Computer Program for Diagnosing and Teaching Geographic Medicine

Stephen A. Berger and Uri Blackman

One of the unique aspects of infectious disease is its wide variety, both in time and place. The specialist practicing in India may have little or no expertise in Peruvian disease. A colleague in New York may be called upon to diagnose and treat conditions originating in Africa, Asia, South America, Fiji and Papua, New Guinea. At the same time, this colleague must be familiar with the pathogens that originate in Texas, Hawaii, and Canada. Indeed, even the full-time infectious diseases specialist may not be conversant in diseases such as lagochilascariasis, louping ill, and lobomycosis. War, famine, education, immigration, and business travel have contributed to the advent of specialists in Geographic Medicine and Epi-emiatrics, otherwise known as Travel medicine.

The “art” of diagnosis is largely an ability (albeit subconscious) to rank probabilities based on the incidences of likely diseases and the chance of encountering given clinical features within each disease. In theory, Bayesian analysis could be employed to diagnose disease accurately when given proper input. A multicenter study was undertaken to test a comprehensive computer driven-software program that incorporates worldwide epidemiologic and clinical parameters.

Materials and Methods

Computer Program Design

Interactive data bases that represent rates and clinical probabilities were constructed for 308 diseases; 127 symptoms, signs, and laboratory findings; and 205 countries. Reported statistics published by the World Health Organization and national health ministries were used where available. These were supplemented by data for neighboring countries and previous years when necessary (Table 1). In cases where the accuracy of disease reporting was suspect (e.g., AIDS in Africa), more realistic published estimates were used.

The data base is limited to infectious diseases (Table 2). It does not include slow viral illnesses and a number of self-defined and obvious conditions such as otitis externa and furunculosis. As the program is designed to diagnose clinically apparent disease, data regarding asymptomatic carriage or infestation were adjusted accordingly. Figures regarding the incidence of signs and symptoms within each specific disease were derived from standard textbooks and reviews. Clinical and epidemiologic data are updated on a continuous basis.

The program user is first requested to indicate the country of disease origin and is then presented with a list of 22 basic clinical parameters, which are grouped according to body system. A + or - response to each of the latter is indicated by using any of a variety of computer keystrokes. A + response automatically opens a computer window that requests further details. Thus, if the user indicates that a rash is present, he will be asked to further define the nature and distribution of the skin lesions. An additional window is available for the entry of laboratory test results (hematologic, cerebrospinal, hepatic, or renal) if available.

User input is processed by a Bayesian matrix, and compatible diagnoses are presented in order of probability in a bar graph and numerical format. Ancillary clues for all listed diseases are accessed by specified key strokes as follows: incubation period, clinical hints, geographic distribution, vector, vehicle, reservoir, etc. Additionally, drugs of choice and dosages for adult or pediatric therapy are listed. The diagnosis list is accompanied by an ancillary screen, which indicates rare (albeit compatible) clinical findings in each disease listed for the patient in question. An additional interactive screen lists all additional clinical findings that could improve diagnostic specificity.

Separate computer modules allow the user to study specific diseases and antinfective agents without regard to a specific patient. The user may, for example, request a listing for all parasitic diseases acquired in Togo from the bites of mosquitoes; or of all drugs which interact with alcohol. In addition to the epidemiologic and clinical parameters outlined above, screens are available that outline the worldwide distribution of each disease, as well as the current status of AIDS, malaria, tuberculosis, yellow fever,
Table 1  Sources Used in Maintaining The Epidemiologic Database

