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RESEARCH ARTICLE

Comparison between Glycated Hemoglobin and Blood Glucose in Monitoring Diabetic Patients at Point of Care Testing

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ABSTRACT

Point of care testing is a mode of testing where immediate laboratory tests are performed on the patient at the site where healthcare is provided close to the patient. Diabetes mellitus type 1 and 2 can be monitored using point of care kits for random blood glucose and glycated hemoglobin. The aim of the study was to compare point of care kits for random blood glucose with that of glycated hemoglobin in monitoring diabetes mellitus.

A purposeful randomized study was carried out at the Nyeri Provincial General Hospital on 157 patients attending diabetes clinic. On monitoring random blood glucose of these patients ranged from 3.0 – 36.1mmol/L. 31.3%, 24.2% and 43.9% of the patients had controlled borderline and uncontrolled diabetes mellitus in all age groups. Glycated hemoglobin (HbA1c) glycemic control of the same patients was found to be ideal (HbA1c: <7%) at 26%, good (7.1 – 7.9%) at 12.7% and fair (8.0 – 8.9%) at 10.2%. The correlation between glycated hemoglobin and random blood glucose was r= 0.66, $p<0.05$.

It is necessary to perform the two tests in combination for monitoring and evaluation of severity during point of care testing for better management of diabetes mellitus.

KEYWORDS: Glycated hemoglobin, diabetes mellitus, blood glucose

INTRODUCTION:

The diabetes disease occurs either as insulin dependent (type1) or non-insulin dependent (type 2). Type 1 diabetes constitutes the 5% to 10% of cases and it is primarily due to pancreatic islet beta–cell destruction. It is attributable to an autoimmune process or other conditions that destroy beta – cells of the pancreas through known or unknown aetiology and pathogenesis (1). Type 2 diabetes is caused by relative insulin deficiency. People with this type of diabetes frequently are resistant to the action of insulin and are at an increased risk of developing macrovascular and microvascular complications (2, 3).

Availability of immediate laboratory testing during patient visits (point-of care testing) may influence diabetes management (4). Glycated hemoglobin is formed non-enzymatically by condensation of glucose with α and β chains of hemoglobin A (5). Thus, regular measurement of glycated hemoglobin in the long term can assist to identify patients with poor glycemic control and this allows the clinicians to expedite results to patients and readily change treatments to improve glycemic control (6). The aim of the study was to compare the point of care kits for random blood glucose with that of glycated hemoglobin in monitoring diabetes mellitus.

MATERIALS AND METHODS:

The study was carried out at Nyeri Provincial General Hospital, a referral hospital for Central Province that handles about 3000 cases of diabetes in routine clinic yearly. Patients participating in the study were purposefully selected using an inclusion/ exclusion criteria by the attendant physician, while the consent and questionnaire administered by attending nurse.

SPECIMEN COLLECTION AND ASSAY:

The investigator with the assistance of the nurse collected blood samples for random blood sugar and glycated hemoglobin testing. Fresh capillary whole blood was collected using a sterile lancet after the patients finger had been sterilized using 70% alcohol.

A drop of capillary whole blood for glucose measurement was applied to the sample channel at the end of the test strip, once the monitor was ready for analysis.

Blood for glycated hemoglobin was collected using a capillary tube provided in the kit. The capillary tip containing blood was submerged into a tube containing sample dilution (0.69ml buffered detergent solution with ferricyanide) and squeezed to rinse all the capillary blood.

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The dilution tube was capped and shaken 6-8 times until the diluted sample appeared red-orange in color. The diluted sample was applied onto the test cartridge using a dropper provided in the kit. Glycated hemoglobin was analyzed using the A1cNow+® (Metrika) which provides quantitative measurement of the percent glycated hemoglobin (%A1C) levels in capillary or venous whole blood samples. Test results are expressed as %A1C (A1C ÷ total Hb × 100). The degree of glycemic control for glycated hemoglobin assay was classified as ideal (≤ 7.0%), good (7.0-7.9%), fair (8.0-8.9%) and poor (>9.0%).

