An eye on the web

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Biomedical databases:

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Introduction

Retrieval of literature from biomedical journal databases is important for medical practitioners, since it is a scholarly need, an academic and publishing requirement, and a means of updating oneself professionally. Present-day computer technology, internet and communication networks offer the medical profession the benefit of timely and convenient access to premium biomedical and journal databases. Biomedical journal databases now represent a paradigm shift sweeping across areas such as text access, topical coverage, retrieval methods, quantity and quality of offered contents and payment systems. Reviewed here are some currently available biomedical and leading medical journal databases.

Are there any databases other than Medline?

It is well known that major biomedical databases cover only a fraction of the world literature. Indeed, Medline, the premier medical database, takes in just a portion of the vast amount of medical literature. The medical fraternity faces a dilemma when it comes to searching and retrieving biomedical literature beyond what is offered from databases such as Medline. This is skewed further by a preference worldwide to selectively include English language publications. Medline does not have all the answers and is particularly lacking in biomedical information from various countries including India, as well as languages other than English. Further, strict selection criteria narrow the scope of coverage by the inclusion of indexed journals only. There is no cataloguing of databases using evidence-based methods or a built-in critical analysis of the vast amounts of biomedical literature, even for common clinical conditions.

Plugging the aforementioned lacunae while resolving scholarly needs, newer databases have surfaced, some with trend-setting features. While databases such as IndMED and Lilacs are country-specific, regional biomedical databases, there are others such as PsychLit and Toxline, which are quality databases focusing on specialties. Database that cover diseases are emerging as well such as Cancerlit and Aidsline.

While medical journal databases contain peer-reviewed and other journals as their sole resource, biomedical databases are a larger repository that take in an assortment of books, journals, theses, dissertations, newsletters, magazines, e-journals and publications, in different combinations.

The ongoing transformation of
biomedical databases

In the early 1990s, until the onset of exponential growth of the internet, there was the Index Medicus. As a copyright product of the National Library of Medicine (NLM), the Index Medicus was created by meticulously organized references and indexing of biomedical publications, with an electronic version, referred to as Medline.1 By the mid-1990s, NLM produced Medline, licensed it to vendors who made it available at a substantial cost to individual users.2

The increasing impact of the internet was felt across the world of biomedical databases and journal publishing. By the end of the 1990s, free electronic access of numerous journals to paid subscribers commenced. The internet not only offered global connectivity, but also facilitated globalization of scientific literature. It was evident that electronic versions of journals had some inherent advantages over a print copy such as incorporation of multimedia, liberal use of colour, elimination of delays in manuscript processing, news alerting, instant 'real-time' online discussions and was less expensive to bring out than paper versions.

The NLM by this time began providing free access to its key Medline service, in the form of Pubmed.3 Reflecting the technological advances, a revised 'new look' Pubmed was launched in early 2000, overshadowing the earlier Internet Grateful Med by its more flexible and sophisticated searching, as well as full text links to publishers on the internet. These new features seamlessly connected the premium biomedical database with numerous publishers worldwide.

In 1999, Harold Varmus, Director of the National Institutes of Health (NIH), made a far-reaching proposal suggesting the creation of a national biomedical literature server called 'E-Biomed'.4 This proposed

server was to offer three radical features: free accessibility, full searchability and full-text version availability. The server, with a modified name 'Pubmed Central' came into being in 2000, with the aim of being a digital archive of the full text of all original research articles listed in NLM's Medline database, accessible free on the internet.

A major development occurred in July 2001, heralded by an announcement from Richard Smith, editor of the British Medical Journal; Gro Harlem Brundtland, director-general of the WHO; and Jon Conibear of Blackwell, that six of the world's leading medical publishers (Blackwell Science, Elsevier Science, Harcourt International, John Wiley, Springer Verlag and Wolters Kluwer) had decided to enable more than 100 of the world's poorest countries to access scientific information free through the internet, thereby offering them access to over 1000 of the top 1240 international biomedical journals.5 Achieved by the automatic detection of IP addresses of users, many consider this as a defining moment in the dissemination of scientific knowledge and 'perhaps the biggest step ever taken towards reducing the health information gap between rich and poor countries'.6

