

The Heart Disease Program: Assisting Diagnosis

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This demonstration will introduce and show how to use the Heart Disease Program over the Web to assist physicians in the diagnosis of patients with symptoms possibly caused by cardiac disease.

The Heart Disease Program (HDP)[1,2] has been under development for about 15 years. The HDP is an expert system to help physicians with the diagnosis of heart disease. It takes a patient description from the physician, including history, symptoms, physical examination, and pertinent laboratory results – essentially the same data that the physician uses to determine a diagnosis. The program uses a physiologic model to construct one or more complete and consistent hypothesized models explaining the findings in terms of diseases and physiologic mechanisms. These models form a set of hypotheses that are rank ordered, summarized, and presented to the user as a differential diagnosis.

METHODOLOGY

The HDP uses a pseudo-Bayesian network representing the causal physiology of the cardiovascular system and associated diseases. The network is not purely Bayesian because we have included forward loops to preserve the sense of causality among nodes and have added temporal constraints because of their importance in the cardiology domain. For example, the program knows that an acute myocardial infarct (MI) can cause pulmonary congestion and that pulmonary congestion can cause pleural effusion, but that the pleural effusion requires weeks to develop and so can not be caused by an MI a few hours ago.

The program generates a differential diagnosis consisting of a number of hypotheses that are instantiated subsets of the network explaining all of the findings. The heuristic hypothesis generator has been refined and tested over a number of years.

INTERFACE

The HDP is accessible via the internet at our Web site: <http://medg.lcs.mit.edu/projects/hdp/>. After user registration and assurance that the program will only be used for research purposes, the user is presented with a large form covering the history, vitals, physical exam, and test results. Once this information is entered and submitted, forms are presented asking for details on important findings.

The HDP then runs on a separate server. The results are presented to the user: 1) The input with comments about any assumptions made because of missing input. 2) Leading hypothesis outlined including the presumed causality, supporting findings for the physiologic states, and pertinent negatives. The intent is to provide enough detail about the hypothesis to allow the user to intelligently accept or reject it and know what findings are the basis for that decision. We have tried to strike a balance between adequate detail while summarizing the hypothesis sufficiently to make it comprehensible in a clinical context. 3) Matrix of the hypotheses in the differential indicating what significant physiologic states each includes. This helps the user distinguish those parts of the hypothesis for which there are alternate viable explanations from those with relatively solid support. Included are lines explaining the alternate physiologic states in the same way as the first hypothesis. 4) The different explanations for each finding found in the differential.

EVALUATION

The HDP has been evaluated[3] over the last couple of years with cases entered by residents who were treating the patients. In this evaluation of 114 patients, the HDP diagnoses were significantly more sensitive to the actual final diagnoses than the entering physician's diagnosis (53% vs 35%) and about the same as the cardiologists who reviewed the entered case descriptions. The main challenge is that it took an average of slightly less than 15 minutes for the residents to enter their cases – excellent by the standards of other diagnostic programs, but too long for routine use by physicians. If online data were available, this could be reduced to 5 minutes.

References

1. Long WJ, Naimi S, Criscitiello MG. Evaluation of a New Method for Cardiovascular Reasoning. J Am Med Inform Assoc. 1994;1:127-141.
2. Long WJ, Fraser HSF, Naimi S. Reasoning Requirements for Diagnosis of Heart Disease. Artificial Intelligence in Med. 1997; 10:5-24.
3. Fraser HSF, Long WJ, Naimi S. Prospective Clinical Evaluation of a Computer Program to Assist with the Diagnosis of Cardiac Disease. Am College of Cardiology Meeting, March 1998.