Blood glucose was analyzed using One Touch® Horizon™ test strips used with the One Touch® Horizon™ glucose meter for quantitative measurement of glucose in whole blood. Diabetes mellitus was categorized as controlled diabetes mellitus (<7.8mmol/l), borderline controlled diabetes mellitus (7.8-11.1mmol/l) and uncontrolled diabetes mellitus (>11.1mmol/l)

STATISTICAL ANALYSIS:

Data was managed statistically using Statistical package for social sciences (SPSS) version 14 and Microsoft office, Excel 2007.

RESULTS:

RANDOM BLOOD GLUCOSE LEVELS IN DIFFERENT AGE GROUPS:

The values of random blood glucose ranged from 3.0-36.1mmol/L for the 157 patients.

Patients with controlled diabetes mellitus (<7.8 mmol/l) were 31.3%, borderline controlled diabetes mellitus (7.8-11.1 mmol/l) was 24.2% and uncontrolled diabetes mellitus (>11.1mmol/l) were 43.9% in all age groups (Figure 1). Uncontrolled diabetes mellitus was highest 18.5% in patients between 60-79 years, followed by 40-59 year category (14.6%) and 20-39 year category (6.4%).

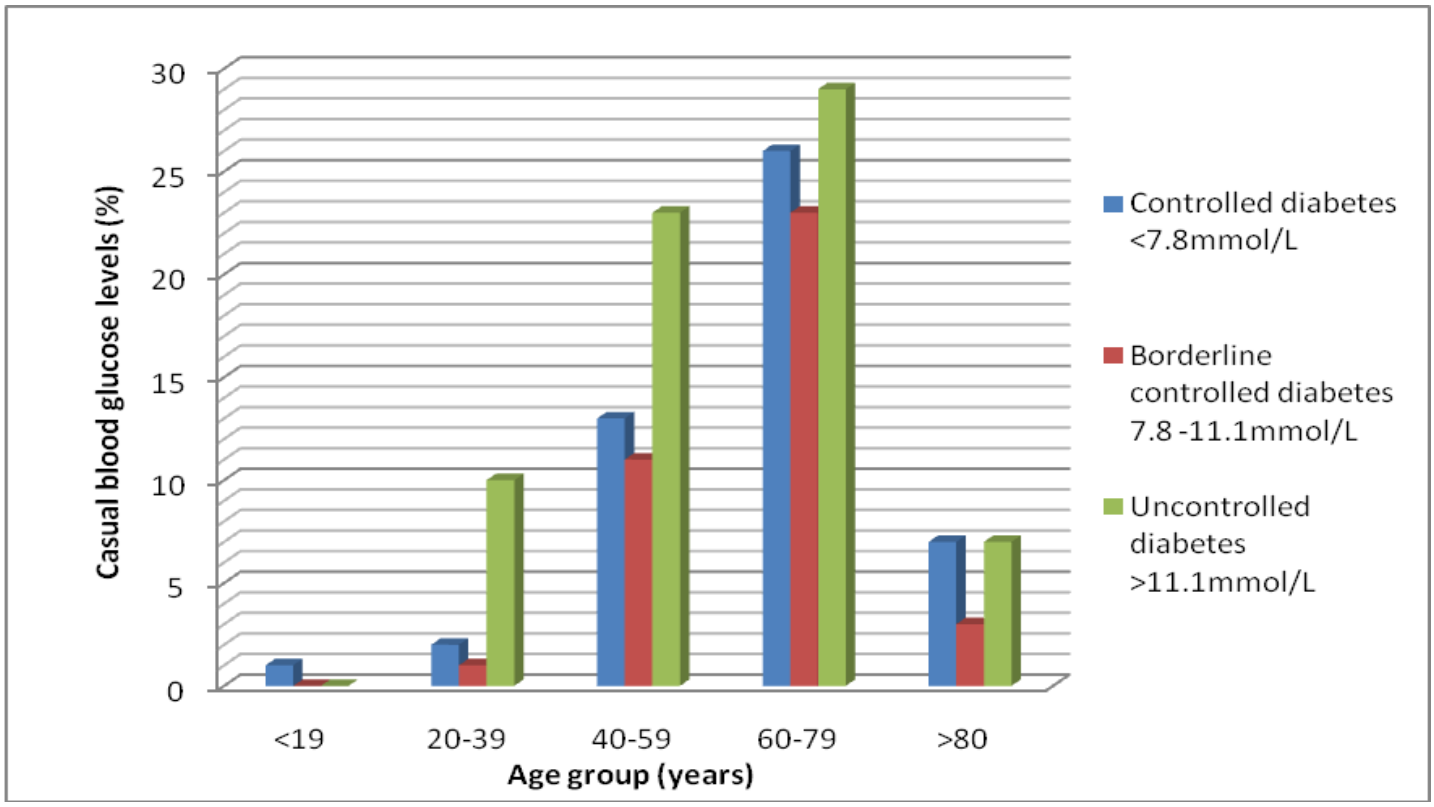

Figure 1: Random blood glucose levels in percentages in different age groups of patients sampled

GLYCEMIC CONTROL IN DIFFERENT AGE GROUPS:

Glycemic control varied within different age groups. The mean glycemic control in all patients was 9.3 (±2.74%). The distribution of patients with ideal glycemic control (HbA1c: <7%) was 26.2%, good glycemic control (7.1-7.9%) was 12.7% and fair glycemic control (8.0-8.9%) was 10.2%. Poor glycemic control (HbA1c: >9%) was highest in patients between 60-79 years of age (27.4%), followed by those in the 40-59 year category (14%), and 5.7% in the 20-39 age category (Figure 2).

Age was significantly related with glycated hemoglobin (p<0.05) and patients less than 60 years old were 67% less likely to have glycated hemoglobin <7% compared to patients older than 60 years (OR = 0.33; C.I = 58.68, 63.177).

