Predicting Response to Intralesional Steroids in Keloid Patients Using Machine Learning Models Trainedon Clinical Survey Data

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BACKGROUND:

Intralesional triamcinolone acetonide (ILTA) is a widely used first-line corticosteroid therapy for keloid disorder, yet many patients show limited or no response, while a significant number see a worsening of their keloids. Given the variability in steroid treatment outcomes, there is a pressing need for tools that can predict patients' steroid responsiveness prior to initiating therapy. *We hypothesized that machine learning (ML) models trained on keloid patient-reported data could be leveraged to provide accurate, pre-treatment predictions for their response to steroid therapy, enabling more personalized and effective treatments for keloid patients.*

METHODS:

An IRB-approved online survey-based dataset of self-reported responses from 1,940 keloid patients was used to obtain data for 940 patients (290 male, 650 female) who had provided sufficient information on their steroid treatment for our analysis. This data was used to develop and validate several ML models, including Neural Networks (NN) and Random Forest (RF). Features included demographics, lesion morphology and location, growth history, number of ILTA injections, and triggering factors. After preprocessing and handling class imbalance using SMOTE-ENN (Over-sampling using SMOTE and cleaning using ENN), models were trained using 5-fold cross-validation. Feature importance was evaluated using SHAP (SHapley Additive exPlanations) and permutation importance.

RESULTS:

NN and RF models demonstrated high accuracy (~95%)in predicting patient response to ILTA.SHAP analysis identified patient gender and keloid lesion morphology as the most influential features. Younger female patients with flat or nodular lesions were more likely

to respond favorably to treatment, while persistent lesion growth over time was associated with resistance. Notably, the models maintained strong predictive performance even when growth history or ILTA injection data were excluded,highlighting their applicability in treatment–naive patients or those lacking detailed medical records.

CONCLUSION:

ML models, particularly NN and RF, can accurately predict steroid response in keloid patients based on basic clinical data. These models offer a promising tool for identifying patients unlikely to benefit from ILTA and may guide clinicians in personalizing treatment plans. Additionally, feature analyses suggest gender–and morphology–specific patterns of steroid responsiveness, providing insight into the biological variability of keloid treatment outcomes. This approach represents an important step toward precision medicine in keloid management.

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