Hyperglycemia and Length of Stay in Patients Hospitalized for Bone Marrow Transplantation

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Hyperglycemia has been shown to be associated with increased mortality and morbidity and prolonged hospital stay in inpatients (1–4). This association has been established for several conditions including cardiac surgery, acute myocardial infarction, stroke, trauma, burns, pneumonia, and critical illness (5–10). Good glycemic control has been shown to decrease length of stay (LOS) and save hospitalization costs (11,12). In randomized controlled trials of critically ill patients, the beneficial effects of good glycemic control were most prominent in those with longer hospitalizations and no previous history of diabetes (13).

Patients hospitalized for bone marrow transplantation (BMT) tend to be critically ill and have prolonged hospital stays. To our knowledge, there have been no previous reports that describe the relationship between blood glucose levels and LOS in patients admitted for BMT. This study was performed to establish the relationship between blood glucose and LOS in nondiabetic patients electively admitted for BMT.

RESEARCH DESIGN AND METHODS

— A retrospective review of electronic medical records of patients electively admitted to the BMT unit between 1 January 2006 and 30 June 2006 was conducted. Patients were identified from the hospital admission/discharge data. Medical records were accessed to collect data on age, sex, date of admission, date of discharge, diabetes status, renal status, all available laboratory blood glucose values, steroid use, immunuosuppresssive drugs, antibiotics, and documented blood culture–positive infections. The Human Research Committee of Partners Health Care (Boston, MA) approved the protocol.

A mean blood glucose value for each patient was calculated from all the available blood glucose values. These values included those obtained from the central laboratory and did not include values from bedside glucose monitoring. Data were analyzed by categorization into quintiles of mean blood glucose levels as follows: <91, 91–100, 101–110, 110–120, and >120 mg/dl. Data were further categorized into a mean blood glucose value ≤100 mg/dl (normoglycemia) and a mean blood glucose value >100 mg/dl (hyperglycemia). Student's unpaired *t* test was used for group comparisons of continuous variables, and χ^2 test was used for comparison of categorical variables. Pearson's correlation coefficient was derived between mean blood glucose values and LOS. Correlation was also derived between the highest blood glucose value during hospitalization and the LOS. All data are presented as means ± SD. Statistical significance was set at $P < 0.05$.

RESULTS

— A total of 126 patients were electively admitted during the 6-month period. Eight patients had a previous diagnosis of diabetes and were excluded from the initial analysis. LOS in quintile ranges of the average blood glucose values during the hospital stay is shown in Fig. 1. A mean blood glucose of 100 mg/dl was the threshold for an increase in LOS.

While 53 patients had a mean blood glucose ≤100 mg/dl, 65 patients had a mean blood glucose >100 mg/dl. Mean age was similar in the two groups: 49.7 ± 12.2 years and 49.0 ± 12.7 years in normoglycemic and hyperglycemic groups, respectively. No patient had renal failure or serum creatinine >2.0 mg/dl. Mean blood glucose was 94.8 ± 3.9 mg/dl (range 66–199) in the normoglycemic group and 111.3 ± 10.6 mg/dl (72–368) in the hyperglycemic group. One patient in the normoglycemic group and 18 patients in the hyperglycemic group had at least one blood glucose value >180 mg/dl. No patient in the normoglycemic group and only six patients in the hyperglycemic group received sliding scale subcutaneous insulin therapy. Mean LOS for the normoglycemic group was 15.9 ± 5.7 days versus 19.8 ± 9.0 days for the hyperglycemic group ($P < 0.01$).

There was a significant correlation between mean blood glucose and LOS ($r = 0.37$, $P < 0.001$) as well as between the highest blood glucose value and LOS ($r = 0.44$, $P < 0.001$). Twenty-four patients, 7 in the euglycemic group and 17 in the hyperglycemic group, received glucocorticoids. Those treated with glucocorticoids had higher blood glucose (111.2 ± 14.8 mg/dl [range 61–368]) and longer LOS (22.1 ± 11.54 days) than those who did not receive glucocorticoids (blood glucose 102.0 ± 9.9 mg/dl [range 72–286] and LOS 17.0 ± 6.4 days) ($P < 0.01$ for blood glucose as well as LOS). Four patients on glucocorticoid therapy received sliding scale insulin therapy. After exclusion of patients on glucocorticoids, the correlations between mean blood glucose and LOS ($r = 0.29$, $P < 0.005$) as well as between highest blood glucose value and LOS ($r = 0.36$, $P < 0.005$) were still significant. Infections were documented in 21 (39.6%) euglycemic patients and in 29 (44.6%) hyperglycemic patients (P = NS). After excluding pa-

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Received for publication 18 December 2006 and accepted in revised form 15 January 2007.

Published ahead of print at http://care.diabetesjournals.org on 26 January 2007. DOI: 10.2337/dc06-2563.

Abbreviations: BMT, bone barrow transplantation; LOS, length of stay.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

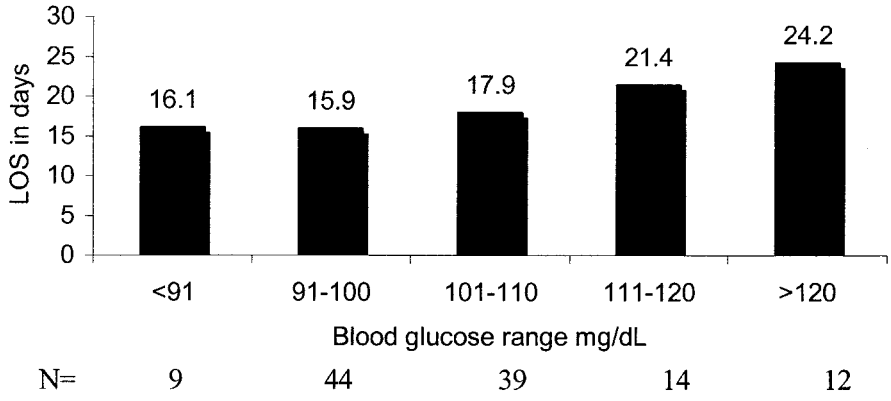

Figure 1—*Quintiles of average blood glucose value and LOS in nondiabetic patients admitted for BMT.*

tients with infections, there was a significant correlation between the highest blood glucose value and LOS ($r = 0.32$, $P < 0.05$). There was no effect of sex on LOS. All the patients were receiving immunosuppressive drugs and prophylactic antibiotics. Eight diabetic patients had a mean LOS of 17.5 ± 7.9 days, and their inclusion did not affect the results of any analysis.

CONCLUSIONS — Our study shows a positive association between blood glucose levels and LOS in patients electively admitted for BMT. This is consistent with results of other studies linking hyperglycemia to LOS (12,14). If LOS is used as an indicator of comorbidities, worse clinical outcomes will be expected in BMT patients with mean blood glucose >100 mg/dl. Glucocorticoid use was associated with significant hyperglycemia in BMT patients as has been shown in other hospitalized patients as well (15). A relation between parenteral nutrition and hyperglycemia has been shown in BMT patients in another study (16) but was not examined in this study. Whatever the cause, hyperglycemia is associated with poor clinical outcomes.

Our study does not prove causality. It is certainly possible that patients with higher blood glucose levels had more severe primary disease and therefore had a longer LOS. High blood glucose levels may represent a stress response to more severe illness in these patients. Moreover, LOS may be affected by social and administrative factors rather than medical necessity alone. Due to these limitations, our observations will need to be confirmed in trials aiming at glucose control in BMT patients.

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