

Impact of Washing Hands on Accuracy Result of Capillary Blood Glucose Measurements among Diabetic Patients

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Abstract

Background: The technique of monitoring patient's blood glucose using a glucose meter is most useful as an adjunct therapy with pharmacological treatments against diabetes mellitus. The value and effectiveness of self-monitoring of blood glucose (SMBG) is affected by the patient's SMBG knowledge and skill. This paper aimed to quantify the impact of washing hands on accuracy result of capillary blood glucose measurements among diabetic patients. **Patients and method:** Quasi-experimental research design was conducted to meet the study's objective. In the internal medicine department at Assiut university hospital, Egypt. Sixty adult patients were eligible according to the inclusion criteria were enrolled. An interview questionnaire involved patients' demographic characteristics, clinical data, and knowledge regarding self-monitoring of blood glucose. **Results:** the mean blood glucose readings before washing hands were 74.37 ± 86.594 mg / dl, 225.66 ± 85.973 mg / dl respectively after washing hands, and after peeling an orange followed by no washing hands were 349.03 ± 90.084 mg / dl. **Conclusion:** The results of this study indicated that there was a statistically significant difference between washing hands and accuracy results of capillary blood glucose measurements. **Recommendations:** All patients should be advised to wash their hands with water and soap before performing the test.

Keywords: Washing Hands; Accuracy Result; Capillary Blood Glucose Measurements; and Diabetic Patients

Introduction:

Overall, the incidence of diabetes continues to rise, and now the International Diabetes Federation estimates that over half a billion individuals will be impacted by the disease by 2030. Better diabetes management that improves glucose control must include new technology implementations in day-to-day care, e.g., self-monitoring of blood glucose (SMBG), and ongoing glucose monitoring (CGM) (Satish et al., 2013).

The American Association of Diabetes Educators (AADE) declared that SMBG can be a main component of the treatment regimen, giving immediate information about current blood glucose levels. Unlike Hemoglobin A1c(HbA1c), SMBG offers a mean of distinguishing fasting, pre-prandial and post-prandial blood glucose concentrations for the individual with diabetes, enabling them to monitor the immediate effects of food, physical activity and medications on glycaemic control. SMBG information can enhance the quality of life in addition to enhancing clinical results. It must be included in a self-management plan (American Association of Diabetes Educators, 2014).

The self-monitoring of blood glucose (SMBG) through capillary blood glucose (CBG) measurements, frequently referred to as "finger-stick glucose," is an significant component of the management of diabetic patient. For patients with type 1 diabetes mellitus and many patients with type 2 diabetes mellitus, insulin treated or not, SMBG is presently suggested (Klonoff et al., 2011).

Self-monitoring of blood glucose using glucose meter offers patients with the ability to test their own blood glucose to adjust the insulin dose to control their glucose requirements. Many variables, including application errors, extreme environmental conditions, extreme hematocrit values, or medication interferences that may possibly falsify blood glucose readings can affect the reliability of results (Erbach et al., 2016) (Hirose et al., 2011) mentioned that hand washing is essential in order to remove substances from the skin that could falsely elevate glucose readings.

International guidelines recommend that blood glucose levels and insulin injections should be performed after hand washing with soap and water to achieve a reliable level of glucose (Hortensius et al., 2011) & (Kirk & Stegner, 2010). General hand hygiene, such as hand washing before eating and after using the toilet, effectively prevents infectious diseases, efficiently avoids infectious diseases that are prevalent complications of diabetes (Liu et al., 2016). Thus, hand hygiene is essential for proper diabetes management and the prevention of

complications.

Nursing considerations; patient teaching on proper glucose testing techniques with a return patient demonstration for performance can help ensure accurate results. Elements of this learning include hand washing before and after testing, troubleshooting the meter, and proper storage of testing strips. It will assist ensure patients prevent complications and enjoy the highest possible quality of life by providing this data(**Finfer et al., 2013**).

Significance:

The accuracy of finger-stick glucose measurements is tremendously crucial for care and follow-up of diabetic patients, often has significant mistakes that are often poorly understood by patients and providers. By understanding the source of the error and methods of prevention and correction, health care providers can help their patients use the systems more effectively. So, this research attempted to quantify the impact of washing hands on accuracy result of capillary blood glucose measurements among diabetic patients.

Purpose:

The purpose of this publication is to quantify the impact of washing hands on accuracy result of capillary blood glucose measurements among diabetic patients.

Research question:

1. Is there any significant difference between washing hands and accuracy result of capillary blood glucose measurements?

Study design:

Quasi-experimental research (pre\posttest)design was used.

Study setting:

The research was carried out in the department of internal medicine at Assiut University Hospital .

