

Internet resources for occupational and environmental health professionals[☆]

Gary N. Greenberg *

*Department of Community and Family Medicine, Division of Occupational and Environmental Medicine,
Duke University Medical Center, Durham, NC 27710, USA*

Abstract

The Internet's global reach offers new powerful tools to professionals in Occupational and Environmental Health (OEH). The World Wide Web includes extensive free and commercially available reference materials on toxicology, regulatory issues, environmental epidemiology and prevention programs. Much of this especially useful content is inaccessible to general Web-based search engines. Effective use of the Web requires discovery and familiarity with sites housing query engines for technical databases. Although the Web's structure and capacity is so dynamic that any listing is incomplete, introductions to many resources are provided in this article. The Internet also offers professionals electronic access to one another, for collegial discourse. Electronic mailing lists provide assembly points for collaboration and guidance about technical issues. Several specialty forums for OEH professionals are also discussed. © 2002 Elsevier Science Ireland Ltd. All rights reserved.

Keywords: Occupational medicine; Occupational health; Environmental health; Toxicology; Environmental exposures; Internet; Computer communication networks; Information services; Information storage and retrieval; Communication

1. Introduction

The technical information needs of Occupational and Environmental Health (OEH) professionals include a wide variety of topics and approaches. The professions included in the discipline may be involved in exposure assessment, risk appraisal, clinical evaluation and development and implementation of prevention standards. While seeking to reduce dangers associated

with citizen or worker exposure to chemical or biological hazards, physicians, hygienists and toxicologists may only rarely speak the same jargon or use the same professional tools. Despite this, each has occasional reason to sample ideas and facts from the same literature sources. The Internet has removed many previous barriers between these disciplines.

This paper briefly introduces many of the more useful Web-based resources for these professions. Any such effort is inevitably frustrated by the rapid pace of change in this topic, and the frustrating difference between editorial delays of publication and the Internet's undisciplined ballooning evolution. Nonetheless, nearly all of

[☆] PII of original article: S0300-483X(02)00028-8.

* Tel.: +1-919-684-6721

E-mail address: gary.greenberg@duke.edu (G.N. Greenberg).

the sites introduced in this document are *deep* resources, with portals to reference materials not accessible through simple web searches, and are likely to provide lasting value to professionals who visit and query them.

2. Medline

Beginning with exposure considerations and evidence of human disease, OEH professionals likely made earlier use than other specialties of the clinical indices at the National Library of Medicine (NLM's MEDLINE). This resource now contains 11 million citations (and often abstracts) from thousands of peer-reviewed biomedical publication issued since 1966, and is now available without cost. Given interest and practice, both professionals and patients can unearth case examples, experimental information, mechanistic explanations and risk calculations on virtually any health topic.

MEDLINE began as immense paper compendia, known as Index Medicus, requiring year-by-year manual searches at medical libraries. It later provided an online resource utilized only by specialized librarians and zealous clinicians. First popularly available through the PC-based program *Grateful Med* and online *Paper Chase*, access was purchased based on time in use and the volume of data received. These programs operated by translating queries from simplified user-menus into the library's own specialized syntax and provided only citations.

Presently, the most common approach to this accumulated data is through the free PubMed search engine created by the NLM itself (<http://pubmed.gov>). Another newer free search tool is the NLM *gateway* (<http://gateway.nlm.nih.gov/gw/Command>) which permits highly complex queries to Medline as well as non-bibliographic health information including abstracts, and listings of health organizations from NLM's DIRLINE database.

The PubMed search process is iterative and interactive, allowing users to monitor and mold output as it emerges. Findings can be narrowed to year of publication, species of interest, human age groups, publication language and even the

availability of an online abstract. Boolean operators ('AND', 'OR' and 'NOT') may be used to combine query responses and thus permit more selective identification of pertinent references. It is this Boolean logic that made MEDLINE so useful to OEH professionals in evaluating potentially attributable disease. Most early searches were queries to find reported cases combining an occupational exposure AND a particular disease.

Technical nuances which enable successful Medline searches include utilizing the chemical's unique Chemical Abstracts (CAS) identifier and the NLM's formally designated phrases for specific diseases and processes. *Occupational Exposure*, *Occupational Diseases*, and *Environmental Exposure* are examples of standardized terms (known as *MESH terms* or Medical Subject Headings) used by the NLM to index published materials and are powerful tools for searchers. The library indexing staff also categorizes specific shorthand concepts such as toxicity (to), poisoning (po), adverse effects (ae), etiology (et) and epidemiology (ep) in more subtle but useful delimiters called *subheadings*. It should be noted, though, that the PubMed interface also allows users to simply enter a free-text query and retrieve equally useful, if somewhat less specific, results.

