Comparing the Performance of Mathematical Models for Surgical Decisions on Head Injury Patients

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Computerized medical decision support systems have been a major research topic in recent years. Intelligent computer programs were implemented to aid physicians and other medical professionals in making difficult medical decisions. This report compares three different mathematical models for building a head injury medical decision support system (MDSS). These models were developed based on a large head-injury patient database. This MDSS accepts a set of patient data such as the types of skull fracture, Glasgow Coma Scale (GCS), episode of convulsion and return the chance that a neurosurgeon would recommend an open-skull surgery for this patient.

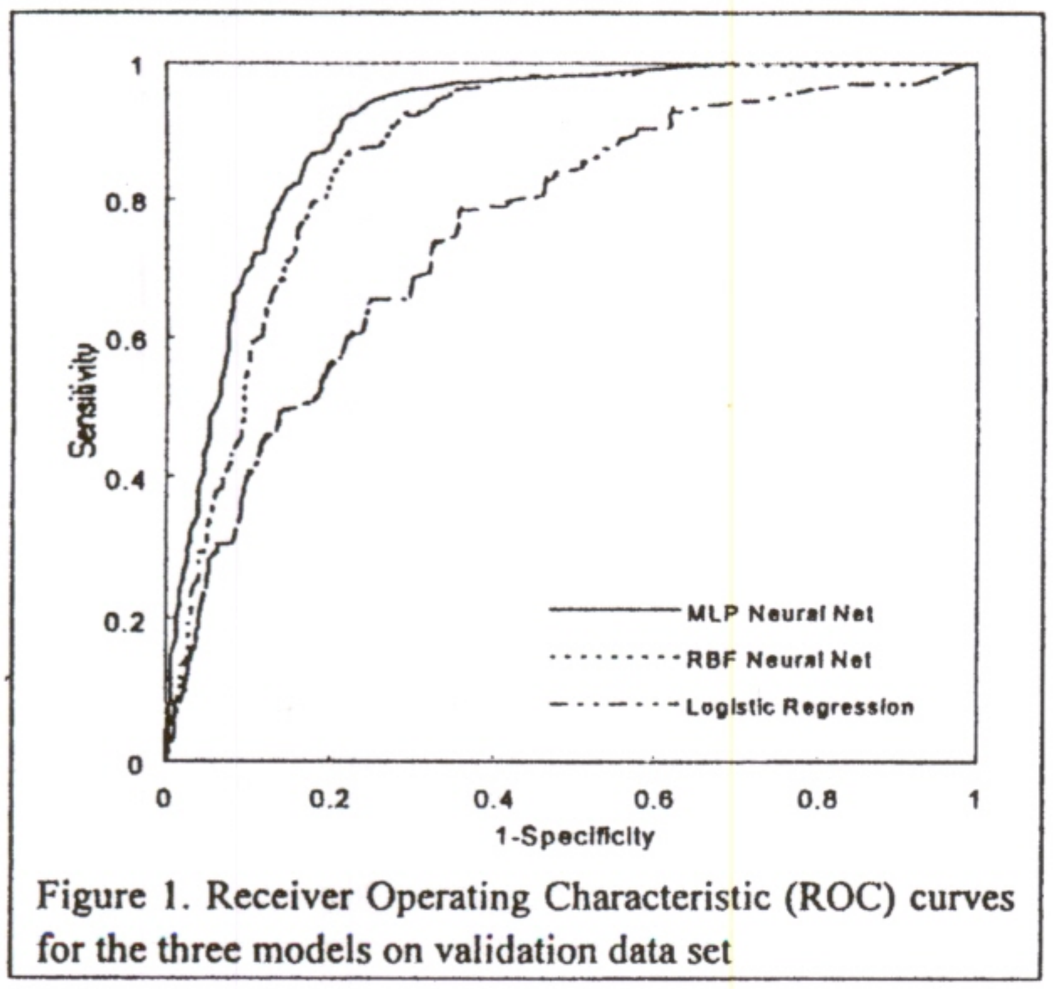

Figure 1. Receiver Operating Characteristic (ROC) curves for the three models on validation data set

The three mathematical models described in this report including a logistic regression model, a multi-layer perceptron (MLP) neural network and a radial-basis-function (RBF) neural network. From the 12,640 patients selected from the database. A randomly drawn 9480 cases were used as the training group to develop/train our models. The other 3160 cases were in the validation group, which we used to evaluate the performance of these models. We used sensitivity, specificity, areas under ROC curve and calibration curves as the indicator of how accurate these models are in predicting a neurosurgeon's decision on open-skull surgery.

The results showed that, assuming equal importance of sensitivity and specificity, the logistic regression model had a (sensitivity, specificity) of (73%, 68%), compared to (80%, 80%) from the RBF model and (88%, 80%) from the MLP model. The resultant areas under ROC curve for logistic regression, RBF and MLP neural networks are 0.761, 0.880 and 0.897 respectively ($P < 0.05$). Among these models, the logistic regression has noticeably poorer calibration.

This study demonstrated the feasibility of applying neural networks as the mechanism for head-injury decision support systems based on clinical databases. The results also suggest that neural networks may be a better solution for complex, non-linear medical decision support systems than conventional statistical techniques such as logistic regression.