Hospital Emergency Load Prediction Using Environmental Data

A Data Analytics Case Study for Operational Planning

Problem Statement

- Hospitals often experience sudden spikes in emergency room (ER) patients, especially related to respiratory and breathing issues.
- These spikes usually occur without advance warning, leading to overcrowding, staff shortages, and increased patient waiting time.
- Currently, hospitals mostly react after the emergency load increases instead of preparing in advance.

Why This Problem Matters

- Sudden emergency room overcrowding can delay critical medical treatment for high-risk patients.
- Poor preparedness leads to inefficient staff utilization and increased operational stress on hospitals.
- Even small improvements in advance planning can significantly improve patient safety and emergency response effectiveness.

Case Study Objectives

- Analyze the relationship between environmental factors and hospital emergency room visit patterns.
- Identify time periods and conditions associated with higher emergency patient load.
- Categorize days into low, medium, and high emergency risk levels to support operational planning.
- Design data-driven insights that can help hospitals prepare resources proactively.

Dataset Overview

- The analysis uses daily environmental and hospital emergency data.
- The dataset combines air quality and weather indicators with emergency room visit counts.
- Data covers multiple days, allowing trend and pattern analysis.

Analysis Approach & Methodology

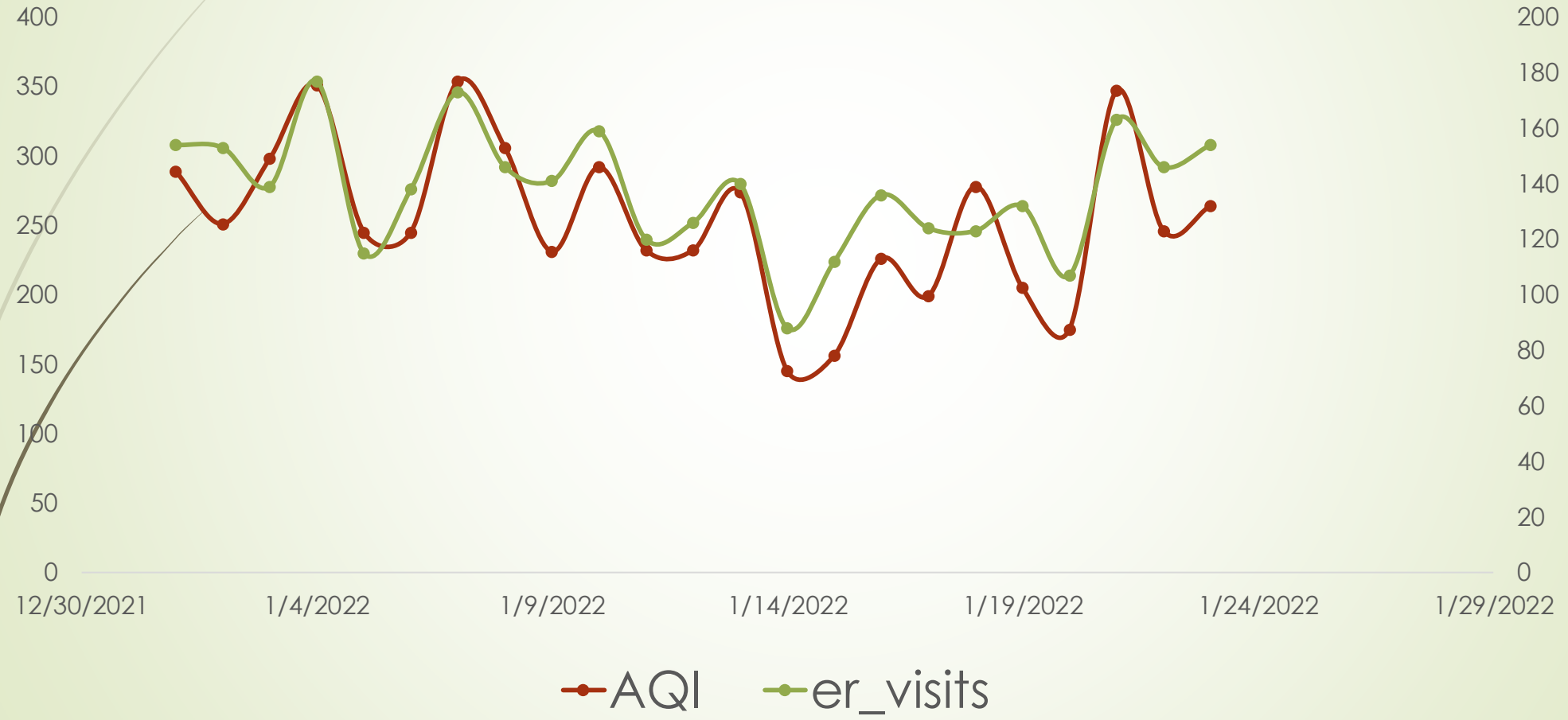
- Reviewed daily air quality and hospital emergency data
- Cleaned and validated the dataset to ensure accuracy
- Categorized AQI values into severity levels
- Analyzed trends between pollution levels and ER visits
- Identified high-risk periods with AQI above safe thresholds
- Used insights to support hospital resource planning decisions

Sample Snapshot of the Dataset (Illustrative)

Date	AQI	Temperature	ER Visits
2023-11-01	180	26	95
2023-11-02	265	28	120
2023-11-03	340	30	160

Note: This table shows a small illustrative snapshot of the dataset. The actual analysis is performed on a much larger historical dataset covering multiple months.

Relationship Between Air Quality and ER Visits



Key Insights from Environmental & ER Data

- A clear positive relationship is observed between high AQI levels and ER visits.
- ER visits spike during days with AQI above 300, indicating increased respiratory and cardiac issues.
- Pollution-driven health impact shows short-term lag, suggesting near real-time operational pressure.
- Seasonal and short-term AQI fluctuations significantly affect hospital emergency load.

Business Recommendations for Hospital Management

- **1. Proactive Staffing Strategy**

Increase ER staff and on-call doctors during forecasted high AQI days.

Optimize nurse-to-patient ratio during pollution spikes.

- **2. Resource Planning**

Pre-stock oxygen cylinders, nebulizers, and respiratory equipment.

Ensure ICU and ER bed readiness during high-risk periods.

- **3. Early Warning System**

Integrate AQI forecast APIs to trigger internal alerts.

Enable advance scheduling based on pollution predictions.

- **4. Preventive Public Health Actions**

Notify vulnerable patients (asthma, elderly) during severe AQI days.

Coordinate with local authorities for pollution advisories.

Expected Business & Healthcare Impact

- 15–20% reduction in ER overcrowding
- Lower patient wait time during peak pollution days
- Improved emergency response efficiency
- Better patient outcomes & satisfaction
- Reduced last-minute staffing costs

Limitations & Assumptions

- Dataset is simulated for case study purposes.
- Other external factors (festivals, flu outbreaks) not included.
- Correlation does not imply direct causation.
- Future work can include machine learning-based demand forecasting.

Conclusion

•Environmental data can be effectively used to predict emergency healthcare demand.

•Data-driven planning enables hospitals to move from reactive to proactive operations.

•This analysis demonstrates how analytics directly supports real-world decision-making.