



## Can Serum Glucose Level in Early Admission Predict Outcome in Patients with Severe Head Trauma?

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■ **BACKGROUND:** Traumatic brain injury is a major general health concern. This study aims to evaluate a possible relationship between the serum level of glucose during admission and the outcome of patients with severe traumatic brain injury.

■ **METHODS:** In this prospective study, 80 patients with severe traumatic brain injury were recruited from the emergency department of Urmia Imam Khomeini Hospital. Serum level of glucose was measured at the time of admission and its correlation was investigated with the Glasgow Coma Scale score (on admission, 24 hours, 48 hours, and 1 week later, and at discharge) and Glasgow Outcome Score. In addition, the value of admission serum glucose was compared between deceased and discharged patients.

■ **RESULTS:** Eighty patients with severe head trauma, 71 men (88%) and 9 women (11.2%) with a mean age of  $31.71 \pm 15.66$  years, were enrolled into the study. The in-hospital mortality rate was 25% ( $n = 20$ ). There was no significant correlation between serum glucose level and Glasgow Coma Scale score (at different intervals) or Glasgow Outcome Score. The mean serum level of glucose was comparable between deceased and discharged patients ( $186.10 \pm 51.36$  vs.  $187.98 \pm 76.03$  mg/dL, respectively;  $P = 0.91$ ).

■ **CONCLUSIONS:** Admission serum glucose is not a significant indicator of outcome in patients with severe head trauma.

### INTRODUCTION

Despite tremendous progress in modern medicine, traumatic brain injury still constitutes a huge burden worldwide. Although most cases (75%–80%) involve mild lesions, almost all patients with severe head trauma and roughly two thirds of patients with moderate head trauma have lifelong disability.<sup>1</sup> Primary injury is caused by direct mechanical damage and secondary (delayed nonmechanical) damage is induced by changes in cerebral blood flow (such as hypoperfusion and hyperperfusion), inadequate cerebral oxygenation, and impairment of cerebrovascular autoregulation, cerebral metabolic dysfunction, excitotoxic cell damage, and inflammation. Primary damage cannot be therapeutically influenced, and treatment should focus on secondary damage.<sup>2,3</sup> According to some reports, patients with head trauma and hyperglycemia may have a lower Glasgow Coma Scale (GCS) score<sup>4-6</sup> and have an unfavorable neurologic outcome. Acute hyperglycemia is probably a result of stress-induced catecholamine release.<sup>7,8</sup> Some investigators<sup>9</sup> do not believe that there is a relationship between hyperglycemia and poor prognosis in head trauma. They believe that this hyperglycemia is transient and is merely a physiologic body response to injury. The present prospective study investigates a possible association between serum glucose levels of patients with severe head trauma at the time of admission with in-hospital prognosis.

### METHODS

After approval by the ethics committee of Urmia University of Medical Sciences, this prospective cross-sectional study was performed in an emergency department and intensive care unit over a 24-month period (January 2011–December 2012). Written informed consent was obtained from the patients' accompanying

#### Key words

- Trauma
- Serum glucose level
- Severe head trauma
- Traumatic brain injury

#### Abbreviations and Acronyms

**GCS:** Glasgow Coma Scale

**GOS:** Glasgow Outcome Score

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family members/guardians before enrollment. Patients with accompanying trauma to the thoracic/abdominal regions, hospital stay less than 24 hours, patients younger than 7 years of age, patients without a documented blood glucose value on admission, and diabetic patients were excluded. The patients had no general injury. The type of fluid resuscitation used was Prostigmin and anticholinergics. The patients had been referred to hospital less than 1 hour previously and they had not received any D5 (dextrose 5%) intravenous solutions. Glybenclamide was used to control glucose levels. Eighty patients with severe head trauma (GCS score  $\leq 8$ ) were included in the current study. All patients were thoroughly examined by a neurosurgeon at the time of admission and regularly during their hospital stay. All patients were managed in a similar way during hospitalization. Severity of head trauma was assessed by GCS score on admission, and 24 hours, 48 hours, and 1 week later, and at discharge. Glasgow Outcome Score (GOS) was also calculated for discharged patients. Blood samples were taken from the peripheral vein in the emergency department at admission, and levels of blood glucose in the blood samples were recorded.

### Statistical Analysis

Data are given as means  $\pm$  standard deviation. A  $\chi^2$  test (categorical data) and independent samples t test (numerical data) were used for comparisons. The Pearson correlation coefficient ( $r$ ) was calculated to investigate the relationship between serum glucose value and GCS/GOS score. Statistical analysis was performed using SPSS software (SPSS, Chicago, Illinois, USA).  $P$  value  $\leq 0.05$  was regarded as statistically significant.

