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Medical Expert Systems

Who Needs Them?

The subject of medical expert systems is of growing interest, to judge by the sudden increase in publications on the subject. Whereas the National Library of Medicine's MEDLARS system for searches of the current medical literature did not even have a separate listing for artificial intelligence before 1984, since 1984, there have been 85 articles listed for this heading, of which 61 were non-repetitive and non-veterinary. Most of these articles have appeared in computer-oriented or in non-English language journals, rendering information about expert systems time-consuming and difficult for most clinicians to obtain. Yet, the subject matter of these articles may be of more relevance than their location in the literature would suggest. For example, 26 of the 61 articles describe one or more actual medical expert systems, all of which were intended to assist and support the clinician. Considering ". . . the problem of the glut of information in which the physician is immersed,"[1] one of the major benefits of expert systems is that expert systems can retain and accurately process more facts than a human can. Expert systems can be likened to "tools that extend the ability of human beings rather than substitute for them."[2] In addition, because they mimic clinical reasoning, expert systems can be used as teaching tools.

Expert systems are considered a subset or an application of the branch of computer science known as artificial intelligence. In turn, artificial intelligence is broadly defined as comprising certain techniques that allow computers to take on the characteristics of human intelligence.[3] (The terms artificial intelligence and expert systems sound rather pompous but are pretty much fixed as is by long usage.)

A medical expert system is a computer program that, when well-crafted, gives decision support in the form of accurate diagnostic information or, less commonly, suggests treatment or prognosis. Diagnostic, therapeutic, or prognostic advice is given after the program receives information (input) about the patient, usually via the patient's physician. Expert systems have characteristics which make them dissimilar from other kinds of medical software. One of these characteristics is that the sequence of steps used by the expert system in coming to a diagnostic or therapeutic conclusion often is designed to mimic clinical reasoning. Also, the sequence of steps is, in many expert systems, available to the physician using the system. Because clinical medicine often does not deal in certainty, expert systems may have the capability of expressing conclusions as a probability. It is generally agreed that expert system software must contain a large number of facts and rules about the disease or condition in question in order to deliver accurate answers. It has been estimated that two general internal medicine textbooks and three specialty textbooks would require 2 million rules.[4] Because large amounts of data are needed, in the recent past, expert systems were only feasible when used with large, expensive computers. With the advent of more powerful microcomputers and more efficient microcomputer languages, expert systems could now be available to any physician with a microcomputer.

If one measures the success of expert systems in terms of their routine clinical use, then their success has, to date, been limited[4,5] by the difficulty involved in creating expert systems, and by the "hesitancy of physicians to use such programs."[5] It usually takes five years or more to create an expert system;[3] it is by no means rare to find expert systems that are incomplete.[3,6] Coolness towards medical expert system is sometimes phrased in terms of the practice of medicine and medical expert systems being competing techniques. For example, one report notes the possibility of expert systems obscuring "a global overview of the patient's situation" by focusing on "details of a medical problem."[4] It has been suggested that expert systems cannot simulate medical insight;[7] this point overlooks the fact that some expert systems utilize principles as well as facts. Expert systems require continual updating, and the maintenance and support of a large expert system may "represent a very long-term commitment on the part of any institution."[1] As small expert systems become easier to create, and

therefore become increasingly common, one should raise the question of "whose expertise is being distributed."[1] The best answer to this question may be to place more emphasis on the technique known as induction.[8] Induction involves creating rules from examples; therefore, the accuracy of a rule is not limited by the insight, intellect, or experience of any one person creating the expert system. Another important question relates to the adequacy of the validation process necessary to test the accuracy of expert system answers. To date, however, there is no consensus about how to validate an expert system.

On balance, it is likely that more and more microcomputer-based medical expert systems will become available. One can already find surprisingly complex expert systems that run on a microcomputer, although the scope is usually narrow. (One exception is QMS, which is described as an "information resource intended for eventual use in general internal medicine."[9]) The subjects addressed by microcomputer-based expert systems are diverse, and include the interpretation of pulmonary function tests,[2,6] diagnosis of drug interactions,[10] diagnosis of rheumatologic disease,[11] diagnosis of azotemia,[12] the diagnosis of chest pain,[13] and the diagnosis and treatment of patients with transient ischemic attacks.[14] Clinicians with an interest in expert systems should find that there are many opportunities to examine them through the increasing number of publications and conferences devoted to all facets of medicine and computing, including medical expert systems.

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