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REVIEW

Internet resources for neurologists

R Al-Shahi, P A G Sandercock

This fourth and final review in the *JNNP* internet series summarises the essential internet resources for adult and paediatric clinical neurology, neuroradiology, and neurophysiology. This article is freely available on the *JNNP* website (www.jnnp.com), where—within seconds—the complete list of recommended websites can be easily downloaded and incorporated into your web browser as a Bookmark/Favorite file. The further progress of clinical neurology on the world wide web will be monitored in *JNNP* Neuronline fillers and *JNNP* Neurology in Practice supplements.

The internet has become inescapable and increasingly essential in the everyday practice of neurology, largely because of the unparalleled medical resources on the world wide web (www). The ebb and flow of internet content calls for an update of older reviews of neurology and neuroscience resources.^{1,2}

Rather than attempt a comprehensive summary, which is precluded by the proliferation of the internet,³ we have distilled internet content down to a manageable list of high quality portals for easy reference (table 1). Uniform resource locators (URLs) are provided in the text if they are not mentioned in table 1.

This review concludes the *JNNP* internet series, which has already covered concepts and websites for medicine in general,⁴ neurosurgery/neuropathology,⁵ and psychiatry/neuropsychiatry.⁶ Our recommendations are based on continual surveillance of the internet, as well as a Medline search from 1966 to 1 August 2001 using the exploded medical subject heading (MeSH) terms, “computer communication networks” and “internet”, combined with the MeSH terms, “neurology, neurosciences, neurophysiology, diagnostic imaging”.

NEUROLOGY RESOURCES

Within half a second, the Google search engine (www.google.com) retrieves over 1.5 million websites relating to the search term “neurology” from its computer generated index of www content. But however fast and sensitive search engines are, they are best searched with more specific criteria.^{4,7} For the neurologist in a hurry, a search engine will often provide something of relevance, even if not of the best quality.

Portals (also known as directories) are more reliable gateways to smaller selections of neurology resources because they are repositories of websites chosen or edited by humans for their quality. Google’s directory yields a mere 1850

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websites using the same search criterion, and the websites are ranked by their perceived order of relevance.

Neurology portals

Neurologists and their patients are likely to find that portals specifically dedicated to neurology have a higher yield of pertinent websites than general directories. Neurology portals are distinguished from each other by various attributes including the comprehensiveness of their selection of websites, any bias in their compilation (in language, country of origin, funding, or disease category), the sophistication of software for searching the directory, and their presentation.

Recognising that readers are likely to use at most a handful of portals to direct their further browsing, we have been rather selective. Although the dot.com world is now relatively impoverished, forcing medical website developers to take recourse to advertising (especially from the pharmaceutical industry), we have tried to avoid recommending sponsored sites because they are unsightly and may be biased in their content. Despite the global nature of the internet, reviews of www resources are inevitably biased towards the authors’ country/continent of origin,² and we suspect that ours is no exception.

Evidence based neurology portals

The Trip database is perhaps the most user friendly evidence based resource for neurologists. It is dedicated to bringing together all the evidence based healthcare resources available on the internet, and has a dedicated neurology “clinical area” which issues monthly updates that can be received by email. The Trip database includes coverage of the Cochrane Library, which has review groups dedicated to dementia and cognitive impairment, epilepsy, movement disorders, multiple sclerosis, neuromuscular disease, and stroke. Although the Cochrane Library operates on a subscription basis, free access is provided to low income countries, and many countries have arranged national provisions (www.update-software.com/cochrane/provisions.htm); for example, in England the full text of the library can be accessed through the National Electronic Library for Health (www.nelh.nhs.uk). The Cochrane neurological network (www.cochraneneuronet.org) functions as a link between neurologists and the Cochrane collaboration.