### RESULTS

Eighty patients with severe head trauma, including 71 men (88.8%) and 9 women (11.2%), were enrolled in the study. The mean age of the patients was  $31.71 \pm 15.66$  (range, 18–76) years. The mechanism of head trauma was traffic accidents ( $n = 70$ ), fall ( $n = 7$ ), and quarrel ( $n = 3$ ). The final diagnoses are summarized in **Table 1**. Craniotomy was performed in 12 patients (15%). Variables at the time of admission and during hospitalization are summarized in **Table 2**. The mean hospital stay was  $14.93 \pm 11.55$  (range, 2–57) days. Twenty patients (25%) died during hospitalization and the remaining 60 patients (75%) were discharged. There was no significant correlation between the serum level of glucose at admission and GCS score at baseline ( $r = -0.06$ ;  $P = 0.63$ ), 24 hours ( $r = -0.67$ ;  $P = 0.55$ ), 48 hours ( $r = -0.13$ ;  $P = 0.90$ ), 1 week ( $r = -0.19$ ;  $P = 0.13$ ), and at discharge ( $r = -0.13$ ;  $P = 0.26$ ), or GOS ( $r = -0.63$ ;  $P = 0.58$ ). Variables of the study are compared between the deceased and discharged patients in **Table 3**. According to this table, there was no significant difference between the deceased and discharged patients in terms of sex, serum level of glucose at admission, and GCS score 24 hours after admission. Although the mean age of the deceased patients was higher, the difference was only marginally insignificant ( $P = 0.06$ ). The mean GCS score was significantly higher in the discharged patients at the time of admission ( $P = 0.04$ ) and 48 hours and 1 week later ( $P = 0.001$  for both comparisons).

**Table 1.** Final Diagnoses in the Study Population with Severe Head Trauma

| Diagnosis                       | Number (%) |
|---------------------------------|------------|
| DAI                             | 31 (38.8)  |
| SDH                             | 10 (12.5)  |
| Contusion                       | 5 (6.2)    |
| SAH + contusion                 | 5 (6.2)    |
| SDH + contusion                 | 5 (6.2)    |
| EDH                             | 3 (3.8)    |
| SAH + SDH                       | 3 (3.8)    |
| SAH                             | 2 (2.5)    |
| DAI + open fracture             | 2 (2.5)    |
| DAI + SAH                       | 2 (2.5)    |
| ICH + contusion                 | 2 (2.5)    |
| SAH + EDH + contusion           | 2 (2.5)    |
| SAH + SDH + EDH                 | 2 (2.5)    |
| SDH + ICH + contusion           | 1 (1.2)    |
| SAH + ICH + contusion           | 1 (1.2)    |
| EDH + IVH                       | 1 (1.2)    |
| Contusion + SAH + open fracture | 1 (1.2)    |
| EDH + contusion                 | 1 (1.2)    |
| IVH + SAH                       | 1 (1.2)    |

DAI, diffuse axonal injury; SDH, subdural hemorrhage; SAH, subarachnoid hemorrhage; EDH, epidural hemorrhage; ICH, intracerebral hemorrhage; IVH, intraventricular hemorrhage.

### DISCUSSION

It is generally believed that hyperglycemia after traumatic brain injury is a physiologic response to stress. Stress-induced release of catecholamines enhances gluconeogenesis and glycogenolysis, leading to the increased level of serum glucose in these patients.<sup>10–13</sup> Insulin resistance is another proposed underlying cause of hyperglycemia after severe head trauma.<sup>14</sup> In this study, we demonstrate that there was no significant relationship between the serum level of glucose at early admission with GCS score at different periods (admission, 24 hours, 48 hours, and 1 week) or GOS (**Table 3**). Likewise, the mean level of serum glucose was not significantly different between the deceased and discharged patients ( $P = 0.91$ ). This finding is in contrast with the results of many previous reports. For example, Laird et al.<sup>15</sup> demonstrated that hyperglycemia (glucose level  $>200$  mg/dL) at admission was significantly associated with higher rates of infection and mortality in patients with trauma. Even milder hyperglycemia (glucose level  $>150$  mg/dL) has been proposed as an indicator of poor prognosis in these patients.<sup>16,17</sup> This association has been claimed to be independent of age and Injury Severity Score.<sup>18</sup> It is suggested that hyperglycemia is an indirect marker of