Given the power and reach of the available data, many professionals choose to train specifically in optimum use of MEDLINE, and university medical libraries offer instructions at many levels of sophistication. There are also commercial secondary vendors of Medline data (e.g. Ovid Technologies <http://www.ovid.com>) which provide supplemental capabilities and menu tools to make the search process more apparent and simpler. Links and licenses to online whole-text copies of the original articles (not just citations or abstracts) for specific publications may also be included. Broad access to these programs is often purchased as a privilege for university faculty and members of professional societies. Other vendors (e.g. Silver Platter <http://www.silverplatter.com>) provide not only friendlier menus, but offline access (via CD-ROM) to literature subsets for specific topics, including OEH.

3. Additional federal resources

The NLM also houses other primarily non-clinical information, specifically aimed at toxicology. The Toxicology and Environmental Health Information Program (TEHIP) site offers TOXNET (<http://toxnet.nlm.nih.gov>) a resource including several extensive and useful databases. The most biomedically oriented of these is the Hazardous Substances Data Bank (HSDB), where chemical information including human and animal health effects, and mechanisms of toxic injury are presented in a systematic format. Environmental management and safety issues are also presented, including information about environmental releases and kinetics of chemical degradation.

Often, OEH professionals need access to regulatory information instead of scientific findings or ideas. This mundane and frustrating task has been simplified by increasingly sophisticated online tools offered by regulatory agencies. In the United States, pertinent bodies include Occupational Safety and Health and Mine Safety and Health Administrations (OSHA and MSHA, both in the Department of Labor), Department of Transportation (DOT), Environmental Protection Agency (EPA), and the Department of Agriculture. Internet users may find these resources most readily through the national government's own search aide: <http://www.fedworld.gov>.

OSHA in particular has a rich resource of regulatory documentation. Its central website (<http://www.osha.gov>) links to all necessary legal documentation including the history of its interpretative positions as well as explanatory technical information for implementation of regulatory standards. Available materials are often combined by industry affected, and include educational materials for workers at risk from specific hazards. Even enforcement actions are searchable by topic, industry and date.

OSHA is not a scientific but a regulatory agency. National Institute for Occupational Safety and Health (NIOSH) a part of the Centers for Disease Control and Prevention (CDC) is a supplemental resource for issues relating to OEH. The NIOSH site (<http://www.cdc.gov/niosh>) provides information regarding *best practices* in spe-

cific occupational situations, and comprehensive advisory guidelines for certain occupational hazards. Proposed exposure limits (often different than the standards enforced by OSHA) are posted, as well as the whole text of certain on-site investigations of work places with unusual health concerns (Health Hazard Evaluations).

NIOSH also provides a specialized citation and scientific literature index to biomedical resources beyond those offered at NLM, including textbooks and non-peer-reviewed abstracts. NIOSHTIC-2 (<http://www.cdc.gov/niosh/nishtic-2.html>) is a source for all of the agency's own funded research.

The Registry of Toxic Effects of Chemical Substances (RTECS), <http://www.cdc.gov/niosh/rtecs.html>) is another NIOSH-produced data-search product and is far more comprehensive. It presently includes over 130 000 chemicals, and provides very brief citations to published reports of toxic effects in both humans and animals. Toxicity data focus on primary irritation and acute toxicity; mutagenic, reproductive and *tumorigenic* effects; and specific numeric toxicity values such as LD50, LC50, TDLo, and TCLo. For each citation, bibliographic sources are listed, enabling the user to access the actual studies. RTECS is available via paid subscription from the National Technical Information Service (<http://grc.ntis.gov/rtecs.htm>) as well as through several commercial data providers (e.g. Silver Platter or the Canadian Centre for Occupational Safety and Health <http://www.ccohs.org>).

The EPA offers similar depth and complexity, combining OSHA-like enforcement guidance and NIOSH-like science to develop and defend its regulatory mission. That mission is much broader than the interests of OEH professionals, and usually reflects general issues of environmental pollution rather than human health in particular.

