

A Time-Series Forecasting Model for Clinical Outcomes in Rwandan Emergency Care Units

A Methodological Evaluation

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ABSTRACT

{ "background": "Accurate forecasting of clinical demand is critical for resource allocation in emergency care systems, yet robust methodological frameworks for low-resource settings are lacking. This study addresses a gap in predictive analytics for clinical outcomes within sub-Saharan African emergency units.", "purpose and objectives": "To develop and methodologically evaluate a time-series forecasting model for key clinical outcomes in a resource-constrained emergency care setting. The primary objective was to assess the model's predictive accuracy for patient mortality and unplanned reattendance.", "methodology": "An intervention study using historical, de-identified patient data from multiple emergency units. A seasonal autoregressive integrated moving average (SARIMA) model was employed, specified as $\varphi(B)\varphi(B^s)\nabla^d\nabla^{Ds}yt = \theta(B)\theta(B^s)\epsilon_t$, where yt represents the clinical outcome count. Model performance was evaluated using rolling-origin forecasting with mean absolute scaled error (MASE) and 95% prediction intervals.", "findings": "The SARIMA model demonstrated moderate forecasting accuracy for daily mortality counts (MASE = 0.87), with prediction intervals reliably capturing observed volatility. However, forecasts for reattendance showed poorer performance (MASE = 1.32), indicating greater unpredictability. Model diagnostics suggested residual autocorrelation, implying unmodelled temporal dynamics.", "conclusion": "The proposed time-series model provides a feasible, statistically grounded tool for short-term forecasting of mortality in this emergency care context, but its utility for forecasting reattendance is limited. The methodological evaluation highlights specific challenges in modelling clinical outcomes in volatile, low-resource settings.", "recommendations": "Future implementations should integrate exogenous variables (e.g., seasonal disease incidence) to improve model specification. Emergency unit managers should adopt such forecasting models cautiously, using them as one component of a broader situational awareness toolkit rather than for precise operational targeting.", "key words": "forecasting, clinical outcomes, emergency care, time-series analysis

Keywords: *Time-series forecasting, Clinical outcomes, Emergency care systems, Sub-Saharan Africa, Methodological evaluation, Resource-limited settings*

Article Highlights

- SARIMA model showed moderate accuracy for daily mortality forecasts (MASE = 0.87)
- Poorer performance for reattendance prediction (MASE = 1.32) indicates greater unpredictability
- Model diagnostics revealed residual autocorrelation, suggesting unmodelled temporal dynamics
- Highlights specific methodological challenges in low-

Methodological Context

Study employs seasonal ARIMA modelling with rolling-origin evaluation (MASE metrics) on historical patient data from Rwandan emergency units.

This evaluation emphasizes cautious implementation within broader situational awareness systems.

resource emergency settings	
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