

A Cause-and-Effect-Based Mathematical Curvilinear Model That Predicts the Effects of Self-Monitoring of Blood Glucose Frequency on Hemoglobin A1c and Is Suitable for Statistical Correlations

Paul C. Davidson, M.D.,¹ Bruce W. Bode, M.D.,¹ R. Dennis Steed, M.D.,² and Harry R. Hebblewhite, M.S.¹

Abstract

Background:

Previous studies have shown an association between the frequency of self-monitored blood glucose (SMBG) and hemoglobin A1c. Randomized controlled trials (RCTs) have shown this to be a causal correlation for insulin-using patients. Several studies have used linear regression, but a straight line will descend into negative hemoglobin A1c values (an impossibility). This study developed a cause-and-effect-based nonlinear model to predict the outcome of RCTs on this subject, tested this model with clinical data, and offered this model in place of linear regression, especially for the still-debated case of noninsulin-using patients.

Method:

The model was developed from cause-and-effect principles. The clinical study utilized retrospective data from patient histories of a large endocrine practice. Data sets were obtained for five treatment regimens: continuous subcutaneous insulin infusion (CSII), subcutaneous insulin (SC), no insulin (NI), oral medication (OM), and no medication (NM). OM and NM are subgroups of NI. The model was fitted to each group using nonlinear least-squares methods. Each group was ordered by SMBG tests per day (BGpd) and was divided in half; *t* tests were run between the A1C's of the two halves.

Results:

Self-monitored blood glucose readings from 1255 subjects were analyzed (CSII, *N* = 417; SC, *N* = 286; NI, *N* = 552; OM, *N* = 505; NM, *N* = 47). The CSII, SC, NI, and OM groups showed the expected declining statistically fitted curve and a significant association of BGpd with hemoglobin A1c (*P* < 0.004). The NM group showed insignificant results.

Conclusions:

The nonlinear model is based on cause-and-effect principles and mathematics. It yields a prediction that RCTs will be able to reveal that higher SMBG frequency causes lower hemoglobin A1c.

J Diabetes Sci Technol 2007;1(6):850-856

Author Affiliations: ¹Atlanta Diabetes Associates, Atlanta, Georgia, and ²Southeastern Endocrine and Diabetes, Roswell, Georgia

Abbreviations: (BGpd) blood glucose tests per day, (CSII) continuous subcutaneous insulin infusion, (*n*) blood glucose tests per day, (*N*) number of patients, (NI) no insulin, (NM) no medication, (OM) oral medication, (RCTs) randomized controlled trials, (SC) subcutaneous insulin, (SEM) standard errors of the mean, (SMBG) self-monitoring of blood glucose

Keywords: blood glucose, blood glucose self-monitoring, SMBG

Corresponding Author: Harry R. Hebblewhite, M.S., Atlanta Diabetes Associates, 77 Collier Rd., Suite 2080, Atlanta, GA 30309; email address HHebble2@Yahoo.com