Guidelines for the practice of clinical neurology are not as yet united on one website, presumably because they tend to vary by region. The American Academy of Neurology (AAN) practice guidelines, which are kept updated, are freely available as pdf files on the AAN website. Other

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Table 1 Useful web sites

Site name	URL	Site description
Neurology portals		
Trip database	www.tripdatabase.com	An attempt to bring together all the evidence based health care resources on the internet, with a dedicated neurology section and email updates
Cochrane Library	www.update-software.com/cochrane	A synthesis of reliable evidence about the effects of health care
American Academy of Neurology practice guidelines	www.aan.com/professionals/practice/guidelines.cfm	North American evidence based aids to clinical decision making
Neurosciences on the Internet	www.neuroguide.com	A comprehensive directory of internet neuroscience resources
Online textbooks		
eMedicine Neurology	www.emedicine.com/neuro	Free multiauthored textbook, covering the whole of medicine
Neuromuscular Diseases Textbook	www.neuro.wustl.edu/neuromuscular	Free multiauthored textbook dedicated to neuromuscular diseases
MedLink Neurology	www.medlink.com	Subscription only neurology textbook
Patient information		
National Institute of Neurologic Disorders and Stroke	www.ninds.nih.gov	USA based funding and information resource
National Organisation for Rare Disorders	www.rarediseases.org	USA federation of voluntary health organisations dedicated to rare disorders
Neurological Alliance	www.neurologicalalliance.org.uk	UK alliance of charities dedicated to neurological diseases
Brain and Spine Foundation	www.brainandspine.org.uk	Foundation to develop research, education and information about neurological disorders
News and discussion		
<i>Neurologists</i>		
NeurologyLinX	www.neurologylinx.com	Web based and emailed daily news about general neurology and subspecialties
Neurologist discussion list	www.neurolist.com/site	Email discussion list for neurologists
<i>Patients</i>		
BrainTalk communities	www.braintalk.org	Online discussion forums for patients with neurological illnesses
Massachusetts General Hospital neurology chatrooms	www.BrainChat.org	Online discussion forums for patients with neurological illnesses
Paediatric neurology		
Child Neurology in the UK	www.child-neuro.org.uk	A gateway to news, education, information and discussion about child neurology
Child Neurology	www.waisman.wisc.edu/child-neuro/	Portal for paediatric neurology resources
Online Mendelian Inheritance in Man	www.ncbi.nlm.nih.gov/omim/	Catalogue of genes and genetic disorders
Neuroradiology		
Whole Brain Atlas	www.med.harvard.edu/AANLIB	Superbly illustrated examples of normal brain anatomy and neurological diseases
RadiologyEducation.com	www.radiologyeducation.com	A directory of www radiology resources
Neurophysiology		
Clinical Neurophysiology	www.clinicalneurophysiology.org.uk	A British portal for clinical neurophysiology www resources
TeleEMG.com	www.teleemg.com	Useful information for clinical neurophysiologists, with an online store and doctor/patient discussion groups
Clinical Neurophysiology on the Internet	www.neurophys.com	A directory of basic and clinical neurophysiology www resources
Professional web sites (incomplete list)		
Association of British Neurologists	www.theabn.org	Professional association for British neurologists
American Neurological Association	www.aneuroa.org	Professional association of North American neurologists
American Academy of Neurology	www.aan.com	Resources for professional and practice development for neurologists
World Federation of Neurology	www.wfnurology.org	Promotes worldwide practice, education and research in neurology, in association with the WHO
European Neurological Society	www.ensinfo.com	Promotes neurology – especially education and research – in Europe
European Federation of Neurological Societies	www.efns.org	Promotes neurology – especially education and research – in Europe
British Paediatric Neurology Association	www.bpna.org.uk	Professional association for British paediatric neurologists
International Child Neurology Association	www.child-neuro.net	Professional association for paediatric neurologists worldwide
Child Neurology Society	www.childneurologysociety.org	Professional association for North American paediatric neurologists
British Society of Neuroradiologists	www.bsnr.co.uk	British society to promote research and technological progress in neuroradiology
American Society for Neuroradiology	www.asnr.org	Professional society for neuroradiologists
European Society of Neuroradiology	www.esnr.org	Professional society for neuroradiologists
World Federation of Interventional and Therapeutic Neuroradiology	www.wfitn.org	Global organisation for interventional neuroradiologists
British Society for Clinical Neurophysiology	www.bscn.org.uk	Professional association to promote and assist the science and practice of clinical neurophysiology
American Clinical Neurophysiology Society	www.acns.org	Professional association for clinical neurophysiologists
American Academy of Clinical Neurophysiology	www.presenter.com/~dtjorneh/	Dedicated to communication among clinical and basic neurophysiologists
American Association of Electrodiagnostic Medicine	www.aaem.net	Professional association for clinical neurophysiologists, affiliated to the American Medical Association
International Federation of Clinical Neurophysiology	www.ifcn.info	Organisation to promote education and research in clinical neurophysiology

