Review Article

"CYBERMEDICINE AND CYBERHEALTHCARE" REVIEW OF MEDICINE ON THE INTERNET

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Introduction

The Internet is a vast network of computers spanning the entire globe. Created initially to suit the requirements of the military in United States of America, it has now broken all barriers and has been seamlessly integrated into the personal computer. From recreation to applied science and technology and from Critical Care Medicine case scenarios to pathology specimens and digitized radiology images, the Internet has become increasingly useful for medical practitioners. This review article describes the world of Internet when applied in the context of Medicine and attempts to briefly overview the gamut of medical web sites on the internet in order to provide the reader a nutshell view of the powerful and magical world of internet.

What is Internet?

The Internet was created in 1969, when the Advanced Research Projects Agency (ARPA) of the United States Department of Defence funded up an experimental long-distance telecommunication network consisting of only four computers. In the 1980s, ARPANET was superseded by NSFNET, a series of networks created by the National Science Foundation, which established the present-day structure of the Internet [1]. Over the last few years there has been an exponential explosion in the number of computers added to this network. Telecommunications on the Internet are standardized by a set of communications protocols, the TCP/IP protocol suite, that describe routing of messages over the internet, computer naming conventions and commonly used internet services such as e-mail. The Internet is so vast that practically every aspect of human interest including medicine, communications, commerce, science, media, law, art etc is represented in some form or fashion.

For those who are desirous to learn the Net on the

Net itself, there are a host of sites that fulfill the need. These include the under mentioned :

- i) Doctors guide to Internet at <http://www.pslgroup.com/docguide.htm>,
- ii) Beginners guide to Internet at <http://www.silverlink.net/poke/IIP/>,
- iii) Learn the net at <http://www.learnthenet.com/english/index.html> and
- iv) Hitchhikers web guide at <http://www.hitchhikers.net/guide.phtml> [2].

A concise and informative online basic primer of Computers in Medicine is available from the BMJ group of publications : ABC of Medical Computing <http://www.bmjgroup.com/data/abcmc.htm>. Another web site dealing with basic information on computers is "What is Computers?" <http://www.whatis.com>. Once one becomes familiar with Internet there are many sites offering a variety of Internet related features. One such popular site is Internet Tools <http://www.december.com/net/tools/index.html>.

Overview of Medicine on the Net

The Internet has approximately 800 million web pages at the moment, with a remarkable tendency to grow further. Of these, it has also been estimated that there are close to 100 million web pages dealing primarily with Medicine. It is therefore not surprising that medical teaching has evolved from Vesalius to the Electronic library [3].

Clearly, it would be impossible to browse and evaluate all the million sites. At the moment a variety of techniques are used to access medical information on the Internet. These include medical search engines, general-purpose search engines, medical meta-lists, and commercial sites on the Web. However, the best method of information retrieval from the Web is not known.

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Search Techniques

The first strategy employs Search Engines. Search engines are comparable to yellow pages, delivering a list of sites pertaining to any medical topic. Most of the search engines have a blank field where the topic is typed, and utilise a search button, which needs to be clicked, displaying in a period of usually less than ten seconds a list of sites. The current popular search engines include Yahoo, Alta Vista, Excite etc.

Search engines have evolved further with the introduction of Metasearch engines. Metasearch engines function as "yellow pages of yellow pages" and query multiple search engines, echoing the oft repeated sentiment "Why search when you can metasearch?". The popular metasearch engines include All the Web at <http://www.alltheweb.com/>, Google at <http://www.google.com/>, Dogpile at <http://www.dogpile.com/>, Hotbot at <http://www.hotbot.com/>, Metacrawler at <http://www.metacrawler.com/> and Savvysearch at <http://www.savvysearch.com/>. For a list of search engines, Beaucoup is a site that has compiled a variety of 1600 search engines in various categories including metasearch engines: <http://www.beaucoup.com>.

