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THE ROLE OF COMORBIDITY: A FRAMEWORK FOR PERSONALIZING INTERVENTIONS FOR PATIENTS WITH SEPSIS

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ABSTRACT

Sepsis is a difficult-to-diagnose, life-threatening condition associated with high mortality and a critical need for timely intervention. The presence of comorbidities often complicates diagnosis and treatment options. Using inpatient data over multiple visits from a large hospital system, this research presents a simulation framework to model the impact of comorbidities on sepsis in order to personalize interventions. Severity is measured via the PIRO score and outcomes of interest include patient stability and disposition.

1 INTRODUCTION

Sepsis, the body's inflammatory response to infection, is a complication that can potentially result in organ failure and death. Timely intervention is both critical and difficult due to the lack of a gold-standard test to diagnose sepsis. Furthermore, sepsis can result in organ dysfunction (i.e., severe sepsis) and septic shock, making sepsis one of the leading causes of in-hospital mortality. The lines between these stages are often unclear, increasing the difficulty associated with decision-making.

The diagnosis and treatment of sepsis can be further complicated by the burden of comorbidities (i.e, the presence of two or more diseases). Comorbidities can affect the progression of sepsis in several ways. Examples include difficulties in attributing observable physiological responses to a single disease and increased vulnerability in the immune-suppressed due to diseases like cancer and HIV. Sepsis can present and progress very differently in patients depending on their comorbidity profiles, age, race and gender.

This PhD research on the care for complex patients presents a framework for a Discrete-Event Simulation (DES) model at a patient level to understand the impact of comorbidities on sepsis. By comparing different guidelines for timely sepsis interventions, we can determine personalized interventions for a given population, based on their comorbidity and demographic profiles. We do so using de-identified inpatient data from a large hospital system in Delaware consisting of demographical, diagnosis- and visit-related attributes for 49,023 adult inpatients over 80,042 visits.

2 METHODS

The inpatient sepsis population is selected using administrative codes to identify any ICD 9 diagnosis of sepsis in their admitting, primary or secondary diagnoses codes. These same diagnoses codes are used to identify the presence of any of the Elixhauser et al. (1998) comorbidities. Corresponding histories of comorbidities are directly available in the dataset for patients with a previous visit.

The Predisposition-Infection-Response-Organ Failure (PIRO) score is often used by decision-makers to stage sepsis. We use the PIRO score to quantify patient severity (Howell et al. 2011). Each of the four PIRO components has a point-score for static attributes (e.g., age, certain pre-existing conditions such as malignancy) as well as dynamic attributes (e.g., respiratory rate, heart rate).

Figure 1 presents an overview of the model framework. Inputs to the framework include the inpatient dataset, used to simulate the demographic, comorbidity and clinical characteristics of patients, and the guidelines for diagnosing and treating sepsis. Comorbidity clusters for race, age and gender groups are identified using hierarchical cluster analyses. Patients are classified into sub-groups based on their comorbidity clusters. The PIRO score is then simulated over time to study disease severity. Different sepsis guidelines are used to inform diagnostic (e.g., ordered cultures) and therapeutic (e.g., antibiotics administered) decision-making. Outcomes of interest include measures of patient stability and patient disposition.

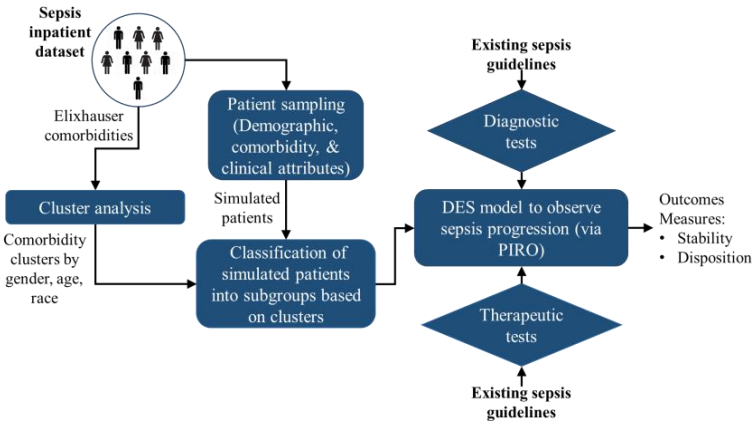

Figure 1: Overview of the simulation framework. Text in bold indicates model inputs.

3 RESULTS AND CONCLUSIONS

Clusters analyses suggest that fluid and electrolyte disorders, anemia, hypertension and neurological disorders behave uniquely in patients diagnosed with sepsis. Clusters also show that histories and comorbidities can be grouped together. The existence of race, gender and age differences in comorbidities underscore the need to personalize interventions for patients with sepsis. This framework allows us to identify the comorbidity phenotype of sepsis at presentation and study the PIRO score over time. By doing so, we can therefore determine specific interventions for groups of people that are at a higher risk for deterioration.

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