**Table 2.** Variables in the Study Patients with Severe Head Trauma at the Time of Admission and During Hospital Stay

| Variable                             | Mean $\pm$ standard deviation (range) |
|--------------------------------------|---------------------------------------|
| Serum parameters (admission)         |                                       |
| Blood urea nitrogen, mg/dL           | 36.12 $\pm$ 17.96 (12–80)             |
| Potassium, mEq/dL                    | 4.46 $\pm$ 3.66 (0.8–6.3)             |
| Sodium, mEq/dL                       | 143.71 $\pm$ 5.05 (128–170)           |
| Hemoglobin, mg/dL                    | 13.70 $\pm$ 9.88 (7.5–19.2)           |
| Creatinine, mg/dL                    | 0.99 $\pm$ 17.96 (12–80)              |
| Prothrombin time, seconds            | 14.28 $\pm$ 0.30 (0.3.5–1.70)         |
| Partial thromboplastin time, seconds | 35.00 $\pm$ 15.6trun -18 (23–120)     |
| International normalized ratio       | 1.36 $\pm$ 0.55 (1–3.5)               |
| Glasgow Coma Scale score             |                                       |
| At admission                         | 6.36 $\pm$ 1.58 (3–8)                 |
| 24 hours                             | 6.62 $\pm$ 1.73 (3–11)                |
| 48 hours                             | 6.70 $\pm$ 2.25 (3–14)                |
| 1 week                               | 8.30 $\pm$ 3.20 (3–15)                |
| At discharge                         | 8.75 $\pm$ 5.22 (3–15)                |
| Glasgow Outcome Score                | 2.87 $\pm$ 1.76 (1–5)                 |

extensive brain damage.<sup>19</sup> Bochicchio et al.<sup>20</sup> concluded that early euglycemia is followed by improved outcome and appears to be protective in critically injured patients with trauma. DuBose and Scalea<sup>21</sup> also confirmed this conclusion. Babbitt et al.<sup>22</sup> suggested that increased serum glucose level is a good marker of intracranial injury in very young children. However, despite these findings and recommendations, there was no significant association between the serum level of glucose at admission with either GCS score or mortality in the present study. Young et al.<sup>23</sup> showed that although there was a significant association between admission serum glucose level and prognosis in severe head trauma, this association faded when the effect of GCS score was included. This may suggest a superior role of trauma severity compared with serum level of glucose in predicting the outcome of patients with head trauma. In another series by Cochran et al.,<sup>24</sup> the mean serum glucose level was significantly higher in deceased patients with head trauma compared with survivors (mean, 267 mg/dL vs. 135 mg/dL). The mean serum level of glucose was considerably higher in both deceased and

**Table 3.** Comparison of the Variables Studied Between the Deceased and Discharged Patients with Severe Head Trauma

| Variable             | Discharged (n = 60) | Deceased (n = 20)  | P Value      |
|----------------------|---------------------|--------------------|--------------|
| Sex, number of males | 55 (91.7)           | 16 (80)            | 0.15         |
| Age, years           | 29.83 $\pm$ 15.24   | 37.35 $\pm$ 15.93  | 0.06         |
| Serum glucose, mg/dL | 187.98 $\pm$ 76.03  | 186.10 $\pm$ 51.36 | 0.91         |
| GCS (admission)      | 6.57 $\pm$ 1.45     | 5.75 $\pm$ 1.83    | 0.04         |
| GCS (24 hours)       | 6.80 $\pm$ 1.43     | 6.10 $\pm$ 2.38    | 0.11         |
| GCS (48 hours)       | 7.20 $\pm$ 1.98     | 5.20 $\pm$ 2.40    | <b>0.001</b> |
| GCS (1 week)         | 9.15 $\pm$ 2.82     | 4.40 $\pm$ 1.89    | <b>0.001</b> |

Data are presented as mean  $\pm$  standard deviation or frequency (%).  
GCS, Glasgow Coma Scale.

discharged patients in the present study (mean, 186.10 vs. 187.98 mg/dL, respectively), indicating a homogeneous increase in serum level of glucose at admission in all patients with severe head trauma. The glucose level at discharge was 103.5  $\pm$  14.7. This is in line with the results of another study by Melo et al.<sup>25</sup> that indicated that hyperglycemia was prevalent in all patients with severe head trauma with or without multiple trauma. Another factor that may play an interfering role is gender. Gender differences in the physiologic response to trauma can affect outcome.<sup>26</sup> Admission diagnosis is another factor that may alter the association between serum glucose level at admission and prognosis in patients with head trauma.<sup>27</sup> However, despite this complexity, our findings are supported by other studies. Griesdale et al.<sup>28</sup> performed a retrospective study of 170 patients with severe head trauma. These investigators did not report a significant association between serum glucose level and in-hospital mortality. Klein et al.<sup>29</sup> concluded that hyperglycemia was not significantly associated with prognosis in critically ill children. In another similar study, Lodha et al.<sup>30</sup> analyzed the association between day 1 glucose values in 209 critically ill children and the outcome (mortality). Contrary to the prevalent view supporting the association of hyperglycemia with poor outcome, these investigators demonstrated a significant association between hypoglycemia and bad prognosis in this study. Based on the findings of this study, serum glucose level at the time of admission of the patients with severe head trauma is not a significant prognostic factor.

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