All websites accessed 7 January 2003. These URLs are downloadable as a Bookmarks/Favorites file from the JNNP website (www.jnnp.com).

high quality guideline repositories, not dedicated to clinical neurology, are the Scottish Intercollegiate Guidelines Network (www.sign.ac.uk) and National Guideline Clearing House (www.guidelines.gov).

General neurology portals

Without doubt the single most useful directory for neurologists is Neurosciences on the Internet. This website was established in late 1994 and it is strong on clinical neuroscience (including lists of other portals, disease related websites, patient organisations, mailing lists and discussion groups, educational resources, and useful software), although it has a slight north American bias.¹⁻⁸ Other directories simply do not compare, so we suggest it should be the starting point for a survey of www resources in any particular area of neurology. While many websites devoted to particular categories of neurological disorder are worthy of mention (for example, www.wemove.org, dedicated to worldwide education and awareness for movement disorders), the majority are indexed by www.neuroguide.com.²

Journals

Almost every neurology journal has a website that can provide the full text of latest and recent issues. Exceptionally, only abstracts or tables of contents are available. Table 2 lists a small selection of clinical neurology journals, ranked by their impact factor; a more complete list is available from Neurosciences on the Internet and from PubMed's journal database (www.pubmed.org). Most online journals are reproductions of their print counterparts. However, some peer reviewed journals only exist in electronic format, *BioMed Central Neurology* being the main example (www.biomedcentral.com/bmcneurol). One of the many advantages of the electronic format is the cross referencing of bibliographies using citation linking backbones.

Sadly, the ideal of free online journals has not yet been realised in neurology, and full text access mostly requires a paid subscription. Although www.freemedicaljournals.com lists 25 such journals, the degree of access varies from complete availability to only articles published more than two years ago. Some journals offer the alternative of purchasing individual articles. Without a subscription, many offer free access to selected articles from each issue, and most provide article

abstracts and email table of contents (eTOC) services. If eTOCs are not available from the journal itself, various alerting services exist to provide a comprehensive eTOC,⁴ while news services (below) provide edited synopses.

e-Textbooks

There are two www based general neurology textbooks.⁹ *eMedicine Neurology* is a North American multiauthored work which is freely accessible with registration, searchable, well designed, and comprehensive. *MedLink Neurology* is a subscription only north American electronic textbook (available on the www and a CD-ROM updated quarterly), which also includes neurosurgery topics, videos, and a discussion board, but it costs at least \$299 per year. The *Neuromuscular Diseases Textbook* is an unrivalled speciality resource, which provides up to date, comprehensive, intuitively indexed medical and patient information.¹⁰

Many of the resources above offer text and picture content suitable for creating lectures. Additional teaching resources include www.neuroexam.com, which illustrates the various stages of the neurological examination with streaming video. Neurologists wishing to test their knowledge on a regular basis can attempt to diagnose the Baylor College of Medicine case of the month, using the history and examination provided with an interactive battery of tests, and then return to the website the following month for the dénouement (www.bcm.tmc.edu/neurol/case.html).

News and discussion

NeurologyLinx is a website dedicated to providing news about both general and specialised neurology. Although the website is sponsored its advertisers do not influence content. News is updated daily on the website and in email bulletins, which mostly comprise information from journals and conferences.

