Modeling of Insulin Sensitivity for Sepsis-AKI and Sepsis Non-AKI

M. Farhah, M.S. Fatanah, *Senior Member, IEEE*, M.M. Zulfakar, K.J. Ummu, R. Normy, M.Z. Syatirah, M.Z.N. Jihan

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***Abstract*— Sepsis-induced acute kidney injury (SAKI) patients are linked to high rates of death and morbidity. Additionally, infection and injury increase blood glucose levels, making glycemic control difficult. To control the glycemic level, insulin therapy is required to maintain blood glucose in a normal range. Hence, this study intended to investigate the sepsis and AKI factors in blood glucose outcomes, especially for successful glycemic control. In this study, blood glucose level, insulin administration, and insulin sensitivity between sepsis-AKI And sepsis non-AKI were compared, along with the stochastic model of the two cohorts. Using retrospective clinical data of 20 ICU patients aged 18 years old and above from Hospital University Sains Malaysia from September to November 2021, 10 sepsis AKI patients spent longer total treatment hours (2526) and longer length of stay (median = 8 days) and had a higher median APACHE II score (median = 28) compared to sepsis non-AKI. Additionally, they had higher blood glucose levels per cohort (median = 9.8 mmol/L) and higher insulin administration (median = 0.5 U/hr). However, the statistical analysis determined no significant difference between sepsis AKI and sepsis non-AKI in blood glucose level per cohort, per patient metrics, insulin sensitivity, and insulin dosage. In conclusion, it can be concluded that sepsis contributes much to reducing insulin sensitivity and thus plays an important role in affecting the blood glucose level.**

***Clinical Relevance*— This demonstrates that, despite AKI, sepsis had more impact on insulin sensitivity and plays an essential role in blood glucose outcome and the success of glycemic control.**

I. INTRODUCTION

Sepsis is becoming more widespread and is a primary cause of death and morbidity in intensive care units (ICU) [1]. Acute kidney injury (AKI) of any cause is associated with an increased risk of developing sepsis, despite the fact that sepsis is the most common cause of AKI [2]. When a patient has sepsis, it is difficult to identify the onset of the sepsis. Thus, it is challenging to act quickly particularly to prevent kidney damage [3]. Sepsis associated AKI is highly related with poor clinical outcomes and increases patient morbidity [3]. It was related to a greater risk of in-hospital death in severely AKI patients [2].

According to the Malaysian Registry for Intensive Care 2017, the number of sepsis AKI patients (57.7%) with in-hospital mortality was higher than the number of sepsis non-AKI patients (41.6%) [4]. In China, AKI was discovered in 47.1% of sepsis cases in retrospective research involving 146,148 patients [5]. AKI has a substantial impact on several organ functions, is linked to an extended stay in the intensive care unit, and hence spends a large amount of healthcare resources [3] creating these components, incorporating the applicable criteria that follow.

During ICU admission, the consequences of infection and surgery cause the human body to experience tremendous metabolic stress [6], so critically ill patients often exhibit a high level of blood glucose of more than 10.0 mmol/L (hyperglycemia) and poor insulin sensitivity (insulin resistance), which worsens patients' outcomes [7]. It is known that insulin sensitivity decreases with sepsis [8, 9].

Interestingly, tight glucose control (TGC) below 7.8 mmol/L decreased the mortality rate by up to 45% [10, 11]. It is known that TGC has been used to reduce hyperglycemia while assessing insulin sensitivity [12]. Insulin sensitivity acts as an indicator of disease severity since the metabolic marker reflects the inflammatory state in an individual, which is identified by the validated glucose-insulin model [1, 12]. The ability of the body to respond to the effects of insulin through changes in blood glucose levels can be determined by insulin sensitivity [13]. Hence, this study intended to investigate the sepsis and AKI factors in blood glucose outcomes, especially for successful glycemic control in the ICU.

II. METHODS

A. Clinical data

The clinical data used in this study was based on the retrospective medical records of 20 patients from the ICU, Hospital Universiti Sains Malaysia (HUSM), Kelantan. The data comprised 10 sepsis AKI patients and 10 sepsis non-AKI patients from September to November 2021. It included ICU patients older than 18 years old, diagnosed with sepsis, and requiring intensive insulin therapy. The exclusion criteria were the ICU admission of less than 24 hours and no consent from the patients.

Demographic variables such as age, gender, weight, and height were recorded. Vital signs reported were heart rate (HR), respiratory rate (RR), temperature, systolic blood pressure (SBP), diastolic blood pressure (DBP), blood oxygen saturation (SaO_2), Glasgow Coma Scale (GCS), partial pressure of oxygen (PaO_2), partial pressure of carbon dioxide ($PaCO_2$), random blood sugar (RBS), and urine

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M. Farhah is with Advanced Medical and Dental Institute, Universiti Sains Malaysia, Kepala Batas, 13200 Malaysia (e-mail: farhah_muhammad@student.usm.my).

M.S. Fatanah is with Advanced Medical and Dental Institute, Universiti Sains Malaysia, Kepala Batas, 13200 Malaysia (phone:+604-5622561; fax: +604 -5622468; e-mail: fatanah.suhaimi@usm.my).

M.M. Zulfakar is with School of Medical Sciences, Universiti Sains Malaysia. Kubang Kerian, 16150 Malaysia (e-mail: zulfakar@usm.my).

K.J. Ummu is with Human Engineering Focus Group, Universiti Malaysia Pahang, Pekan, 26600 Malaysia (e-mail: ummu85@ump.edu.my).

R. Normy is with College of Engineering, Universiti Teknologi Nasional, Kajang, 43000 Malaysia, (e-mail: Normy@uniten.edu.my)

M.Z. Syatirah is with Advanced Medical and Dental Institute, Universiti Sains Malaysia, Kepala Batas, 13200 Malaysia (e-mail: syatirah.matzin@usm.my).

M.Z.N. Jihan is with Advanced Medical and Dental Institute, Universiti Sains Malaysia, Kepala Batas, 13200 Malaysia (e-mail: nurjihan.mohdzukhi@student.usm.my).