<table>
<thead>
<tr>
<th>Official Health Ministry Reports</th>
<th>Archives of Internal Medicine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bericht Uber dat Gesundheitswesen in Osterreich [Austria]</td>
<td>British Medical Journal</td>
</tr>
<tr>
<td>Boletin Epidemiologico de Chile [Argentina]</td>
<td>Bulletin of the World Health Organization</td>
</tr>
<tr>
<td>Boletin Epidemiologico Nacional [Argentina]</td>
<td>Clinical Infectious Diseases</td>
</tr>
<tr>
<td>Boletin Epidemiologico y Microbiologico [Spain]</td>
<td>Clinical Microbiology Reviews</td>
</tr>
<tr>
<td>Boletin Informativo [Bolivia]</td>
<td>European Journal of Microbiology and Infectious</td>
</tr>
<tr>
<td>Bulletin Epidemiologique Hebdomadaire [France]</td>
<td>Diseases</td>
</tr>
<tr>
<td>Canada Communicable Disease Report [Canada]</td>
<td>Harfus</td>
</tr>
<tr>
<td>CDR Weekly [United Kingdom]</td>
<td>Infectious Disease Clinics</td>
</tr>
<tr>
<td>Choroby Zakazne I Zatrucia W Polsce [Poland]</td>
<td>Infectious Disease Clinics of North America</td>
</tr>
<tr>
<td>Communicable Diseases Intelligence [Australia]</td>
<td>International Journal of Systematic Bacteriology</td>
</tr>
<tr>
<td>Community Health &amp; Disease Surveillance News Letter [Oman]</td>
<td>Israel Journal of Medical Sciences</td>
</tr>
<tr>
<td>Comportamiento de Patologias Immunoprevenibles [Argentina]</td>
<td>JAMA</td>
</tr>
<tr>
<td>Daten des Gesundheitswesens [Germany]</td>
<td>Journal of Antimicrobial Chemotherapy</td>
</tr>
<tr>
<td>Epidemiology Bulletin [Taiwan]</td>
<td>Journal of Clinical Microbiology</td>
</tr>
<tr>
<td>EPI-NYT [Denmark]</td>
<td>Journal of Clinical Pathology</td>
</tr>
<tr>
<td>Heilbrigdisskyrslur [Iceland]</td>
<td>Journal of Hospital Infection</td>
</tr>
<tr>
<td>IASR [Japan]</td>
<td>Journal of Internal Medicine</td>
</tr>
<tr>
<td>Health Statistics Ireland [Ireland]</td>
<td>Journal of Infectious Diseases</td>
</tr>
<tr>
<td>Morbidity and Mortality Weekly Report [USA]</td>
<td>Journal of Travel Medicine</td>
</tr>
<tr>
<td>MSIS-rapport [Norway]</td>
<td>Lancet</td>
</tr>
<tr>
<td>Notiziario dell’Istituto Supersiore de Sanita [Italy]</td>
<td>Medical Journal of Australia</td>
</tr>
<tr>
<td>Terveyt [Finland]</td>
<td>Medicine</td>
</tr>
<tr>
<td>Journals and Periodicals</td>
<td>New England Journal of Medicine</td>
</tr>
<tr>
<td>AIDS</td>
<td>Pediatric Clinics of North America</td>
</tr>
<tr>
<td>American Journal of Clinical Pathology</td>
<td>The Pediatric Infectious Disease Journal</td>
</tr>
<tr>
<td>American Journal of Diseases of Children</td>
<td>Pediatrics</td>
</tr>
<tr>
<td>American Journal of Epidemiology</td>
<td>Reviews of Infectious Diseases</td>
</tr>
<tr>
<td>American Journal of Medicine</td>
<td>Scandinavian Journal of Infectious Diseases</td>
</tr>
<tr>
<td>American Journal of Public Health</td>
<td>South African Medical Journal</td>
</tr>
<tr>
<td>American Journal of Tropical Medicine and Hygiene</td>
<td>Southern Medical Journal</td>
</tr>
<tr>
<td>Annals of Internal Medicine</td>
<td>The Medical Letter</td>
</tr>
<tr>
<td>Antimicrobial Agents and Chemotherapy</td>
<td>Transactions of the Royal Society of Tropical</td>
</tr>
<tr>
<td>Applied Microbiology</td>
<td>Medicine and Hygiene</td>
</tr>
<tr>
<td></td>
<td>Tubercle</td>
</tr>
<tr>
<td></td>
<td>World Health Statistics Quarterly</td>
</tr>
</tbody>
</table>

and cholera. The therapeutic spectrum, toxicity, dosage and other characteristics of anti-infective agents and vaccines are also available.

