Global Infectious Diseases and Epidemiology Network (GIDEON): A World Wide Web–Based Program for Diagnosis and Informatics in Infectious Diseases

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The Global Infectious Diseases and Epidemiology Network (GIDEON) (http://www.gideononline.com) consists of 4 modules. The first is designed to generate a ranked differential diagnosis list for any infectious diseases scenario in any of 220 countries. The second follows the country-specific epidemiology of 337 individual diseases. The third presents a comprehensive encyclopedia of 308 generic anti-infective drugs and vaccines, including a listing of >9500 trade names. The fourth generates a ranked identification list based on the phenotype of bacteria, mycobacteria, and yeasts. The program performs well and serves as a useful paradigm for World Wide Web–based informatics. GIDEON is an eclectic program that can serve the needs of clinicians, epidemiologists, and microbiologists working in the fields of infectious diseases and geographic medicine.

If asked to design a useful information system for infectious diseases, what would the end user require? First and foremost, such a system would be comprehensive and would encompass the clinical features and epidemiology of all infectious diseases in every country, all human pathogens, and all anti-infective drugs and vaccines. The program would be flexible, would be updated "in real time," and would allow for modification of data by both the manufacturer and the end user. Additional requirements would include easy transmission and reproduction of data across institutional networks, student modules, et cetera.

One of the principal problems in developing such a system is the availability and quality of the actual data. The list of "reportable" diseases varies widely from country to country, and the numbers reported are often far removed from the true estimate (e.g., underreporting of AIDS and cholera). ProMed-mail (http://www.promedmail.org) and similar Web sites carry a wealth of reliable and current data, but they often quote material published in the lay press.

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Although GIDEON was originally marketed as a CD-ROM–based system through subscription, a complete interactive program can now be accessed online. Unlike the version available on CD-ROM, the Internet version can be operated on any computer and is updated weekly. Both versions allow for addition of custom notes by users in their own languages and alphabets. Such notes can include addresses and phone numbers, costs of drugs or laboratory tests, and a listing of local outbreaks and cases, among other things.

GIDEON (http://www.gideononline.com) consists of 4 modules: Diagnosis, which is designed for decision support or disease simulation; Epidemiology, which largely consists of text files on the country-specific status of individual infectious diseases; Therapy, which is an up-to-date encyclopedia of anti-infective drugs and vaccines; and Microbiology, which is designed to identify or contrast bacteria and yeasts.

Diagnosis. The Diagnosis module is designed to generate a ranked differential diagnosis on the basis of signs, symptoms, laboratory tests, incubation period, and country of disease origin. Options in the data entry screen (figure 1) are organized by body system, country of disease acquisition, and details of exposure. The lower "personal notes" box is used to record additional case data, and notes can be written in the user's own language. The resulting differential diagnosis list allows the reader options that include a hard-copy or e-mail report, gen-
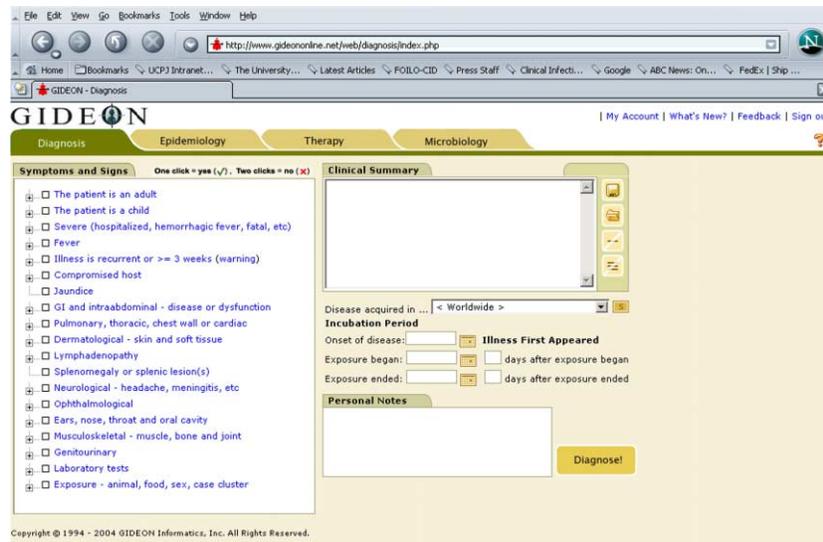
Figure 1. Global Infectious Diseases and Epidemiology Network (GIDEON) data entry screen. Available at: http://www.gideononline.net/web/diagnosis/index.php.

eration of a table comparing the clinical features of the diseases listed, and queries concerning the omission or ranking of specific diseases. If the user clicks on a disease name, additional screens describe the disease itself and its clinical epidemiology.

