Original Article

Effect of glucose management levels on the incidence of systemic inflammatory response syndrome (SIRS) in intensive care

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Abstract

Background: Systemic inflammatory response syndrome (SIRS) is an excessive defence reaction of the body to a noxious stressor (infection, trauma, surgery, acute inflammation, ischemia or reperfusion, or cancer, to name a few) to pinpoint and then eradicate the endogenous or external source of the insult. Even while the cytokine storm serves a defence role, it can trigger a huge inflammatory cascade that results in reversible or permanent end-organ failure and even death.

Objective: The regulation of glucose levels in ICU patients is intimately connected to the occurrence of SIRS. Also to investigate the effect of glucose management level on the incidence of systemic inflammatory response syndrome (SIRS) in intensive care.

Methods: The study was carried out on 200 patients who were admitted to our hospital's intensive care unit (ICU) for treatment. Inclusion and exclusion criteria were recorded. According to their blood glucose control levels, they were separated into 3 groups. After 28 days following ICU admission, differences in serum inflammation level, blood glucose level, SIRS incidence, and death rate were compared.

Results: On the first day, there were no considerable variations in HR, RR, or T across the 3 groups. Only on the 7th day statistically significant variations (P<0.05) were observed in group C. Group A's average blood glucose level was substantially reduced than groups B and C. Group A had much greater hypoglycemia than groups B and C. Insulin levels were substantially greater in groups A and B than in group C. Group A had a considerably reduced duration of stay and mechanical ventilation time than groups B and C. CRP, IL-6, TNF-, and insulin levels did not differ significantly between groups A and B. Group C had a considerably higher incidence of SIRS, MODS, and 28-day mortality. Group C had a high prevalence of nosocomial infection than groups A and B, while group B had a higher incidence than group A. The differences were statistically significant (P<0.05), and the logistic results showed that blood glucose levels and insulin dosage were risk factors for SIRS incidence (P0.05).

Conclusion: Active control of blood glucose levels in ICU patients is beneficial to reduce the incidence of SIRS, according to the standard range. [*Ethiop. J. Health Dev.*2022;36(3):00-00]

Keywords: Blood glucose; Intensive care unit; Systemic inflammatory response syndrome; incidence rate

Introduction

Systemic inflammatory response syndrome (SIRS) usually relates to the effect of infectious or non-infectious factors on the body. In turn, it is a systemic physiological state of overreaction, which leads to a series of chain reactions caused by excessive release of inflammatory mediators and excessive activation of inflammatory cells (1). Clinical manifestations of the disease include elevated body temperature, rapid heartbeat, high metabolic status and other signs. The disease is characterized by acute onset, rapid progression and high mortality (2). The stress state of the body, the release of inflammatory mediators and the secretion of neuroendocrine hormones in critically ill ICU patients may lead to the occurrence of metabolic disorders in the body, and also lead to stress hyperglycemia in clinical practice (3). Although stress hyperglycemia can provide tissue repair and the metabolites of inflammatory cells such as M1-type macrophages and others secreting large quantities of IL-1, TNF, and IL-6, among other cytokines and chemokines. The continuous existence of stress hyperglycemia magnifies the systemic inflammatory response, which leads to glycogen breakdown, catecholamine, and adrenocorticotrophic hormone synthesis, glucagon synthesis, and insulin resistance. It results in immune suppression and multiple organ dysfunction syndrome (MODS). and leads to the mortality of patients (4). Therefore, the level of blood glucose management in ICU patients is closely related to the incidence of SIRS. Currently, there are many clinical research results on blood glucose control level of severe ICU patients, such as Nachtigall et al. (5), which showed that normal blood glucose was associated with lower MORTALITY in ICU associated with abnormal blood glucose, and the incidence of hypoglycemia in this study was generally low. Mahmoodpoor et al. (6) acute hyperglycemia has a considerable impact on mortality in critically sick patients. As per the current findings, there have been several researches on the association between blood glucose management and poor prognosis in ICU patients; however the connection among blood glucose regulation and SIRS incidence in ICU patients with severe disease is uncommon. Therefore, there is a need for a brief study on the influence of blood glucose regulation on SIRS incidence in ICU patients. The outcome of the study raises awareness of the disease, and it may be useful to develop the mental strength of the patients, which gives patients confidence and builds

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mental fortitude to face the disease. As a result, for this study, 200 ICU patients admitted to our hospital were chosen as research subjects to investigate variations in SIRS incidence and other indicators under different glucose control levels in order to offer a theoretical foundation for clinically related investigations. The outcomes are as follows.

