned to an article. The abstract format is very useful because it gives you a pretty detailed look at the contents so you can decide if you need to get the full text. Next to each citation/abstract is a Links button; this will take you to free or fee sources of the full text.

A Send To pull-down menu on the results screen allows you to save or send search results. For example, you can e-mail them, download them, or send them to a Lonesome Doc order screen; Lonesome Doc is the fee-based online ordering system of the National Library of Medicine. The user has only to point and click to order the full text of desired articles.

PubMed has several other useful features; (links are on the homepage sidebar):

- **The Journals Database** lets you look up journal names, MEDLINE abbreviations, or ISSN numbers.
- ·**Single Citation Matcher** allows you to verify a single citation.
- **The Batch Citation Matcher** allows you to verify multiple citations.
- **A Clinical Queries form** is available so a user can search for the therapy, diagnosis, etiology, and prognosis of a topic.
- **Cubby** is a stored search feature that allows users to store and automatically update searches. To register for Cubby, click on the button and follow the instructions.

NLM Gateway

NLM Gateway is the user-friendly way to search MEDLINE and other National Library of Medicine databases. It is broader in scope than PubMed because it goes beyond journal citations to include the monographs, serials, and audiovisual materials of the NLM collection as well as the contents of several other databases in a "one-stop shopping" search and retrieval interface. Introduced in October 2000, NLM Gateway searches its network of NLM databases simultaneously. Its target is "the user who comes to NLM not knowing exactly what is here, or how best to search for it". As with PubMed, it helps to read the Help screen.

Enter your search into a simple query box on the home page. The current version of Gateway searches:

- **MEDLIN**E via PubMed
- **LOCATORplus**, the online catalog of the National Library of Medicine; it includes 800,000 records of monographs, serials, and audiovisual materials.
- **MEDLINEplus**, the consumer health web site of NLM.
- **ClinicalTrials.gov**, information about clinical research studies
- **DIRLINE**, the Directory of Information Resources Online
- **Meeting Abstracts**, abstracts of meetings on selected subjects
- **HSRProj**., with information about ongoing grants and contracts in health services research.

There also is a link to TOXNET on the left home page sidebar; however, Gateway does not include this database in its searches. TOXNET, a product of the National Library of Medicine, consists of a group of databases on toxicology, hazardous chemicals, and related areas.

By entering a term in the search box and then clicking on Find Terms, you can access MeSH Headings (the controlled vocabulary thesaurus) and NLM's Unified Medical Language System's Metathesaurus (which contains information about biomedical concepts and terms from many sources). Unlike PubMed, you do not have to enter phrases in quotes. If you do not want adjacent terms searched as a phrase, use Boolean operators. You can also just enter the term and click on Search or hit enter without also clicking on Find Terms. Gateway automatically selects the correct

MeSH terms and searches it across all Gateway databases. It doesn't get much simpler than this,

Click on Limits under the search box button to narrow your search by document category, English language, and publication year. Limits also lets you search the following subject subsets: AIDS, Bioethics, History of Medicine, OLDMEDLINE, and Space Life Sciences. Note that PubMed's Limits button offered many more options. According to the Gateway Help page, searchers have to use field tags to search by age, gender, title, author, etc. However, there is no pull-down menu of these tags that I could find on the search screens; the user would have to check the Help page and make a note of them or remember them. In my opinion, this is somewhat contrary to Gateway's goal of being user-friendly.

On the Results Summary page search results are divided into categories, another nice feature. My search for "Norplant" retrieved 2,306 journal citations, 629 books/serials/AV materials, 15 consumer health references, 15 meeting abstracts, and 1 from "Other collections". For each category you can click on search details to see what terms and databases were searched, e.g., PubMed. Although I only entered the term Norplant, levornorgestrel was also searched. Hit Display Results to bring up citations with an option to display abstracts if they exist. You can also ask to see articles related to a particular citation. Hit the Expand button next to the citation to get an abstract. This page will also give you a publisher link if it exists, plus links to retrieval options (download, e-mail or display), an opportunity to Order Documents (a link to Lonesome Doc), and the ability to put the record into the Locker, which permanently stores selected search items. The Locker requires free registration.

The History button will show you previous search statements and allow you to modify or combine them. I recommend you read the FAQ on the left sidebar of the home page to find basic search tips and how to print or download information.

