RENEX: An Expert System for the Interpretation of \textsuperscript{99m}Tc-MAG3 Scans to Detect Renal Obstruction

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A renal expert system (RENEX) has been developed to assist physicians detect renal obstruction in patients undergoing pre- and postfurosemide \textsuperscript{99m}Tc-mercaptoacetyltriglycine (\textsuperscript{99m}Tc-MAG3) scans. RENEX uses quantitative parameters extracted from the dynamic renal scan data and heuristic rules in the form of a knowledge base (KB) obtained from expert interpreters to conclude whether a kidney is obstructed.

**Methods:** Normal limits were established for 47 quantitative parameters extracted from the \textsuperscript{99m}Tc-MAG3 scans of 100 potential renal donors. From these data the domain expert estimated 5 boundary conditions for each parameter: (i) definitely abnormal, (ii) probably abnormal, (iii) equivocal, (iv) probably normal, and (v) definitely normal. A sigmoid-type curve was then generated from these 5 boundary conditions, creating a parameter knowledge library used for converting the value of a prospective patient's individual quantitative parameters to a certainty factor (CF). Sixty heuristic rules were extracted from the domain expert to generate the KB for detecting obstruction. A forward-chaining inference engine was developed using the MYCIN combinatories (an approximation of Bayes theorem) to determine obstruction. A justification engine was implemented, which recorded the sequence of each rule that was fired and the current CF value of all input and output parameters at the time of instantiation to track and justify the logic of the conclusions. The entire system was fine tuned and tested using a pilot group of 32 patients (11 males, 21 females; mean age, 56.8 ± 17.2 y; 63 kidneys) deemed by an expert panel to have 41 unobstructed kidneys, 13 obstructed kidneys, and 9 equivocal findings.

**Results:** RENEX agreed with the expert panel in 92% (12/13) of the obstructed kidneys, 93% (38/41) of the unobstructed kidneys, and 78% (7/9) of the kidneys interpreted as equivocal for obstructions. Processing time per patient was practically instantaneous using a 3.0-GHz personal computer programmed using interactive data language.

**Conclusion:** We have developed a renal expert system for detecting renal obstruction using pre- and postfurosemide \textsuperscript{99m}Tc-MAG3 renal scans, at a standardized expert level. These encouraging preliminary results warrant a prospective study in a large population of patients with and without renal obstruction to establish the diagnostic performance of this system.