Description and Validation of PNEUMON-IA: A medical expert system for pneumonia diagnosis.


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First, we are going to describe the medical expert system called Pneumon-IA. Pneumon-IA is an expert system for the etiological diagnosis of community-acquired pneumonias in adults. It is programmed in the expert systems shell MIŁORD, which uses fuzzy logic to express uncertainty. The knowledge of Pneumon-IA is implemented by means of production rules which are controlled by meta-rules. Pneumon-IA uses linguistic labels to express the posibilities associated to each etiological agent for each particular case. The rules are structured in modules. Strategies are a set of modules to be evaluated and are controlled in a declarative way by using meta-rules.

In its present form the knowledge base of Pneumon-IA comprises 487 facts, 659 rules, 92 meta-rules and 25 modules. Finally we will present the external multicentre validation study comparing Pneumon-IA with several physicians.

It is difficult to establish a gold standard for this application. The etiological diagnosis of pneumonia imply a lot of uncertainty, since the etioloj is seldom confirmed. One of the possible methods to be applied is the selection of a sample which would only include confirmed cases as it was done in the validation of MYCIN. However, the confirmed cases are often biased towards severe patients and are caused by particular etiological agents. These facts would introduce an unwanted bias in the study.

The aim fo this validation is the comparison between the etiological approximations as proposed by the ES and those proposed by several medical specialists in a group of patients with community-acquired pneumonia. In the present validation we have taken the consensus of several medical specialist as a reference, although in a different way to that of other ES validation studies. For each case the distances between the matrices of possible etiologies given by the specialists and the ES has been taken as a mesure of the proximity between the specialists diagnoses and PNEUMON-IA diagnoses and these are compared with the distances between the specialists themselves.

The agreement with the confirmed diagnoses in those cases where it was known was considered a secondary way of validation.

We took a sample of 76 medical records of community-acquired pneumonia patients who met the criteria for inclusion. A randomized selection of cases from the hospital files was performed, stratifying them according to the WHO's ICD code of diagnoses.

The reports together with the chest X-ray slides were assessed independently by five specialists from five hospitals. No limit was established on the number of etiologies cited to asses the cases. These specialists had not participated in the development of the ES. The ES gave diagnoses for each case. Each diagnosis took the form of an array in which the 22 possible etiologies were qualified with one of the eight possible labels used to qualify the uncertainty.
Cross-evaluation of specialist's proficiency

Each specialist was asked to assess their colleagues' proficiency in a confidential report, using scores on a scale from 1 to 10. Results were averaged and the specialists were ranked from highest to lowest. The scores were: specialist E2 obtained 10, specialist E1 and E3 obtained a score between 8 and 8.5 and specialists E4 and E5 obtained an average of 6.5

Results

1) A descriptive statistical analysis was carried out by determining the frequencies of the etiologies mentioned with a certainty degree greater than 'almost impossible'. Since each specialist usually provided more than one etiological diagnosis for each case, the total number of etiologies recorded was greater than the number of cases. It should be noticed that the ES cited viral pneumonias more often than the specialist. Although no data was available on the true etiology for the majority of pneumonias, these differences might be due to an underestimation of this etiology by the specialist if we compared it with published medical reports.

2) We considered 'Singular Etiologies' those mentioned only by one specialist in one particular case. One way of determining the concordance of a single specialist with the consensus of the group is to note the occurrence of singular etiologies. If the viral etiologies are excluded, the percentage of singular etiologies of the ES is similar to the others specialists.

3) An 'Omitted Etiology' was considered as a etiology mentioned by 5 of the 6 specialists (including PNEUMON-IA). The number of omitted etiologies is a measure of disagreement with respect to the consensus.

4) Although only 10 of the 76 cases selected were confirmed by microbiological tests we also studied the concordance between the etiologies proposed with these confirmed cases.

5) Distances between specialists. The distances between the matrices of the possible etiologies provided by each specialist and the ES were calculated for each case. To obtain the distances, the linguistic labels were substituted by their associated first momentum. We represented graphically the results of the cluster analysis performed using these distances as a dendogram.

From the results it may be concluded that the differences between etiological diagnoses made by PNEUMON-IA and those made by some specialist were smaller than the differences between some specialists themselves.

The specialists with highest proficiency scores gave closest diagnoses. The best specialist was, moreover, the one with least omitted etiologies and least singural etiologies. The medical ES were closed to the 'best' specialist than the 'worst'. The success of the medical ES in cases of confirmed etiologies was similar to that of the specialists. In summary, the etiological diagnoses emitted by the medical expert system PNEUMON-IA agreed with the best known specialists in our area.