NLM Gateway is easy to use, and allows for simultaneous searching of several medical databases and of different types of medical literature. It is a good first step for researchers. Those who need more powerful search features for journal literature should turn directly to PubMed.

PubMed and Gateway are wonderful resources for medical researchers, and they are free. They do take a bit of practice, at least for me. Maneuvering among the MeSH browser, pull-down menus, and various fields - i.e., defining and modifying the query - can be a little confusing. However, upgrades have made these systems easier to use, and no doubt this will continue. With practice, the user will find that PubMed and Gateway are excellent vehicles with which to retrieve medical information.

MEDLINEplus

Before we leave NIH, let me mention MEDLINEplus, NLM's effort to provide consumer-oriented medical information. Launched in the fall of 1998, this system is easy to use and understand. Sources include medical dictionaries, a medical encyclopedia, provider directories, health news, and access to health-related government and non-government databases, including a link to PubMed for MEDLINE searching. It is updated daily, and is a good place to get basic information on a disease, medical condition or treatment, or a drug; you can then turn to the medical literature for more sophisticated information.

If MEDLINE is available in not one, but two, formats from NLM, why would a researcher choose to search it on a non-NLM web site? One reason is convenience, especially if the user is already on another medical site that links to MEDLINE. Often the link is to PubMed. A more compelling reason is that some sites offer MEDLINE searching with a little extra added.

Commercial Web Sites

Medscape

One such site is Medscape, part of the WebMD Corporation. Its goal is to provide medical professionals with an integrated web product. The site offers MEDLINE searching, but it also contains information from texts, news providers, medical education programs, and materials created specifically for Medscape, including a collection of articles with a clinical focus. Thus, its real value is not so much access to MEDLINE as it is access to these additional sources of information. Like many medical web sites, Medscape requires a free, one-time registration, after which the user can create a personal home page that focuses on his or her medical specialty. However, the web site is pretty confusing. Details on what is covered are few; navigation involves too much trial and error. An About Medscape button, buried on the bottom of the home page, leads to a brief description of Medscape content: "Physician Optimized MEDLINE" (this is not explained here), CME materials, conference coverage, current medical news, journals and textbooks, and the Internet's first primary-source medical journal, Medscape General Medicine. There's more...the page says so...but it does not tell you what it is. Some additional information is available if you hunt for it. Or you might run into it by accident. When I clicked on Advanced Search, I was led to a page called Medical Search Resources, with an option to select MEDLINE. When I did, I got a search screen. Under "Limit your search to any of the following" was a button for Medscape Select. Clicking on those words finally brought an explanation of one MEDLINE enhancement: Medscape Select consists of a core collection of 269 English-language only MEDLINE journals that have been selected by Medscape editors as the most valuable journals for clinicians. You can limit your search to just these journals. This is a great tool, but it should be a little easier to find out about it.

Another difference in Medscape's MEDLINE is the searching itself. Medscape has designed its own search screens instead of defaulting to PubMed. The basic search screen is a simple query box on the right sidebar of the home page or on the bottom of every Medscape page. The advanced screen accepts either natural language queries or Boolean searching. You can search by author and journal and limit searches to English, date, and a number of other fields found in a pull-down menu. You can also select to have your query searched by "concept mapping", i.e., the automatic selection of correct medical terms, and to have variant terms searched.

In addition, the advanced search page links to

a search screen for Medscape Professional, which covers news, clinical articles written especially for Medscape, and images. It also leads to a search screen for Medscape DrugInfo.

Another way to approach Medscape is by subject. Medscape has organized its information by medical specialties, each with its own home page. Click on the Medical Specialties button at the top of any page for a list of the medical specialties and links to different kinds of medical information on each specialty.

Also on the top of the Medscape screen is a button to Medscape Today, which is subdivided into different categories of recent medical information., such as CME News. Resource Centers covers regularly updated collections of key clinical content and is arranged by subject.

