

ML-Driven Predictive Analytics for Healthcare Management to Optimize Costs and Outcomes in Diverticulitis Treatment

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Abstract

Diverticulitis is a prevalent gastrointestinal condition in which most recover without complications. However, about one-third present with complicated cases. And predicting patient outcomes remains a challenge, impacting hospital resource allocation, cost efficiency, and overall healthcare management. This study utilizes a large-scale dataset from the National Inpatient Sample (NIS) 2016-2022 to identify key risk factors and procedural impacts on mortality, leveraging machine learning (ML) and predictive modeling to enhance clinical decision-making and optimize healthcare operations.

We identified 567,460 patients diagnosed with diverticulitis, of whom 3,760 (0.66%) died during hospitalization. Statistical and ML models, including XGBoost, were applied to assess mortality risk factors and their financial implications.

The mortality group was older (mean age 75 vs. 58, $p < 0.001$) and predominantly female (65.7%). Hypertension (70.6% vs. 49.7%) and chronic pulmonary disease (30.9% vs. 15.1%) were significantly more prevalent in deceased patients ($p < 0.001$). The mortality group had a longer mean length of hospital stay (12.03 vs. 5.69 days) and incurred \$149,842 higher total hospitalization charges, on average, than survivors ($p < 0.001$). Deceased patients were 8.8 times more likely to develop acute kidney injury (AKI) and 9.3 times more likely to require noninvasive ventilation ($p < 0.001$). XGBoost models identified that higher age and Black race were strongly associated with mortality, while private insurance, self-pay status, and Hispanic ethnicity were associated with survival.

These findings demonstrate AI's impact on hospital management, financial planning, and risk stratification. ML-driven predictive analytics enable proactive resource allocation, cost reduction, and optimized treatment pathways, fostering more sustainable and resilient healthcare operations. This study underscores AI's role in aligning clinical decisions with financial strategy, driving intelligent transformation in healthcare management for diverticulitis treatment.