Medical resources or Medical directories deal with a huge catalogue of topics by categorizing them, usually by specialities. The largest and comprehensive Medical directory are accessible as Medmark at <http://www.medmark.org>, Medmatrix at <http://www.medmatrix.org>, Medguide at <http://www.medguide.net/>, Medtap at <http://www.medtap.com/links.html>, Galaxy Guide to Medical Topics at <http://galaxy.einet.net/galaxy/Medicine.html>, Medical Education Online <http://www.med-ed.online.com> and Virtual Hospital Major Links <http://www.vh.org/Providers/Providers.html>.

Medicine and Internet : The range of sites

Internet contains Medical topics ranging from "the history of Medicine" to "new medical sites" that are added every week. Tracing of the history of medicine is depicted in engaging sites such as history of medicine at http://www.asap.unimelb.edu.au/hstm_medicine.htm and Medical history on the net at <http://www.anes.uab.edu/medhist.htm>. At the other end of the spectrum are the updated sites that are added to the net, perused at; What's new this week <http://medwebplus.com/whatsnew/week.html> and New Medical site added this week <http://www.pslgroup.com/MEDSITES.HTM>. Besides there are sites dealing with basic topics in Medicine such as Basic Clinical Skills at [\[info.ufl.edu/year1/bcs/index.html\]\(http://info.ufl.edu/year1/bcs/index.html\), Medical Dictionary and Links at <http://www.sciencekomm.at/advice/dict.html>. The internet is a rapidly developing and useful tool for emergency physicians. There is a web site for emergency medicine aptly titled E Medicine at <http://www.emedicine.com/emerge/index.shtml>.](http://www.med-</p>
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To cater to the needs of medical students there is a "lounge" where common topics of interest are dealt comprehensively :IMS lounge <http://www.medstudents.net/>. Similarly, there are sites dealing with Hippocratic Oath at <http://chrononet.hypermart.net/hippocratic/>, Medical Audio items at <http://www.med-library.com/medilibrary/Audio/>, a wide range of Medical books catalogue at <http://www.cs.cmu.edu/bookssubjects.html>. Furthermore there are sites dedicated to syndromes at http://www.kumc.edu/AMA-MSS/study/pdx_syndromes.htm, Rare diseases in adults at <http://rare-diseases.info.nih.gov/ord/> and Rare genetic diseases in children at <http://mcrc22.med.nyu.edu/murphp01/texthome.htm>.

Medical Specialities and Internet

Some of the absorbing and enticing speciality Medical websites are reviewed here. The finest sites on Pathology are Pathmax at <http://www.pathmax.com>, Weblab at <http://www-medlib.med.utah.edu/WebPath/webpath.html> and HemoSurf. An Interactive Atlas of Hematology <http://www.aum.iawf.unibe.ch/viz/BWL/HemoSurf/Indexe.htm>. A huge set of Cardiology links are located as Cardiology Links <http://www.cardio-info.com/linkanat.htm>, at Welcome to Cardiology Compass at <http://www.cardiologycompass.com/> and at http://www.second-vision.com/msc/med_ed/links/topics/systems/heart.htm. There are many Cardiac and Respiratory Auscultation online sites, which provide downloadable audio files that one can listen to. These include McGill Cardiac Respiratory Auscultation Sounds Atlas at <http://www.music.mcgill.ca/~tkatsia/auscultation.html> and Cardiac Auscultation Links at http://www.west-ernu.edu/lib_hrtsound.html. An illustrative Paediatric chest atlas is available at <http://www.tc.umn.edu/nlhome/m475/bjarn001/stuff/chd.html>. A useful site on Paediatric Cardiology Links is available at <http://www.neosoft.com~rlpierce/pc.htm>. A descriptive text on 550 childhood illnesses is at hand from the Pediatric Database at <http://www.icon-data.com/health/pedbase/pedlynx.htm>.

A primer of Brain tumour is accessible at

<http://www.abta.org/primer/types.htm> while a large set of links to various surgical topics is available at Dr Bagga's Surgery links <http://members.wbs.net/homepages/b/a/g/baggas/medicine.html>. An online Atlas of surgery is obtainable at <http://www.bgsm.edu/surg-sci/atlas/atlas.html>. An absorbing set of Surgery links is on offer at <http://207.226.184.98/cat1/s/s561.htm> while a large set of Breast carcinoma links is at hand at <http://www.med.umich.edu/1libr/cancer/breast06.htm>. The largest set of Oncology links is available at <http://micf.mic.ki.se/Diseases/c4.html> and <http://advocacy-net.com/cancermks.htm>.

