Computer Applications in Neurootology

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Which cliché do you prefer?

- We live in the Computer Age.
- We live in the Age of the World Wide Web.
- We live in the Age of Globalization.
- We live in the Information Age.
- We live in the Intellectual Age.
- We live in the Age of Communication.

At least we can all agree that we have moved on from the Industrial Revolution!

Computers are a fact of life. Bill Gates believes that their impact on society is only just beginning. Alan Greenspan, Chairman of the U.S. Federal Reserve Board, thinks that their potential impact is overrated, though he attributes the low rate of inflation to the effect of the computer in lowering costs. Just as was the case with the typewriter, the new technology of computers was 20 years or more in making a major impact on the economy. Only now are word processors significantly reducing the need for secretarial help. In particular, the computer has had a major beneficial effect in the financial world for two reasons. First, the financial arena is a numerate environment and, second, it is a very large and wealthy environment with plenty of capital to invest in new technology.

The Internet has done for computer applications what the printing press did for the written word [1]. Approximately 160 million people worldwide logged on in 1999, and the number of World Wide Web users is increasing at a rate of approximately 7 per second. Nearly 7 million Web sites were available in 1999 and, by February 2000, at least 800 million general-content Web pages existed. According to 1999 statistics, Web pages are added at the rate of 1 million per day. Not surprisingly, almost all researchers in the developed world have access to the Web.

The human intelligence pool is devolving; it is following the path of machines. Cross-functional teams and learning networks spring up spontaneously in response to specific problems. There is an explosion in "open-source" software development. In the financial field, private Internet "currencies" are becoming more popular and eventually may even replace government notes.

Clearly, many remarkable things are happening with the Internet. Most of them are already familiar to you, and there are far too many to review them all here. Therefore, in this address I will touch on only a few of the most interesting developments as regards medicine in general and neurootology in particular.

COMPUTERS IN MEDICINE

Remote diagnostics and the ability to fix problems remotely are becoming commonplace, in medicine as well as in numerous other fields. Our ability to monitor physiological systems at a distance was, in large part, one of the spin-offs of the United States' space exploration program. With such ready availability of information, the role of the specialist might decline. How will this affect neurootologists?

Medicine deals mostly in methodologies and opinions rather than numbers. The insatiable patient demand for medical services leaves very little money to invest in research and development. Medical informatics in the best hospitals represents only approximately one-third of the typical informatics budget of a major business corporation. Sooner or later, society will acknowledge that the only way to reduce medical expenditure and to make the provision of health care more efficient is with the help of computers.

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Laboratory Applications

One of the most immediate and obvious computer applications has been the gradual shift from analog to digital laboratory equipment. For example, electrocardiography machines now spit out a string of alphanumerical data as well as the (digitized) analog signal. Current-day test procedure protocols are driven by computer, and a technician simply follows instructions. Visual field mapping, for example, now is completely automated.

Electronic Medical Records

Data Entry

The acceptance by the medical community of any computer-based medical record system depends on the ease of data entry and extraction. These remain major problems.

Generally speaking, the more data in the database, the better. Fortunately, more and more medical data now are generated electronically. Laboratory test results, x-ray reports, word-processed medical progress notes, and the like all are being electronically created. Documents can be scanned, and videotapes can be accessed, such that fewer data remain to be entered manually.

A major step forward was the introduction of HL7 in 1987. This hospital-based system set the standards for the electronic interchange of clinical, financial, and administrative functions. It now is used widely throughout the United States and around the world.

For the physician, data entry has the potential to be very time-consuming. This fact is known as the *data entry barrier*. Much effort has been expended in researching painless, rapid means of data entry. Currently, voice entry systems, which have proven successful in areas with limited vocabulary and standardized formats (e.g., dictation of x-ray reports), appear to offer the most promise. It is claimed that the accuracy rate of voice entry systems ranges between 95% and 98% and that such systems offer a 30,000–50,000 word vocabulary at an entry rate of up to 160 words per minute.

Prior to the advent of computers for general office use, a professional generally dictated letters, reports, and other documents to a secretary, who recorded the notes and then generated a typewritten copy for the professional's signature. In the more modern office, professionals are more likely to key letters, reports, and other data themselves. This has dramatically changed the way that professional offices function.

To some extent it may be possible to bypass the data entry barrier by having a patient enter his or her own data. This patient history can be obtained via a preprinted form. Surprisingly, patients are more likely to be candid about risky health behaviors when communicating via a form or a computer rather than with a human interviewer.

Better still, to maximize the accuracy and reliability of data, a patient's history may be obtained by creating interactive computer programs that extend the normal activity of completing a medical history form. Irrelevant parts of the form are filtered out. Information presentation is incremental and interactive. Included are educational activities that help the patient to understand terminology and that suggest topics that patients might wish to discuss with their doctor [2].

Database

The accuracy of data is key. A common computer term applies: *GIGO*, or "garbage in, garbage out."