Medscape is to be applauded for its comprehensive approach to medical information and for the fact that it is free. Nevertheless, I found the lack of details frustrating. Medscape has been redesigned in the last two years but not for the better. For example, it seems to have eliminated its Site Map and this was a mistake. There is so much content that some kind of guide is needed or the value of the site is diminished.

eMedicine.com

Launched in 1996 as a privately held company, eMedicine.com's goal is to provide quality medical literature for healthcare professionals. Nearly 10,000 physician authors and editors contribute to the eMedicine Clinical Knowledge Base, which contains articles on 7,000 diseases and disorders. It provides the latest practice guidelines in 62 medical specialties. eMedicine content undergoes 4 levels of peer review to ensure quality. In addition to textual information, there is also a collection of medical images. Basic and advanced searching are available. I entered "anxiety" as a simple search and got 100 hits, which were arranged by title. Also given were the medical specialty (e.g., pediatrics) and the date of the latest update. The advanced search allowed me to limit searches by specialty and date and to use Boolean Operators. Accessing the full text required free registration. There is also a link to MEDLINE on the left sidebar. A sister site, www.eMedicineHealth.com, contains 5,500 pages of health information written by physicians for consumers and patients.

MedicineNet.com

When I do medical research, I usually try to find a plain English description of the topic before I start to search MEDLINE - and sometimes after. MedicineNet.com is a good place to go for understandable yet in-depth medical information. Produced by a network of U.S. board certified physician-writers, this site has hundreds of web articles on diseases, treatments, procedures, tests, and drugs. And it has a Site Map. There is a simple query box, or you can click on one of the following categories: Diseases and Conditions, Procedures and Tests, Medications, and MedTerms Dictionary. Each category has an A to Z list of terms, or you can enter a term in a search box. The Home Page also features links to information on focused topics, for example, allergies. There are also links to other e-publications, such as health newsletters.

InteliHealth

Another site that seeks to make health care information accessible to a wide audience is InteliHealth, a subsidiary of Aetna U.S. Healthcare. It seeks to provide "credible information and useful tools from the most trusted sources, including Harvard Medical School and the University of Pennsylvania School of Dental Medicine." Health information developed by InteliHealth is reviewed and approved by medical experts. Over 150 health care organizations, including NIH, are contributors. On the home page are two search boxes, one for Drug Names and one for Search Terms. Entering a drug name links to information found on SafeMedication.com, a site produced by the American Society of Health System Pharmacists. This site includes pronunciation guides for drugs; what a useful tool!

Entering search terms results in short articles and questions from consumers that are answered by experts. You can also click on the home page category Diseases and Conditions for an alphabetical list of topics. Look It Up links to a page of different health resources, including the Symptom Scout, a medical dictionary, information on tests and procedures, and the Drug Resource Center. Search Medical Literature links to TopicDoc, a user-friendly medical literature service that offers a topic-driven approach to MEDLINE. TopicDoc (formerly MedCite) consists of the search results for over 15,000 topics that have been searched by medical research librarians from the Johns Hopkins Health Science Centers. Citations of or abstracts to the 50 best articles are immediately accessible for each topic. All TopicDoc searches are updated and document delivery is available. If your topic is covered, it's like having a medical librarian on hand.

Achoo

This whimsically named web site is designed as a gateway to health care sites for the medical community and other users interested in health care information. Achoo strives to include web sites that cover all aspects of health care, including business aspects. The home page allows you to select from several categories: Business and Finance of Health, Human Health and Diseases Directory, Organizations and Sources, and Reference Sources. Each category is subdivided. For example, under Reference Sources you will find Databases and Directories (which links to a simple version of MEDLINE), Journals and Periodicals, Statistical Information, and so on. The organization and layout of the categories is user-friendly. You can also choose to search by keyword via the search box on the home page. An advanced search page is available but it is not clearly marked; I found it via random clicking. Select Search on the top of the screen, then click on search Achoo from the list that pops up. The resulting search screen allows you to specify not only keywords, but also geographic location, fields, and type of site producer (e.g., e-journals, associations). A search brings up annotated links to relevant web sites. I would not turn to Achoo for strictly research purposes, but it would be useful to identify medical web sites.

BioMedNet

BioMedNet, owned by Elsevier Science, targets the worldwide biomedical research community. Free registration is required to use the site. I used to consider BioMedNet as one of the premier medical research sites on the web. Although it was a commercial site be-

fore it was acquired by Elsevier, it seemed to be dedicated to providing expert and free information. Now it seems to be more concerned with finding buyers for Elsevier journal articles. One of its most valuable features was Evaluated MEDLINE. This feature provided experts' evaluations on selected MEDLINE articles. It was a good reason to search MEDLINE on BioMedNet rather than through NLM. Evaluated MEDLINE is gone. The site also used to link to the full texts of thousands of articles on various topics that were part of BioMedNet's own collection and were available free. Now the user can access this collection, called BioMedNet Review, only through an institutional subscription. The purchase of the complete text not only incurs a charge but requires a subscription to ScienceDirect, the distributor for the Elsevier Science journal collection. BioMedNet also seems to have dropped another valuable feature, its annotated and evaluated list of medical web sites.