The differential diagnosis list in GIDEON is based on a Bayesian formula that compares the mathematical product of disease incidence times the rate of symptom occurrence for all relevant infectious diseases within a given country. Additional options allow for analysis of a worldwide scenario (e.g., a list of the complete differential diagnoses of eosinophilia and splenomegaly or of arthralgia with rash). A "bioterrorism" option produces the differential diagnosis of signs and symptoms associated with suspected bioterrorism scenarios. Interestingly, the latter option is not based on a Bayesian formula, because the concept of "incidence" is not relevant.

As the manufacturers point out, the module should not substitute for clinical acumen, and should be considered an "expert" or "decision support" system. In many cases, the correct diagnosis does, in fact, appear as the first item on GIDEON's list. In a blinded study of 500 cases conducted by the developer of GIDEON, the correct diagnosis appeared in the differential diagnosis in 94.7% of cases and was ranked first in 75% [1]. A later study, which examined 86 hospitalized patients, found that the correct diagnosis appeared in only 69% of cases and was ranked first in only 60% [2]. For this reason, a "why not" option was added to GIDEON to analyze why certain diagnoses are not listed.

How important is ranking in the performance of expert systems? In 1994, Kassirer [3] found that existing medical decision-support programs were often inadequate when it came to ranking the correct disease as "number one" in a list of dif-

ferential diagnoses, but he also noted that the list itself is valuable in reminding the clinician of alternative diseases that might otherwise have been ignored.

Epidemiology. The Epidemiology module follows the global and country-specific status of 337 generic infectious diseases in 220 countries. The manufacturer states that the current version contains >1.5 million words of text among its 11,000 notes. One such note is depicted in figure 2. All material in GIDEON is derived from health ministries, military agencies, dedicated Internet lists (e.g., for rabies and anthrax), peer-review journals, standard texts, and data presented at major conferences. The user may also access >10,000 graphics that note the incidence, prevalence, and other numerical data concerning global and country-specific disease status. The blue text in figure 2 indicates availability of a pop-up incidence graph.

Additional submodules present the descriptive epidemiology and clinical features of each disease, country-specific vaccine schedules, and links to relevant Web sites. A number of "synonym" tabs allow the user to access this material through alternative terms for diseases and countries, including disease names in Spanish, German, and French, among other languages. Historical data record the incidence of individual diseases and significant outbreaks spanning decades. For example, the yearly incidence of smallpox in Japan is recorded from 1892 until the country's last reported case in 1955. As in the Diagnosis module, users may expand these notes with data relevant to their own institutions and in their own language.

An additional option in the Epidemiology module generates a list of diseases compatible with user-selected parameters. For example, the user can access information on the trematode diseases acquired from fish in Japan, mosquito-borne Togavi-

ruses of the United States, or pathogens found in Australian marsupials.

Therapy. The Therapy module follows the pharmacology and use of all drugs and vaccines used in the field of infectious diseases. The current version contains 308 generic agents. One section lists the mechanism of action; dosages for adults, children, and infants; elimination half-life and metabolism; levels found in bile, CSF, and breast milk; and suggested dosage adjustments for renal dysfunction and dialysis. Other sections list toxicities and drug-drug interactions (contraindications and booster schedules for vaccines), proprietary names, spectra (including recommendations of drugs of choice), and susceptibility testing standards. International synonym lists containing >9500 trade names allow the user to access the generic name for any preparation.

Other sections allow the user to access a list of drugs associated with a given toxicity, drug interaction, or therapeutic indication. The latter may be directed at a list of pathogens (e.g., to determine which drugs might be useful for a patient with both tuberculosis and a *Pseudomonas* superinfection, or which drugs might be useful for a child infested with *Capillaria* species, *Strongyloides* species, and hookworm). As in other modules, users may add custom notes (e.g., local trade names, prices, and resistance patterns) for each drug or vaccine.

