預測前列腺癌之病理期別-類神經網路模型之建構及分析

Development and Validation of Artificial Neural Networks for the Prediction of Pathologic Stage in Prostate Cancer

中文摘要

目的：本篇論文的目的系建構及分析一類神經網路模型，用於預測前列腺癌患者預備接受根除性前列腺切除手術之病理期別，以探討前列腺包膜被腫瘤細胞侵犯之可能性。 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臨床預測模型 (Partin tables) 作比較。

方法：此回溯性研究包含了九年當中 124 位接受恥骨後前列腺根除手術或機器手臂輔助式腹腔鏡前列腺根除手術之病患，利用患者手術前的臨床資料 (如年齡、肥胖度、血液 PSA 檢驗、肛門指診結果、經直腸前列腺超音波檢查結果及前列腺切片組織病理等等) 來建構一類神經網路預測模型用於預測其前列腺包膜被腫瘤細胞侵犯之機率。 最後，我們利用 ROC 曲線及 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臨床預測模型 (Partin tables)作比較。

結果：研究中，大約有 32.25% 之病患在接受前列腺根除手術之後發現包膜被腫瘤細胞侵犯，另 67.74% 病患則無包膜侵犯情形。所建構之類神經網路預測模型包含了 7 個預測因子 (輸入因子)。 測試結果發現其 ROC 曲線下之面積 (AUC) 是 0.795，大於羅吉斯迴歸模型之 AUC (0.746)且有顯著統計差異. 而將此研究包含之 124 位個案應用於臨床預測模型 (Partin tables) 所得之 AUC (0.688) 亦遠小於類神經網路及羅吉斯迴歸預測模型。 但是，在幾個關鍵的臨界點上，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前列腺癌預接受前列腺根除手術患者之病理期別提供即時而準確的預測。

英文摘要

Objective: An artificial neural network (ANN) was developed to predict the pathologic stage of prostate cancer more effectively than regression models based on the combined use of pelvic magnetic resonance imaging (pMRI), prostate specific antigen (PSA) and biopsy Gleason score in patients ongoing receiving radical prostatectomy (RP).

Materials and methods: One hundred and twenty-four patients undergoing retropubic RP or robotic assisted LRP with pelvic lymphadenectomy were evaluated. An ANN was developed using two randomly selected training and validation sets for predicting pathologic stage. Predictive study variables included age, body mass index (BMI), preoperative serum PSA, pathology biopsy Gleason score 1 and Gleason score 2, transrectal ultrasound (TRUS) findings, and digital rectal examination (DRE). The predicted result was a pathological stage of prostate cancer (T2 or T3) after receiving radical surgery. The predicted ability of ANN was compared with those of logistic regression analysis and "Partin Tables" by area under the receiving operating characteristic curve (AUC) analysis.

Results: Of the participants, 40 were prostate cancer with capsule invasion (32.25%) and 84 were prostate cancer without capsule invasion (67.74%). In this model, the hyperbolic and logistic functions were used as an activation function in the hidden and output layers respectively. The LR analysis showed that only PSA and Biopsy pathology Gleason score 1 of the independent variables had a statistically significant influence on prostate cancer with capsule invasion. The classification threshold for predicted values was optimally set to 0.2477. The overall accuracy rate of ANN was 65%, which is higher than that of LR (60%). As to the traditional evaluation tool of prostate cancer, MRI revealed relatively lower predictive ability to previous ANN and LR models. The ANN overall outperformed LR overall significantly (0.795 ± 0.023 versus 0.746 ± 0.025; $p = 0.016$). The ANN testing performed better than LR testing (0.735 ± 0.051 versus 0.65 ± 0.055; $p = 0.093$). Therefore, we applied each patient of the total data set ($n = 124$) to the Partin table, the performance of the clinical predictable model showed the AUC of 0.688. The clinically practicable model has worse performance of predictability than ANN and LR models.

Conclusions: ANN was superior to logistic regression and Partin Tables to predict accurately final pathologic result of extracapsular invasion. Artificial neural network models can be developed and used to better predict final pathologic stage of extracapsular invasion when preoperative pathologic and clinical features are known.