建立類神經網路模型以預測 **propofol** 用於麻醉誘導時所產生的睡眠效應

Neural Network Modeling to Predict the Hypnotic Effect of Propofol Bolus Induction

中文摘要

Propofol 的臨床劑量需求，決定於個別病人的特異性，以及併用藥物的交互作用。當以單次劑量給予 propofol 以達到麻醉誘導目的時，如何計算個別病人的最佳劑量，以及此劑量是否完全適合於此位病人，至目前爲止一直沒有明確地被研究。本篇論文的目的，希望以普遍可得的臨床參數爲基礎，訓練一類神經網路模型，此模型可根據個別病人的特異性，對於利用 propofol 實行麻醉誘導時，所達到的睡眠效應是否足夠做出預測。

預定在靜脈麻醉下接受常規手術的病人，共兩百七十位成爲我們的研究對像。根據相關的醫學文獻以及過去的臨床經驗，總共十項參數，包括 propofol 劑量，病人的年齡性別，身高體重等等，被選定爲訓練類神經網路的輸入參數。我們使用畢斯腦波指數（bispectral index）監測病人的意識清醒程度，用以判斷 propofol 的造成的睡眠效應，並以此做爲網路訓練的輸出參數。以一百八十位病人的資料用來訓練類神經網路，完成兩種不同架構的模型之後，再以另外未參與訓練的九十組病人資料，來測試此模型的效能。三位資深麻醉醫師對於 propofol 的睡眠效應的預測結果，將和類神經網路模型的結果做比較。

類神經網路模型之一的 standard networks，對於測試組資料的 sensitivity 爲 76.19 %，specificity 爲 65.22 %，而另外一種網路架構 Ward networks 則分別爲 80.95 % 和 57.97 %。臨床麻醉醫師的預測結果，sensitivity 爲 23.81 %，specificity 爲 91.30 %。兩種類神經網路模型得到的結果，繪製出 ROC 曲線，曲線下面積分別爲 0.7552 和 0.7272。

在計算 propofol 的劑量需求時，個別病人的特異性應列入考慮，但是在目前的臨床醫學卻無法確實做到。在此篇論文中，我們訓練了類神經網路模型，針對病人的不同特性，來預測 propofol 的麻醉效應，最後得到的結果雖然優於臨床醫師，但仍然不盡理想。包含心輸出量，中心血液容積等幾項重要的因素無法被加入訓練，應是主要的原因。未來應可以此實驗架構爲基礎，增加收錄的樣本數，以及加入重要的決定性因素，如此應能進一步強化類神經網路模型的預測能力，未來可做爲臨床醫師在決定 propofol 劑量時的決策輔助。

英文摘要

Dose requirements of propofol to achieve loss of consciousness depend on the interindividual variability and on the interaction with other concomitant medication.

Until now when propofol was administrated by a single bolus, how to define the optimal individual dose and to investigate its hypnotic effect have not been clearly studied. The goal of this study is to develop an artificial neural network model on the basis of common clinical parameters. We would demonstrate its ability in predicting the hypnotic effect of propofol bolus induction and compare the network output to clinician's prediction.

Two hundred and seventy patients undergoing elective surgery under total intravenous anesthesia were enrolled into this study. Ten parameters were chosen as the input factors based on the related literatures and clinical experiences. The bispectral index of EEG was used to record the consciousness level of patients and served as the output factor. The predictive model derived from the artificial neural network was validated on an entirely different data set that was not included in the training set. The architectures selected in this study were the standard nets and the Ward nets using the NeuroShell 2 software system. Three senior anesthesiologists in our department would make predictions of validation set according to the chosen input factors. The results would be compared to those of trained artificial neural networks.

The standard nets had a sensitivity of 76.19 % and a specificity of 65.22 %. The ward nets had a sensitivity of 80.95 % and a specificity of 57.97 %. The clinician made prediction for the 3rd min BIS >60 with a sensitivity of 23.81 % and a specificity of 91.30 %. The area under ROC curve for the standard nets and ward nets were 0.7552 and 0.7274 respectively. The predictive results of neural net models were superior to that of clinician.

When calculating the dose requirement of propofol, we should consider the individual condition of each patient. In this study we constructed the artificial neural network model to predict the 3rd min of anesthesia depth under propofol bolus induction. In the future we could enhance the sensitivity and specificity by adding more important parameters. The dosing support system of propofol might be accomplished on the basis of this model to provide the optimal bolus dose to achieve the ideal induction endpoint. This model can potentially help determine the optimal dose of propofol and thus reduce the anesthetic cost.