RED: A Red-Cell Antibody Identification Expert Module*

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We describe a software module in an expert system RED, which interprets data related to red cell antibody identification. There are three portions to this module: (1) the problem-solving component, which incorporates the knowledge required for antibody identification as a hierarchy of programs. The programs in the hierarchy organize within themselves small pieces of knowledge represented in the form of production rules, which are capable of making judgments concerning a specific hypothesis; (2) an intelligent data base for storage of patient data, red cell attributes, and test results; (3) the "overview critic" portion, which combines the atomic hypotheses judged favorably by the antibody programs into a unified judgment concerning the case. Overview makes the decision to terminate processing with a conclusion about which antibodies are actually present and what specific further tests need to be performed to resolve any remaining ambiguities.

INTRODUCTION

Although the blood bank is one of the most complex divisions of the clinical laboratories, computers have served only a limited function in blood banking. Computer systems for blood banks have addressed clerical problems in donor recruitment, mobile unit scheduling, and inventory control. However the application of modern automatic problem-solving aids has been minimal.1

One area where such aids would be useful is in the choice of compatible blood products for patients. This paper describes one module of an envisioned computer assistant for the testing and selection of red-cell-containing blood components for medical therapy (RED). The envisioned RED system would also include a number of additional problem-solving modules besides the one described in this paper.

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The comprehensive RED system should be able to (1) determine ABO blood groups and resolve typing discrepancies, (2) interpret results of red cell antibody screening procedures, (3) choose candidate red cell units for transfusion to the patient on the basis of attributes of currently inventoried blood units, (4) evaluate the results of cross-match testing between the candidate units and the patient.

The interpretation of typing information and antibody-identification information is critical in providing compatible blood products for transfusion to potential recipients. Implementation of a decision module for the latter is discussed here.

THE BLOOD BANK

The blood bank is responsible for providing safe blood products for transfusion. The activities that are required to accomplish this objective may be divided into two distinct, but interrelated, subsystems: technical and clerical. The technical subsystem includes the actual testing procedures of ABO blood grouping, red cell antibody screening, red cell antibody identification, and cross-matching. These must be performed prior to the release of blood or blood products for transfusion into a recipient.

The clerical (or data management) subsystem of the blood bank deals primarily with detailed patient and donor information. This includes a broad range of information regarding the blood groups of patient and donor, the results of red cell antibody screening procedures, the results of serological tests for infectious diseases, the disposition of inventoried blood and blood components, and various other internal management information.

The maintenance and organization of records accounts for a substantial portion of the work load in the blood bank. As with all manual systems involving ordered, complex filing, the chance of clerical error is significant. Consequently, most clerical work in areas where extreme accuracy is required involves a system of safety cross-checks, which results in a considerable amount of paper work. This results in the need for record keeping that is beyond the effective capacity of manual systems.²

For a variety of reasons, therefore, it has become desirable for blood banks to look for computer systems to solve problems with the manual record-keeping system. Such computer systems are available commercially.

Current Computer Systems

The development of computer systems in blood banking has focused on improving the quality and performance of established manual record-keeping operations.¹ The major problems that they attempt to remedy are (1) lack of control over the number and blood group of blood donations, (2) shortcomings in the administration and clinical surveillance of blood donors, (3) increases in analytical work load, (4) organizational deficiencies in the storage of blood units, (5) overstocking of blood products by hospitals, and (6) repeated expensive serological analysis due to unavailability of previous test data.

Previous applications of computers to these problems have focused on four major areas. These are blood donor recruitment, blood product processing, blood inventory control, and laboratory automation.