Established by a core group of reputed research scholars in 1999, the Public Library of Science at http://Publiclibraryof-science.com is committed to the spread of free access to scientific literature. Two key areas advocated by this body are imploring scientific publishers to offer for free research articles from journals to a public online archive within six months of publication and appealing for the boycott of publishers who do not allow the above.7

Evidently, the ongoing metamorphosis to electronic versions of biomedical literature, driven by the expansive growth of the internet, has symbolically transformed the axiom 'Publish or perish' to 'Publish online or perish' and this has been modified lately to 'Publish free or perish'.8

Premium Online Biomedical Databases
There are many biomedical and journal databases that are available free on the internet today. Catering to a variety of scholarly needs, they range from multispecialty databases (Medline and Pubmed) to retrieval of specific biomedical literature that focuses on countries (IndMed), regions (Caribbean: Lilac), disease entities (Cancer), specialties (PsychLit), evidence-based medicine (Bandolier) and randomized controlled trials (Cochrane). A set of premium biomedical databases are alphabetically categorized below.

ACP Journal Club Online at http://www.acpjc.org/ is a database compilation that contains critiques of recent journal articles on clinically relevant topics. Formerly called ACP Best Evidence, the ACP Journal Club Online is published bimonthly by the American College of Physicians–American Society of Internal Medicine (ACP–ASIM). It offers a quick review of original articles and seminal reporting studies, and systematic reviews that shape the practice of internal medicine.9

Bandolier is an evidence-based health journal available at http://www.jr2.ox.ac.uk/bandolier. Bandolier uses evidence-based medicine techniques to provide advice about particular treatments or diseases and is considered as one of the premier sources of evidence-based information for general practitioners in England. First published in February 1994, the monthly journal commenced its internet version in 1995. The content is derived from (secondary) reviews of (primary) trials. The information about evidence of effectiveness (or lack of it) is placed in simple 'bullet-points'. The site is also linked to the Bandolier migraine site at http://www.jr2.ox.ac.uk/bandolier/booth/booths/migraine.html, the Bandolier gout site at http://www.jr2.ox.ac.uk/bandolier/booth/booths/gout.html, and the Oxford pain internet site at http://www.jr2.ox.ac.uk/bandolier/booth/painpag/index.html.

BIOME at http://biome.ac.uk/ is a gateway to a searchable catalogue of internet sources. Comprising a host of databases such as OMNI (health and medicine), Biores (biological and biomedical sciences) and VetGate (animal health), it has been created by a core team of information specialists and subject experts from the University of Nottingham Greenfield Medical Library, in partnership with key organizations throughout the UK. Organizing Medical Networked Information (OMNI) at http://omni.ac.uk/ 'offers free access to a searchable catalogue of internet sites covering health and medicine'. Bioresearch is a searchable catalogue of internet sites covering the biological and biomedical sciences, genetics, biotechnology, virology, biochemistry and molecular biology.

BioMed Central, a part of the Current Science Group from London, is accessible at http://biomedcentral.com. This biomedical portal is credited with ushering in a new concept in publishing in the electronic age, by offering online publishing of biomedical and research articles in nearly 20 biological and 40 biomedical disciplines with no barriers to access. It is an independent publishing

house that facilitates immediate and free access to peer-reviewed biomedical research. Interestingly, authors pay a fee of US$ 500 for processing an article, which includes submission, peer review, revision and publication, and the copyright is retained by the authors. After acceptance, original articles are published sequentially in BioMed Central online journals, posted in PubMed Central and catalogued in PubMed. This biomedical portal is stated to complement PubMed Central.
BioMedNet is available at http://www.bmn.com/. Owned by Elsevier Science and part of the Reed Elsevier group of companies, BioMedNet is a premier website for biological medical researchers. Membership to BioMedNet is free and members can search all of BioMedNet without any charge. However, viewing full-text articles from publishers often requires payment or a subscription. E-mail alerts are available from http://my.bmn.com/myalerts/availalerts. Besides, there is a reviewed list of over 3500 websites.