Microbiology. The Microbiology module is similar to the Diagnosis function discussed above, but instead of signs and symptoms, the user enters any combination of phenotypic tests, and instead of a differential diagnosis list, GIDEON generates

a ranked probability list of compatible bacteria (e.g., mycobacteria and yeasts). The current version incorporates 1100 taxa. Unlike standard systems used in nearly all clinical laboratories, this list is Bayesian—that is, it uses relative organism occurrence in determining probability. For example, if a given set of phenotypic reactions is compatible with both *Staphylococcus aureus* and *Staphylococcal hyicus,* the currently marketed automated and semiautomated identification systems would assign a 50% probability to each and would recommend additional tests to resolve the identification. Before inserting the name of the organism in question into one of these systems, we already know intuitively that *S. aureus* is many-fold more likely than *S. hyicus* to be present in clinical specimens and that a 50/50 likelihood cannot be correct [4]. GIDEON is programmed to adjust for the relative prevalence ("prior probability") of these 2 taxa, and it would rank *S. aureus* first, with a probability of >99%.

Additional options in the Microbiology module can be used to generate the complete phenotype, prior names, ecology, and disease association for any given taxon, and they can produce a chart that contrasts the characteristics of any combination of taxa selected by the user. As in other modules, a synonym list is available for location of the current name for previously used taxonomic designations.

LIMITATIONS OF THE SYSTEM

Although the GIDEON text files are impressive in size and scope, it would be useful for the future versions of GIDEON to include tables, maps, and photographic material (e.g., depictions of skin lesions or photomicrographs). The Bayesian matrix upon which the Diagnosis module is based is somewhat rigid and might discount a given diagnosis on the basis of a single sign or symptom.

Another limitation is related to the fact that the program treats each country as a unit. Thus, the differential diagnosis of pneumonia in an American person will include coccidioidomycosis and histoplasmosis, even if the patient is living in Hawaii or Alaska. This problem is corrected to a large extent by the associated country-specific notes and the general knowledge base of the treating physician. In theory, the manufacturer could follow the incidence of each disease for every state (in the United States, India, or Venezuela, for example), district (in Chile), or province (in Canada), but variability in the terrain, in occupation, and in rural versus urban settings would still remain.

The cost of a single-user subscription is $695.00 per year. The prices of institutional networks and multiple-user subscriptions are based on the number of users. Overall, GIDEON is a useful program that makes optimal use of the World Wide Web, with regard to both the access to and the presentation of data for the infectious diseases community.
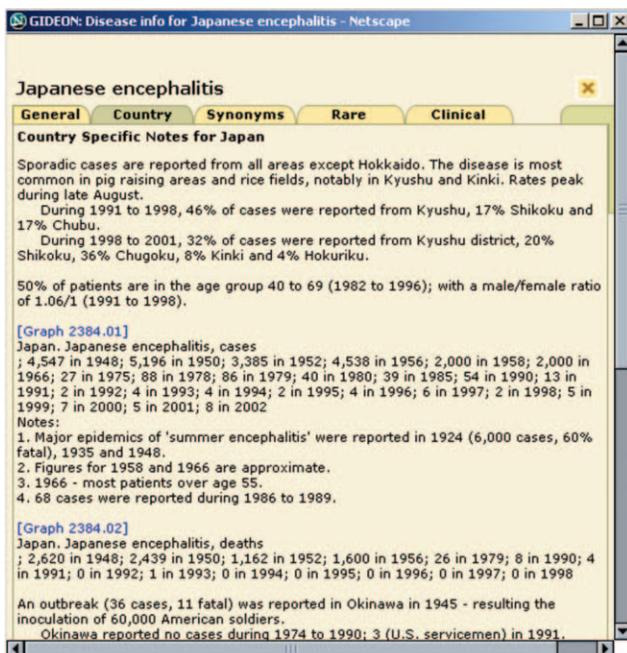

Figure 2. Country-specific note. Blue script denotes availability of a pop-up graph.

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