Newsgroups offer an often unrestricted, interactive, www based means of exchanging news and (mostly) views.⁴ At the time of writing, the index of newsgroups—Google Groups (<http://groups.google.com>)—dating back to the Usenet discussion groups of 1981, did not list a dedicated neurology group, although at first glance bionet.neuroscience appeared to qualify. However, bionet.neuroscience contained around 29 500 discussion threads at the time of writing, most of

Table 2 Popular clinical neurology journal websites

Journal name	URL	Free full text?	Email table of contents?
<i>Annals of Neurology</i>	www.interscience.wiley.com/jpages/0364-5134	No	Yes
<i>Brain</i>	http://brain.oupjournals.org	Articles >2 years old	Yes
<i>Journal of Neuropathology and Experimental Neurology</i>	http://neur.allenpress.com/neuroonline/	No	Yes
<i>Stroke</i>	http://intl-stroke.ahajournals.org	Articles >1 year old	Yes
<i>Neurology</i>	http://intl.neurology.org	No	Yes
<i>Archives of Neurology</i>	http://archneur.ama-assn.org	No	Yes
<i>Current Opinion in Neurology</i>	www.co-neurology.com	No	Yes
<i>Cephalalgia</i>	www.blackwellpublishing.com/journals/cha	No	Yes
<i>Epilepsia</i>	www.epilepsia.com	No	Yes
<i>Journal of Neurology, Neurosurgery and Psychiatry</i>	www.jnnp.com	Articles >1 year old	Yes
<i>Practical Neurology</i>	www.blackwell-science.com/pnr	No	Yes

All websites accessed 7 January 2003. The journals selected by the authors are partly based on the journals' impact factors provided by the Institute for Scientific Information's journal citation reports (<http://wos.mimas.ac.uk/jcrweb>). These URLs are downloadable as a Bookmarks/Favorites file from the JNNP website (www.jnnp.com).

which were unscientific, unsurprisingly generating a thread devoted to the creation of a scientific neuroscience newsgroup. There are newsgroups dedicated to particular diseases (for example, [sci.med.diseases.als](#), [sci.med.diseases.alzheimer](#), [sci.med.diseases.lyme](#), and [sci.med.diseases.mult-sclerosis](#)), although neurologists are unlikely to find them informative. Some patients may benefit from discussions with others in the [alt.support.disorders.neurological](#) newsgroup.

Email discussion lists provide a more secure forum for neurologists to discuss professional issues by email. One of the longest established lists of this nature is the Neurologist Discussion List, vetted by a neurologist at the medical college of Georgia; members admitted to this list can control the frequency and content of emails updating them about ongoing discussions. Neurosciences on the Internet ([www.neuroguide.com/neurolist.html](#)) has compiled the contact details of many other email discussion lists (ranging from special interests in neurology, to paediatric neurology and clinical neurophysiology).

Patient information

Portals supplying patient information of uniformly high quality about the whole breadth of neurological diseases are hard to find, but the United States' National Institute of Neurological Disorders and Stroke (NINDS) comes close. The National Organisation for Rare Disorders (NORD) is a useful supplement to the NINDS website, especially for physicians based in the USA. MEDLINEplus ([www.nlm.nih.gov/medlineplus/neurologicdiseasesgeneral.html](#)) provides comprehensive patient information (mostly from the NINDS website), with further links to news, diagrams, research, organisations, and medical dictionaries. In the United Kingdom, the Neurological Alliance has collated links to the major patient support organisations, one of which is the Brain and Spine Foundation that publishes a growing number of well written and freely downloadable information leaflets.

Patients' further need for communication and discussion can be fulfilled in disease specific online support groups through some of these websites. Where this is lacking, many patients—particularly those in the USA—join the www based BrainTalk communities or the Massachusetts General Hospital neurology chat rooms, to interact with nearly 55 000 others about general and specific neurological conditions.