MEDLINE searching is adequate: there are simple and advanced search screens that allow you to Browse by Journal and Browse MeSH. You can also view, sort, and combine previous searches. Click on History on the MEDLINE search screen to see a list of searches that have been automatically saved. The Books and Labware button allows the user to browse and/or search for medical textbooks and book reviews. Online ordering is possible.

Medical Matrix

Formerly a free site from a nonprofit organization, Medical Matrix started requiring subscriptions in 2002. An individual can subscribe for $89 per year or $14 per month; an institutional subscription for up to 5 users costs $249. Because I do not subscribe and because there is little information on what is now covered, I could not evaluate this web site as it exists today. However, a sample search from the Take a Tour button shows that Medical Matrix still annotates and evaluates different categories of medical web sites, including news sites, patient information sites, medical image sites, and sites on medical education and drugs. It also links to them. I have tried to include only free web sites in this review; however, Medical Matrix may be worth a trial since it does what it does very well.

Drugs.com

Drugs.com contains free drug information that is supplied by two independent medical information suppliers, Cerner Multum and Thomson Micromedex. It is not affiliated with any pharmaceutical companies. This is a great site with lots of information. By selecting a drug from the alphabetical list or by entering a name in a search box, you will get information divided into categories, such as basic and advanced consumer information, the entry from the Physician's Desk Reference (access to this requires free registration on the Drugs.com site), and news and related articles.

What truly is outstanding about this site is that it allows you to search by medical condition, drug interactions, and visual images of drugs. The Pill Identifier lets you use pull-down menus to enter a description of a drug. It responds with the names and pictures of all the pills that fit that description. Conversely, you can use Search Image to enter the name of a drug and get an image of it. This is very useful and also fun to use.

Libraries and Nonprofit Organizations

MedWeb@Emory University

As they have with all types of information, librarians have helped to make medical information more available and easier to search. MedWeb is a catalog of biomedical and health sites maintained by the staff of Emory University's Health Sciences Library. One impressive feature is its links to health-related sites located around the world (click on Institutions on the home page). You can also search this by location. It also has links to a great deal of medical information. For example, if you click on Subject Index on the left sidebar, you will be taken to a long list of medical subjects. Browse and select for relevant links. Medical libraries brings up 345 links to medical libraries around the world. MEDLINE links to various sites that offer MEDLINE searching as well as information about searching MEDLINE. Back on the homepage, the button Publications links to numerous e-publications, including journals, texts, practice guidelines, databases, directories, and encyclopedias. Some are free; some are fee-based. There is also a search box for keyword searching.

Medical/Health Sciences Libraries on the Web

Hospitals, medical libraries, and professional associations that have a presence on the Web often provide links to sites that reproduce or index medical literature. In addition, the online catalogs of medical libraries are a window to the world of medical publishing. Medical/Health Sciences Libraries on the Web links to academic, hospital, and military medical libraries and many other medical sites in the U.S. and around the world. The home page also has a link to a selected list of free full-text online electronic medical journals (click on Free Medical Journals on the top of the page). In addition, this site, produced by the University of Iowa Hardin Library for the Health Sciences, compiles the Hardin Meta Directory of Internet Health Sources, a directory of what it considers to be the best health-related sites on the web. They are arranged by medical specialty.

Medical Society of Virginia

The Medical Society of Virginia is good example of a medical association that compiles links to regional medical resources. Click on Links & Resources on the sidebar to see a page of links of Virginia-based health care sites, including state and local agencies, Virginia medical schools, and nonprofit organizations. One such link is to the Eastern Virginia Medical School, whose Medical Library provides links to electronic resources such as its online catalog and PubMed.

HealthWeb

HealthWeb has links to evaluated, noncommercial, health-related resources on the World Wide Web that are selected by librarians and information professionals at over 20 leading academic medical centers in the Midwest. Selection stresses quality and the content is directed toward both health care professionals and consumers. Using a no-frills approach, HealthWeb's home page is

simply a list of medical subjects that you can click on for an annotated list of links to web sites on that subject. For example, clicking on Psychiatry/Psychology yields annotated links to 11 web sites. There are also simple and advanced search screens.