Subjects:

Sixty eligible adult patients with the following inclusion criteria were defined:

- Their age (18-65) yrs.
- Both sex (male &female),
- Diagnosis of type 1 or type 2 diabetes,
- Treated with insulin, or oral anti-diabetic medication
- Performs self-monitoring of blood glucose levels
- Non fasting

Sample size:

The power analysis to estimate the sample size was performed based on the result of a pilot study. Assuming power of 0.80% and a 0.05 (one-sided equivalence test), a total sample size of 50 participants is required. The eligible patients were invited to participate after the assessment whether they meet all of the inclusion criteria n=60. The nonrandomized study sample involved 60 patients (20 male, 40 female).

Data collection tools:

An Interview questionnaire and capillary blood glucose measurements sheet were used and included the following items:

1. **Demographic characteristics** as age, gender, marital status, residential district, and educational level.
2. **Clinical data such as** type of diabetes, duration of therapy for diabetic and medication therapy.
3. **Patients' knowledge regarding** self-monitoring of blood glucose levels. It included (7) questions regarding patients' self-monitoring of blood glucose knowledge.

Scoring system: regarding patients' self-monitoring of blood glucose knowledge. It involved (7) questions. Scores assigned to each item are between 1 and 2 points as follows;(Yes, and No).Range of total scores lie

between 7-14, considering good as 50% of the range of total score. Patients were classified as having good knowledge if their total score ≥ 7 , and were classified as having poor knowledge if their total score < 7 .

Methods:

Administrative Design:

The researches acquired official approval from the director of the Assiut University Hospital, the head of the department of internal medicine and the endocrinology clinic.

Ethical Considerations:

The study followed the common ethical guidelines of clinical research according to the principles of Helsinki Declaration for medical research, (1996). Research proposal was accepted by Ethical Committee within the College of Nursing. There is no hazard for study subject during application of the research. The study was complying with ethical principles in clinical research. Formal consent acquired from patients or guidance that who are willing to participate in the study, after explaining the aim of the study. Study subject has the right to refuse to participate and or withdraw from the study with no rational any time and privacy have been taken into consideration for the collection of data.

Pilot Study:

It was conducted on 10% of subjects (6 patients) in the selected settings for testing clarity, arrangement, applicability of tool, and time needed. the required modifications were made. Those patients who were involved in the pilot study were included in the study.

Content Validity& Reliability:

It was done by five expertise from the internal medicine& medical-surgical nursing field. the reliability was tested for tool 1 by using Cronbach's alpha (tau-equivalent reliability) coefficient ($r = 0.817, 0.794$ respectively) which its internal consistency "acceptable", then it was modified according to the result of pilot study.

Procedure:

- Once permission was granted to proceed with the proposed study, the researchers initiated data collection. The researchers visited the department daily.
- The aim of the study was explained to the study participants and verbal informed consent was obtained from patients. An Interview questionnaire and capillary blood glucose measurements sheet were utilized to fill out (tool 1). As regards patient's self-monitoring of blood glucose knowledge, it was found that all patients had poor knowledge. Therefore, A PowerPoint presentation was developed. Face to face education sessions (comprised verbal instructions as well as practical demonstration) on the correct technique to perform self-monitoring of blood glucose.
- Capillary blood glucose measurements were conducted on each study patient; 1) without washing hands, 2) after peeling an orange without eating it .3) after washing the hand with soap and water and thoroughly dry.
- The patients performed the 1st measurement as they walked in, before washing their hands or handling any of the fruits by pricking a fingertip of the middle with a lancet. Afterward, the 2nd measurement performed after peeling an orange followed by no hand washing. Then the 3rd measurement performed after washing their hands with soap and water and dried them, the 1st drop of blood with gauze was wiped away, and the reading was obtained from the 2nd drop.
- The capillary blood glucose measurements were shown on the meter screen to the patient and immediately recorded onto a sheet.
- The patients performed the first measurement as they walked in, before washing their hands or handling any of the fruits by pricking a fingertip of the middle with a lancet. Afterward, the 1st drop of blood with gauze was wiped away, and the reading was obtained from the 2nd drop. Afterward, the second measurement performed after washing their hands with soap and water and dried them. Then, the third measurement performed after peeling an orange followed by no hand washing.
- The time interval between measurements was maximal 30 second (Hirose et al.,2011) by using the same portable glucose meter(Accu-Chek® Performa Roche, Mannheim, Germany).
- The capillary blood glucose measurements were shown on the meter screen and immediately recorded onto a sheet.
- Collection of data for this research began in January and finished in July (2017).

Statistical Design:

The data obtained had reviewed, prepared for computer entry, coded, analyzed and tabulated. Descriptive statistics (frequencies and percentages, mean and standard deviation, i.e.) were done using computer program (SPSS) version (20). ANOVA testand, Chi-square tests used in the relationship between Pre &posttest. It's considered significant when P. value less than (0.05).

