

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

A Methodological Evaluation

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ABSTRACT

{ "background": "Emergency care systems in sub-Saharan Africa face significant challenges in resource allocation and demand forecasting. Robust predictive tools for clinical outcomes are scarce, hindering proactive management and strategic planning within these critical healthcare units.", "purpose and objectives": "This study aimed 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": "A retrospective cohort study used anonymised administrative data from multiple urban emergency units. The core forecasting model was a seasonal autoregressive integrated moving average (SARIMA) formulation, specified as $\varphi(B)\nabla\phi(B^s)\nabla^d\nabla^{Ds} yt = \theta(B)\theta(B^s)\epsilon_t$, where yt represents the outcome count. Model performance was evaluated using rolling-origin forecasting with mean absolute scaled error (MASE) and 95% prediction intervals.", "findings": "The SARIMA(1,1,1)(0,1,1)7 model for daily mortality counts demonstrated a MASE of 0.87 (95% CI: 0.82 to 0.93) on the test set, indicating forecasts were, on average, 13% more accurate than a naïve seasonal benchmark. Predictions for reattendance showed higher uncertainty, with prediction interval coverage falling below the nominal 95% level.", "conclusion": "The evaluated time-series model provides a statistically robust and operationally feasible tool for forecasting mortality in this context. Its application can support data-driven staffing and resource decisions.", "recommendations": "Integration of this forecasting approach into routine health management information systems is recommended. Further research should focus on incorporating exogenous variables, such as seasonal disease patterns, to improve forecast precision for a wider range of outcomes.", "key words": "forecasting, emergency medicine, health systems, SARIMA, sub-Saharan Africa, clinical outcomes

Keywords: Emergency care, Sub-Saharan Africa, Time-series analysis, Clinical outcomes, Resource allocation, Forecasting model, Senegal

Article Highlights

- SARIMA model achieved MASE of 0.87 for daily mortality forecasts in test set.
- Forecasts for patient reattendance showed higher uncertainty with sub-nominal prediction interval coverage.
- Model provides operationally feasible tool to support staffing and resource allocation decisions.
- Study recommends integration into routine health management information systems.

Core Forecasting Formulation

Seasonal ARIMA (SARIMA) model:
 $\varphi(B)\Phi(B^s)\nabla^d\nabla^{Ds} yt = \theta(B)\Theta(B^s)\epsilon_t$, where yt represents the clinical outcome count. Evaluated using rolling-origin forecasting with MASE and 95% prediction intervals.

This methodological evaluation focuses on forecast accuracy and operational feasibility in a specific resource-constrained context.

ABSTRACT-ONLY PUBLICATION

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