### Research Summary: Enhancing Patient Prioritization Systems in Healthcare

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#### Current Standard Practice

The **Emergency Severity Index (ESI)** is a widely-used, standardized triage tool implemented in emergency departments (EDs) across the United States and internationally. It prioritizes patients based on the urgency of their medical conditions and the resources they are anticipated to require during their visit (Wuerz et al., 2000; Guzzi et al., 2023). While effective in emergency scenarios, there is room for improvement in refining variables, assigning appropriate weights, and minimizing bias.

#### Objectives

1. **Variable Determination**: Identify the most relevant variables influencing patient prioritization by examining clinical research and related studies.
2. **Weight Justification**: Establish the rationale behind assigning specific weights to variables by leveraging clinical evidence and optimization methods.
3. **Bias Mitigation**: Develop methods to minimize biases in the prioritization process, whether stemming from subjective judgment or systemic issues.

#### 3. Similar Research Results

* **National Early Warning Score (NEWS)**: This track-and-trigger system aggregates patient vital signs into a score ranging from 0 to 20, measured at least twice a day (Smith et al., 2019). The score determines the escalation protocol, influencing monitoring intervals and preventive actions for patient deterioration.
* **Pareto Optimization in Patient Sorting**: The Pareto front represents trade-offs between conflicting objectives in multi-objective optimization. For example:

**Objective 1**: Minimize the average patient waiting time.

**Objective 2**: Minimize facility completion time (time the last patient leaves).

Solutions on the Pareto front ensure no single objective can improve without worsening the other (Saremi et al., 2015). Using this concept, decision-makers can select optimal solutions that balance waiting times and resource efficiency.

#### 4. Research Proposal: Priority Score-Based Optimization

To further enhance patient sorting and prioritization:

1. **Incorporating Machine Learning**: Recent studies suggest that machine learning methods outperform human judgment in grouping patients into priority classes. For example, using clustering techniques like **K-means** provides more accurate and unbiased grouping (Yousefia et al., 2023).
2. **Optimizing Variable Scores**: Beyond clustering, the focus should shift to optimizing the scores of individual variables to improve resource allocation and minimize delays. Determining which variables to include and their respective weights can be refined using:
   * Statistical analysis of clinical datasets.
   * Simulation modeling to evaluate different scoring configurations.

#### 5.Limitations and Future Directions

#### **Generalizability**: Systems like ESI and NEWS are tailored to emergency or deteriorating patients, leaving a gap for routine or primary care applications.

#### ****6. Future research could explore:****

Enhancing machine learning models by incorporating real-world data from diverse populations to reduce systemic biases (Yousefia et al., 2023).

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