Multicenter Study

Questionnaires reflecting the computer input screen were distributed to six senior full-time infectious disease specialists. (The authors' own institution was excluded). Participants were requested to record all positive and negative clinical data for consecutive patients with established diagnoses. Since the majority of cases were anticipated to represent disease acquired in the study country (Israel) a similar number of "hypothetical" cases acquired abroad was also elicited. Questionnaires were assigned code numbers and submitted in a blinded fashion, with diagnoses recorded on a separate sheet. All results were collated and entered into a database (dBase III+) prior to review of the clinical diagnoses. Statistical analysis employed the chi-square test for unpaired proportions.

Results

Four hundred ninety and five of 513 cases submitted were suitable for analysis (Table 3). Ninety four individual infectious diseases were represented among these cases (Table 2). The computer program accurately identified the clinical diagnosis in 75.3% of actual cases and in 64.0% of hypothetical cases (p = .009). The clinical diagnosis was included in the computer differential diagnosis list in 94.7%. The accuracy of diagnosis was highest for parasitic disease (p = .04) and diseases acquired...
<table>
<thead>
<tr>
<th>Diseases and Pathogens Included in the Data Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abscess, intraabdominal*</td>
</tr>
<tr>
<td>Actinomycosis</td>
</tr>
<tr>
<td>Adenovirus infection</td>
</tr>
<tr>
<td>Aeromonas &amp; marine</td>
</tr>
<tr>
<td>Vibrio inf.</td>
</tr>
<tr>
<td>AIDS*</td>
</tr>
<tr>
<td>Amebiasis*</td>
</tr>
<tr>
<td>Amoeba - free living*</td>
</tr>
<tr>
<td>Angiointerstitial</td>
</tr>
<tr>
<td>Anglostrongylbiasial abdominal</td>
</tr>
<tr>
<td>Anisakiasis</td>
</tr>
<tr>
<td>Anthrax*</td>
</tr>
<tr>
<td>Argentine hemorhagic fever</td>
</tr>
<tr>
<td>Ascarias*</td>
</tr>
<tr>
<td>Aseptic meningitis, viral*</td>
</tr>
<tr>
<td>Aspergillosis</td>
</tr>
<tr>
<td>Babesiosis*</td>
</tr>
<tr>
<td>Bacillary angiomatosis</td>
</tr>
<tr>
<td>Bacillus cereus food poisoning</td>
</tr>
<tr>
<td>Balantidiasis</td>
</tr>
<tr>
<td>Barteliosis</td>
</tr>
<tr>
<td>Blastocystis hominis infection</td>
</tr>
<tr>
<td>Blastomyosis*</td>
</tr>
<tr>
<td>Bolivian hemorhagic fever</td>
</tr>
<tr>
<td>Botulism</td>
</tr>
<tr>
<td>Brain abscess*</td>
</tr>
<tr>
<td>Brazilian purpuric fever</td>
</tr>
<tr>
<td>Brucellosis*</td>
</tr>
<tr>
<td>California encephalitis group</td>
</tr>
<tr>
<td>Campylobacteriosis*</td>
</tr>