Healthfinder

A product of the U.S. Department for Health and Human Services, healthfinder is a gateway to reliable consumer health and human services information. The medical researcher who clicks on Health Library will be rewarded with links to libraries, dictionaries, online journals, databases (including MEDLINE), foreign language resources, listservs, medical search engines and metasites.

Public Library of Science

Just as electronic information and the Internet have changed the very nature of legal publishing, they are also having a profound effect on medical and scientific publishing. The Public Library of Science is a non-profit organization of scientists and physicians committed to free and timely online access to the world's scientific and medical literature. It has just issued the first issue of its first online journal, PLoSBiology. A second journal called PLoS Medicine will be launched in 2004. These journals will be funded by authors and participating institutions, which does away with the need for increasingly expensive subscriptions by users and thus makes research accessible to "even the poorest of graduate students." It also is intended to speed up the pace at which research is published and eliminate the control now held by journals on scientific publishing.(2) Standards of quality will be retained. To ensure further access to the articles, the full contents of every issue will be placed in PubMedCentral, the National Library of Medicine's collection of free, full text articles.

Journals and Textbooks

FreeMedicalJournals.com & FreeBooks4Doctors.com

For direct access to the current issues of 1300 free, full-text medical journals, go to FreeMedicalJournals.com.. This site is somewhat mysterious; there is very little about the producers. But its goal is admirable: to promote the free availability of full text medical journals on the Web. The journals are sorted alphabetically and by specialty, and cover both English-language and non-English publications. FreeBooks4Doctors is a sister site that links to the full text of 600 medical texts. They are arranged by specialty or title and language. This site also links to AMEDEO, a current awareness resource. For journal alerts, you can enter a topic, select some journals and you will receive weekly e-mail news updates with overviews of the new articles that have been published in the journals subset you have created as well as abstracts of the articles in your journal subset. To get news of new books, create a profile in AMEDEO's book alert service.

Internet Medical Bookstore

Often researchers will need to consult medical texts. First, however, they must be identified and obtained. For information about print and electronic products that are available for sale, visit the Internet Medical Bookstore. Over 75,000 items can be ordered online. Click on Browse to search by subject matter. To search by author, title, ISBN, category, year of publication, or price, hit the Search option. Advanced Search lets you select keyword searching, but I could find no separate box in which to enter the keywords.

Merck Manual of Diagnosis and Therapy

A standard medical reference text, the Merck Manual is available free for searching on the Web. Select topics from the Table of Contents or perform a basic or advanced keyword search.

Medical Search Engines and Visual Information

MedNets

MedNets uses proprietary search engines to search only medical databases and is international in scope. There is not much explanation of how it works and after working with it I'm still not sure exactly what is covered. To see a list of searchable databases hit Searchable Databases on the sidebar. The National Library of Medicine is one of them. You can customize your search by first selecting an area of medicine from a pull-down menu, a language (English, French or Spanish), and a type of information to be searched, such as conferences. If you just enter a search term, you will be taken to several subcategories, such as patient information. Clicking on the category will then lead to links to specific web sites.

MedBot

Another medical search engine that I would like to mention is MedBot by Stanford University. MedBot brings together several types of resources: general search engines, medical indices, news sites, medical education, and medical imaging and multimedia sites. Some of these resources can be combined for a single Super Search; the user selects up to 4 databases to be searched at one time. Or, you can click on each category and search the listed sites one at a time. MedBot is easy to use and gives good results.

The button marked Medical Images and Multimedia underscores the fact that the research of medical sources is often a hunt for visual information. The fact that the Internet is not restricted to textual medical information makes it an extremely valuable research tool. Clicking on that button on the left sidebar brings up query boxes for:

- **WebPath**, an electronic collection of 1900 images of pathology specimens along with text, tutorials, laboratory exercises, and examination items.
- **The Digital Anatomist,** a collection of computer-generated images based on cryosection studies.
- **Virtual Hospital,** a digital health sciences library that includes educational images from medical texts.

Medscape also has compiled a file of medical images. Click on Advanced Search near the search box, then on Medscape Professional. The resulting search screen allows you to select images from the Content Type pull-down menu. Entering "cyst" resulted in 57 images. Expand an image by clicking on it; you will also get a caption that gives the

source for that image.

