Developing a Risk Prediction Model for Identification of Necrotizing Fasciitis

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Background

- Necrotizing Fasciitis (NF) is a rare, fatal infection affecting 0.4 per 100,000 people annually. It involves subcutaneous tissue and fascia and progresses rapidly, often within hours.
- Early diagnosis is vital, reducing mortality from 13.2% to 5.7% and hospital stays by 10 days, preventing complications.
- Machine learning (ML) models can help predict NF risks in the population, aiding early detection and treatment.

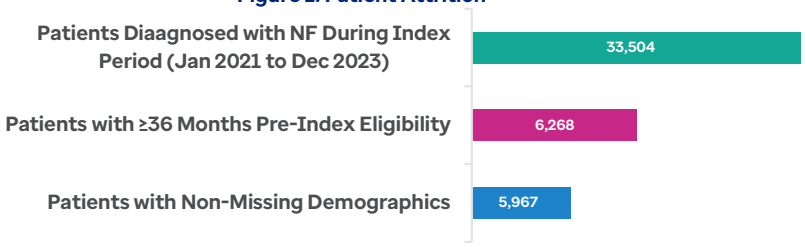
Objective

This study develops and evaluates a predictive ML model for early NF detection using Logistic Regression, XGBoost, Random Forest, and K-NN ML techniques. It identifies key risk factors to improve early diagnosis of NF and clinical decision-making.

Methodology

- NF patients were identified from Optum® Market Clarity Data, covering cases from January 2021 to December 2023 using ICD-10 code M72.6.
- Propensity Score Matching (PSM) was carried out to identify the matched controls using covariates such as age, gender, race, and region.
- A total of 11,934 patients were analyzed, including 5,967 NF cases and 5,967 non-NF patients (Figure 1).
- The dataset was split into 80% for model training and 20% for testing, and four supervised ML models – Logistic Regression (LR), XGBoost (XGB), Random Forest (RF), and K-NN – were deployed to predict NF risks.
- Recursive Feature Elimination was used to identify the most important features to be used in the model.
- Model performance was evaluated using Precision, Recall, and Accuracy.

Figure 1. Patient Attrition



Results

- Logistic Regression (**Figure 2**) outperformed other models, achieving an F1-score of 78% and AUC of 85%, followed closely by XGBoost, Random Forest, and K-NN.
- Odds Ratio (**Figure 3**) depicts several key factors which were identified, including Diabetes Mellitus (OR: 3.34), Soft Tissue Disorders (OR: 2.78), Hospital Admissions (OR: 2.76), Kidney Disorders (OR: 1.75), and Mobility Issues (OR: 1.66). These key factors demonstrated statistically significant associations with the risk of developing NF, supported by p-value ($p < 0.05$), indicating strong evidence of their clinical relevance.

Figure 2. ROC Curve for Logistic Regression

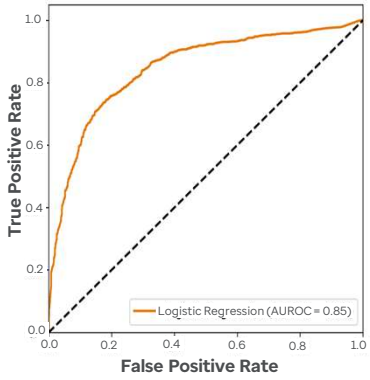
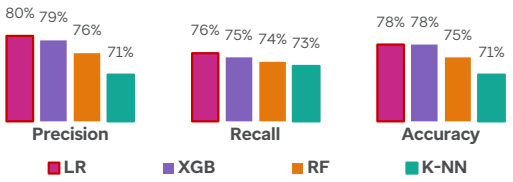


Figure 3. Odds Ratio

Figure 4. Model Result



Conclusions

- ML models identified NF risk factors, enabling early detection and informed clinical decision-making.
- Potential impact includes enhanced patient outcomes, reduced morbidity/mortality, improved healthcare resource utilization, and healthcare cost.
- This study can be leveraged for personalized and targeted healthcare intervention among different clusters.

References:
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