<tr>
<td>Candidias*</td>
</tr>
<tr>
<td>Capillariasis, hepatic</td>
</tr>
<tr>
<td>Capillariasis, intestinal</td>
</tr>
<tr>
<td>Cat scratch disease*</td>
</tr>
<tr>
<td>Cerarcial dermatitis</td>
</tr>
<tr>
<td>Chancroid*</td>
</tr>
<tr>
<td>Chikungunya</td>
</tr>
<tr>
<td>Chlamydia infections, misc.</td>
</tr>
<tr>
<td>Chlamydia pneumonia infection</td>
</tr>
<tr>
<td>Cholecystitis &amp; cholangitis*</td>
</tr>
<tr>
<td>Cholera*</td>
</tr>
<tr>
<td>Chromomycosis</td>
</tr>
<tr>
<td>Chronic fatigue syndrome</td>
</tr>
<tr>
<td>Chronic meningococemia</td>
</tr>
<tr>
<td>Clonorchiasis*</td>
</tr>
<tr>
<td>Clostridial food poisoning</td>
</tr>
<tr>
<td>Clostridial myonecrosis</td>
</tr>
<tr>
<td>Clostridium difficile coli*</td>
</tr>
<tr>
<td>Coccidioidomycosis</td>
</tr>
<tr>
<td>Coenurus</td>
</tr>
<tr>
<td>Colorado tick fever</td>
</tr>
<tr>
<td>Common cold*</td>
</tr>
<tr>
<td>Conjunctivitis inclusion</td>
</tr>
<tr>
<td>Conjunctivitis viral</td>
</tr>
<tr>
<td>Cowpox</td>
</tr>
<tr>
<td>Crimean Congo</td>
</tr>
<tr>
<td>Hemorrhagic fever</td>
</tr>
<tr>
<td>Cryptococcus*</td>
</tr>
<tr>
<td>Cryptosporidiosis*</td>
</tr>
<tr>
<td>Cyclospora infection</td>
</tr>
<tr>
<td>Cutaneous larva migrans*</td>
</tr>
<tr>
<td>Cytaneus leishmanias*</td>
</tr>
<tr>
<td>Cyclopsora infection</td>
</tr>
<tr>
<td>Cysticercosis*</td>
</tr>
<tr>
<td>Cytophagocytosis infection*</td>
</tr>
<tr>
<td>Dengue*</td>
</tr>
<tr>
<td>Dermatophyisis</td>
</tr>
<tr>
<td>Dicrococcoiasial</td>
</tr>
<tr>
<td>Dientamoeba diarrea</td>
</tr>
<tr>
<td>Dierotphyme renal infection</td>
</tr>
<tr>
<td>Diphteria</td>
</tr>
<tr>
<td>Diploglobothriasis</td>
</tr>
<tr>
<td>Diphylidias*</td>
</tr>
<tr>
<td>Dicrofilariais*</td>
</tr>
<tr>
<td>Dracunculiasial*</td>
</tr>
<tr>
<td>Eastern equine encephalitis</td>
</tr>
<tr>
<td>Ebola Disease</td>
</tr>
<tr>
<td>Echinoccocus*</td>
</tr>
<tr>
<td>Echinoccocus multilocular</td>
</tr>
<tr>
<td>Echinoccus vogelii infection</td>
</tr>
<tr>
<td>Echinostomiasial</td>
</tr>
<tr>
<td>Ehrlichiosis E chaferrensis</td>
</tr>
<tr>
<td>Ehrlichiosis E - senetsu</td>
</tr>
<tr>
<td>Endemic syphils (bejel)</td>
</tr>
<tr>
<td>Endocarditis - infectious*</td>
</tr>
<tr>
<td>Entamaeba polcki infection</td>
</tr>
<tr>
<td>Enteritis necroticans</td>
</tr>
<tr>
<td>Enterobias*</td>
</tr>
<tr>
<td>Enterovirus infection*</td>
</tr>
<tr>
<td>Entomophtheromycosis</td>
</tr>
<tr>
<td>Epideral abscess</td>
</tr>
<tr>
<td>Erysipelas or cellulitis</td>
</tr>
<tr>
<td>Erysiployd*</td>
</tr>
<tr>
<td>Erythroma</td>
</tr>
<tr>
<td>Escherichia coli diarrhea</td>
</tr>
<tr>