Medical terms mean different things to different people. In the United States, we have established the American National Standards Institute (ANSI) Health Care Informatics Standards Board Vocabulary Working Group and the Computer-Based Patient Records Institute Working Group on Codes and Structure to address this problem [3]. Over the last 10 years, the National Library of Medicine has developed a Unified Medical Language System [4]. This system has a variety of uses, including computer-based medical records and expert systems, as well as links to knowledge-based information sources. It includes lists of terms in English and 10 other languages.

In Europe, a Web site addresses the problem of multiple meanings of medical terms [5]. It contains "the electronic form of eight glossaries, in which you can find 1,830 technical and popular medical terms in eight of the nine official European languages: English, Dutch, French, German, Italian, Spanish, Portuguese, and Danish" [5].

However, even this tool does not address the fact that equivalent terms (e.g., *vertigo*, *schwindle*, and *vertige*) have different connotations in different cultures. Dieter Schneider, Phillipe Perrin, and I spent an hour trying to resolve some of these differences among our three languages and eventually had to admit defeat! What does a *kreislaufstörung* or *kreislaufkolaps* mean to a non-German, *crise de foie* to a non-Frenchman or "a terrible strong weakness" to a non-Irishman?

Another area of major concern is the protection of medical data once it is embedded electronically. Such data must be protected from access by irresponsible people. In the United States, this problem is being addressed by the National Research Council (NRC) of the National Academy of Sciences in their report "For the Record: Protecting Electronic Health Information" [6]. In addition, the U.S. Congress is currently addressing this issue, with new regulations proposed by the president.

Diagnostic Decision Support Systems

One of the most exciting computing developments has been in the area of artificial intelligence (AI). There are now AI expert systems that can equal or exceed human capabilities. In addition, software programs can now "learn" from experience.

Rindfleisch [7] states as goals for medical informatic capabilities the need to "support human reasoning with problem-solving aids, to augment human memory, to help in the retrieval of relevant information, to take advantage of human perceptual capabilities, and to allow the automation of tedious and lengthy processes beyond human stamina." In a controlled study at three academic institutions, Friedman et al. [8] were able to show that a computer-based diagnostic decision support system was significantly able to improve the correct diagnosis rate.

Expert Systems

Medical expert systems are a field of applied AI. An expert system is a compact program designed to solve a specific problem. In the past and, to some extent, at present, such systems were designed to run on handheld calculators.

Medical expert systems have been developed to support many routine clinical practices and are in standard use in intensive care units, pediatric neonatal facilities, and other health care arenas. In the intensive care unit, blood electrolyte laboratory test values are now delivered in alphanumeric format. These results then are interpreted by expert systems, and the appropriate intravenous dosages are automatically calculated. Expert systems are in use for the medical diagnosis of polycythemia rubra vera, acute viral hepatitis, malignant hyperpyrexia, Parkinson's disease, melanoma, jaundice, and the like.

Patient Triage

Patient triage conducted by a nurse supported by a sophisticated expert software system now is established as a safe and efficient method for handling patient telehone calls. In fact, it is anticipated that by 2001, telephone triage lines will be an active part of the health care system for more than 100 million people [9].

Computerized Diagnosis

Small, specific programs have been shown to be equivalent to or better than physicians in the diagnosis of anemia, pneumonia, childhood meningitis, and diseases that are manifest in vaginal discharge, among other disorders. One of the best comprehensive programs is "Iliad," which covers more than 930 diseases and 1,500 syndromes and provides treatment protocols for each [10]. The input data are symptoms, physical signs, and laboratory test results, and the output is a differential diagnosis. "Iliad" may act "as an expert consultant that provides a differential diagnosis" or, conversely, it may act "as a second opinion, to critique a presumptive diagnosis" [10]. In the latter case, the operator may select a particular disease, and the program will list the pros and cons for a given patient and will offer suggestions as to how to proceed to prove or disprove the hypothesis.

Although the program description includes the politically correct disclaimer that "[t]his product in no way replaces the expertise of the health care professional," little imagination is required to reach the conclusion that the program can take over a large portion of the physician's diagnostic workup of the patient.

A similar program is offered by Lisa Developments in Australia at http://www.ozemail.com.au/~lisadev/sftdoc.htm. The home page describes this system as "an expert system . . . Its internal decision-making 'thoughts' imitate those of experts in a disease." Interestingly, the program incorporates learning software, which enables the software to be taught "how to think and reason, and find the wanted information." It includes a database of "2,000–3,000 known medical diseases and conditions" with a "symptom/indicator" list of approximately 5,000 items and can deliver "short lists . . . of the most common or likely" diagnoses.

With medical knowledge doubling every 5 years, such programs can be expected to increase in number, complexity, degree of sophistication, and accuracy as the years go by. If a computer can beat the world's chess champion, it can certainly "outsmart" relatively unsophisticated health care providers and, in time, will undoubtedly give the experts a run for their money! Broad-based programs such as these will likely be particularly useful for neurootologists who do not possess detailed information about the wide variety of neurological and medical diseases that may cause a patient to complain of dizziness or unsteadiness.