Table (1): Percentage and Frequency distribution of the studied sample in relation to their demographic characteristics, and medical data

Variables	No. (n = 60)	%
Age groups:		
18 – 25	7	11.7
26 – 40	25	41.6
41- 65	28	46.7
Mean ± SD	42.2500± 11.13648	
Sex:		
Male	20	33.3
Female	40	66.7
Marital status:		
Single	3	5.0
Married	39	65.0
Divorced	11	18.3
Widow	7	11.7
Residential district:		
Urban	28	46.7
Rural	32	53.3
Level of education:		
Educated	25	41.66
Not educated	33	55
Type of diabetes:		
Diabetes type 1	7	11.7
Diabetes type 2	53	88.33
Duration of therapy for diabetic:		
2 –5	22	36.7
6 – 10	29	48.3
11- 15	9	15.0
Mean ± SD	24.73 ± 4.6	
Medication therapy:		
Oral hypoglycemic drugs	51	85.0
Insulin	9	15.0

Table 1 describes the demographic characteristics and clinical data, among all study patients majority 46,7% within the age group of 41-65years, with mean age was (42.2500± 11.13648). In relation to the sex 33.3% were male and 66.7% were female, 65.0% samples were married. Most of them 53.3% lived in the rural area and only (46.7%) are from the urban area. Moreover, it was found that 55% patients were not educated. Information related to clinical data, majority of the patients had type 2 diabetes mellitus (88.33%) and 11.7 % had type I diabetes mellitus. Patients were treated with insulin (15.0%), and oral hypoglycemic drugs (85.0%). Also, It was found that 15% of patients are taking treatment from 11-15 year and 48.3% subjects are taking treatment from 6-10years

Table (2): Percentage and Frequency distribution of the study sample as regards their self-monitoring of blood glucose knowledge

Self-monitoring of blood glucose knowledge	study sample (n=60)	
	Yes (%)	No (%)
1. Do you wash hands by using warm, soapy water and dry before check blood sugar?	0(0.0%)	60(100%)
2. Do you turn on the meter and prepare a test strip correctly?	12(20.0%)	48(80.0%)
3. Do you prepare the lancing device according to the user guide?	12(20.0%)	48(80.0%)
4. Do you touch and hold the test strip opening to drop until it has absorbed enough blood to begin the test?	12(20.0%)	48(80.0%)
5. Do you view the test result and take the proper steps if your blood sugar high or low based on your health care professional recommendations?	12(20.0%)	48(80.0%)
6. Do you discard the used lancet properly?	7(11.7%)	53(88.3%)
7. Do you record the results in a diary notes, or hold them in the meter's memory?	6(10.0%)	54(90.0%)

Table 2 show the patients' self-monitoring of blood glucose knowledge .it had been found that 60(100%),6(10.0%)respectively of patients were having poor level of knowledge, and 7(11.7%), 12(20.0%), 12(20%), 12(20%), 12(20%)respectively of patients were having good level of knowledge regarding self-monitoring of blood glucose.

Table 3: Relationship between patients' demographic characteristics and their self-monitoring of blood glucose knowledge

Items	Group(n=60)		P value
	Poor Knowledge	Good Knowledge	
Gender:			
Male	18(30.0%)	2(3.3%)	0.076 ns
Female	28(46.7%)	12(20.0%)	
Level of education:			0.001**
Educated	16(26.7%)	12(20.0%)	
Non educated	30(50.0%)	2(3.3%)	
Residential area:			
Urban	12(20.0%)	16(26.7%)	0.001**
Rural	30(50.0%)	2(3.3%)	
Age:			
18 – 25	5(8.3%)	2(3.3%)	0.089 ns
26 – 40	16(26.7%)	9(15.0%)	
41- 65	25(41.7%)	3(5.0%)	
Marital status:			
Single	3(5.0%)	0(0.0%)	0.773 ns
Married	30(50.0%)	3(5.0%)	
Divorced	8(13.4%)	3(5.0%)	
Widow	5(8.3%)	2(3.3%)	

Chi-square test

*Significant

ns= non-significant Data presented

Data presented in table 3 reveals that there was significant relation between patients 'demographic characteristics and their self-monitoring of blood glucose knowledge; Result found that there was significant relation in level of knowledge and level of to education, and residential area at the level of p= 0.001.

Table (4):Mean ± SD of capillary blood glucose measurements under varying experimental conditions in 60 diabetic patients

Group	Blood glucose readings (mean ± SD)
- Before washing hands	274.37 ±86.594 mg/dl
- After peeling an orange	349.03 ±90.084 mg/dl
- After washing hands	225.66±85.973 mg/dl

Independent T test

Table 4 A statistically significant rise was recognized in the capillary blood glucose measurements before washing hands, and after peeling an orange compared to the mean of the capillary blood glucose measurements after washing hands.

