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# The effect of electronic reminders on risk management among diabetic patients in low resourced settings

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ABSTRACT

*Background:* Information technology has potential to improve health care delivery particularly among individuals with chronic diseases such as diabetes in low and middle-income countries (LMIC). Research on the usefulness of information technology to manage persons living with chronic diseases is scarce in LMIC. We sought to evaluate the effect of an electronic reminder system on cardiovascular risk factors (blood pressure, heart rate, and fasting plasma glucose) and adherence to clinical appointments among persons living with diabetes.

*Research Design and Methods:* A randomized controlled design was used to recruit 200 diabetic patients (intervention n = 100, control n = 100) from the National Diabetes Management Research Centre, Accra. All patients received usual diabetes care. The intervention group was given electronic reminders for their clinical appointments and their physicians were prompted with abnormal laboratory results for six months.

*Results:* Baseline characteristics were largely similar for both groups. At six months follow up, the mean reductions of all the cardiovascular risk factors in the intervention group were significantly greater than in the control group: −1.7 kg/m$^2$ versus −1.1 kg/m$^2$(p = 0.002) for BMI; −4.7 mmHg versus −2.8 mmHg (p = 0.002) for SBP; −5.3mmH versus −3.1 mmHg (p = 0.001) for DBP; −1.7 bpm versus −0.1 bpm (p = 0.001) for heart rate and −2.3 mmol/L versus −1.6 mmol/L (p = 0.001) for fasting plasma glucose, respectively. Adherence to appointment schedules was also significantly higher in the intervention group compared with the control group (97.8% versus 89.4%, p = 0.010).

*Conclusions:* Locally developed electronic initiatives such as this resulted in improved cardiovascular risk factors and effective compliance to clinical practices and improved quality of care for persons living with diabetes.



## 1. Introduction

Diabetes is a growing clinical and public health burden worldwide. The burden of diabetes is particularly high in low- and middle-income countries (LMIC), and imposes enormous problems on the health systems of these countries. Complications of diabetes include diabetic retinopathy, neuropathy and nephropathy which results in low quality of life of persons living with it and high health care cost. Good clinical management of diabetes is associated with reduced complication rates and improved quality of life (Chim, Fung, & Wong, 2006; Felt-Lisk, 2006). However, rates of diabetes control in general clinics in LMIC are less than optimal. Persons living with diabetes follow lifelong complex treatment regimen often associated with high comorbidities such as hypertension and dyslipidemia, and these often possess challenges to controlling the disease. At the National Diabetes Management Centre at the Korle-bu Teaching Hospital (NDRMC), it is not unusual for patients to miss their clinic appointments. This affects the control of the disease and usually results in complications and lower quality of life.

In recent times, the use of Information Technology in clinical practice has advanced quality of care, primarily through timely diagnosis and intervention, reduction of medical errors, and better communication within the health care team (Sequist et al., 2005; Thomas et al., 2007; Weber, Bloom, Pierdon, & Wood, 2008). It's function may include the creation of alerts to inappropriate prescriptions and to abnormal biochemical laboratory, radiology, or pathology results. Crosson et al. (2007) reported that persons living with diabetes require management of complex information, which electronic medical records (EMR) can be used to improve on. Other studies (Chen et al., 2008; Elston & Baker, 2001a) have reported

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improved cardiovascular risk factors in the use of electronic clinical systems to manage persons living with diabetes in high resource settings.

The need for comprehensive electronic data on persons living with diabetes in LMIC will help in decision making, patient management and monitoring, save time and enhance research. To achieve this, a database management system with specific reminders on the various levels of measured metabolic risk factors is required. Currently, the National Diabetes management research centre (NDMRC) in Ghana uses paper base records though efforts are being made to automate these processes. Appointment schedules are written at the back of identity cards of patients or in their folders who usually forget these dates or misplace the cards. The stress posed by diabetes causes patients to be psychologically burdened. Thus the tendency to forget is quite high, and such patients must be reminded to honour their clinical appointments. This study sought to evaluate the effect of an electronic clinical reminder system on metabolic risk factors and adherence to clinic appointments among persons living with diabetes at the NDMRC in Accra, Ghana.

## 2. Research Design and Methods

### 2.1. Setting and patients

The study was carried out at the NDMRC of the University of Ghana Medical School, Korle-Bu Teaching Hospital, Accra, Ghana. Two hundred patients attending NDMRC regularly for care were randomly recruited into the study after informed written consent. The study was approved by ethics and protocol review committee of the Ghana Health Service and that of the University of Ghana Medical School.