Recently, the diagnostic process has moved down one level, such that it now is possible to receive a diagnosis over the Internet without consulting a doctor. The National Medical Society offers online diagnosis at http://www.medical-library.org. One is instructed to "[c]lick on the symptom (e.g., dizziness, vertigo), enter additional symptoms, then receive a diagnosis." The National Mental Health Association has a Web site for "depression screening" at http://depression-screening.org, where a patient can log on and respond to a number of questions; the answers then are scored. If the test result is positive, the patient may print out the score and consult a therapist. Individual medical professionals are offering similar programs. An example is that of Joshua Freedman of the University of California at Los Angeles Department of Psychiatry, whose program at http://www.MediConsult.com is 96% sensitive and 90% specific for depression.

Computerized Guidelines

Patient Evaluation

More and more national societies are publishing legitimate consensus guidelines for medical care. The Agency for Health Care Policy and Research has published various Health Services Technology Assessment Texts (HSTAT; http://text.nlm.nih.gov), which contain, among other documents, clinical practice guidelines. More than 600 peer-reviewed clinical practice guidelines contributed by more than 50 societies and governmental agencies also are available, at http://www.mdconsult.com. Most of this material is fairly basic. Unfortunately, studies have shown that a very large percentage of physicians fail to follow these guidelines in many cases [11]. The reasons for this failure to follow established guidelines vary [12].

At the other end of the spectrum, third-party payers are advocating their own guidelines, some of which cut corners to minimize their costs. Physicians themselves tend to be somewhat ambivalent about all this. Nonetheless, the majority harbor a great fear that "cookbook" medicine will put them out of business. Regardless, the concept is here and will continue to develop.

Treatment

A number of treatment protocols of limited value have been developed for specific diseases. The most comprehensive single compendium of such protocols is the software program "Iliad," which may be purchased at http://education.adam.com/products/iliad/iliad.htm. It provides treatment protocols for more than 930 diseases and 1,500 syndromes, and its selections are based on "cost-effective" data.

THE INTERNET AND MEDICINE

In 1999, at least 100,000 Web sites were devoted to health and medicine, and three-fourths of the doctors in the developed world had access to the Internet. October 1998 data suggest that 27% of female Internet users and 17% of male users accessed medical information weekly or daily.

The two major segments of the Internet are electronic mail (e-mail) and the World Wide Web. In the medical arena, the impact of both has been great, offering us communication abilities and access to information far beyond those available to us before the Internet existed. Collaborative programs include facilitating physician referrals (and consultation reports), greatly improving the old-fashioned curb-side consultation, and physician education.

E-Mail

By 1999, approximately 3 billion e-mails were being sent hourly! More and more, patients are using e-mail to obtain general or specific medical information and as a means of seeking advice from their own physicians. For the physician, this practice presents a number of liability issues. The American Medical Informatics Association Internet Working Group, Task Force on Guidelines for the Use of Clinic-Patient Electronic Mail, has addressed this problem [13]. This group's guidelines identify the most pressing problems and make recommendations about how to deal with them.

Cybermedicine

Cybermedicine has been defined as "(1) the science of applying Internet and global networking technologies to medicine and public health; (2) the science of studying the impact and implications of the Internet; and (3) the science of evaluating opportunities and challenges for health care" [14]. Home self-monitoring systems will automatically inform the doctor when a specific patient's status exceeds desired medical parameters. It would be possible, for example, for a doctor to reprogram a cardiac pacemaker without the necessity of an office visit.

Electronic Publications

Journals

Disseminating research developments in printed journals is a slow, expensive, and complicated process. According to Delamothe and Smith [15], "The academic community, particularly in the United States, has come to resent the money sucked out of the research system by publishers." Further, there are "too many journals and too many publishers." Perhaps as a consequence of such attitudes, many journals are now available online. Some simply provide the titles of articles, whereas others provide abstracts and some the full text (e.g., the *Journal of the American Medical Association [JAMA]* at http://www.jama.com and the *British Medical Journal [BMJ]* at http://www.bmj.com). Some provide full text articles free to paid; others will provide the same for a fee. Dr. George Lundberg, former editor of *JAMA*, has begun a comprehensive online journal, "Medscape General Medicine" (http://www.Medscape.com). Medscape's subscribers include 180,000 physicians, 600,000 other health care professionals, and 300,000 "consumers."

The United States National Library of Medicine at http://www.nlm.nih.gov offers journal searches on Medline. Internet Grateful Med searches Medline using the retrieval engine of PubMed (http://www.ncbi.nlm.nih.gov/PubMed). This year, Medline includes more than 40 databases containing more than 20 million records. It indexes more than 360,000 articles annually, including many that have low circulations and are relatively inaccessible. On the other hand, some of its disadvantages are that Medline indexes articles from only the top 4,000 journals and rarely provides more than an article's abstract.