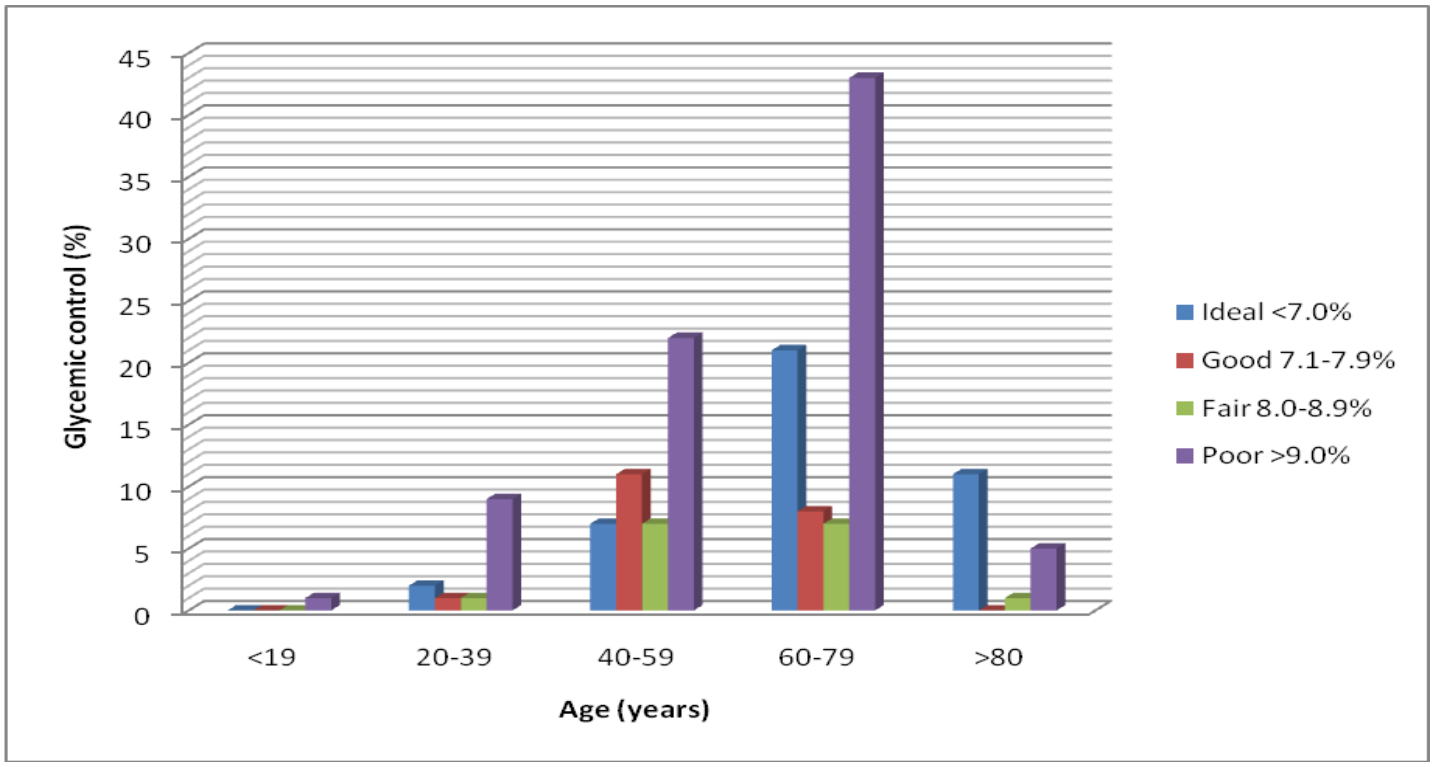

Figure 2: Glycemic control in percentage of different age groups of patients sampled

LINEAR ASSOCIATION BETWEEN GLYCATED HEMOGLOBIN AND RANDOM BLOOD GLUCOSE:

The correlation between glycated hemoglobin and random blood glucose of 157 cases was r = 0.66, p<0.05 (Figure 3). The linear equation is represented by y = 1.682 × -3.584 ($\hat{Y} = a + bX_i$), where $\hat{Y}$ is the predicted value (glycated hemoglobin), X_i is the predictor variable (random blood glucose), b is the slope and a, the intercept.

