Knowledge–based diagnostic and therapeutic recommendations using fuzzy set approaches in patients with severe ARDS: a multicentric approach of quality control

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Patients with severe acute respiratory dysfunction are characterized by both hypoxemia (i.e. $paO2 < 50$ mm Hg) and high mortality rates between 80–90%. In this particular group of patients, after fulfillment of exactly defined entry criteria, a special therapeutic approach, extracorporal lung assist (ECLA) is used in order to improve survival. However, despite increased survival rates of these patients in Europe (i.e. 50%) as shown by a recent meta analysis [1], randomized controlled studies reported no improvement in survival [2].

The purpose of our study was therefore to design a knowledge–based expert system by means of fuzzy logic [3] on the one hand as a quality control system and on the other hand as a tool to create uniform entry criteria on the basis of a special scoring system. While scoring in contrast to logical operators can indicate the exact number of fulfilled criteria, it cannot account for the case if the entry criterion is a near miss rather than a clear deviation from the definition. For this purpose, the concept of fuzzy boundaries is introduced. In our study, fuzzy limits are denoted by a pair of numbers, the first representing the value below the condition is fully fulfilled and the second limit denotes the bound at which it is certainly not fulfilled.

In order to test this system, a total of 190 patients treated with ECLA from three European centers were screened in terms of fulfillment of entry criteria to this method and we looked also at those parameters by which a clear improvement of the patient could be monitored. A total of 22 diffe-rent entry criteria recently used in different European centers were used to test the overall fulfill-ment during four different phases of the procedure (I= 24 hr. before, II= 24 hr. after begin of the bypass, III= on day seven, IV = at the end of the procedure). The mean fulfillment rate of entry criteria before bypass was between 56% and 98%. However, it was interesting to note that at the end of the procedure the fulfillment of entry criteria was between 34% and 84%. A clear theoreti-cal improvement of the patient was defined as decrease of fulfillment of $> 25\%$ from I to IV and was only shown by 5 criteria [i.e. paO2/FIO2< 70 (–34%), Morel score (–38%), SVO2 (–28%), minute ventilation (–41%), and QS/QT (–28%)].

We conclude that by means of our fuzzy logic system, both individual patients and groups could be characterized in order to compare different patients from different centers. Furthermore when using as a data based "expert chart", recommendations about enrollment decision or not may be supported by the system and will be available via the internet (WWW). As a third conclusion, in order to compare a conventional therapy with an ECLA–protocol, the principle and the data-base could be used instead of a true clinical randomized trial.

References

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