<td>European tick encephalitis</td>
</tr>
<tr>
<td>Far eastern tick - borne enceph.</td>
</tr>
<tr>
<td>Faschiolias*</td>
</tr>
<tr>
<td>Fasciolopsis*</td>
</tr>
<tr>
<td>Filariasis - Brugia malayi</td>
</tr>
<tr>
<td>Filariasis - Brugia timorii</td>
</tr>
<tr>
<td>Filariasis - Bancroftan</td>
</tr>
<tr>
<td>Gardnerella vaginals infection</td>
</tr>
<tr>
<td>Gastrococcioiasial</td>
</tr>
<tr>
<td>Giardias*</td>
</tr>
<tr>
<td>Glanders</td>
</tr>
<tr>
<td>Gnathostomiasial</td>
</tr>
<tr>
<td>Gonorrrhea</td>
</tr>
<tr>
<td>Granuloma inguinale</td>
</tr>
<tr>
<td>Group C viral fevers</td>
</tr>
<tr>
<td>Hantavirus resp distress*</td>
</tr>
<tr>
<td>Hemorrhagic fever &amp; renal synd.</td>
</tr>
<tr>
<td>Hepatitis A*</td>
</tr>
<tr>
<td>Hepatitis B*</td>
</tr>
<tr>
<td>Hepatitis C</td>
</tr>
<tr>
<td>Hepatitis delta infection</td>
</tr>
<tr>
<td>Hepatitis E</td>
</tr>
<tr>
<td>Herpes simplex infection*</td>
</tr>
<tr>
<td>Herpes simplex encephalitis*</td>
</tr>
<tr>
<td>Herpesvirus simiae infection</td>
</tr>
<tr>
<td>Herpes zoster*</td>
</tr>
<tr>
<td>Heterophylis*</td>
</tr>
<tr>
<td>Histoplasmosis*</td>
</tr>
<tr>
<td>Histoplasmosis - African</td>
</tr>
<tr>
<td>HIV infection - initial</td>
</tr>
<tr>
<td>Hookworm</td>
</tr>
<tr>
<td>Hymenomepis diminuta infection</td>
</tr>
<tr>
<td>Hymenomepis nana infection</td>
</tr>
<tr>
<td>Ilheus</td>
</tr>
<tr>
<td>Influenza*</td>
</tr>
<tr>
<td>Infragall veinious venous thrombosis</td>
</tr>
<tr>
<td>Isosporias*</td>
</tr>
<tr>
<td>Japanese encephalitis*</td>
</tr>
<tr>
<td>Karielan fever</td>
</tr>
<tr>
<td>Kawasaki disease</td>
</tr>
<tr>
<td>Kinyella infection</td>
</tr>
<tr>
<td>Kyasanur Forest disease</td>
</tr>
<tr>
<td>Lagochilascarisial</td>
</tr>
<tr>
<td>Laryngotracheobronchitis</td>
</tr>
<tr>
<td>Lassa fever*</td>
</tr>
<tr>
<td>Legionellosis*</td>
</tr>
<tr>
<td>Leprosy</td>
</tr>
<tr>
<td>Leptospirosis*</td>
</tr>
<tr>
<td>Linsutolus*</td>
</tr>
<tr>
<td>Listeriosis*</td>
</tr>
<tr>
<td>Liver abscess, bacterial*</td>
</tr>
<tr>
<td>Lobomycosis*</td>
</tr>
<tr>
<td>Loiias*</td>
</tr>
<tr>
<td>Louping ill</td>
</tr>
<tr>
<td>Lyme disease*</td>
</tr>
<tr>
<td>Lymphocytic choriomeningiosis</td>
</tr>
<tr>
<td>Lymphogranuloma venereum</td>
</tr>
<tr>
<td>Malaria*</td>
</tr>
<tr>
<td>Malignant otitis externa</td>
</tr>
<tr>
<td>Mansonelliasis - M. ozzardi</td>
</tr>
<tr>
<td>Mansonelliasis - M. perstans</td>
</tr>
<tr>
<td>Mansonelliasis - M. strepocerca</td>
</tr>
<tr>
<td>Marburg virus disease</td>
</tr>
<tr>
<td>Mayaro</td>
</tr>
<tr>
<td>Measles*</td>
</tr>
<tr>
<td>Mediterranean spotted fever*</td>
