Machine Learning Classification of Patients with Degenerative Cervical Myelopathy into Clinically Relevant Clusters and Development of an Adoptable Clinical Algorithm

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ABSTRACT SECTION #1: Objectives

Degenerative cervical myelopathy (DCM) affects thousands of Canadians yearly, often requiring surgery to minimize disability and suffering. Literature indicates that surgery leads to improved functional status and patient satisfaction, but the absence of reliable predictive tools contributes to uncertainty in clinical decision-making.

ABSTRACT SECTION #2: Method

Data was extracted from an ongoing, prospective national DCM observational cohort study. Patient-related, clinical, and radiological variables were selected based on relevant features influencing outcomes in the literature. An unsupervised K-prototypes machine learning (ML) model was developed to cluster patients into distinct groups with clinically relevant characteristics. The elbow and silhouette methods, followed by clinician validation, were used to determine the optimal number of clusters. Outcome measures of interest were computed for each cluster, with clinical and outcome measures within each cluster compared using the Kruskal Wallis and Mann-Witney U tests. A Classification and Regression Tree (CART) model was developed to adapt the clustering model into a predictive clinical algorithm.

ABSTRACT SECTION #3: Results

The K-prototypes model was derived from 774 patients who met inclusion criteria, with 15 features utilized. Baseline clinical, demographic, and radiographic findings were used to classify patients into four different subgroups with distinct feature means and clinical prognoses. Despite baseline differences, all clusters reported similar satisfaction with surgery. The CART model was comprised of three levels with eight leaf nodes. Only three features, Age, SF-12 Mental Component Score, and SF-12 Physical Component Score contributed to the CART model from the initial 17 features. The CART model attained an AUC score of 0.93 and an accuracy of 84% on the testing dataset and reached similar levels of predictive success for all four classes.

ABSTRACT SECTION #4: Conclusions

Four clinically relevant subgroups with unique patient profiles and distinguishable outcomes were identified in the DCM patient cohort using the K-prototypes model. The CART algorithm accurately predicted all four classes using only three pre-surgical features. This clustering approach, coupled with the CART clinical algorithm, would allow physicians to provide personalized, nuanced care based on patient risk criteria and improve expectation counselling.