Cancerlit® at http://cnetdb.nci.nih.gov/cancerlit.shtml or http://www.cancer.gov/search/cancer_literature/ is a comprehensive bibliographic cancer literature database published from the 1960s to the present that covers nearly 2 million citations and abstracts from over 4000 different sources including 'biomedical journals, proceedings, books, reports, and doctoral theses'. Updated every month, the material can be searched by Title, Author, MeSH (medical subject headings) word, Publication type and by the popular Topic Searches. CANCERLIT® Topic Searches is generated monthly from CANCERLIT®, National Cancer Institute's (NCI) bibliographic database, presenting literature searches on more than 90 topics such as AIDS-related cancers, breast cancer, head and neck cancers, etc.

CDC Wonder Database at http://wonder.cdc.gov/ is essentially a single point of access to a variety of CDC reports, guidelines and numeric public health data. After a mandatory registration, one can query statistical datasets or retrieve reports and guidelines or obtain an overview of the same. Besides this, scientific material is also available at http://www.cdc.gov/scientific.htm comprising scientific data, surveillance, health statistics, laboratory information and information resources.

Clinical Evidence at http://www.clinicalevidence.com/ is 'a compendium of summaries of the best available evidence about what works and what doesn't work in health care'. It 'aims to provide clinicians with a summary of the best available evidence to answer clinical questions'.10 Published by the BMJ Publishing Group, Clinical Evidence is a monthly, updated directory, focusing on a 'concise account of current state of knowledge, ignorance, and uncertainty about the prevention and treatment of a wide range of clinical conditions based on thorough searches of the literature'.

Clinical Trials.gov is a site accessible at http://clinicaltrials.gov/, and provides information about medical studies to evaluate the safety and effectiveness of new drugs, medical procedures, or other means of treating, diagnosing, or preventing diseases. Launched in February 2000 to establish a registry of clinical trials for both federally and privately funded trials of experimental treatments for serious or life-threatening diseases or conditions, this website currently contains approximately 5700 sponsored clinical studies. The site has been developed by NIH through NLM in collaboration with the Food and Drugs Administration (FDA). Clinical Trials can be searched by a basic trial search or by specific focused search of disease, location, treatment or sponsor.

Cochrane Library at http://www.cochranelibrary.com/ is named after Archie Cochrane, a British proponent of randomized controlled trials (RCTs), particularly in pregnancy and childbirth. The Cochrane Library comprises a regularly updated collection of evidence-based medicine databases, the Cochrane controlled trials register, Cochrane database of systematic reviews, Database of abstracts of reviews of effectiveness (DARE) and the Cochrane review methodology database. Published quarterly, the material has emerged as a single source of reliable evidence about the effects of healthcare. While the abstracts of Cochrane Reviews are available free at http//www.cochrane.org/cochrane/revabstre/mainindex.htm and http://www.update-software.com/cochrane/abstract.htm, the Cochrane Database of Systematic Reviews is available through subscription. Recently, the Cochrane Library is accessible by low-income countries by means of HINARI—Health InterNetwork Access to Research Initiative, a partnership between WHO and Update Software, that requires online registration at http://www.healthinternetwork.org/src/registration.php.
CRD Databases are a group of three databases available at http://144.32.228.3/scripts/WEBC.EXE/NHSCRD/start. They are DARE, also available at http://agatha.york.ac.uk/darehp.htm, NHS Economic Evaluation Database and Health Technology Assessment (HTA) Database. They can be searched here free, individually or together.
EMBASE (denoting Excerpta Medica database) is a bibliographic database accessible by payment at http://www.elsevier.com/locate/embase. It has a comprehensive international coverage containing over

4000 biomedical journals from 70 countries, dating back to 1974. Updated weekly, it is available online through major database vendors such as DataStar, Ovid Online, ScienceDirect, etc. A unique indexing system is available that utilizes EMTREE, which is an hierarchically ordered, synonym-controlled thesaurus. Besides, exclusive searches can be made in specialized areas such as drugs, biotechnology, pharmacy and medical devices.

Evidence-Based On-Call at http://www.eboncall.co.uk/ is a compiled database of evidence-based summaries for the management of specific major medical problems. Catering to junior hospital doctors, some common topics in internal medicine are catalogued alphabetically and the material is organized in levels.