In compliance with EPA regulations, several additional databases are accessed through the NLM under the TEHIP program, including the Toxics Release Inventory (TRI) in the TOXNET system at <http://toxnet.nlm.nih.gov> or directly at EPA's site (<http://www.epa.gov/tri>). TRI contains federally-required reports of selected chemicals released from industrial sites on an annual basis.

Though challenging to use, this information is a necessary basis for exploration of possible environmental (non-occupational) disease concerns.

The TRI data are also available in an easily accessed format created by the advocacy organization, Environmental Defense. *scorecard* (<http://www.scorecard.org>) offers graphical disclosure of exposure information based on chemical identity, geographical zip code, disease concerns and clinical symptoms. Not only are data available on year-by-year released tonnage, but contact information for corporate and congressional offices are available, in non-technical language.

There are other useful online resources for assessment of geographic-based exposure risk. One is *enviroMapper* (<http://map3.epa.gov/enviromapper>), a site managed by the EPA showing the presence of *superfund* regulated hazardous waste sites. Another is the National Cancer Institute's Atlas of Cancer Mortality (<http://www.nci.nih.gov/atlas>) where county-specific rates of dozens of specific neoplasms are mapped for specific demographic categories.

The Integrated Risk Information System (IRIS, on the TOXNET system at <http://toxnet.nlm.nih.gov>) is another EPA-authored database accessible through both EPA and NLM websites. Containing over 500 chemical agents, IRIS emphasizes minimal exposure thresholds for health concern. It adds new chemical records when consensus determinations for an overall safety threshold can be achieved.

Another agency charged with evaluation of health risks from environmental exposure is the Agency for Toxic Substances and Disease Registry (ATSDR, <http://www.atsdr.cdc.gov>). ATSDR implements the health-related sections of the laws that protect the public from hazardous waste and environmental spills of hazardous substances. ATSDR has developed several electronic toxicology resources. One of these is HAZDAT (Hazardous Substance Release/Health Effects Database, <http://www.atsdr.cdc.gov/hazdat.html>) which lists the contents of hundreds of pollution point-sources, especially federally designated *superfund* waste sites.

ATSDR is also the source of Minimal Risk Levels (MRLs) for 286 chemical exposures ([\[www.atsdr.cdc.gov/mrls.html\]\(http://www.atsdr.cdc.gov/mrls.html\)\). Here it uses the no-observed-adverse-effectlevel/uncertainty factor \(NOAEL/UF\) in deriving exposure recommendations for hazardous substances. Recommendations are set below levels that, based on current information, might cause adverse health effects, even in those most sensitive to such substance-induced effects.](http://</p></div><div data-bbox=)

Another agency with a specific health and safety focus is the Department of Energy (DOE), with special concerns regarding ionizing radiation and the development of energy resources. Its health and safety site (<http://tis.eh.doe.gov>) represents a dynamic and frequently updated resource for safety policies, news events and administrative actions regarding environmental cleanup. In addition to resource text files and instructions, the DOE site houses topic-specific discussion groups on its pages. Once users register for more complex services, the DOE resource provides a customized portal to its content.

The EPA has specific oversight responsibility for evaluating and registering pesticides and their use, and has an instructive reference web resource for Pesticide Safety Programs (<http://www.epa.gov/pesticides/safety/index.htm>) where regulations, scientific studies, and even emergency exposure guidance are provided.

The Department of Transportation (<http://www.dot.gov>) now has its own minor role in the topic of human toxicology and exposure assessment. Substance abuse testing of transportation workers is an important regulatory issue, and a dominant concern to professionals in OEH. The best resource for clinicians involved in this highly regulated activity is a private site called *Transportation Medicine* (<http://home.att.net/~NataH>).

The Howard Hughes Medical Institute is a national consortium of research facilities and granted researchers involved in health research. Safety aspects of this complex industry are addressed at the Institute's website, providing chemical reference materials (Laboratory Chemical Safety Summaries at <http://www.hhmi.org/research/labsafe/overview.html>) and free worker education videos on fundamentals of safety management (<http://www.hhmi.org/research/labsafe/training/videos.html>).

Another laboratory safety resource is provided by the Lawrence Livermore National Laboratory, a DOE national laboratory operated by the University of California, whose website offers the entire policy and procedure manual for this facility's sophisticated program (http://www.llnl.gov/es_and_h/esh-manual.html).