### 2.2. Intervention

The patients were randomized and matched into intervention and control groups using Microsoft Excel 2007. Intervention group were those that were managed by the newly developed clinical reminder system while the control group were those managed by the usual diabetes care (paper base method). The electronic reminder system consisted of MySql5.1.30 and Apache 2.2.11 web server which were available as open source. MYSQL (5.1.30) is a relational database management system used to store, organize and manage large amount of data. It makes it easier to access information using a server side scripting language called Personal Home Page (PHP). We used the structured query language (SQL) and PHP 5.2.8 to write scripts and queries which prompted clinicians of normal and abnormal laboratory results of metabolic risk factors through alerts and pop ups generated instantly after entry of the results into the database on their screens. The system marks normal results as green, borderline as yellow and abnormal (low or high) as red prompting clinicians to take the necessary action. The system used these colours to differentiate laboratory results (International cut-offs for indicators) to enhance physicians decision making process which helped primary care physicians to identify high risk patients and focus on them. Also, the system generated appointment reminders using the cell phone numbers of patients a week and a day before their next clinical appointment dates. The reminder messages were sent in English and one preferred local language (Twi, Ga and Ewe). Both groups (intervention and control) were followed over a period of six months. Compliance to appointment dates was measured with their corresponding metabolic risk factors at the end of each month. In addition, caregivers or physicians usage of the system was also recorded.

### 2.3. Outcomes and measurements

Compliance with appointment dates as well as metabolic risk factors (systolic blood pressure, diastolic blood pressure, pulse rate and fasting plasma glucose) were measured every month for 6 months follow-up. Fasting plasma blood samples were taken from subjects in the morning by a qualified phlebotomist from the research laboratory. Fasting Plasma glucose was determined with glucose oxidasekits (Randox Laboratories Ltd., Crumlin,UK) on an automatic chemistry analyzer (ErbaSmartlab, Mumbai, India) at the National Diabetes Research Laboratory, University of Ghana Medical School, Accra. Anthropometric measurements were performed on subjects in light clothing and without shoes by two research assistants. Weight was measured with a heavy duty Seca 770 floor digital scale (Hamburg, Germany) to the nearest 0.1 kg. Height was measured with a measuring tape to the nearest millimeter. Body mass index (BMI) was calculated as weight (kg) divided by height in metres squared ($m^2$). After at least 10 minutes rest, blood pressure was measured to the nearest 2 mmHg, in the right arm of seated subjects three times at an interval of not less than 2 minutes with a mercury sphygmomanometer and appropriate cuff sizes. The average of the three readings at each visit was used for analysis. Demographic information such as age, gender, use of National Health Insurance (NHIS) and primary language were recorded from participants. Data from the six month intervention period were pooled for the present results. Compliance with appointments was measured as 1 for honoured appointments and 0 for not honoured appointments.

### 2.4. Statistical analysis

The statistical package STATA 10.0, (Stata Corp, College Station, Texas) was used for analyses. Data were summarized as percentages, mean and standard deviations. After testing for normality (Shapiro-Wilk), Generalised linear models using multivariate analyses unadjusted and adjusted for age, sex, primary language and use of NHIS was used to evaluate the effect of the intervention on metabolic risk factors. McNemar test was used to establish any association between the group (Control or Intervention) in which a participant belonged and the number of appointments honoured. Significant level was set at $p < 0.05$.

## 3. Results

### 3.1. Baseline characteristics

The overall success rate of caregivers/physicians using the system for diabetes management among the intervention group was 85% throughout the study period. All the caregivers/physicians fully used the system for diabetes management through the study period except for 3 participants in month 3 and 4 participants in month 4 that were not put in the system. The study comprised 200 participants (100 controls and 100 intervention group). Table 1 shows the baseline characteristics of the study participants. Apart from sex ($p = 0.018$), baseline demographical characteristics were largely similar for both groups ($p > 0.05$).

### 3.2. Effect of the intervention on metabolic risk factors and adherence to appointments

Table 2 compares changes from baseline to end point on metabolic risk factors. All the metabolic risk factors (BMI, systolic blood pressure, diastolic blood pressure, pulse rate and fasting plasma glucose) were similar between the intervention group and the control group at baseline ($p > 0.05$).

At six months follow-up, the mean reductions of all the metabolic risk factors from baseline in the intervention group were significantly greater than the control group: $-1.7$ kg/m$^2$ versus $-1.1$ kg/m$^2$ with between groups mean difference of $-0.6$ kg/m$^2$ (95% C.I. $-0.671$ to $-0.528$) for BMI; $-4.3$ mmHg versus $-2.8$ mmHg ($-1.5$ mmHg 95% C.I. -1.784 to $-1.215$) for systolic blood pressure; $-5.3$ mmHg versus $-3.1$ mmHg ($-2.2$ mmHg, 95% C.I. -2.536 to $-1.836$) for