The U.S. National Institutes of Health is spearheading a movement toward new ways of disseminating research information through an online program called PubMed Central, which may be reached at http://www.nih.gov/welcome/director/pubmedcentral/pubmedcentral.htm. It will provide free access to both peer-reviewed and non-peer-reviewed articles (and books) and will be integrated with PubMed, the Medline search service.

The BMJ Publishing Group, in collaboration with Stanford University libraries at http://www-med.stanford.edu/medworld, is setting up a similar but more user-friendly system [15], which currently provides "net-prints" via the Internet at http://clinmed.netprints.org. Netprints include both electronic preprints (e-prints) and electronic reprints. E-prints are drafts of articles that are circulated first on the Internet, inviting feedback from other researchers before the article is finally published in a peer-reviewed journal. The "hit parade" lists the number of downloads in the first week of an e-print's posting. Readers can see their comments posted within 24 hours. Audio and video clips will also be available soon. With such a system, articles may benefit as much or more from online feedback, which is open to all, as from the conventional closed-referee process. E-prints have proven successful in the discipline of high-energy physics. Within our areas of interest, e-print listings have been posted in the disciplines of neurology and surgery (otolaryngology; ear, nose, and throat).

The peer-reviewed journals are striking back! As of January 2000, 25 peer-reviewed journals will accept articles that have appeared on preprint servers. In addition, 12 publishers of leading scientific journals have announced a collaborative effort to link their publications online. The service, which is to become available in early 2000, will initially link 3 million articles and will add another 50,000 each year [16]. Furthermore, through the National Institutes of Health, a program is being developed to offer the international scientific community free, fast, and full access to the entire biomedical literature through a single electronic database called *e-biomed*. In time, part of the World Wide Web will evolve into a global medical knowledge base that can be browsed and searched across languages.

Textbooks

General publications such as *The Merck Manual* (http://www.merck.com/pubs/mmanual/) and specialty textbooks such as *The Virtual Anaesthesia Textbook* (http://www.usyd.edu.au/su/anaes/VAT/VAT.html) are available online. Three leading medical publishers, for a fee, now offer 35 medical texts and 48 medical journals online (http://www.mdconsult.com/). They also offer 2,500 patient-education handouts.

COMPUTERS IN NEUROOTOLOGY

Laboratory Applications

Nowadays, most neurootological laboratory test equipment is computer-based or, in the common vernacular, PC-based. Many biomedical engineering companies offer such equipment, which is well exemplified in the areas of electrooculography (EOG) and electronystagmography (ENG).

In EOG and computerized dynamic posturography (CDP), for example, the software provided by the manufacturer, which is modifiable by the physician, dictates to the technologist in what order the individual portions of the tests should be performed and just how each of these should be performed.

Measurement

Dr. Mohammed Hamid of the Cleveland Clinic (personal communication) stated that in 9 of 10 ENG tests performed clinically, the computer printout is inaccurate. Undeniably, much of the signal analysis software is imperfect. Although a steady stream of software programs for the analysis of eye movements is emanating from many research laboratories, such programs are not readily transportable. Hence, these developments are slow to be picked up and incorporated into commercial products.

Financial constraints likely influence the ability of manufacturers to produce more exacting equipment and programs. The market is small, as is the profit margin. The purchasers of such equipment (primarily physicians) have limited capital because of the limited amount of money that they receive from third-party payers.

Nevertheless, progress *is* being made. For example, software is being developed for the measurement of rotatory eye movements using videooculography. Three-dimensional eye movement measurement is now possible.

Report Generation

Software programs are available that will generate reports for the benefit of the clinician. An example of a good report is that which NeuroCom International, Inc., has developed for its CDP system. This computer-generated report is divided into three sections. Page 1 provides a summary (normal or abnormal test battery?), which includes bar graphs and *x-y* plots. Next follows detailed derived data of each part of the test battery, including more bar graphs and *x-y* plots as well as a small expert system. Finally, the report provides the raw numerical data on which all the preceding information is based, as well as some time-intensity plots.

Imaging

We are all familiar with the applications of computed tomography (CT) and magnetic resonance imaging (MRI) in neurootology. Such modalities are now sufficiently sophisticated to permit MRI virtual endoscopy of the ear. One can now take a leisurely three-dimensional guided tour through the semicircular canals [17].

Initially, computer-aided navigation programs were developed to help guide the surgeon in critical areas (e.g., sinus surgery, in which such programs proved accurate to within 2 mm), based on preoperative three-dimensional CT imaging. Recently, experimental techniques are being developed that will take temporal bone CT data and program a robotic drill to do most of the mastoid excavation without damage to such vital structures as the facial nerve and semicircular canals.