Tuberculosis has been extensively indexed at Lupin TB Links <http://www.lupingroup.com/index1.htm> while Malaria Links have been comprehensively compiled at <http://www.geocities.com/HotSprings/Resort/5403/Links.htm>. Diabetes mellitus has its links at <http://www.mtsinai.org/diabetese.html> while Acid Base tutorial is an excellent info base at <http://www.tmc.tulane.edu/departments/anaesthesiology/acid/acid.html>. The entire George Simon's plain film collection is accessible at <http://www.sbu.ac.uk/dirt/museum/g-topics.html>. There is a Temporal bone - interactive electronic textbook at http://206.39.77.2/temporalbone/temporal_home.html and an Atlas of Diagnostic Laparoscopic Surgery at [http://www-surgery.med.ohio-state.edu/atlas/.Dermatological Online Atlas](http://www-surgery.med.ohio-state.edu/atlas/.DermatologicalOnlineAtlas) is a database, available on the WWW at <http://www.derma.med.uni-erlangen.de>. GynObst is a website featured at <http://www.gynob.com/index.htm> while Infertility resources are located at <http://www.ihr.com/infertility/index.html>. A complete textbook of Orthopaedics by Wheelless is available at <http://www.medmedia.com/med.htm>.

Urology and Nephrology is compiled exhaustively at <http://www.medmark.org/uro> and <http://www.medmark.org/neph/>. The foremost transplantation site at the moment is transweb at <http://www.transweb.org/> and there is a large set of organ transplantation links at <http://www.asf.org/other.html>. The entire range of pharmaceutical products can be accessed from Drug Search Lists <http://www.rxlist.com/or> at Pharminfo Net <http://pharminfo.com/>. Specifically for antibiotics, there is a guide, which offers details at Antibiotic Guide <http://www.intmed.mcw.edu/AntibioticGuide.html>

Multiple specialities links

There are special "one-stop" medical sites that conveniently catalogue the best of each speciality and link

them directly from a single page. These popular sites are located as MSSM Speciality Links at <http://www.mtsinai.org/msites.html>, Omni Multiple Medical teaching Modules at <http://omni.ac.uk/search/>, Essential Medical Links at <http://www.el.com/elinks/medicine/>, Medical Students Links at <http://som.flinders.edu.au/FUSA/FMSS/NAMSA/medicine.html>, Galaxy Guide to Medical Topics at <http://galaxy.einet.net/galaxy/Medicine.html>, Internet Medical Search Guide <http://www.pcom.edu/library/clinical.htm>, Disease Link <http://www2.mc.duke.edu/depts/ptot/Current-Site/Links/JC-Bookmarks.html>. Nursing and Medical Links at <http://www.seaox.com/nurse.html>,

Electronic Books on the Net

A further significant feature on the Net is the access to medical textbooks online which are freely available. At the moment, the most popular e-medical books are AIDS at <http://hivinsite.ucsf.edu/akb/1997/> [6]. Pediatric Critical Care at <http://pedscm.wustl.edu/AllNet/main.html>, Telemedicine Textbook at <http://www.coiera.com/>, Textbook of Virtual Anaesthesia accessible at <http://www.usyd.edu.au/su/anaes/VAT/VAT.html>, Wheelless' Textbook of Orthopaedics at <http://www.medmedia.com/med.htm>, Yale University Heart Book at [http://www.med.yale.edu/library/heartbk/Online Merck's manual](http://www.med.yale.edu/library/heartbk/OnlineMerck'smanual) accessible at <http://www.merck.com/pubs/mmanual/> and Harrison's online at <http://www.harrissononline.com/>.

Searching medical literature and articles on the Net

The widespread use of computers and the internet have made searching the medical literature easier and more accessible to most medical practitioners. Medline is the National Library of Medicine's premier bibliographic database from 1966 to the present. It covers the fields of medicine, nursing, dental medicine, the healthcare system, veterinary medicine, and the preclinical sciences and is available free on the Internet through many agencies including PubMed: <http://www.ncbi.nlm.nih.gov/PubMed/> [5]. This retrieval system allows users of all skill levels to obtain important medical information. A shortcoming however is that the full articles may not be available freely.

