# FuzzyKBWEdit: Fuzzy Knowledge Acquisition for Weaning from Mechanical Ventilation in Intensive Care Units

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## 1. Introduction

The process of weaning a patient with respiratory insufficiency from mechanical ventilation is complex and requires expertise obtained from long clinical practice. The adequate application of human expertise for computer-assisted weaning is a widespread problem in this setting. The knowledge acquisition component we developed is designed to formalize knowledge in an easier way. It helps the cooperating physicians to generate crisp and fuzzy knowledge bases for computer-assisted weaning in intensive care units (ICUs).

## 2. Objective

Patients who require mechanical ventilation during surgery, at a time when they are deeply sedated, must be slowly weaned from mechanical ventilation after the operation to the point when they can breathe spontaneously. The adequate use of expertise for computer-assisted weaning is a common problem in this setting [1]. The knowledge acquisition component we developed is designed to formalize knowledge in an easier way. This knowledge acquisition tool, which is used for computer-assisted weaning in ICUs, is represented by a so-called fuzzy knowledge-based editor (FuzzyKBWEdit), that allows the cooperating physicians to carry out changes in the knowledge base directly at the ICU, without the assistance of a knowledge engineer (Figure 1).

## 3. Methods

The crisp and fuzzy knowledge bases generated by the editor FuzzyKBWEdit consist of variables, values, and rules. The variables represent the physiological parameters and respirator settings. The values are described in terms of fuzzy sets and linguistic terms. The knowledge bases as well as various experimental versions are implemented as plug-in knowledge bases for the FuzzyKBWean frame program [2]. Our application focuses on building knowledge bases for patients who are

weaned by the Biphasic Positive Airway Pressure (BIPAP) ventilation mode, since the mode allows a very smooth and gradual change from controlled to spontaneous breathing [3].
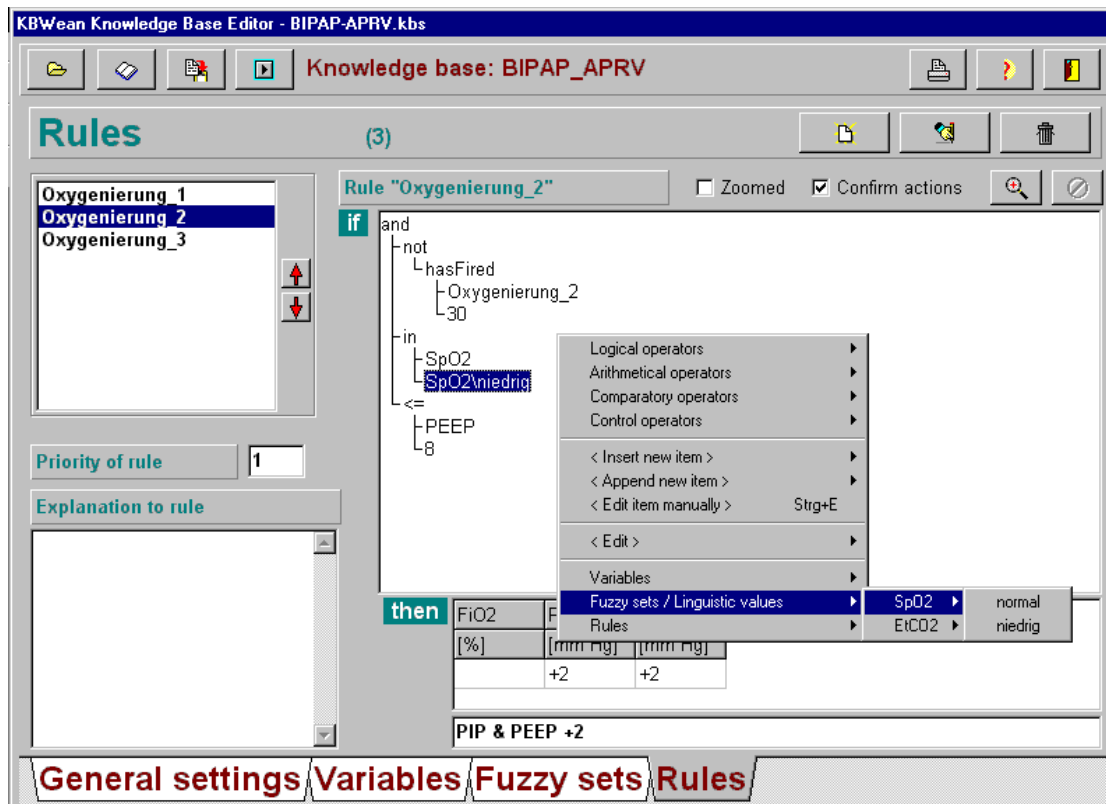


**Figure 1: FuzzyKBWEdit application generating an oxygenation rule.**

## 4. Results

FuzzyKBWEdit has been developed with Delphi® 4.0 running on Windows® platforms. Fuzzy knowledge bases can be formalized with practically no restriction. The interface can easily be modified for the use of other computer-assisted weaning applications in the future. The system is used at an ICU for postoperative cardiac patients in the Vienna General Hospital. The advantage of the FuzzyKBWEdit is its easy application and the generation of more specific knowledge bases, which permits smooth treatment of weaning patients.

## 5. Conclusion

The results of the study confirm the applicability of FuzzyKBWEdit to introduce medical standards in the weaning process and to make weaning activities transparent and comprehensible. Nevertheless, the formalization of knowledge bases needs to be syntax-guided in order to make knowledge bases usable for expert systems, in our special case for the expert system FuzzyKBWean.

# References

[1] Dojat, M., Pachet, F., Guessoum, Z., Touchard, D., Harf, A., and Brochard, L. (1997) NéoGanesh: A Working System for the Automated Control of Assisted Ventilation in ICUs. *Artificial Intelligence in Medicine* 11, 97–117.

[2] Schuh, Ch., Hiesmayr, M., Adlassnig, K.-P., Zelenka, Ch., and Klement, E.P. (1998) Integration of Crisp- and Fuzzy-Controlled Weaning in an ICU PDMS (FuzzyKBWean). In *Proceedings of the World Automation Congress – WAC' 98*, TSI Press, Albuquerque, 299–304.

[3] Hiesmayr, M. (1995) Enhanced Ventilatory Efficiency of Airway Pressure Release Ventilation (APRV) versus SIMV after Cardiac Surgery. *International Meeting of the American Thoracic Society*, Seattle, 43–47.