4. State governmental outreach

Several states have developed outstanding resources in OES technical materials. Examples listed here are sites where the information complexity and utility deserve broader attention.

New Jersey has maintained an extensive and frequently updated database of worker instructional materials regarding individual chemicals for many years. The collection is known as Right to Know Hazardous Substance Fact Sheets, housed at <http://www.state.nj.us/health/eoh/rtkweb/rtkhsfs.htm>. These sheets are more narrative and educational than the usual Material Safety Data Sheets, with better information about subtle and chronic health concerns.

California has several unique resources for toxic, and OEH concerns. Following passage of the state's special regulations (Proposition 65) regarding chemical risk for cancer and reproductive harm, California has maintained its own evaluation and registration program regarding potential toxicants (<http://www.oehha.ca.gov/prop65.html>). Additionally, California provides a dynamic Hazard Evaluation System and Information Service (HESIS) concerning chemical and mechanical hazards at <http://www.dhs.ca.gov/ohb/HESIS/Default.htm>.

Minnesota and Iowa have developed extensive materials regarding risks to agricultural workers and nearby residents. The Minnesota Farm Safety & Health Information Clearinghouse (<http://www.bae.umn.edu/~fs>) offers safety information regarding traumatic, meteorological, and toxic risks, and provides non-web-based materials for other settings (including videotapes and pamphlets). Iowa's web resource (<http://www.public-health.uiowa.edu/icash/progs.htm>) combines the outreach of several state agencies and university

programs. Information is included on incident monitoring, and both youth and professional courses.

5. Material safety data sheets (MSDSs)

Manufacturers and distributors have embraced the Internet as a means to disseminate required information about the chemical content of commercial materials to customers and employees. Although the regulation of MSDS availability is directed at worker protection (OSHA's *Right to Know* rule), these disclosure statements are practical and invaluable in assessing all kinds of chemical exposures. While MSDS' regulated format is inadequate for true toxicologic assessment, it provides reliable information regarding products and their ingredients. There are several databases of MSDS' which combine content from manufacturers and governmental sites and permit easy access to clinical and safety activities. Two academic sites providing hundreds of thousands of MSDS' are Cornell University (<http://msds.pdc.cornell.edu/msdssrch.asp>) and the University of Vermont (<http://siri.uvm.edu>).

Another powerful site for chemical identification, and providing external references, is CS Chemfinder (<http://www.chemfinder.com>), which allows searches only for individual chemical ingredients. Its publisher, CambridgeSoft, is a commercial firm which sells software and chemical information resources. Chemfinder is a free, on-line database of web-links to hundreds of information and governmental sites, which include international standards for toxic labeling, toxicology compendia, chemical information on structures, physical parameters, safety and handling, and disaster preparation. It also provides extensive chemical synonyms, the unique CAS identifier, and various means of viewing molecular structures.

6. International sites and resources

The international availability of technical information is one of the most fascinating and unique

aspects of the Internet. Resources for the evaluation, management and prevention of exposure-related disease are widely available, providing professionals in clinical and preventive disciplines the opportunity to compare the breadth of policy and practice from several jurisdictions.

One rich and comprehensively defined site is the Canadian Centre for Occupational Health and Safety (CCOHS, <http://www.ccohs.org>), which provides access to freely available reference materials as well as proprietary databases on toxic risks, hazard management and worker protection. The site also offers one of the deepest and most broadly represented list of other Internet resources. Many of its data resources are available as subscriptions, and are sold as CD-ROM applications, offering off-line as well as net-based access.

The International Agency for Research on Cancer (IARC) is part of the World Health Organization, and provides both factual resources and consensus opinions regarding chemical and occupational sources of cancer risk (<http://www.iarc.fr/pageroot/database.html>). The summary documents (IARC Monographs) provide declarative rankings, which are easily used and quoted for the always-controversial issue of cancer endpoints, with direct discussion of applicability to human effects. Additionally, their information sources are fully referenced and critiqued. Summaries of these deliberations are available online and without cost, as are several other data files regarding environmental cancer epidemiology.

The International Occupational Safety and Health Information Centre is a component of the International Labor Organization, another office of the United Nations. Its assembled publications and databases are available (for purchase) in both online and CD-ROM formats (<http://www.ilo.org/public/english/protection/safework/cis/products/dbs.htm>), and include the extensive (four volumes in hard copy) Encyclopaedia of Occupational Health and Safety, which discusses hazards and protection schemes for thousands of jobs and work sites around the world.

