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## **Machine Learning-Based Prediction of Contrast-Induced Nephropathy in Cardiac Catheterization Patients: A Prospective Cohort Study**

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**Objectives :** Contrast-induced nephropathy (CIN) is a significant concern in patients undergoing cardiac catheterization procedures, impacting patient outcomes. Early identification of high-risk individuals for CIN is crucial for timely intervention. This study aims to develop a robust machine learning model using comprehensive clinical, demographic, and procedural data to predict CIN in cardiac catheterization patients.

**Methods :** We enrolled 1,200 consecutive cardiac catheterization patients in a prospective study, gathering comprehensive information, including age, gender, comorbidities, baseline renal function, contrast volume, and procedural data. To identify cases of contrast-induced nephropathy (CIN), we monitored serum creatinine levels before the procedure and again between 48-72 hours afterward. Feature engineering techniques were employed to extract relevant features from the collected data. The model's performance underwent thorough assessment using sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and the area under the receiver operating characteristic curve (AUC-ROC), accompanied by 95% confidence intervals (CI) to ensure robust evaluation.

**Results :** Our machine learning model exhibited exceptional predictive accuracy for CIN in cardiac catheterization patients. The model achieved a sensitivity of 88% (95% CI: 85.7% - 90.3%) and specificity of 92% (95% CI: 89.7% - 94.3%) with an AUC-ROC of 0.90 (95% CI: 0.88 - 0.92) in the validation set. The PPV was 79% (95% CI: 75.3% - 82.7%), and the NPV was 95% (95% CI: 93.7% - 96.7%), indicating robust diagnostic performance. Importantly, the model identified specific risk factors and procedural variables associated with CIN, enabling targeted interventions.

**Conclusions :** This prospective study emphasizes the potential of machine learning in predicting CIN in cardiac catheterization patients. The model's robust sensitivity, specificity, and risk factor identification provide clinicians with a valuable tool for assessing and mitigating CIN risk, enabling personalized strategies and ultimately improving patient outcomes during cardiac catheterization.