預測冠狀動脈繞道手術之重大併發症 - 類神經網路模型之建構及分析

Development and Validation of an Artificial Neural Network Prediction Model for Major Adverse Outcomes after Coronary Artery Bypass Graft (CABG) Surgery

中文摘要

目的：本篇論文之目的系建構及分析一人工類神經網路模型，用於預測心肺體外循環式冠狀動脈繞道手術 (CABG) 之重大併發症 (包括死亡、心臟休止、昏迷、腎衰竭、心肌再次壞死、腦中風或呼吸器依賴)。 我們也將此一類神經網路模型之研究結果與傳統統計學之羅吉斯迴歸模型及危險因子分數模型作比較。

方法：此回溯性研究包含了五年當中 563 位單獨接受心肺體外循環式冠狀動脈繞道手術之病患，利用患者手術前的臨床資料 (如年齡、性別、血液檢驗結果、心導管檢查結果等等) 來建構一類神經網路預測模型用於預測其住院期間發生術後重大併發症之機率。 最後，我們利用 ROC 曲線 (receiver operating characteristic curve) 及 ROC 分析法對此一類神經網路模型之鑒別能力作分析，也將此分析結果與傳統統計學之羅吉斯迴歸模型及危險因子分數模型作比較。

結果：研究中，大約有 12.3% 之病患在接受心肺體外循環式冠狀動脈繞道手術之後發生重大併發症。所建構之類神經網路預測模型包含了 18 個預測因子 (輸入因子)。 測試結果發現類神經網路模型有最大的 ROC 曲線下面積 (AUC = 0.886)。 類神經網路模型之 AUC 雖遠大於危險因子分數模型之 AUC，但與羅吉斯迴歸模型之 AUC 比較卻無統計學上之顯著差異。 羅吉斯迴歸模型與危險因子分數模型之 AUC 亦無統計學上之顯著差異。 此外，在兩個關鍵的 ROC 曲線臨界點上，類神經網路預測模型都有最佳之共存敏感度及特異度。

結論：未來如果有更龐大更完整的資料庫以及更精確的運算模式，類神經網路預測模型的科技將可以對心肺體外循環式冠狀動脈繞道手術是否會發生重大併發症提供即時而準確的預測。

英文摘要

OBJECTIVE: In this study, we construct and internally validate an artificial neural network (ANN) model for prediction of in-hospital major adverse outcomes (defined as death, cardiac arrest, coma, renal failure, reinfarction, cerebrovascular accident, or prolonged mechanical ventilation) in patients who received ''on-pump'' coronary artery bypass grafting (CABG) surgery. The results were compared with two other conventional statistical models:

a logistic regression model which is developed using the same dataset, and a clinical risk score model previously described in the literature.
METHODS: We use a descriptive, non-experimental design to retrospectively analyze data from an existing 5-year CABG surgery database with a final study population of 563 patients. We assessed in-hospital major adverse outcomes and their predictors using information on admission, coronary angiography, and postoperative hospital course. Predictive variables were limited to information available before the procedure, and outcome variables were represented only by events that occurred postoperatively. The ANN''s ability to discriminate outcomes was assessed using receiver operating characteristic (ROC) analysis and the results were compared with a multivariate logistic regression model and a clinical risk score model.
RESULTS: A major adverse outcome occurred in 12.3% of all patients and 18 predictive variables were identified by the ANN model. When tested on the same validation set, the ANN model has the greatest area under the ROC curve (AUC = 0.886). Statistically, the ANN model performed much better ($p < 0.05$) than the risk score model (AUC = 0.752). However, pairwise comparison between the ANN and LR (AUC = 0.807) models showed similar performance ($p = 0.076$). The LR and RS models perform similarly well ($p = 0.453$). The ANN model also has the best simultaneous sensitivity and specificity at two predefined cut-off values.
CONCLUSION: With larger, more complete databases, and with advanced network algorithms, the ANN technology becomes an increasingly useful tool for real-time, accurate prediction of any postoperative major adverse outcome in CABG surgery.