ExtraMed at http://www.iwsp.org/extraMed.htm focuses and publishes material from journals that are largely excluded from the international indexes. Recently joining the free health information initiative for reducing the health information gap between rich and poor countries, Informania Ltd, the world's largest electronic publisher of biomedical journals from the Third World, now provides ExtraMED full-text database to developing country users for free or at a very low cost, through its Information Waystations and Staging Posts Network at htttp://www.iwsp.org

HIV Database at http://hiv-web.lanl.gov/content/index contains data on HIV genetic sequences, immunological epitopes, drug resistance-associated mutations and vaccine trials. Similarly, the European Database on AIDS and HIV Infection at http://www.edoa.org/ is a bibliographic database of educational material on European centres specializing in AIDS and HIV infection.

IndMED at http://indmed.nic.in/indmed.html is the premier online biomedical research and healthcare database for India. The database has been created by a partnership between the Indian Council of Medical Research and National Informatics Centre for Biomedical Information at the Department of Information Technology. Seventy-five peer-reviewed Indian biomedical journals have been included in the IndMED database, in the first phase. It is expected to offer journals from 1985 onwards. Recently recognized as the seventeenth international Medlar centre, its next phase entails the development of a full-text database of Indian biomedical journals.

ISI Web of Science at http://www.isinet.com/isi/products/citation/wos/ provides access to the Science Citation Expanded®. The ISI® Science Citation Index (SCI®) at http://www.isinet.com/isi/products/citation/sci/ offers, for a fee, science and technical references from nearly 3700 of the world's leading scholarly journals from several disciplines. Besides, there is an expanded format available through ISI Web of Science® and an online version, SciSearch®, that covers more than 5800 journals. Special features include broad-based, comprehensive searches, multi-disciplinary searches, availability in formats such as internet, intranet and CD-ROM.

Medline is the NLM's premier biomedical, multijournal, bibliographic database, accessible at http://www.nlm.nih.gov/, incorporating the fields of medicine, nursing, dentistry, veterinary medicine, the healthcare system and the preclinical sciences. Medline contains bibliographic citations and author abstracts from more than 4000 published biomedical journals and over 12 million citations, dating back to 1966.3 Only a part of the biomedical publications available worldwide are indexed in Medline. Medline (Old) at http://gateway.nlm.nih.gov/gw/Cmd has references to articles published before 1966, particularly during the period 1960–65.

The Ministry of Health and Family Welfare at http://mohfw.nic.in/reports/index.htm offers a variety of reports and publications on issues related to health and family welfare. Most documents are in the Acrobat Reader format. A special feature is the downloadable Hindi fonts.

Multiple Congenital Anomaly/Mental Retardation (MCA/MR) Syndromes is essentially an informative 'database of structured descriptions of congenital abnormalities associated with mental retardation' created by Stanley Jablonski. The online database stores nearly 700 syndromes of multiple congenital anomalies that are associated with mental retardation, and has links to the full text of Online Mendelian Inheritance in Man (OMIM). The site, available at http://www.nlm.nih.gov/mesh/jablonski/syndrome_title.html, utilizes a powerful search engine that enables search by fields, major features, syndrome name, synonym, MeSH term or by OMIM number. A table of contents with the disorders catalogued from A to Z is available at http://www.nlm.nih.gov/mesh/jablonski/syndrome_toc/toc_a.html
NIH Clinical Alerts and Advisories, available at http://www.nlm.nih.gov/databases/alerts/clinical_alerts.html, expedites the release of findings from

the NIH-funded clinical trials, where such release could significantly affect morbidity and mortality. At the moment, there are 19 clinical alerts and 3 clinical advisories. To illustrate, details on 'Important therapeutic information on prevention of recurrent Pneumocystis carinii pneumonia in persons with AIDS' from the National Institute of Allergy and Infectious Diseases (NIAID) is an example of a clinical alert, while 'Treating hypertension in the patient with type 2 diabetes' from National Heart, Lung, and Blood Institute (NHLBI) is a clinical advisory.

Online Mendelian Inheritance in Man (OMIM) is now incorporated into NCBI's Entrez system and can be queried using the same approach as the other Entrez databases such as PubMed and GenBank. OMIM is available at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=OMIM. The OMIM database is a catalogue of human genes and genetic disorders authored principally from Johns Hopkins, and developed for the internet by the National Center for Biotechnology Information (NCBI). Physicians and professionals concerned with genetic disorders, researchers in the field of genetics and advanced students in science and medicine draw on OMIM for reference. The database contains textual information and references. It also contains links to MEDLINE and sequence records in the Entrez system, and links to additional related resources at NCBI.