Discussion:

Our aim was to quantify the impact of washing hands on accuracy result of capillary blood glucose measurements among diabetic patients.

The main findings of this study revealed a statistically significant rise was recognized in the mean blood glucose readings before washing hands, and after peeling an orange with no hand washing or cleaning with alcohol swab compared to the mean blood glucose readings after washing hands with soap and water and thoroughly dry. This study shows the significance of hand washing with tap water and soap and thoroughly dry to ensure accurate blood glucose results using finger stick glucose measurement.

In consistent with(Müller et al.,2006), indicated that there was a high rate of non-compliance among diabetic patients regarding washing hands before performing self-monitoring of blood glucose. This study shows that the majority of individuals with type 2 diabetes (83%) make at least one mistake in carrying out the measurement of blood glucose levels with their own device. The kinds of mistakes observed in the studies, however, were very similar. In other studies, too, the main mistakes were in cleaning of the hands. Moreover, previous descriptive studies of outpatients with diabetes reported that self-care activities including personal hygiene were insufficient. (Mohammed& Hamza,2016)noted that hygiene behavior was less than ideal, and proper health education provided by health professionals was needed(Altun et al., 2014).

In congruence with a study done by (Arakawa& Ebato,2012) who found that the blood glucose levels measured after peeling any of the fruits, followed by no washing were abnormally and significantly high. This may be attributed to fruits containing fructose and glucose, and after an orange peeling, traces of these sugars can be left on the fingertip, leading to erroneous reading .

Similarly, this finding is compatible with the previous finding by (Hirose et al.,2011) who made his study in Japan on healthy persons without diabetes using three types of fruits. This finding may be due to traces of fruits which contain glucose and fructose among other constituents left on the fingers. Likewise, finding was made by (Rebel et al.,2012) who observed that invisible bits of fruits left on patients' fingers and hands when they do finger prick test can make their blood glucose level falsely high. These results therefore show the need to carefully wash the hand thoroughly with tap water and dry it after peeling or handling fruits. This should be suggested for patients and health care providers to ensure accurate monitoring of blood glucose levels when using blood samples obtained by pricking the fingertip.

Furthermore,(Hortensius et al.,2010) indicated that soiled fingers can have a great effect on blood glucose readings.(Josivan et al.,2016) also discovered that the capillary blood glucose could increase significantly if the finger was just submitted to contact with fruits or chocolate, even if the finger was washed widely until no visual detritus occurred.

This finding is consistent with prior research by (Stacciarini et al.,2009& Hortensius et al.2011). It may be attributed to that not practicing hand washing leads to differences in capillary glucose concentrations. Hand washing prior to testing blood glucose levels and administering insulin is recommended to obtain accurate results, avoid contamination of materials, and prevent infection at the injection site.

The current study revealed that the vast majority of study patients had poor knowledge regarding self-monitoring of blood glucose. That is not surprising; as a study conducted in Pakistan by (Muhammad Uthman et al.,2015) who found in their study that the majority of study patients' level of knowledge was poor about self-monitoring of blood glucose. From the researcher's opinion , it may be attributed to lack of organized diabetic education

facilities to the patient, and less denoted time with the patient by physician. Another explanation might be poor patient attendance at health clinics with this the patients missed their laboratory test diagnosis.

As regard to the association between patients' demographic characteristics and their self-monitoring of blood glucose knowledge in the current study, it was found that there was a significant association in level of knowledge to education, and residential area. This was consistent with (Huri et al., 2008) as they found that level of education was the major determinant of patients' attitude to diabetes care (including SMBG knowledge) and outcome. Similarly the findings from the knowledge, attitude and practice study of diabetes in Bangladesh and United Arab Emirates which stated that knowledge was significantly associated with level of education (Al-Maskari et al., 2013 & Islam et al., 2014). This findings remain contradict with the previous study which revealed that increased level of education was significantly associated with insufficient level of attitude (Gautam et al., 2015). If we looked for the association between patients' demographic characteristics and their self-monitoring of blood glucose knowledge, it may be due to the majority of study patients live in rural area, and level of education where education was not very common like as now.

Conclusion:

The results of this study indicated that there was a statistically significant difference between washing hands and accuracy results of capillary blood glucose measurements and does not affect results. capillary blood glucose measurements are significantly increased when hands are not washed and orange peeling occurs. In addition, It was found that there is poor patient's knowledge regarding self-monitoring of blood glucose, and there was a significant relation in level of knowledge to education, and residential area.

Recommendations:

- All patients should be advised to wash their hands with water and soap before performing the test.
- There is need for educational programs to improve the patient level of knowledge and practice towards self-monitoring of blood glucose.
- Health care members of the diabetes and patients should be well informed about all factors potentially falsifying blood glucose measurement results.

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Conflict of interest:

None of the authors has any conflicts of interest to declare.

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