Researchers can search a FindLaw database of over 10,000 medical images. The illustrations were developed for legal matters, such as medical malpractice exhibits. Enter a term in the query box or select lists arranged by body part, medical specialty, and medical topic. Selecting "kneecaps" brings up 268 images from different categories, such as anatomical models and medical exhibits. You can also search by category. Clicking on an image enlarges it. Downloading the image, however, incurs a fee.

Physician Information

Researchers often need information on medical providers as well as on medical conditions. Licensing data and educational background are usually available from the provider's state medical board or licensing agency. The State Board Directory website is a directory of state medical boards with links to most of the boards' web sites. The Federation of State Medical Boards is made up of 70 medical licensing authorities in the 50 states, the District of Columbia, Guam, Puerto Rico, the Northern Mariana Islands and the US Virgin Islands; the FSMB's web site links to these organizations. To find out if a doctor is board-certified, go to the web site of the American Board of Medical Specialties. Once you register for free use, you can login and search by name and location or specialty and location.

While it is not that difficult to determine if a physician is licensed, the lack of information about whether he or she has ever been disciplined is a growing concern. Part of the problem is that the availability of this information varies from state to state. But here, as with every area of information, the Internet is making a difference. The watchdog group Public Citizen publishes a survey of the quality of information found on state Medical Board web sites. Of the 50 state boards that regulate medical doctors and that of the District of Columbia, all have web sites and only two (South Dakota and Montana) do not name disciplined doctors. Since the kind of disciplinary information on these web sites varies from state to state, Public Citizen grades them for their quality. Only 7 states, including Maryland and Virginia, got an "A" for the quality of its content. The sites are also graded by ease of use. An overview of the survey and detailed results are available. There are also links to each state board's website.

If you are not satisfied with what you can find for free with regard to disciplinary actions against doctors, you can use the Federal Physician Data Center, which was launched in early 2001 by the aforementioned Federation of State Medical Boards. The Data Center lists 117,000 state board charges against 35,000 doctors dating back to the 1960s, although some information goes back to the 1940s. The site covers only U.S. medical licensed physicians, osteopathic physicians and physician assistants. To be included in the database, a disciplinary action must be a matter of public record or be legally releasable; there is no information on malpractice claims or settlements. The database, which is updated monthly and quarterly, costs $9.95 per search, whether an action is found or not. Users will learn whether action was taken, what type of action (e.g., license revocation), and the date and reason for the action.

Another new web site that names questionable doctors is named, appropriately, Questionable Doctors. Sponsored by Public Citizen, it is a database of doctors in 42 states who have been disciplined by state medical boards and federal agencies in the past ten years. According to the introduction, "It contains data on actions taken for medical incompetence, misprescribing drugs, sexual misconduct, criminal convictions, ethical lapses and other offenses". After you register for free, you can search for a name. The information you can get at “no charge” is very brief (the location and sanctioning body). The catch with Questionable Doctors is that getting a copy of the full report on the doctor requires a subscription. However, the cost is low: only $10 for a one-year subscription that yields ten individual reports a year.

Researchers may need information on organizations as well as on individuals. The Joint Commission on Accreditation of Healthcare Organizations evaluates and accredits over 16,000 healthcare organizations and programs in the United States, including hospitals, nursing homes, and laboratory services. If you want to see what entities have been accredited in a particular geographic location or to see if a particular organization is accredited, go to its Quality Check page. This is a very easy-to-use site that rewards the searcher with useful, current information.

Conclusion

The Internet has become an important source of information in medicine and the health sciences, as it has in so many other areas. Medical information professionals are at the forefront of the effort to organize this vast, ever-increasing store of knowledge. The sites mentioned above reflect this effort and are meant to be a sampling of the marvelous tools that are now available to the medical researcher. Take some time to explore medicine on the Web; no doubt you'll discover many more.

Footnotes

1. I am going to review a selected group of websites. For a more comprehensive, annotated guide to electronic and print medical resources, please see *Medical Resources for Non-Medical Librarians,* by Lynne M. Fox, Information and Outreach Librarian, Denison Memorial Library, University of Colorado Health Sciences Center.

2. An editorial in the first issue explains the PLoS philosophy and methodology in detail Why PLoS Became a Publisher, 1 PLoS Biology, no. 1, October 13, 2003.

For comments to this article, send email to: JULGM@PediatricCardiologyToday.com

~PCT~

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