Material and methods

A total of 200 patients hospitalised in our hospital's critical care unit between March 2019 and May 2021 were chosen as research participants, and were separated into group A (4.4-6.1mmol), with 60 cases, based on their blood glucose control level. There were 70 cases in group B (6.1-10.0mmol) and 70 cases in group C (10.0mmol/ L to 13.3mmol/ L). Group A included 35 males and 25 females, with an average age of 52.48±6.34 years. The types of diseases were chronic obstructive pulmonary disease (COPD) in 15 cases, bronchial asthma in 10 cases, severe pneumonia in 10 cases, cerebrovascular disease in 15 cases and severe pancreatitis in 10 cases. There were 34 men and 36 females in group B, with an average age of 53.217.14 years. The disease types were chronic obstructive pulmonary disease (COPD) in 18 cases, bronchial asthma in 12 cases, severe pneumonia in 13 cases, cerebrovascular disease in 17 cases and severe pancreatitis in 10 cases. In group C, there were 37 males and 33 females, with an average age of 55.21±4.32 years. There were 16 cases of chronic obstructive pulmonary disease, 18 cases of bronchial asthma, 16 cases of severe pneumonia, 12 cases of cerebrovascular disease and 8 cases of severe pancreatitis. There were no noticeable variations between the three groups in terms of gender composition, average age, or illness kinds (P>0.05). It has a similar effect.

Diagnostic Criteria

The diagnostic criteria for SIRS are based on the applicable criteria presented at the Chicago Conference in 1991 (7), which states that SIRS is defined as having two or more of the four clinical signs listed below. 1. Body temperature > 38°C or < 36°C; 2. Heart rate > 90 beats/min; 3. Respiration > 20 times/min or hyperventilation, pCO2 < 32mmHg; 4.Peripheral blood white blood cell count > 12×10^9/L or < 4×10^9/L or the proportion of neutral rods > 10%.

Inclusion and exclusion criteria

Inclusion criteria :1. Those who have been in ICU for more than 3 days; 2. 24 acute physiological and chronic health scores < 25 after admission; 3. Age > 20 years old.

Exclusion criteria: 1. patients with type 2 diabetes; 2. Transfer midway; 3. Incomplete clinical data.

Research Methods

In view of the existence of acute hyperglycemia, can according to the first patient blood sugar levels, intravenous push note 2 ~ 6 u insulin to control blood sugar, and then give all patients were given control blood sugar, insulin pump once every 1 ~ 4 h to patients with peripheral blood sugar monitoring through your fingers, and according to the test results of blood, adjust the dose of insulin, keep patient blood sugar in control. When the patient's blood glucose was lower than 2.8mmol/l, the patient was given a retest of blood glucose and 20ml intravenous infusion of 50% glucose to adjust to the target range. After hemodynamic stability, enteral nutritional support therapy was given within 48h, that is, 5% compound amino acid injection 18AA was given to provide nitrogen source, 20% medium and long chain fat emulsion was given, and alanine glutamine injection was given to patients with normal liver and kidney functions. Pff-d enteral nutrition preparation was given nasal feeding pump for 24h, and continued to pump. During the treatment, adverse reactions such as malignant vomiting were observed, and the dose was gradually increased.

Observation Indicators

1. The differences of Heart rate (HR), temperature (T) and respiratory rate (RR) among the three groups on day 1 and day 7 after admission to ICU were analyzed; 2. The daily blood glucose level of patients was recorded, and the total blood glucose level was obtained by adding the daily blood glucose levels and dividing the total time to obtain the average blood glucose level; 3. Hypoglycemia: Hypoglycemia was defined as < 3.3mmol/ L, and the incidence of hypoglycemia and the total number of measurements were recorded during the process of blood glucose control; 4. The average amount of insulin is the total amount of insulin applied/total treatment days; 5. inflammatory indicators, that is, on the 1st and 7th day after admission to ICU, 5ml of fasting elbow venous blood was taken, centrifuged at 3000r/min for 15min, supernatant was taken, and the levels of PCT, CRP, TNF-α and il-6 were measured by enzyme-linked immunoassay. 6. The ICU admission time, mechanical ventilation time and antibiotic application time of the three groups were recorded; 7. The outcomes of the three groups were evaluated, including the incidence of nosocomial infection, SIRS, MODS and mortality.