Electronic Medical Records

A number of general otolaryngology medical record software programs now are available commercially. Some firms that offer such programs are AllMeds Inc. (OtoMeds; http://www.allmeds.com); ICS Medical Information Systems (http://www.icsmedical.com); and Stone Enterprises Medical Software, Inc. (http://www.stoneent.com).

Data Entry

To use such programs, one has first to enter the relevant medical information about patients into the database. Dieter Schneider, who works with Professor Claussen at Würzburg, has an excellent computer-based patient questionnaire for this purpose, but it is in German and therefore of limited utility. Ilmari Pyykkö and his group [18], at the Karolinska Institute in Stockholm, have devised another patient questionnaire, in English. At the Loyola University Balance Center, we employ a paper questionnaire. Our next step is to emulate McRoy et al. [2] by developing an interactive software history entry program.

Database

The database program can be selected, according to the physician's preference, from a variety of available programs (e.g., Lotus 1-2-3, Excel, Access). The largest neurootological database in the world, which includes data on more than 30,000 patients, is located in the clinic of Dr. C-F Claussen in Bad Kissingen, Germany. The utility of this gold mine of information is easily appreciated when reading Claussen's many publications that are based on the information readily available to him at the click of a mouse.

Diagnostic Decision Support Systems

Expert Systems

Expert systems have been used very little in neurootology. NeuroCom International, Inc., has incorporated such a system into one of their CDP protocols, which automatically identifies four common dysfunction response patterns [19]. Ample information is now available to permit the development of other expert systems in the area of disease-related eye movement abnormalities. It seems prudent to encourage and support the development of computer software programs that can accomplish a task more quickly and efficiently than can the clinician.

Computer Diagnosis

Nonetheless, for many, replacing the doctor with a computer is the "Holy Grail." I have previously entered several neurootological case histories into the Iliad system. Though the information I obtained from this exercise was informative and helpful, the data entry was tedious. The development of a program that would abstract the necessary information from the neurootological database already acquired and then would enter this information into the Iliad program in the required format seems desirable and worthwhile.

In 1972, with my colleague David A. Drachman, I developed a dizziness diagnosis protocol [20]. For a given patient, we were able to devise a short list of the most likely diagnoses in descending order of probability. The correct diagnosis was among the top three diagnoses selected by the protocol in 95% of our patients.

In 1990, Gavilan et al. [21] published an expert system, named "Carusel," for vestibular diagnosis based on symptoms. In the same year, Mira et al. [22] created a similar system called "Vertigo." Kentala et al. [18] first published a more comprehensive system based on symptoms, clinical signs, and laboratory tests in 1996; they named their system "ONE." In a subsequent publication [23], they were able to show that the system was nearly as proficient as were otolaryngology residents.

Guidelines

Clinical Practice

In considering wider usage of computers in medicine in general and in neurootology in particular, one must ponder: Who educates the computer? In the field of neurootology, it is important that we, especially the members of the Neurootological and Equilibriometric Society (NES), do so, or this responsibility will fall to bureaucrats, lawyers, and nonspecialist doctors. Now is the time to develop and publish protocols.

The American Academy of Otolaryngology–Head and Neck Surgery (AAOHNS) has already prepared a number of written protocols for computer application. The protocols are disseminated under the medical euphemism *clinical indicators* (http://www.ent.org/indicators). Each of the protocols closes with a strong disclaimer stating that in no way does the document represent "a standard of care." I would argue that a detailed enumeration of medical indications, required examinations and tests, operative complications, and outcome review does indeed constitute "a standard of care"! Thus far, the AAOHNS has not ventured into neurootological territory, but it is only a matter of time before this occurs. Neurootological specialists must be first to issue standards of care for their patients.

The American Otological (AOS) and American Neurotological Societies (ANS) have published "joint policies" (see http://itsa.ucsf.edu/~ajo/ANS/Policies/JPolicies.html). These statements primarily stake out the organizations' medical turf and endorse vestibular tests (e.g., CDP). Independently, the ANS has published a so-called policy (more aptly called a *guideline*) titled the "Neuro-Otological Examination," which was adopted in May 1996 (see http://itsa.ucsf.edu/~ajo/ANS/Policies/Policy.html). This ANS policy clearly lists all the required otological and neurological examinations.

Treatment

Thus far, most attempts in the direction of expert systems that recommend treatments have been retrogressive rather than progressive. The authors of such systems claim to be advocating a better quality of care, but their hidden agenda is to change medical practice to save money for insurance firms and other similar organizations for whom the system developers work. Most published treatment guidelines fall below medically acceptable standards. In addition, because there are no standards of treatment for many diseases and because no two patients are exactly alike, the concept of standardizing treatment recommendations via computerized data is problematic. It requires a cautious approach and some trial-and-error experiments before any real headway can be made in this area.

Neurootological Resources on the Internet

Rothschild and Kuppersmith [24] have written an excellent review of Internet resources for otolaryngologists and head and neck surgeons. Many of the Web sites mentioned are of interest to the neurootologist.