</tr>
<tr>
<td>Melioidiosis*</td>
</tr>
<tr>
<td>Meningitis, bacterial*</td>
</tr>
<tr>
<td>Metagonomiasis</td>
</tr>
<tr>
<td>Microsporidiosis</td>
</tr>
<tr>
<td>Monkeypox</td>
</tr>
<tr>
<td>Mononucleosis, infectious*</td>
</tr>
<tr>
<td>Mucocutaneous leishmaniasis</td>
</tr>
<tr>
<td>Mumps</td>
</tr>
<tr>
<td>Murray Valley encephalitis</td>
</tr>
<tr>
<td>Mycinema</td>
</tr>
<tr>
<td>Mycobacteriosis - M. marium*</td>
</tr>
<tr>
<td>Mycobacteriosis - M. scrofulaceum</td>
</tr>
<tr>
<td>Mycobacteriosis - M. ulcerans</td>
</tr>
<tr>
<td>Mycobacteriosis - systemic*</td>
</tr>
<tr>
<td>Mycoplasma pneumonia infect*</td>
</tr>
<tr>
<td>Myiatis*</td>
</tr>
<tr>
<td>Nanophytais*</td>
</tr>
<tr>
<td>Necrotizing skin / soft tissue infx.</td>
</tr>
<tr>
<td>Nocardiosis*</td>
</tr>
<tr>
<td>North Asian tick typhus</td>
</tr>
<tr>
<td>Norwalk agent gastroenteritis</td>
</tr>
<tr>
<td>O'nyong nyong</td>
</tr>
<tr>
<td>Ockelbo disease</td>
</tr>
<tr>
<td>Oesophagostomiasial</td>
</tr>
<tr>
<td>Onsk hemorrhagic fever</td>
</tr>
<tr>
<td>Onchocerciasial</td>
</tr>
<tr>
<td>Ophthalmoclisis</td>
</tr>
<tr>
<td>Ophitris media</td>
</tr>
<tr>
<td>Paracocciotidomycosis</td>
</tr>
<tr>
<td>Parainfluenza virus infection</td>
</tr>
<tr>
<td>Parvovirus B19 infection</td>
</tr>
<tr>
<td>Pasteurellosis*</td>
</tr>
<tr>
<td>Pediculosis*</td>
</tr>
<tr>
<td>Penicilliosis*</td>
</tr>
<tr>
<td>Pentastomiasial</td>
</tr>
<tr>
<td>Pericarditis, bacterial</td>
</tr>
<tr>
<td>Perinephric abscess*</td>
</tr>
<tr>
<td>Perrectal abscess*</td>
</tr>
<tr>
<td>Pertitinus, bacterial</td>
</tr>
<tr>
<td>Pertussis</td>
</tr>
<tr>
<td>Pharyngeal &amp; cervical space infx.</td>
</tr>
<tr>
<td>Pharyngitis, acute bacterial</td>
</tr>
<tr>
<td>Pinta</td>
</tr>
<tr>
<td>Plague*</td>
</tr>
<tr>
<td>Plesiomonas enteritis</td>
</tr>
<tr>
<td>Pleurodynia</td>
</tr>
<tr>
<td>Pneumocystis pneumonia*</td>
</tr>
<tr>
<td>Pneumonia, bacterial*</td>
</tr>
<tr>
<td>Pogosta disease</td>
</tr>
<tr>
<td>Poliomyelitis (wild or vaccine)</td>
</tr>
<tr>
<td>Powassan</td>
</tr>
<tr>
<td>Pseudocowpox*</td>
</tr>
<tr>
<td>Pyoderma (impetigo, abscess, etc)</td>
</tr>
<tr>
<td>Pyromysotris*</td>
</tr>
<tr>
<td>Q fever*</td>
</tr>
<tr>
<td>Queensland tick typhus</td>
</tr>
<tr>
<td>Rabies</td>
</tr>
<tr>
<td>Rat bite fever - spirillary</td>
</tr>
<tr>
<td>Rat bite fever - streptobacillary</td>
</tr>
<tr>
<td>Relapsing fever*</td>
</tr>
<tr>
<td>Respiratory syncytial infection</td>
</tr>
<tr>
<td>Rey's syndrome</td>
</tr>
</tbody>
</table>
Table 2  Diseases and Pathogens Included in the Data Base [Continued]