PERI stands for Programme for the Enhancement of Research Information. The web portal, established by the 'International Network for Availability of Scientific Publication', is available at http://www.inasp.org.uk/peri/free.html and provides access to many scientific resources including health information. The site also provides a training programme on the use of The Cochrane Library. There are other areas that focus on delivering international information, disseminating national and regional research and strengthening publishing.

Public Library of Science (PLS) at http://publiclibraryofscience. org/ is a non-profit organization of scientists, focusing on making biomedical literature freely accessible to scientists and the public. The aim of such a movement is mainly to benefit scientific progress and education. Founded by a group of 12 scientists, the Public Library of Science has urged scientific publishers to forward research articles from their journals to public online archives for free within six months of publication. Moreover, the movement threatened a boycott commencing in September 2001, to 'publish in, edit or review for, and personally subscribe to, only those scholarly and scientific journals' that agreed. One important aim of PLS is to integrate biomedical information from disparate and segregated sources to one common library. From early 2003 the library is expected to begin publishing journals that fully realize the principles of this movement.

PubMed is reachable at http://www.ncbi.nlm.nih.gov/PubMed. PubMed has been developed by NLM (http://www.nlm.nih.gov/), NCBI (http://www.ncbi.nlm.nih.gov/) and NIH (http://www.nih.gov/).3 Historically, PubMed is a list of all bibliographic information, drawn primarily from Medline, Pre Medline, Healthstar, and Publisher-Supplied citations. Entrez is a search and retrieval system that integrates information from databases at NCBI on macromolecular structures, DNA and protein sequences, etc. through PubMed. Simply put, PubMed is one of several databases under NCBI's Entrez retrieval system. Both the above databases are now in a portal with a new look 'Entrez PubMed'. The searches are made possible by Journal Browser, MeSH Citation Matchers and Clinical Queries using Research Methodology Filters.

PubMed Central is an outcome of an initiative by Harold Varmus, Director of the US NIH.4 The original proposal centred on a need to create an entirely electronic repository of all biomedical publications in the form of E-biomed. PubMed Central, a barrier-free NIH repository, was launched in January 2000 at http://www.pubmedcentral. nih.gov/ with the aim of being a digital archive of the full text of all original research articles listed in the NLM's Medline database, accessible free on the internet. The objective is to allow citations of interest to be linked to the full text of the articles without having to pay a publisher for the privilege. PubMed Central has no role in publishing journals, but allows voluntary participation of publishers who have the copyright. The response has been slow and steady. While by the end of 2000 only 9 journals had posted their contents free, their number had grown to 23 in 2002 and to 53 in 2003.

TRIP database at http://www.tripdatabase.com/index.cfm searches for information from over 75 sites of high-quality medical information and 26 databases from evidence-based sites around the world. Created in 1997, the database collates 'evidence-based' healthcare resources. Material on special topics such as Cancer, Infectious Diseases, Neurology, etc. are also available.

Table I. Biomedical databases11–14

Biomedical database	URL
ABLEDATA	http://www.abledata.com/text2/search.htm
ACTIS	http://www.actis.org/index.html
BIBLIOSLEEP	http://www.websciences.org/bibliosleep/
CAM DATABASES	http://nccam.nih.gov/databases.html
CANCER PDQ	http://www.cancer.gov/cancer_information/pdq/
CHID	http://chid.nih.gov/welcome/welcome.html
CINAHL	http://www.cinahl.com/
SCIENCE CITATION INDEX	http://www.isinet.com/isi/products/citation/sci/
CONTROLLED TRIALS IN HISTORY	http://www.rcpe.ac.uk/controlled_trials/index.html
CURRENT CONTENTS	http://www.isinet.com/isi/products/cc/
DOD BIOMEDICAL DATABASE	http://www.scitechweb.com/acau/brd/
EMBASE	http://www.embase.com/
ERIC/AE TEST LOCATOR	http://ericae.net/testcol.htm
EXCERPTA MEDICA	http://www.excerptamedica.com/hq/
HAZARDOUS CHEMICAL DATABASE	http://ull.chemistry.uakron.edu/erd
HEALTH PROMIS	http://healthpromis.hda-online.org.uk/
HSTAT	http://text.nlm.nih.gov/
INFOPOEMS	http://www.infopoems.com
INDEX MEDICUS	http://www.nlm.nih.gov/tsd/serials/lji.html
LILACS	http://www.bireme.br/bvs/E/ebd.htm
ALCOHOL DRUG DATABASE	http://www.health.org/dbases/index.htm
NORD	http://www.stepstn.com/nord/db/dbsearch/search.htm
OFFICE OF RARE DISEASES	http://rarediseases.info.nih.gov/
PEDRO	http://ptwww.cchs.usyd.edu.au/pedro/
POPLINE	http://db.jhuccp.org/popinform/
PSYCHINFO	http://www.apa.org/psycinfo/
TOXNET-TOXLINE	http://toxnet.nlm.nih.gov/
TRIALSCENTRAL	http://www.trialscentral.org/