PAEDIATRIC NEUROLOGY

The best emerging resource for child neurology is Child Neurology in the United Kingdom, which despite its emphasis is an up to date source of links, news, discussion, and practice resources for paediatric neurologists worldwide. The Child Neurology website had been the leading paediatric neurology portal for some time,¹¹ although the website's design is rudimentary and brief, but clear. Child Neurology also runs the Child-Neuro email discussion list ([www.waisman.wisc.edu/archives/child-neuro.html](#)), which can be joined by emailing mack@waisman.wisc.edu. Paediatric neurologists will also find the Neuromuscular Disease Center and Online Mendelian Inheritance in Man (OMIM) particularly valuable resources for up to date information about neuromuscular and genetic diseases respectively.^{10 12}

Tables of contents and email alerts are available—sometimes requiring registration—for the main journals, *Developmental Medicine and Child Neurology* ([www.journals.cambridge.org/journal_developmentalmedicineandchildneurology](#)), *Neuropediatrics* ([www.thieme.de/neuropediatrics](#)), and *Journal of Child Neurology* ([www.bcdecker.com/bcdecker/soc3.asp?bjid=69](#)), but free access is not provided to the full text of the online journals.

NEURORADIOLOGY

Despite the growth of the www, there have been few dramatic developments in diagnostic and interventional neuroradiology resources.¹³ RadiologyEducation.com is probably the most comprehensive digital library of radiology textbooks, teaching files, journals, and CME. The collaborative hypertext of radiology, CHORUS (<http://chorus.rad.mcw.edu>), is a lengthy reference work of diseases and their radiological findings, albeit short on illustration, which is well complemented by the superbly illustrated Whole Brain Atlas website, also available on CD-ROM.¹⁴ The Iowa Neuroradiology Library ([www.uiowa.edu/~c064s01](#)) cannot rival the Whole Brain Atlas, but it does provide illustrations of reasonable resolution with accompanying clinical histories, suitable for use as a teaching resource. For patients, RadiologyInfo ([www.radiologyinfo.org](#)) is a source of information about radiological investigations/procedures with almost complete coverage of neuroradiology. Digital Imaging and Communications in Medicine (DICOM) has become the standard interchange format for digital imaging (<http://medical.nema.org>), and free-viewers are widely available on the www. Teleradiology is outside the scope of this article, but the best source for unbiased quality filtered information about it is the Telemedicine Information Exchange (<http://tie.telemed.org>). Radiology news is available from Aunt Minnie ([www.auntminnie.com](#)), RadiologyLinx ([www.radiologylinx.com](#)), and the newsgroup [sci.med.radiology](#), which has an interventional subgroup.

Tables of contents and email alerts are available from the websites of the three main diagnostic neuroradiology journals, *Neuroimage* ([www.elsevier.com/inca/publications/store/6/2/2/9/2/5](#)), *American Journal of Neuroradiology* ([www.ajnr.org](#)), and *Neuroradiology* (<http://link.springer.de/link/service/journals/00234>), but the journals' full text requires a subscription.

CLINICAL NEUROPHYSIOLOGY

There are three main portals for clinical neurophysiologists, each with their own merits. TeleEMG.com provides a wealth of resources (an online EMG manual, educational aids, a practical guide for electromyographers, the TeleEMG calculator for comparing sensory and motor conduction velocities with controls, and discussion groups), but it is a for-profit website that sells some of these products as well as the EMG assistant diagnostic program ([www.emgassistant.com](#)). Clinical Neurophysiology is a very well designed website with many up to date informative links, but some sections remain under development. Least impressive of all is Clinical Neurophysiology on the Internet, which illustrates how a website can attain a high ranking in Google by being extensively linked to, yet get away with negligible content which is, at first glance, masked by apparently comprehensive structure.

Both tables of contents and email alerts are available for the two main journals dedicated to clinical neurophysiology, *Journal of Clinical Neurophysiology* ([www.clinicalneurophys.com](#)) and *Clinical Neurophysiology* ([www.elsevier.nl/inca/publications/store/6/0/1/5/2/8/index.htm](#)), but neither allows free access to the full text of the online journal.