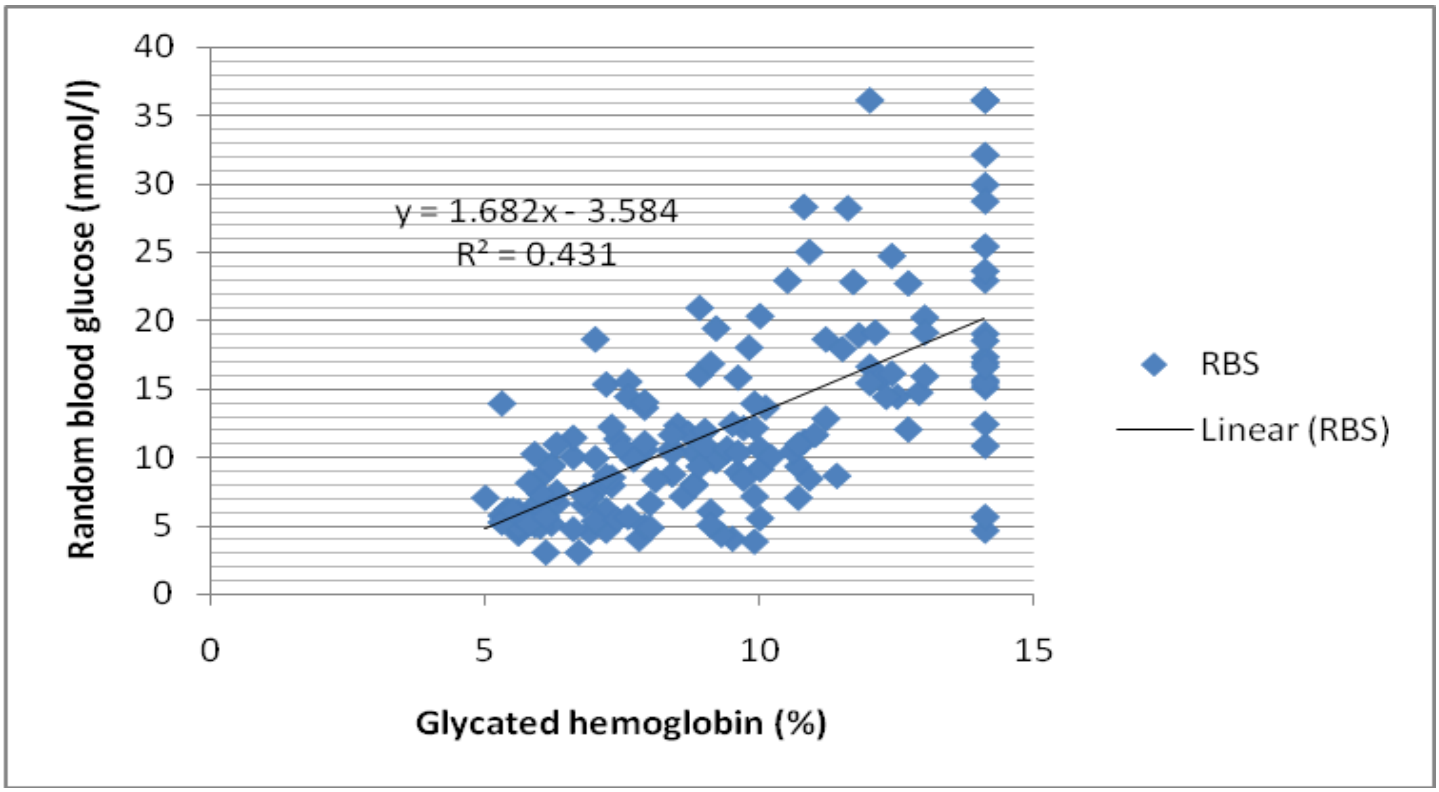

Figure 3: Linear associations between mean casual blood glucose and mean glycated hemoglobin

DISCUSSION:

Most of the patients had poor glycemic control (HbA1c: >9%) with the highest in age group 60-79 years (53.8%) and 40-59 years (27.5%). This observation slightly differs with that of Diabetes atlas (7) estimates for Kenya which indicate a diabetes prevalence of 46% for 40-59 years, and 19% for 60-79 years. This difference could be due to the fact that Nyeri provincial general hospital serves widely a rural population where a large percent of the patients are elderly which could account for the 53.8% of patients in the age group 60-79 years having poor glycemic control compared to the 40-59 years. Regional variations due to socio-cultural behavior in Kenya cannot be ruled out. The age of the patients significantly influenced the outcome of glycated hemoglobin and patients older than 60 years had a lower risk of having glycated hemoglobin greater than 7.0%. Glycated hemoglobin measurements are influenced by conditions that affect the life span of the hemoglobin molecule and aging could be a factor (8).

Glycated hemoglobin and casual blood glucose were correlated in the study (r = 0.66), and exhibited linear glycemic controls. Other studies have shown correlation between plasma glucose and glycated hemoglobin (r=0.66-0.76) at different times during the day, with bedtime and post lunch plasma glucose correlating most strongly with glycated hemoglobin (9). Measurements for this study were conducted before patients had a midday meal. Glycated hemoglobin is a less sensitive indicator of change in blood glucose level at higher mean glucose levels (10). The A1c-derived average glucose (ADAG) study groups have shown that glycated hemoglobin levels can be expressed as estimated average glucose (eAG) for most patients with type 1 and type 2 diabetes ($AG_{mmol/l}$ = 1.59×A1C–2.59; R^2=0.84, p<0.0001) (11). This is compared to the estimated glucose from this study of ($AG_{mmol/l}$ = 1.682×A1C-3.584; R^2=0.431, p<0.05). The International expert committee report on the role of the A1C assay recommends that the A1C assay as a better means for diagnosing diabetes than measures of glucose levels (12). The study demonstrated the reliability of point of care testing using glycated hemoglobin as a measure of glycemic control compared to blood glucose measurement. It is necessary, however, to perform the two tests in combination in studies of diabetes prevalence and evaluation of severity.

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