The directory of the AAOHNS at http://www.entnet.org now offers to identify otolaryngologists by name or by location. Similar services are offered by VLMed at http://vlmed.com/ENT_home.html and worldwide by EntDocShop at http://www.entdocshop.com.

Telemedicine

Wolf et al. [25] have developed a unit that allows the detection and measurement of nystagmus at home, similar to the Holter monitor in cardiology. Telemetric transmission of such data to the home base is quite feasible. (I now live in California, and every month the Northwestern University Cardiac Clinic in Chicago performs a telephone checkup of my pacemaker.) Hence, it now is possible to practice neurootology from a distance. For instance, Viirre et al. [26], using an audiovisual link, have accomplished eye examinations using head-mounted cameras and ear examinations using a videootoscope.

Electronic Publications

Journals Otolaryngology journal articles and abstracts are becoming available online. The transactions of the NES are published in the *International Tinnitus Journal* at http://www.tinnitusjournal.com. Unfortunately, to date we list only the titles of the articles—no abstracts and no text. A list of journals that may be of interest to neurootologists is provided at the end of this article.

The reader who does not wish to review all the journals available online can hire a firm that, on a monthly basis, will review them (or at least 19 of them) for a user and send the review results via diskette. This service is offered as a part of the Continuing Education Program from the AAOHNS (http://www.oakstonemedical.com).

Textbooks A collation of the summaries of ear, nose and throat grand rounds from the University of Texas, "Dr. Quinn's Online Textbook of Otolaryngology," is available at http://www.utmb.edu/oto. More recently, Emedicine, at http://www.emedicine.com, has begun to develop online textbooks in a variety of specialties, including otolaryngology. This volume includes chapters on various types of vestibular physiology, tests, diseases of the inner ear, and specific vestibular diseases. A companion volume in neurology includes movement disorders and neurootology.

Loyola University Balance Center

Our experience at and plans for the Loyola University Balance Center (http://www.lumc.edu/ent) were addressed in my presentation to the NES in Anaheim, California, in 1999 [27]. At the Balance Center, we have developed a number of documents (currently used in word-processing format) for patient processing and laboratory testing. Among the forms available for *patient processing* are the general patient processing form, a clinic information document, symptom information documents, a patient registration form, history questionnaires (general and symptom-specific), neurootological examination forms (one each to be used by a nurse and a physician), patient disposition documents (including a differential diagnosis form, laboratory test order forms, medical consultation forms, record request forms, imaging review request forms, prescription forms, therapy forms, and follow-up instructions), patient information documents (including disease, laboratory test, and consultation information), and medical records (i.e., transcription templates, a medical record document, *International Classification of Disease, ninth revision: Clinical Modification* [ICD 9 CM] diagnosis codes, current procedural terminology (CPT) charge codes, and report and referral letters). Documents for *laboratory testing* (e.g., EOG, ENG, CDP) include test information and instruction documents, patient processing and registration forms, technologists' forms, readers' forms, interpretation forms, medical records, transcription templates, a medical record document, ICD 9 CM diagnosis codes, CPT charge codes, and report forms.

FUTURE STEPS

According to a recent report of the Institute of Medicine, one of the national academies of science, "Medical mistakes kill 44,000 to 98,000 people a year in U.S. hospitals" [28]. Medical and disability expenses and lost productivity could be as high as $29 billion in the United States. Eighty percent of elderly cardiac patients are not prescribed the beta-blockers they need; twenty percent of angiograms are misread; and the list of errors and oversights goes on [28].

Jenkins [29], writing in the *Wall Street Journal*, notes, "Easily within reach are artificial intelligence programs that could correlate a patient's complaint and medical history, ask the right questions and build up a diagnosis with reference to a database of patient histories. The program could order the tests most likely to prove or disprove a diagnosis without the emotional basis of a human physician with his pet theories." In time, AI programs will automate most of the processing of patients, and the physician will become a systems monitor. Patients will be triaged for doctors. The medical history may be entered into the system directly by the patient or under the guidance of a nurse. A physician reviewing such a record will receive many prompts, information, and advice. True online multimedia patient records may be possible in the future. Physicians will be guided down certain diagnostic avenues and toward specific treatments. Management and outcomes will be monitored.

In discussing the future of medicine, Nuland [30], also writing in the *Wall Street Journal*, predicts "uniformity of criteria, accountability to a national authority, standardized treatment plans, and scrupulous surveillance both of immediate and long-term outcomes . . ." Undoubtedly, computers will play a large part in this scenario. However, lest we lose all hope of a professional future, Nuland is quick to add that, fortunately, "Every person who comes to a hospital is sick in his own way and requires a level of personal attention, even devotion, that will ever frustrate the purveyors of total efficiency!"

In 1966, the U.S. government enacted the Health Insurance Portability and Accountability Act and, in 1999, began to implement it. The act requires everyone who holds or transmits medical information to use a standard format for medical records, laboratory reports, and the like. The expectation is that health plans should perform better their job of monitoring the quality of health care.

