FuzzyARDS/STUDY: Definition of Therapy Entry Criteria in Patients Suffering from ARDS

B. Trummer [1], H. Steltzer [2], G. Kolousek [1], K.-P. Adlassnig [1], A.F. Hammerle [2]

[1] Department of Medical Computer Sciences, Section on Medical Expert and Knowledge-Based Systems, University of Vienna Medical School, Spitalgasse 23, A-1090 Vienna, Austria, e-mail: Bernhard.Trummer@akh-wien.ac.at

[2] Department of Anaesthesiology and Intensive Care Medicine, University of Vienna, Währinger Gürtel 18-20, A-1090 Vienna, Austria

Background

The diagnostic and therapeutic process of patients suffering from acute respiratory distress syndrome (ARDS) [1] is a difficult and time consuming task because of the lack of a uniform and broadly accepted definition of the syndrome on one hand and because of various forms of therapy on the other. There is no clear guideline for applying a certain form of therapy and deciding against another, i.e., mechanical ventilation versus extra corporal carbone dioxid removal ($ECCO_2$-R) [2,3].

Objective

A computer-system called FuzzyARDS/STUDY was developed to find a uniform and broadly accepted definition of therapy entry criteria across centers dealing with patients suffering from ARDS like Berlin, Marburg, and Vienna. If those entry criteria are fulfilled, $ECCO_2$-R should be applied; if the criteria are not fulfilled, the patients should be treated by mechanical ventilation. The main task of FuzzyARDS/STUDY is to store patient data (Fig. 1) as well as definitions of entry criteria (Fig. 2) and to evaluate the different criteria by means of a scoring system (Fig. 3).

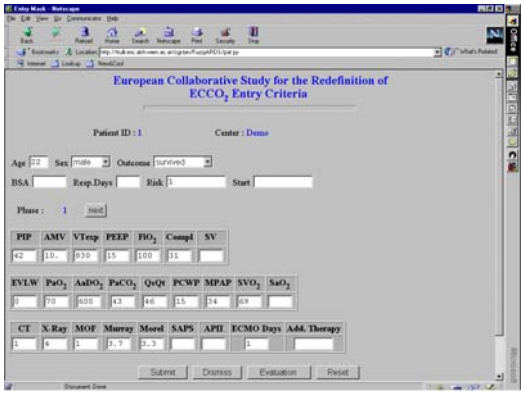

Fig. 1: Entering and retrieving patient data

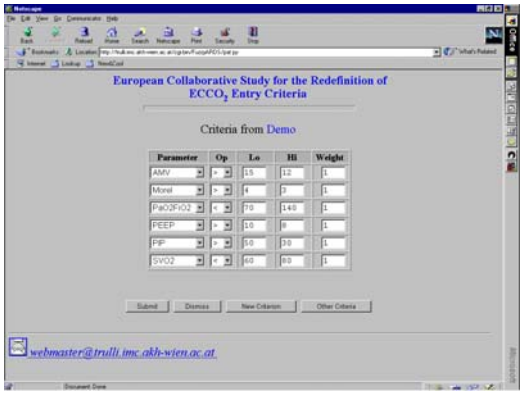

Fig. 2: Entering and storing the definition of entry criteria

Methods

Patient data, that means 25 different parameters such as PEEP and PIP are measured, evaluated, and observed at four points of time: 24h before therapy begin (setting bypass), 24h after bypass, the seventh day of therapy, and at the end of therapy. The ascertainment of those parameters enables the observation of the change of patient's states over time. The other important facility of the system is the storage of the definition of entry criteria. Each center may store his own set consisting of typically three to eight criteria.

Each criterion itself consists of the name of the parameter, a lower and an upper bound, and a weight reflecting the importance of the criterion in relation to the other criteria of a certain set. If the value of the parameter is lower than the lower bound, the criterion is not fulfilled, if the parameter is higher than the upper bound, the criterion is definitely fulfilled. The space between lower and upper bound is called the space of smooth transition, because—if the value of the parameter is in between those two values—the criterion is neither definitely fulfilled nor not fulfilled. As one can see, we generalize the classical logic that offers only two possible states (fulfilled – not fulfilled) to achieve a more intuitive and useful logic known as fuzzy logic [4].