CONCLUSIONS

There is no reason to be daunted by the quantity of information about neurology on the internet. Large amounts of high quality information are provided by a small selection of portals. The complete list of our recommended websites can be easily downloaded from [www.jnnp.com](#) and incorporated into your web browser as a Bookmark/Favorite file. Keeping abreast of the further progress of neurological knowledge merely requires neurologists to embrace the concept of being updated by email, and keeping an eye on *JNNP* Neuronline fillers and Neurology in Practice supplements.

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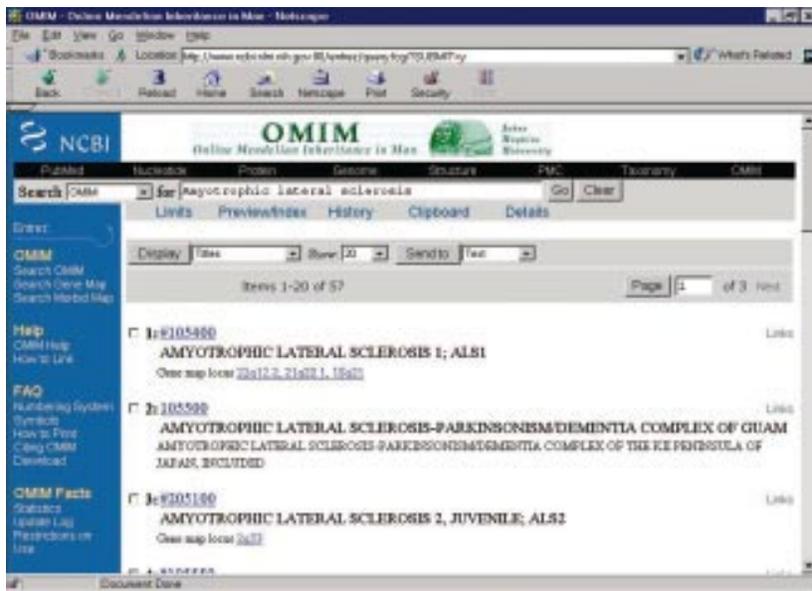
NEURONLINE

Online Mendelian Inheritance in Man OMIM: www.ncbi.nlm.nih.gov/entrez

This website is based on a definitive work on genetic disorders, Victor McKusick's Mendelian Inheritance in Man. But whereas the book is now four years old, OMIM is updated daily—as of January 2003 it included 14 120 references, gaining more than 60 a month and revising a further 500.

The site's authors have reviewed the literature to provide a series of well-referenced summaries of clinical and molecular features, classified on the basis of mode of inheritance. At present, the majority are defective genes or loci that have been established beyond doubt as causing a single disorder with a sole means of transmission (eg the expanded trinucleotide repeat of Huntington's disease). The remaining entries are currently of uncertain inheritance, either because the same condition can result from more than one genetic defect (such as Alzheimer's disease), or because the phenotype may overlap with another.

OMIM is best accessed through the linked Entrez system (familiar as the home of PubMed), integrating it such that a few clicks will generate literature citations, DNA sequence data, or chromosome maps. The site is best at providing an initial overview of a disease or mutation. Some conditions have generated large entries, and are helpfully linked to clinical synopses and to "Mini-MIM"—a summary of their basic details. Readers should, however, remember that OMIM is a secondary source of information—it



only reviews the literature and thus lags behind the very latest findings. In other instances, the limitations of the curators—geneticists but not necessarily super-specialists—become apparent, with an over emphasis on historical details and potential omission of relevant information. Searching for "spinocerebellar ataxia" generates 78 references, but omits Machado-Joseph disease (SCA3; listed only by its eponym).

Providing the caveats about the information it generates are heeded—more

details and, especially, a balanced expert overview will be found by pairing an OMIM search with the reading of a recent review—OMIM is an authoritative, easy to use, and continually updated site, and an excellent first source of information for neurological clinicians and researchers.

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