Table II. Useful sites for the retrieval of biomedical journal articles

AMEDEO	http://www.amedeo.com/
BEST OF SCIENCE	http://bestofscience.free.fr/
ELECTRONIC JOURNAL MINER	http://ejournal.coalliance.org/
EXTRAMED	http://www.iwsp.org/extraMed.htm
EMBASE	http://www.embase.com/
FREE MEDICAL JOURNALS	http://www.freemedicaljournals.com/
HARDIN FREE MEDICAL JOURNAL	http://www.lib.uiowa.edu/hardin/md/ej.html
HIGHWIRE PRESS	http://highwire.stanford.edu/lists/freeart.dtl.
HINARI	http://www.healthinternetwork.net/
IDEAL	http://www.idealibrary.com
JOURNAL CLUB	http://www.journalclub.org/index.html
JOURNAL WATCH ONLINE	http://www.jwatch.org/
MATWEB	http://matweb.hcuge.ch//Medical_journals/Free_medical_journals.htm
MEDICAL JOURNALS.COM	http://www.MedicalJournals.co.uk
MEDBIOWORLD	http://www.sciencekomm.at/advice/up2date.html
PUBLIST	http://www.publist.com/
PUBSCIENCE	http://pubsci.osti.gov/
RESEARCHINDEX	http://citeseer.nj.nec.com/
SCIBASE	http://www.thescientificworld.com/scibase/search.asp
SCIELO	http://www.scielo.br/
SCIRUS	http://scirus.com/
SUMSEARCH	http://SUMSearch.UTHSCSA.edu/cgi-bin/SUMSearch.exe
WEBMEDLIT	http://www.webmedlit.com/

WHOLIS is the library database of World Health Organization, indexing all WHO publications since 1948. Available at hWHOLIS is the library database of World Health Organization, indexing all WHO publications since 1948. Available at http://www.who.int/library/database/index.en.shtml the library database is a part of the Library and Information Networks for Knowledge. This particularly useful database is searchable by a versatile web interface that facilitates search by words or phrase, author, title, subject, series, periodical title or publication type.

UNESCO (United Nations Educational, Scientific and Cultural Organization) has full-text documents available at http://unesdoc.unesco.org/ulis/. These documents are available in text or image mode.

Table I provides a list of other useful biomedical databases. Locating abstracts and text from biomedical journals is an arduous task that is made further intricate by the ongoing upheaval in the world of scholarly publishing. Table II lists a few useful websites that assist in the scholarly exercise.

Conclusion

An unprecedented transformation of biomedical journal databases is taking place globally, triggered principally by relentless advances in computer technology; the internet and communication technology. Towards the end of the last millennium, the traditional models of journals and databases have radically

shifted to an era of free online access of full text.15 There has been a natural transformation to a 'two-speed scholarly communication economy' at the moment with a traditional print model and a new electronic version.16

Within publishing groups an intense debate is on, which is determining what academicians want from electronic versions of journals and in what form. It is difficult to predict where the momentum will take the existing model of biomedical literature retrieval in the years ahead. The end-point of this techno-academic renaissance is not known and will be determined largely by scholarly needs, peer-reviewing strategies, publisher controls and global initiatives.

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