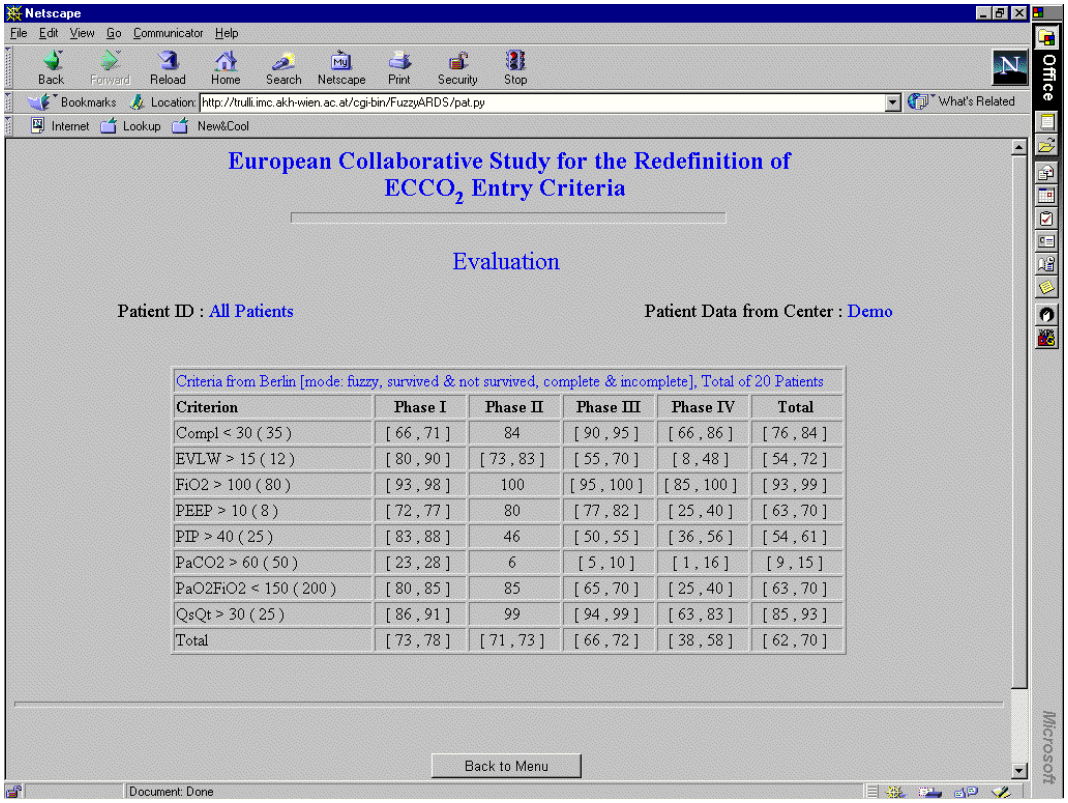

Fig. 3: Example of an evaluation

The evaluation of the score starts with the evaluation of the degrees of fulfillment of the medical criteria using fuzzy set theory. This evaluation is done for each criterion for each patient at the four phases. Next the scores of the four phases are evaluated using a scoring system by combining fulfillment and weights. The result of these two steps is a table for each patient consisting of four columns and a number of rows that is equal to the number of criteria. In the last the mean value of each field of the table over all patients is evaluated. Parameters with a difference between phase I and phase IV is higher than a level defined by the clinicians, are candidates for a uniform set of therapy entry criteria.

Results

Because of the rareness of patients suffering from ARDS and because of the need of as many patient data as possible, an interactive WorldWideWeb (WWW) application was implemented and is available under http://trulli.imc.akh-wien.ac.at/FuzzyARDS.

The present patient's database consists of 180 patients from two different centers and a set of 23 patients for testing. Two different sets of therapy entry critera are used, the first one consisting of eight, the other one of six criteria. For both sets of criteria, a set of possible candidates for a minimal list of therapy entry criteria was evaluated separately. For the first set, the list of possible candidates consists of PEEP, PIP, $PaCO_2$ and PaO_2/FiO_2, for the second one the list consists of PEEP, PIP, PaO_2/FiO_2 and SVO_2. Parameters like Qs/Qt, AMV and Morel do not seem to be adequate candidates for a minimal set of therapy entry criteria [5].

Technical Specification

FuzzyARDS has been designed as a client-server application. The client part of the system needs no implementation done by our group because it may be some well-known and broadly used web-browser such as Netscape Communicator or Microsoft Internet Explorer. The server part of FuzzyARDS/STUDY is implemented in Python and runs on an IBM RS/6000 under AIX. This server-part is called as a CGI-Script by the clients, then stores data or evaluates results and finally sends the results back to the client for presenting them to the user.

Conclusion

The development FuzzyARDS/STUDY as an interactive client-server application seems the best way to use the system by all clinicians interested and to gather as many patient data as possible because no software distribution is needed and because of the fact that FuzzyARDS/STUDY is available by computer-systems that support WorldWideWeb through the usage of a browser.
The results of various evaluations may be used for the design of a finite deterministic fuzzy-automaton. This automaton should describe the state as well as the history of a single patient by combining different parameters over time.

Acknowledgement

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