relaxant reduces the muscle pain after succinylcholine. However, it also prolongs the onset of NMB. The duration of action is slightly decreased following gallamine and d-tubocurarine, and increased when pancuronium is used. The exact mechanisms are unknown, but the nondepolarizing relaxant may bind to the cholinergic receptor and prevent succinylcholine from acting on the receptor. Pancuronium, and to a lesser degree vecuronium, are known to inhibit plasma cholinesterase.

Drugs interacting with plasma cholinesterase

Drugs that change plasma cholinsterase activity aggravate or unmask myasthenia gravis and affect NMB by succinylcholine, mivacurium and maybe ciastracurium, because these muscle relaxants are hydrolyzed by plasma cholinesterase.

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M123
Knowledge-based definition of ARDS therapy entry criteria using fuzzy set theory

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Introduction

Treatment of patients suffering from ARDS is a time-consuming and complex task because of the lack of a uniform and broadly accepted definitions of the syndrome on one hand and various forms of therapy on the other. There are no clear guidelines based on the patients conditions on which form of therapy to apply. Therefore, a knowledge-based computer system has been implemented to develop a uniform set of therapy entry criteria. If those criteria are fulfilled, the expensive and risk ECCO2-R (extra corporal carbone-dioxid removal) has to be applied. If the criteria are not fulfilled, the patient may be treated by cheaper forms of therapy.

Methods

In a first step, parameters of 23 patients from three centers were collected and stored in a database called MedFrame/ FuzzyARDS. The parameters of the patients were gathered at four phases: 24 h before bypass (phase I), 24 h after bypass (phase II), on day seven of the procedure (phase III) and at the end of the procedure (phase IV). The reason for this data collection over four times is necessary to evaluate not only the fulfillment at one point of time but even the dynamic behaviour of the parameters, too, because the dynamic in the patients condition may reflect the success or the failure of the therapy.

In the next step, the different therapy entry criteria from the centers were collected. Those therapy entry criteria of each center were originally defined as a simple list of conditions – one list per center. The definition of the criteria as provided by the

different centers is informal by nature, and thus not suited for direct implementation in an exact evaluation system. To overcome this inherent problem, we suggest to replace the classical logic employing operators such as AND and OR that treat all operand equally by a general scoring system which allows to give weight to certain criteria to refelct their importance, enabling compensation of diverging parameters at the same time. As already mentioned above, the therapy entry criteria of each center are defined by a list of conditions, each of which has to be fulfilled for the whole to work. In a precise environment, therapy entry criteria are bound to cause problems when they are interpreted literally: $PaO_2/FiO_2 < 150$ and $PEEP > 10$ for example, is certainly fulfilled for a patient with $PaO_2/FiO_2 = 149$ and $PEEP = 11$, however it is not for one with $PaO_2/FiO_2 = 50$ and $PEEP = 9$, although these parameters indicate a much more critical status. While the physicians will recognize the problem and act accordingly, any objective evaluation system that interprets AND as logical AND will answer yes in the first and no in the second case. The fact that 50 is much less than 150 and 9 deviates only little from 10 requires some kind of compensation in the evaluation of criteria which cannot be found in conventional logic. Instead, it is achieved by two means: a scoring system and the introduction of fuzzy set theory.

A score is defined as the sum of weights as obtained by evaluation of a list of criteria. Each criterion consists of a condition (as already defined by the differnet centers) followed by a weight. A weight is any positive number that specifies the importance of the criterion in case it is fulfilled. Weights are interpreted in realtion to each other, for example, a weight of two defines a condition to be twice as significant as another one weighted by one. To normalize the score, it is divided by the sum of all weights in the list. Requiring a score of one equals the logical AND, while requiring a score to be greater than zero is equivalent to a logical OR. Changing the weights allows to adapt the criteria so they can account for the significance of certain criteria.

The usage of a scoring system cannot account for the case where one criterion is a near miss, rather than a clear deviation from the definition. For this purpose, the concept of fuzzy limits is introduced. Fuzzy limits may be regarded as a blurred boundary defined by two thresholds, one seperating clear fulfillment from indecision/nonfillmet and the other seperating nunfulfillment from indecision/fulfillment. Fuzzy boundaries are denoted by a pair of numbers, the first representing the value below the condition is fully fulfilled, the second one denotes the bound at which it is certainly not fulfilled. The space inbetween is called the range of smooth transition. Instead of a clear yes/no answer, it rather yields a degree of fulfillment represented by a number between zero and 1.

The evaluation of the score starts with the evaluation of the degrees of fulfillment using fuzzy limits. This evaluation is done for each criterion for each patient at the four phases. Next, the score of the four phases are evaluated using the scoring system. The result of these two steps is a table for each patient consisting of four coloumns and a number of rows that is equal to the number of criteria. In the latter the mean value of each field of the table over all patients is evaluated. Parameters with a difference between phase I and phase four is higher than 30, are possible candidates for a uniform set of therapy entry criteria.

Results

The patient's database consists of 23 patients from three different centers. Two different sets of therpy entry critera are used, the first one consisting of eight, the other one of six criteria. For
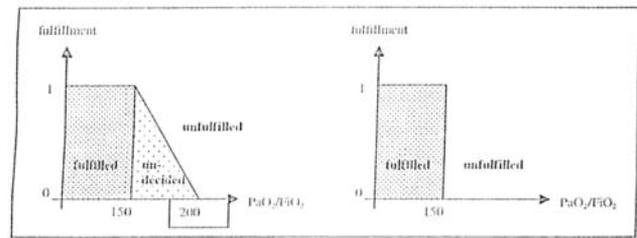
Difference between fuzzy limits and binary logic.

both sets of criteria, a set of possible candidates for a minimal list of therapy entry criteria was evaluated seperatly. 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_2FiO_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.

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