Another popular site utilised for searching the net is Internet Gratefulmed at <http://igm.nlm.nih.gov/> [6]. In addition there are sites which compare the various web agencies that offer Medline, namely Medmatrix Medline Comparator at <http://www.medmatrix.org/info/medlinetable.asp> and a site recently intro-

duced at Invivo Medline List <http://www.in-vivo.net/bg/medline2.html>.

Journals on the Net

Medical Journals undoubtedly form the backbone of scientific learning and effective medical practice [7]. There are sites that have been compiled across the globe which display a list of medical journals. The various medical journals are catalogued at popular sites such as Medical Centre Libraries Journal Index at http://scilib.ucsd.edu/bml/medj_nz.htm, Medwebplus Medical Journals at <http://medwebplus.com/subject/Sciencekomm> Medical Journals at <http://www.sciencekomm.at/journals/medicine/med-bio.html>.

Other excellent compilation of medical journals on the net is located at UNICA Biomedical journals list <http://pacs.unica.it/period.htm>, Stanford Medical Journal Site at <http://highwire.stanford.edu/>, Teleport Medical Journal at <http://www.teleport.com~heston/journal/chat.htm>, Mednets Journal Links <http://www.internets.com/mednets/obgyn.htm>, Webmedlit at <http://www.webmedlit.com/>, Utah Online E-Journals List <http://medstat.med.utah.edu/database/ejournal.html> and Science Direct Medical Journals <http://www.sciencedirect.com>.

There are sites now available, which focus on articles derived from medical journals based in India, too. These are available at Indian Journals Medline database <http://www.qmedin.com/medsites/medlinejournals.htm> and Indian NIC journals database at <http://www.qmedin.com/medsites/fulltext.htm>.

Popular Medical Journals

There are certain medical journals, which comprehensively cater to a wide group of medical professionals merging the barriers between various disciplines. As an illustrative example, a small select group of the popular medical journals available on the internet typically includes British Medical Journal at <http://www.bmj.com/>, JAMA at <http://www.ama-assn.org/public/journals/jama/jamahome.htm>, Lancet at <http://www.thelancet.com/> and NEJM Online at [Http://www.nejm.org/content/index.asp](http://www.nejm.org/content/index.asp).

CME on the Net

Continuing medical education (CME) is meant to bridge the gap between new scientific observations and clinical practice [8]. However, traditional CME has not been effective at altering the behaviour of physicians. In traditional CME, the clinician does not choose the topic, the pace of the programmes or the place of learning, and the CME material cannot be

easily delivered to the point of care where the clinician needs the information. Computers and computer networks have the potential to accomplish these goals. On the Internet, CME has begun to appear but there have been few evaluations of its usefulness, acceptance, and effectiveness. While these issues are being addressed, on line CME can be experienced from the following sites at CME Medscape List <http://www.medscape.com/Home/CMEcenter/CMEcenter.html> CME Web at <http://www.cmeweb.com/> and CME at <http://ahsn.lhsc.on.ca/ce/>.

Consultation Online

Increased use of e-mail by physicians, patients, health care organizations and staff has the potential to reshape the current boundaries of relationships in medical practice. By comparing reception of e-mail technology in medical practice with its historical analogue, reception of the telephone, there are new expectations, practice standards, and potential liabilities that emerge with the introduction of this new communication technology [9]. Doctors, at many places around the world have begun using e-mail for online consultation, fully understanding the ramifications of communicating electronically with patients, by obtaining documented informed consent before using e-mail [10].

