Predicting Cellulitis Emergency Department Visit Frequency Using Environmental Data and Machine Learning

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Background

- Environmental conditions like temperature, humidity, air pollution may influence the skin microbiome and the development of **acute skin infections**, including **cellulitis**.
- **Machine learning** and **time-series modeling** provide new tools to explore relationships between environmental exposures and healthcare utilization.

Objective

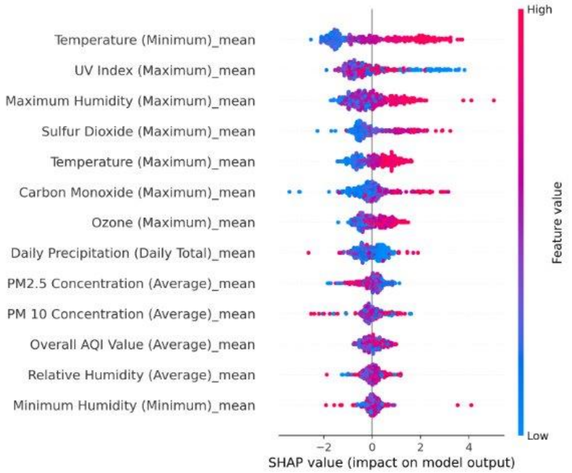
To determine whether **machine learning** models incorporating **environmental variables** can **predict cellulitis**-related **emergency department visit frequency** in **Omaha, NE.**

Results

- **10,204 total ED visits** with a primary diagnosis of cellulitis
- **1,137 ED visits** in 2023 were identified for model prediction testing

Most influential environmental predictors:
1. Temperature (Minimum)
2. UV Index (Maximum)
3. Humidity (Maximum)
4. Sulfur Dioxide (Maximum)
5. Temperature (Maximum)

Adding environmental variables to ML models provided **modest improvement** over ARIMA predictions based on historical visit counts alone



Discussion

- Hybrid **time-series + machine learning framework** demonstrates a novel approach to studying environmental influences on cellulitis.
- Environmental factors showed limited improvement in predicting healthcare visits.
- Access to emergency department care and the multifactorial etiology of cellulitis are limitations of this study

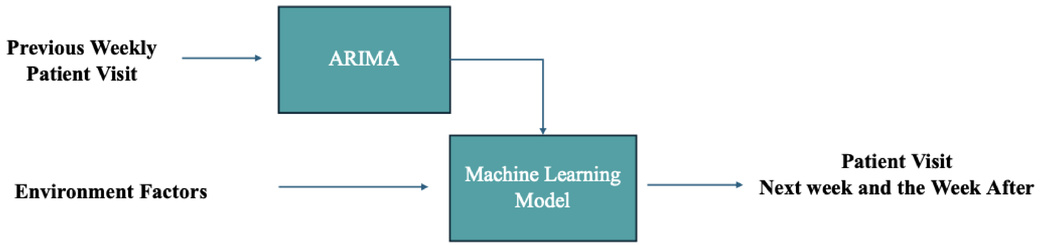
Future Directions:
- Studying **diverse regions** and **climates,** including extreme conditions
- AI-driven approaches may help further clarify the **skin–environment relationship**

Methods

Patient Data
- Emergency department (ED) visit dates for cellulitis at University of Nebraska Medical Center

Environmental Data for Omaha, NE
- Temperature, humidity (Omaha Eppley Airport)
- Ultraviolet (UV) index (NOAA)
- Air pollutants: $PM_{2.5}$, PM_{10}, ozone, SO_2, CO (EPA)

Predictive Machine Learning Model
- Training data: 2013–2019 and 2022
- Testing data: 2023



Hybrid modeling framework
- **ARIMA** model used to capture baseline trends and seasonality.
- **Machine Learning** models trained on residuals to capture nonlinear relationships with environmental variables
- Weekly predictions **combined ARIMA** with **Machine Learning** residuals **incorporating environmental data** for 2023 which were compared to observed counts

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