Statistical methods

Data in this study were processed by SPSS20.0 statistical software. All the data complied with normal distribution and homogeneity of variance test. The measured results from the three groups were represented as standard deviation mean and subjected to the F test. The chi-square test was performed to compare the counting data among the three groups, which were reported as N or percentage. Logistic correlation examination was used to determine the correlation amongst relevant indicators in this study and the risk of SIRS. The difference was significant difference (P<0.25).

Results

Differences in respiratory rate, heart rate and body temperature among the three groups

On the 1st day, there were no statistically noticeable variations in HR, RR, or T across the three groups (P>0.05). Only group C (P<0.05) had statistically significant variations from the 1st DHR and RR on the 7th day, and the aforesaid indices in group C were considerably greater than in group A and B.

As indicated in Figure 1, the difference was statistically significant (P<0.05), however there was no statistically considerable change in T between the three groups on day 7 (P>0.05).

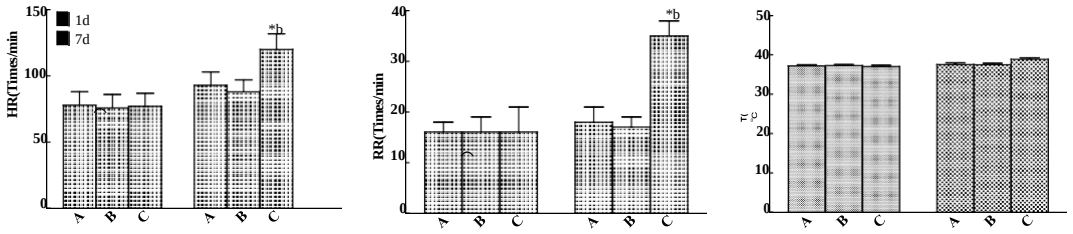

Figure 1. Differences in respiratory rate, heart rate and body temperature among the three groups (*P < 0.05 associated with 1d, bP < 0.05 associated with GROUP B)

Average control level of blood glucose, incidence of hypoglycemia and average dosage of insulin in the three groups

With statistical significance (P<0.05), the mean blood glucose in group A was considerably reduced than groups B and C, and the average blood glucose in group B was considerably reduced than that in group C. Hypoglycemia was much more common in group A than in groups B and C, and the difference was statistically significant (P<0.05). Between groups B and C, there was no considerable variation in the incidence of hypoglycemia (P>0.05). The quantity of insulin in groups A and B was not substantially different (P>0.05), while the amount of insulin in groups A and B was considerably considerably higher than that in group C (P<0.05), as shown in Figure 2.

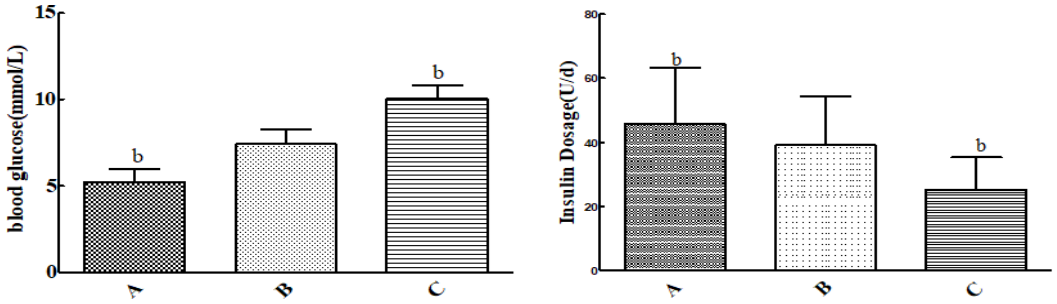

Figure 2. Average glucose control level and average insulin dosage in the three groups (compared with group B, bP < 0.05)

Table 1. Comparison of incidence of hypoglycemia among the 3 groups

Group	A （n=60）	B （n=70）	C （n=70）
Incidence of hypoglycemia	12 （20.00%） b	7 （10.00%）	5 （7.14%）

Note: Compared with group B, bP < 0.05

Comparison of hospital stay and mechanical ventilation time among the three groups

The duration of stay and mechanical ventilation, group A was substantially lesser than groups B and C, and group B was considerably lower than group C; the difference was statistically significant (P<0.05) (Figure 3).