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhinoscleroma</td>
<td>Schistosomiasis – mansoni*</td>
<td>Schistosomiasis – mattheei</td>
<td>Rhodococcus equi infection</td>
<td>Septicemia, bacterial*</td>
<td>Septicemia, fungal*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Schistosomiasis – haematobium*</td>
<td>Schistosomiasis – intercalatum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhinosporidiosis</td>
<td>Schistosomiasis – mansoni*</td>
<td>Schistosomiasis – mattheei</td>
<td>Rhodococcus equi infection</td>
<td>Septicemia, bacterial*</td>
<td>Septicemia, fungal*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Schistosomiasis – haematobium*</td>
<td>Schistosomiasis – intercalatum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhodococcus equi infection</td>
<td>Schistosomiasis – mansoni*</td>
<td>Schistosomiasis – mattheei</td>
<td>Rhodococcus equi infection</td>
<td>Septicemia, bacterial*</td>
<td>Septicemia, fungal*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Schistosomiasis – haematobium*</td>
<td>Schistosomiasis – intercalatum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Septicemia, bacterial*</td>
<td>Schistosomiasis – mansoni*</td>
<td>Schistosomiasis – mattheei</td>
<td>Rhodococcus equi infection</td>
<td>Septicemia, bacterial*</td>
<td>Septicemia, fungal*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Schistosomiasis – haematobium*</td>
<td>Schistosomiasis – intercalatum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Septicemia, fungal*</td>
<td>Schistosomiasis – mansoni*</td>
<td>Schistosomiasis – mattheei</td>
<td>Rhodococcus equi infection</td>
<td>Septicemia, bacterial*</td>
<td>Septicemia, fungal*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Schistosomiasis – haematobium*</td>
<td>Schistosomiasis – intercalatum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shigellosis*</td>
<td>Schistosomiasis – mansoni*</td>
<td>Schistosomiasis – mattheei</td>
<td>Rhodococcus equi infection</td>
<td>Septicemia, bacterial*</td>
<td>Septicemia, fungal*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Schistosomiasis – haematobium*</td>
<td>Schistosomiasis – intercalatum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sinusitis</td>
<td>Schistosomiasis – mansoni*</td>
<td>Schistosomiasis – mattheei</td>
<td>Rhodococcus equi infection</td>
<td>Septicemia, bacterial*</td>
<td>Septicemia, fungal*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Schistosomiasis – haematobium*</td>
<td>Schistosomiasis – intercalatum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schistosomiasis – haematobium*</td>
<td>Schistosomiasis – mansoni*</td>
<td>Schistosomiasis – mattheei</td>
<td>Rhodococcus equi infection</td>
<td>Septicemia, bacterial*</td>
<td>Septicemia, fungal*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Schistosomiasis – haematobium*</td>
<td>Schistosomiasis – intercalatum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schistosomiasis – intercalatum</td>
<td>Schistosomiasis – mansoni*</td>
<td>Schistosomiasis – mattheei</td>
<td>Rhodococcus equi infection</td>
<td>Septicemia, bacterial*</td>
<td>Septicemia, fungal*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Schistosomiasis – haematobium*</td>
<td>Schistosomiasis – intercalatum</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*denotes cases submitted for diagnosis in the present study