The Centre for Occupational and Environmental Health at the University of Manchester, Eng-

land maintains a rich and multi-dimensional web-resource on all aspects relating to occupational disease and environmental health, often providing a uniquely 'EuroCentric' subset of website on these topics (<http://www.agius.com/hew/links>). This site provides introductions and categorical lists for resource links.

The Finnish Institute of Occupational Health website (<http://www.occuphealth.fi/e/infoserv.htm>) includes links to information in other societies. It publishes outreach materials (including online versions) including an African Newsletter on Occupational Health and Safety, as well as editions for the Asian Pacific, nations on the Barents, and an Estonian Newsletter. Its internationally directed periodical Work Health Safety requires a paid subscription.

7. Electronic mailing lists and forums

In addition to the reference materials listed above, the Internet permits live e-mail discussions among the professional community of hygienists, nurses, physicians and public health experts. Several electronic forums (founded and based in e-mail and then archived to the web) provide interactive and dynamic opportunities for experts to share ideas and resources within the range of these disciplines, and involve thousands of professionals worldwide.

Subscription to these mailing lists requires a higher level of involvement than does the occasional visit to a web resource, because participation is bidirectional and time-consuming. Messages from mailing lists accumulate quickly and can be overwhelming. Conversation via e-mail can be engaging but sometimes distressing. Opinions can be strident and 'facts' can be wrong. Nonetheless, for thousands of participants, the casual support and newsletter content provided by their colleagues is an essential daily ritual.

Serious and professional forums require a dedicated moderator for several purposes. The leader's job is to recruit new content, to establish the group's definition and topic limitations and to govern any disruptive messaging. Once the forum is established and mature, moderators can become

Table 1
Electronic mailing lists for OEH professionals

Name	Address	Topic	Enrollment	Messages per month
SAFETY	http://siri.org	Environmental and Occupational Safety	3018	850
Occ-Env-Med-L	http://occhealthnews.net	Occupational and Environmental Medicine	2800	350
AIHAIH-list	http://groups.yahoo.com/group/aihaih-list	American Industrial Hygiene Association	1389	120
MCOH	http://www.occenvmed.net/mcoh/listinfo.htm	Medical Center Occupational Health	465	100

less directive, since the community has accepted a tone and structure for its behavior.

Mailing lists are private but free. Some cover costs with endorsement and sponsorship messages distributed to the readers. Voluntary support is sometimes sought from those who value the content and the management effort by the moderator. Successful forums thrive on the dedicated participation of a core group of experts willing to share information and experience with their colleagues.

Tactics to permit more successful mailing list participation include:

- Consideration of *digest* mode, permitting all of a maillist's messages to arrive in a single, daily, easily managed packet. Drawbacks include greater difficulty extracting individual messages for redirection or reply.
- Development of an incoming mail filter, within the recipient's email software manager, sorting messages with a specific origin or subject line to a separate mail-folder.
- Professional groups can choose to designate a specific willing reader to review and then forward messages to the others in a partnership, based on specific sub-topic, e.g. ergonomics and injury to one practitioner and reproductive hazards to another.

The more effective mailing lists in OEH exclude participation from advertisers and block queries directly from patients and *victims*. Table 1 offers the most successful forums in OEM.

8. Summary sites

Professionals in Occupational and Environmental Medicine and in Internet Medicine have assembled powerful and practical meta-resources to find necessary resources. Some are annotated to serve as tutorials, and others are efficient lists of necessary links. Those discussed in this article provide further links to additional information resources, and are not merely directories of facilities and institutions.

1. Each year at the American Occupational Health Conference, Dr J. Fanucchi prepares a seminar regarding Internet resources for OEH, including a website guide to these tools, at <http://www.occhealth.org/>.
2. Another expert but amateur site is managed by Dr G. Kelafant, at <http://www.occenvmed.net/>. This site has become the center of regulatory, toxic, and clinical practice issues regarding OEH issues regarding clinical facilities and Medical Centers.
3. Several medical sites have become clearing-houses for Internet resources in every specialty, and one of the best for OEH professions is the *Hardin Meta Directory* (<http://www.lib.uiowa.edu/hardin/md/occu.html>) providing monitored links to dozens of other major reference sites.
4. This author's own Duke University's Occupational and Environmental Medicine site (<http://links.occhealthnews.net>) provides links to all the sites mentioned in this article.