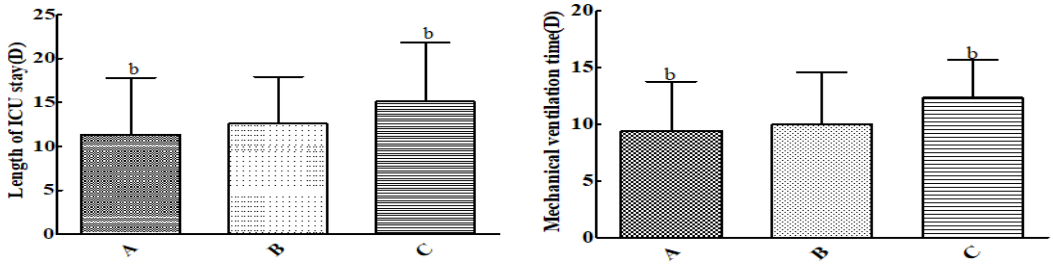

Figure 3. Comparison of length of stay and mechanical ventilation time among the three groups (compared with group B, bP < 0.05)

Changes in levels of inflammatory factors in the three groups

On the 1st day, there was no statistically notable alteration in CRP, IL-6, or TNF- across the 3 groups (P<0.05). The aforesaid indices in the 3groups were considerably lower on the 2nd day as compared to the 1st day. As indicated in Figure 4, on the 7 day, group C was substantially higher than groups A and B, whereas group A was considerably greater than group B, and the aforesaid differences were statistically significant (P<0.05).

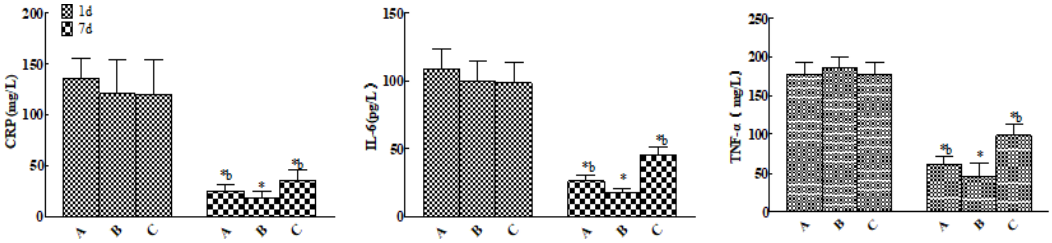

Figure 4. Changes in inflammatory factor levels in the three groups (*P < 0.05 associated with day 1, bP < 0.05 associated with group B)

Prognosis analysis of the three groups

The incidence of SIRS, MODS, and 28-day mortality in group C was considerably higher than in groups A and B, and the prevalence of SIRS, MODS, and 28-day mortality in group A was statistically significant (P<0.05). Group C had a higher prevalence of nosocomial infection than groups A and B, whereas group B had a higher incidence than group A. Table 2 shows that the difference was statistically significant (P<0.05).

Table 2. Prognosis analysis of the three groups

Group	A （n=60）	B （n=70）	C （n=70）
Incidence of nosocomial infection	14 （20.00%） [b]	10 （14.29%）	35 （50.00%） [b]
SIRS incidence rate	13 （21.67%） [b]	6 （8.57%）	25 （35.71%） [b]
MODS incidence rate	8 （13.33%） [b]	4 （5.71%）	15 （21.43%） [b]
28d mortality rate	6 （10.00%） [b]	3 （4.29%）	10 （14.29%） [b]

Note: Compared with group B, bP < 0.05

Logistic analysis of the correlation between blood glucose control level and SIRS risk

To choose the aforementioned difference variables and compute the relative risk of SIRS, a single factor logistic regression analysis was employed. The results showed that blood glucose level and insulin dosage were risk factors for the incidence of SIRS (P<0.05), as exposed in Table 3.

