660

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MODEL FOR DIFFERENTIAL DIAGNOSIS OF LOWER URINARY TRACT DISFUNCTION BASED ON FUZZY LOGIC

Hypothesis / aims of study

This study aims to develop and evaluate the performance of a decision support system modelled by fuzzy logic in order to discriminate the problems of the lower urinary tract, using the terminology of the International Continence Society.

Study design, materials and methods

Fuzzy relations and the maximum-minimum composition approach were used to develop the system. The model was initially tested with 100 cases, whose retrospective data were obtained from medical and clinical urodynamics records. To construct the system model the composition of fuzzy relations called max-min composition[1] was used. A fuzzy relation could express a partial or imprecise relationship between elements of some sets, as opposed to a precise one in the case of a crisp relation in which any elements can either be related or not. In the fuzzy relation, there are gradual relationships that vary from '1' for being fully in relation to '0' for not being in relation at all, through all intermediate values.

A fuzzy relational matrix was constructed (Relational Matrix) based on the knowledge of an expert that provides the association between each sign or symptom and each diagnosis, through fuzzy relation value. These fuzzy degrees of association could vary from 0 (no relation) to 1 (total relation).

A second matrix (Case Matrix) was constructed, containing 100 cases (50 men and 50 women) on the lines and their relation with the sign or symptom on the columns. The presence of each sign or symptom was evaluated considering the following values: 0=absent or not available; 0.25=absent but not sure; 0.50=inconclusive; 0.75=sometimes present; 1=present. Each line of the Case Matrix represents the health status vector of the patient, considering the presence of each sign or symptom

The decision process is similar to a matrix multiplication, changing the algebraic sum operator by the max operator, and the multiplication by the min operator. This procedure is applied to the all diagnoses considered and at the end of the process we find a matrix composed by all fuzzy possibility degrees for that patient in the all possible diagnoses. The decision-making was concluded with a defuzzification method that allowed the determining of the final diagnosis (or diagnoses). In this case, the maximum value of the diagnostic possibility distribution was used. Data were compared with the diagnosis (or diagnoses) of the patient records and revised by a medical specialist in urology.

Results

In some cases, the model indicated one or more diagnoses other than those determined by the specialist. As shown in Table 1, the model was able to determine the diagnosis in total accordance with the specialist for 62% of the cases. A different diagnosis was reached by the model only in two cases.

Table 1 - Concordance of the proposed model with the opinion of the specialist

Results	**n**	**%**
Total concordance	62	62.0
Partial concordance: the model presented more diagnoses*	36	36.0
Total discordance	2	2.0
Total	**100**	**100.0**

*As compared to the number of diagnoses determined by the specialists for a particular patient.

The agreement between model and experts were excellent (kappa=0.98, p<0.0001, IC=0.89-1.06) or substantial (kappa=0.53, p<0.0001, IC=0.45-0.60), according to the interpretation table of Kappa's Index, considering the over-estimative of accordance (accordance was considered when at least one diagnosis was equal) and the under-estimative (discordance was considered if at least one diagnosis was different), respectively.

Interpretation of results

Although the model has a simple structure, the diagnostic performance of the model in terms of agreement evaluation considering the opinion of the expert was very good. In two cases the model pointed out the diagnosis in disagree with the expert. The model indicated the diagnosis Acontractile Detrusor and the specialist, Overactive Bladder Syndrome, but in the two cases (both men) it was referred slow stream what suggest an abnormal detrusor activity; so, this condition must be best investigated.

Very frequently the model suggested others diagnosis that could be investigated, since some important signal or symptom were present.

Concluding message

The proposed model based on fuzzy relations is very simple and has quite good performance. However, more tests with larger samples are recommended before this model can be used as a support system for clinical decision.

References

1. Klir GJ, Yuan B. Fuzzy Sets and Fuzzy Logic: Theory and Applications. New Jersey: Prentice Hall; 1995, p.355

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Was this study approved by an ethics committee?	**Yes**
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Was the Declaration of Helsinki followed?	**Yes**
Was informed consent obtained from the patients?	**No**