Discussion

The major problem in developing an infectious disease diagnosis program is difficulty in obtaining reliable and accurate incidence data. The reporting rate for diseases varies widely between countries and among differing diseases within any given country. Furthermore, the computer program assumes that the patient is a citizen or local resident of the country in question. Incidence data for tourists and expatriates may vary from those of the indigenous population. In some cases, the country of acquisition may not match the country of residence.

Selection of discriminative clinical and laboratory parameters for the data base is complicated by the fact that individual infections are quite similar, often producing fever, cough, rash, elevated white blood cell count, etc.

Table 3  Evaluation of a Computer-Driven Infectious Disease Diagnosis Program (percent)

<table>
<thead>
<tr>
<th>Nature of Infection</th>
<th>Bacterial</th>
<th>Parasitic</th>
<th>Viral</th>
<th>Fungal</th>
<th>Total</th>
<th>Correct *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual cases</td>
<td>150</td>
<td>30</td>
<td>100</td>
<td>15</td>
<td>295</td>
<td>222 (75.3)</td>
</tr>
<tr>
<td>Hypothetical cases</td>
<td>97</td>
<td>60</td>
<td>33</td>
<td>10</td>
<td>200</td>
<td>128 (64.0)</td>
</tr>
<tr>
<td>Total</td>
<td>247</td>
<td>90</td>
<td>133</td>
<td>25</td>
<td>495</td>
<td>356 (71.7)</td>
</tr>
<tr>
<td>Correct diagnosis*</td>
<td>186 (75.3)</td>
<td>60 (66.7)</td>
<td>88 (66.2)</td>
<td>16 (64.0)</td>
<td>350 (70.7)</td>
<td></td>
</tr>
<tr>
<td>Correct diagnosis included in differential†</td>
<td>236 (95.5)</td>
<td>87 (96.7)</td>
<td>124 (93.2)</td>
<td>22 (88.0)</td>
<td>469 (94.7)</td>
<td></td>
</tr>
</tbody>
</table>

Country of Acquisition

<table>
<thead>
<tr>
<th>Country of Acquisition</th>
<th>Israel</th>
<th>Africa</th>
<th>Southeast Asia</th>
<th>Europe</th>
<th>Latin America</th>
<th>North America</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cases</td>
<td>308</td>
<td>66</td>
<td>65</td>
<td>24</td>
<td>7</td>
<td>19</td>
<td>6</td>
</tr>
<tr>
<td>Correct diagnosis*</td>
<td>205 (66.6)</td>
<td>54 (81.8)</td>
<td>54 (83.1)</td>
<td>16 (66.7)</td>
<td>5 (71.4)</td>
<td>12 (63.2)</td>
<td>4 (66.7)</td>
</tr>
<tr>
<td>Correct diagnosis included in differential†</td>
<td>295 (95.8)</td>
<td>62 (93.9)</td>
<td>61 (93.8)</td>
<td>23 (95.8)</td>
<td>6 (85.7)</td>
<td>18 (94.7)</td>
<td>4 (66.7)</td>
</tr>
</tbody>
</table>

*Concordance between the correct clinical diagnosis and the disease listed first in the computer-generated differential diagnosis list; †the correct clinical diagnosis is included in the computer-generated diagnosis list
Similar abnormalities are also found in a variety of noninfectious diseases. An additional difficulty in any diagnostic program is the reliability of user input. The accuracy of clinical input is only as good as the accuracy of history taking, physical examination, and laboratory testing. In some instances, more than one disease may be present, or clinical observations may be factitious or unrelated to the present illness. In the current study, actual cases were correctly diagnosed more often than hypothetical cases (e.g., acquired overseas), thereby suggesting relative unfamiliarity of infectious diseases experts with the clinical features of “exotic” diseases.

During the period January 1989–February 1992, Index Medicus listed 2063 papers under the subject heading, “Diagnosis, Computer Assisted,” and 7139 under the heading, “Software”; however, no program specifically designed for diagnosis in infectious and geographic medicine has been reported in the English language literature to date. Existing computer-driven diagnostic programs have failed to adequately simulate human intelligence or find widespread practical use in the field. As such, software systems (including the program under study) are marketed for “decision support,” and display appropriate disclaimers that remind the user that clinical judgment still takes precedence over computer “expert systems.”

In a recent study, the “sensitivity” (i.e., ability to include the correct diagnosis in a differential list) of foursuch systems was found to be adequate, but often at the expense of low “specificity” (ability to exclude irrelevant diagnoses). Nevertheless, an accompanying editorial suggested that the alternative diagnoses listed were often valuable to the clinician and would not otherwise have been considered. Indeed, when dealing with infection acquired in an exotic country, the clinician might find an exhaustive differential diagnosis to be quite helpful. Although only 94 diseases (30.5% of the program data base) were represented, our preliminary study suggests that the program under study is comprehensive and accurate, and could prove useful in the diagnosis of infectious and tropical disease. An expanded study among infectious diseases physicians in the United States will be undertaken in the near future.

References