Table 3. Risk factors of blood glucose control and SIRS risk were analyzed by Logistic analysis

variable	OR	95%CI	P
Dosage of insulin			
Blood sugar	1.532	1.947~3.784	0.012
Dosage of insulin	1.142	1.423~3.084	0.005
Incidence of hypoglycemia	0.842	0.647~1.245	0.154

Discussion

Under the action of various factors such as trauma or severe infection, the body will activate the neuroendocrine system, resulting in the abnormal secretion of stress hormones, the production of various cytokines and the decomposition of liver glycogen and muscle glycogen, resulting in the impaired application of glucose, thus triggering stress hyperglycemia and SIRS(8-10). The occurrence of SIRS can further induce acute respiratory distress syndrome and MODS (11, 12). Recent studies have confirmed that the occurrence of MODS means the uncontrolled inflammatory response, and SIRS is the initial stage of the imbalance of the inflammatory response of MODS (13). Therefore, SIRS is strictly connected to THE occurrence of MODS and multiple organ failure (MOF), and the induction of SIRS can also gradually develop into MODS and MOF, thus leading to increased mortality of patients. Therefore, in order to reduce the mortality of ICU patients, it is necessary to explore and reduce the occurrence of SIRS (14). The outcomes of the investigation was confirmed that the level of stress hyperglycemia in critical patients was positively correlated with hyperinflammatory mediators (15), so blood glucose management can play a dual role of reducing blood glucose and anti- inflammatory. Therefore, the results of this study are described asfollows.

Results 1-4 of this study indicated that providing insulin to manage blood glucose in ICU patients with severe illness may effectively improve clinical symptoms, decrease inflammation, and successfully control blood glucose, with the optimum impact being a blood glucose control range of 6.1100.0mmol. (16) Shan and researchers found early enteral glucose infusion reduces systemic inflammatory reaction and improves glycemic control in septic rats via increasing enterogenic incretin production. According to Aljada et al. (17), Insulin suppressed McP-1 and sicAM-1 in severely sick patients and tissue components in non- critically ill sick patients. The outcomes of this research are consistent with those of the above studies, confirming that the control of blood glucose can reduce the inflammatory response, and the specific reason may be related to the use of insulin for blood glucose control in this study, while the anti-inflammatory studies of insulin have been reported repeatedly. Zhu et al. (18) demonstrated that insulin inhibits lPS-induced inflammation in macrophages via activating the sr- A1/ERK axis. Yu et al. (19) demonstrated that the PI3K/Akt/RAC-1 and PPAR- signaling pathways were engaged in insulin's anti-inflammatory impact. Insulin suppresses HG-induced transcriptional activation of P38, NF-B, and STAT1 through promoting Akt-RAC-1 signalling. Furthermore, insulin inhibits inflammation via increasing PPAR- expression and inducing P38- mediated PPAR- dephosphorylation (Ser112). In conclusion, glucose control may be connected to the anti-inflammatory impact of insulin itself via improved insulin sensitivity, and the significant changes in PCT and CRP in the findings of this study were attributable to the inclusion of patients with ICU infection in this investigation.

Conclusion

The findings of this study (5-6) showed that using insulin to control blood glucose in ICU patients could effectively reduce the occurrence of poor prognosis, the incidence of SIRS, the incidence of MODS, and mortality. Logistic analysis revealed that blood glucose level and insulin dosage were risk factors for the occurrence of SIRS. Yao etc (20). According to the findings, patients treated with conventional nursing strategy compared with the same parameters, receiving intensive glucose control in critically ill patients with all-cause mortality, ICU duration of stay in hospital, and significantly lower incidence of infection and sepsis, and improved glycemic control strategy with an elevated risk of severe hypoglycemia attack occurred. Marik et al. (21) discovered that rigorous glycemic control had no effect on 28-day mortality, bloodstream infection rates, or the need for renal replacement therapy in seven RCTS including 11,425 patients. Patients randomized to strict glycemic control had a considerably greater frequency of hypoglycemia. According to Naranje et al. (22), glucose problems are common in severely sick children. Glycemic variation is linked to various organ dysfunction and a longer length of stay in the ICU. The preceding findings are congruent with the findings of our investigation, indicating that stringent glycemic control can lower the morbidity and mortality associated with SIRS in ICU patients. The specific mechanism may be that the application of insulin reduces the level of inflammatory factors in patients, thus reducing the incidence of SIRS and MODS in ICU patients, and thus reducing the mortality. In conclusion, active blood glucose management in ICU patients is useful in lowering the incidence of SIRS, and an appropriate blood glucose control range is 6.1-10.0mmol.

Limitation of the study

Patients with diabetes who self-monitor their blood glucose (SMBG) may rely on the accuracy of measurement findings in general. However, a variety of circumstances such as application mistakes, harsh weather conditions, high hematocrit levels, or pharmaceutical interactions may cause blood glucose readings to be skewed. Incorrect blood glucose measurements can lead to treatment problems, such as insulin dose errors.

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