Jenkins [29], on the other hand, hopes that the U.S. government will get out of the business of "setting prices and dictating practices to health care providers." He describes current health care as "a mediaeval corporate backwater." In 5–10 years, health maintenance organizations (HMOs) will have been replaced because managed care "can't do what it was supposed to do—control costs—without antagonizing its customers . . . HMOs are moving out of the cost-control business because of fatigue and lawsuits and public policy threats and actions." Instead, "employees will get vouchers to buy health insurance and pay the difference out of their own pockets if they want gold plated coverage. The onus will finally be on the consumer to decide the proper trade off between price and coverage" [31].

The problem, as we all know, is an economic one. Medicine constitutes one-seventh of the U.S. gross domestic product. Jenkins [29] wants to see medicine turned over to big business and patients given vouchers to buy private health plans.

In contrast, Collen [32] envisions the emergence of a limited number of government-controlled medical care plans that will spell out many aspects of patient care, including "online clinical decision support and practice guidelines for health professionals." These may be physician- or insurer-controlled.

Jenkins [31] is of the opinion that the delivery of improved health care will not "be rationalized by modern business techniques . . . while the current regime of Medicare terrorism keeps the necessary capital from coming into the hospital industry." He argues that whether or not the dead hand of Medicare continues to inhibit business investment in the medical industry, ". . . health care professionals will benefit from the expanding informatics technology to support clinical decisions," and the system will satisfy "management's need for a greater volume of data to monitor and *control* [author's italics] the processes and outcomes of health care" [31].

Clearly, software programs must be developed to meet the needs of medical professionals. No doubt, such programs will evolve as specific needs arise and resources become available.

In an electronic response letter to an editorial by Delamothe and Smith titled "The Joy of Being Electronic" [33], Martley stated, "Patients will drive the real revolution." The phenomenal positive lay response to the drug industry's advertisement of prescription-only drugs has resulted in ever-increasing numbers of patients demanding specific drug prescriptions from their doctors. This is just the beginning. In the United States, the trend is away from expecting the government to provide everything for everyone. Private retirement plans such as 401(k)s supplement Social Security income, and now medical vouchers allow private corporations to get out of the previous (government-mandated) obligation to provide health care benefits for their employees. Web sites such as http://www.eBenX.com offer individuals help in purchasing health care in much the same way that other sites aid in financial planning. Ultimately, the marketplace, in its broadest sense, will rule.

Like it or not, this is where we physicians are headed! The plans to get there must to be spelled out in detail. The only question is whether we will lead the way or whether we will be dragged there, kicking and screaming, by medical administrators.

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SUGGESTED READINGS

Books and Complete Volumes

Friedman CP, Wyatt JC (eds). Evaluation Methods in Medical Informatics. New York: Springer-Verlag, 1997.

Kuppersmith R (ed). Computers in otolaryngology. *Otolaryngol Clin North Am* 31(2), 1998.

Reggia JA (ed). *Computer-Assisted Medical Decision Making*. New York: Springer-Verlag, 1985.

Web Sites

Neurootological Interest

The EAR Foundation: http://www.theearfound.com

Health Informatic Europe: http://hi-europe.co.uk

Johns Hopkins Vestibular Laboratory: http://www.bme.jhu.edu/labs/chb

Loyola University Balance Center: http://www.lumc.edu/ent

MedHunt (Net Foundation) (a medical search engine): http://hon.ch

Medical Research Council, Human Movement and Balance Unit: http://www.ion.ucl.ac.uk/~dizzymrc/hmbu.html

National Institute on Deafness and Other Communication Disorders: http://www.nih.gov/nidcd

Northwestern University's Dizziness Page (under reconstruction)

University of Pennsylvania Medical Center, Center for Hearing and Balance, Division of Balance Disorders: http://www.upmc.edu/EAR/Balance.htm

University of Zurich Oculomotor Laboratory: http://www.unizh.ch/neurol

Organizations

Acoustic Neuroma Association (ANA): http://www.anausa.org

American Academy of Audiology (AAA): http://www.audiology.com

American Academy of Neurology (AAN): http://www.aan.com

American Academy of Otolaryngology–Head and Neck Surgery (AAOHNS): http://www.entnet.org

American Medical Association (AMA): http://www.ama-assn.org

American Medical Informatics Association (AMIA): http://www.amia.org

American Neurotology Society (ANS): http://itsa.ucsf.edu/~ajo/ANS/ANS.html

American Otological Society (AOS): http://itsa.ucsf.edu/~ajo/AOS/AOS.html

American Tinnitus Association (ATA): http://www.ata.org

Association for Research in Otolaryngology (ARO): http://www.aro.org

British Association of Audiological Physicians (BAAP): http://www.baap.org.uk

British Medical Association (BMA): http://web.bma.org.uk

British Society of Audiology (BSA): http://www.b-s-a.demon.co.uk

International Federation of Oto-Rhino-Laryngological Societies (IFOS): http://medlec.uia.ac.be/ifos