Health Care and Internet

Healthcare is a major candidate for improvement in any vision of the kinds of 'information highways' and 'information societies' that are now being visualised. The medical information management market is one of the largest and fastest growing segments of the healthcare device industry. Medicine and health care is not merely a subject matter on national programmes but often has global connotation. Some of the global agencies that are authorities on health care, accessible on the Internet include CDC <http://www.cdc.gov/> and WHO Health Topics http://who.org/home/map_ht.html

Health Care and India

Websites dealing with the various issues of health care in India are emerging fast. These include India Health http://www.healthlibrary.com/india_file.html, Q Med <http://www.qmedin.com/medsites/index.htm>, Oxfam Health Care in India <http://www.oxfam.org.uk/ccolplanet/kidsworld/world/indhealth.htm>, WebIndia Health India <http://www.webindia.com/category/healthcare.html> and Health Library India's first at <http://www.healthlibrary.com/index.htm>

Other sites in Medicine

In addition to the sites described above, there are few Internet sites that cover the spectrum of topics that influences our "day to day" medical practice. Some of these sites that are available on the Internet are Introductory Statistics at <http://www.psychstat.smsu.edu/sbkOO.htm>, Online Statistics to use at <http://www.physics.csbsju.edu/stats/>, Clay Helbers Statistics Links at <http://www.execpc.com~helberg/statistics.html>. Medical Quotations is available at <http://www.doctor-spaga.net/quotes.asp> while Medical Cartoons can be browsed at <http://www.glasbergen.com/>

Telehealth

Telehealth is the practice of providing health care services to people who are distant from the provider by the use of telecommunications and information technology [11]. This sophisticated real online applications tool, also referred as Telemedicine, encompasses various tenets such as tele-education, tele-training, tele-mentoring, teleproctoring and tele-accreditation, tele-presence and telemanipulation. Telehealth and telemedicine services include client care, consultations, education and research in a variety of specialties creating new buzzwords such as telemedicine, telecardiology, teleradiology, telepathology and so on.

The Flipside

Internet and information technologies may help reduce health disparities through their potential for promoting health, preventing disease, and supporting clinical care for all. Unfortunately on the flipside, there are many patients with health problems least likely to have access to such technologies. Barriers to access include cost, geographic location, illiteracy, disability, and factors related to the capacity of people to use these technologies appropriately and effectively [12]. In addition, information on the World Wide Web is unstructured, distributed, multimedia oriented and multilingual [13]. Moreover, there are massive technical, legal, and ethical dilemmas that need to be resolved before Cybermedicine can become a standard method of physician's practice [14]. Indeed, the variable quality of information on the Web is a testament to this uncertainty. Areas of concerns are evident in telehealth too and relate to financial cost, reimbursement, liability, licensure, and confidentiality.

The Scenario at the dawn of the new millenium

At present the Internet and the World Wide Web (WWW) have emerged as trend breaking technologies. Internet sites relevant to practice of medicine are

appearing rapidly. Societies are using the WWW for transmission and review of publication materials. News groups interactively discuss current developments and trends [15]. Sites are available which facilitate medical education using the WWW, program information, symposium coordination, links to regional subspecialty societies, residency cataloguing, patient question and answer forums, and multimedia procedure descriptions. The Internet is rapidly becoming a third party in the doctor-patient relationship. The appropriate and effective use of the Internet, as well as its boundaries, are rapidly expanding in medicine and three special aspects need addressing in the new millenium: privacy, legal requirements, and the necessity of transferring large amounts of data.

The practice of Medicine will be more integrated with the Internet in the twenty first century [17]. Electronic textbooks and conventional slide shows will migrate in large numbers to the WWW for convenient downloading for doctors and patients. Multimedia capabilities of the WWW that expand the depth of information transmission will enable education emanating from remote sites with narration and video depiction of procedures.

The Internet is a vast network of computers spanning the entire globe. Equally limitless and knowing no confines is the world of Medicine and its various disciplines. When the fusion of the two occurs as at present, inevitably there is an explosion of information. At the moment the explosion is yet to settle, with waves of data descending upon the medical fraternity. As far as one can see, it would be impossible to browse and evaluate completely all the medicine and health care related sites. The article strives to outline Medicine on the Internet, in an attempt to facilitate all medical personnel to meaningfully and quickly derive information. At the dawn of the new millennium, it is apparent that the Internet, e-mail, world wide web and the information superhighway is here to stay and medical education, teaching, and research, as well as clinical practice, will be affected in numerous different ways by these advances.

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