International Tinnitus and Hyperacusis Society: http://www.iths.net

Neurootological and Equilibriometric Society, Reg. (NES) (home page): http://www.vertigo-dizziness.com

Politzer Society: http://ato.org.tr/home/ozgirgin

Tinnitus and Hyperacusis site: http://www.tinnitus.org

Journals

Medicine, Otology, and Neurootology

Acta Otolaryngologica: http://www.scup.no (paid subscribers only)

American Journal of Otolaryngology–Head and Neck Medicine and Surgery: http://www.wbsaunders.com (by subscription)

American Journal of Otology: http://itsa.ucsf.edu/~ajo (titles)

Annals of Otology, Rhinology, and Laryngology: http://www.annals.com (abstracts)

Archives of Otolaryngology–Head and Neck Surgery: http://archoto.com (full text)

Audiology and Neurotology: http://www.karger.ch

Auditory Neuroscience: http://www.nwu.edu/auditory-neuroscience (abstracts)

ENT News Online (articles, literature reviews, general interest): http://www.ent-news.com (by registration)

International Online Journal of Otorhinolaryngology–Head and Neck Surgery: http://www.orl-hns.org (full text)

International Tinnitus Journal (transactions of the NES): http://www.tinnitus.com (currently decommissioned)

Journal of Laryngology and Otology: http://www.jlo.co.uk (titles)

Journal of the American Medical Association: http://www.jama.com (full text)

Journal of the British Medical Association: http://www.bmj.com (full text)

Journal of Vestibular Research: http://www.elsevier.com (by subscription)

Laryngoscope: http://www.laryngoscope.com (titles)

Neurology (from the American Academy of Neurology): http://www.aan.com (abstracts)

ORL: http://www.karger.ch (by subscription)

Otolaryngology (*Excerpta Medica* abstract journal, section 11): http://www.elsevier.com (by subscription)

Otolaryngology–Head and Neck Surgery: http://www.mosby.com (full text)

Technology, Computers, and Physics in Medicine (lists of, and links to, journals in otolaryngology and neurology): http://www.sciencekomm.at/journals/medicine.html

Medical Computer Applications

Journal of the American Medical Informatics Association: http://www.amia.org (abstracts)

Journal of Telemedicine and Telecare: http://www.qub.ac.uk/telemed/jtt/ (titles)

Telemedicine Journal: http://www.liebertpub.com/tmj/default1.htm (by subscription)

Biomedical Manufacturing Companies

Hortmann GmbH: http://www.Hortmann.de

ICS Medical: http://www.icsmedical.com

inomed: http://www.inomed.deg

ISCAN: http://www.iscaninc.com

Jaeger-Toennies: http://www.jaeger-toennies.com

Jedmed: http://www.jedmed.com

Life-Tech: http://www.life-tech.com

Micromedical Technologies, Inc.: http://www.micromedical.com

Nagashima Medical Instruments Co., Ltd. (under construction): http://nagashima.co.jp

NeuroCom International, Inc.: http://www.onbalance.com

Nicolet Biomedical: http://www.nicoletbiomedical.com

Reimers & Janssen, GmbH: http://www.fj-medical.de

SensoMotoric Instruments GmbH–SMI: http://www.smi.de; http://www.smiusa.com

Synapsys: http://www.synapsys.fr

Western Systems Research, Inc.: http://www.4wsr.com

zebris Medizintechnik GmbH: http://www.zebris.de

Patient Information and Support

Acoustic Neuroma Association, Canada: http://www.anac.ca

Acoustic Neuroma Association, USA: http://anausa.org

American Academy of Otolaryngology–Head and Neck Surgery: http://www.entnet.org
  "Vertigo," Patient Education Video Series (OT-13)
  "Why do we fall?" Patient information series

American Physical Therapy Association: http://www.apta.org

American Tinnitus Association: http://www.ata.org

Biologische Heilmittel Heel GmbH: http://www.heel.de

Ear Foundation (Ménière's Network): http://www.theearfound.com

Loyola University Balance Center: http://www.lumc.edu/ent

National Institute on Deafness and Other Communicative Disorders: http://www.nih/gov/nidcd

National Neurofibromatosis Foundation, USA: http://nf.org

Neurofibromatosis Association, UK: http://www.users.zetnet.co.uk

NF2Crew WebSite (Neurofibromatosis Webring): http://webcrossings.com/nf2crew

Self-Help for Hard of Hearing People, Inc. (SHHH): http://www.shhh.org

Vestibular Disorders Association: http://www.vestibular.org

Vestibular Disorders Hotsheet: http://conciliocreative.com/dizzy

Virtual Tour of the Ear (directory for the hearing impaired): http://ctl.augie.edu