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The Effect of 70% Isopropyl Alcohol Prep Pads and Blood Drop Number
on Capillary Blood Glucose Values

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Abstract

Capillary blood glucose monitoring is a common nursing procedure. However, no consensus exists regarding which drop of blood to test (drop 1 vs. drop 2) and whether using alcohol pads to prepare the fingertip affects blood glucose values. The purpose of this study was to evaluate the impact of these factors and contribute to the development of evidence-based nursing protocols for capillary blood glucose monitoring. A quantitative, quasi-experimental study was conducted in a laboratory at the University of New Hampshire. 96 volunteers were randomly assigned to one of three groups. Each group underwent a pair of capillary blood glucose tests to determine the impact of alcohol prep pads and blood drop number. Data was analyzed using paired t-tests and ANOVA. Results showed that neither alcohol prep pads alone nor blood drop number alone affect blood glucose results. However, when an alcohol prep pad was used, values from blood drop 1 were a mean of 2.1 mg/dL (Std. Dev. = 5.03) less than blood drop 2 ($p = .042$). This difference is clinically insignificant and would not likely affect patient care. These findings indicate that it is not necessary to wipe away the first drop of blood, even when 70% isopropyl alcohol is used for skin preparation. Further research needs to be done to confirm these results.

The Effect of 70% Isopropyl Alcohol Prep Pads and Blood Drop Number
On Capillary Blood Glucose Values

According to the Centers for Disease Control, 29.1 million Americans have diabetes (2014). To monitor their condition and dose insulins appropriately, many individuals with diabetes perform capillary blood glucose monitoring. In the event that an individual with diabetes is hospitalized, nursing staff performs blood glucose monitoring. Capillary blood glucose monitoring may also be performed when patients are receiving certain medications or experiencing an alteration in mental status. Because high-alert medications and dietary recommendations are adjusted based on capillary blood glucose values, it is critical that the values are accurate. Inaccurate capillary blood glucose values can result in dangerous episodes of hypoglycemia or hyperglycemia.

Facilities have various protocols for obtaining capillary blood glucose values. The general procedure is to clean the fingertip with a 70% isopropyl alcohol prep pad, puncture the fingertip with a lancet, and gently squeeze a drop of blood onto the test strip. Some facilities test the first drop of blood. Others require nursing personnel to wipe away the first drop of blood with gauze, and test the second drop. The rationale for wiping away the first drop of blood is that the alcohol in the prep pad, and consequently on the fingertip, may alter values. However, this rationale is controversial and techniques vary among nurses and facilities. Additionally, not all patients are able to produce a second drop of blood. Because the results of capillary blood glucose monitoring lead to critical patient care decisions, it is essential that evidence-based procedures are developed and disseminated.

Literature Review

Previous work provides a base for this research and highlights the need for consensus. Researchers Ferretti and Martin (2008) performed two capillary blood glucose tests on 192 volunteers. All participants washed their hands. One finger received no further preparation before lancing; the other was prepped with “2 brisk wipes with an alcohol prep pad”. Samples were taken within 2 minutes of each other. Their analysis revealed a statistically significant difference between the two sample sites. On average, the fingers prepped with alcohol yielded results 10.44 mg/dL lower ($P < 0.005$) than the fingers with no prep (Ferretti & Martin, 2008). This is a clinically significant difference that warrants attention. Unfortunately, this study did not address the effectiveness of ‘wiping away the first drop’ currently used by nursing personnel.

A 2014 study by Li, Wang, and Shan measured the first and second drop of capillary blood and compared the readings to a patient’s venous blood sugar. 526 inpatients with type 1 or 2 diabetes were randomly enrolled in the study. “The blood sampling site was the finger-tip, which was wiped with 75% alcohol, dried, and the skin was pierced. The spontaneous overflowing drop of blood was the first drop” (Li et al., 2014, 366). Next, the site was wiped with a cotton swab and the second drop of blood was measured. Simultaneously, venous blood was being drawn and sent to the lab for analysis. There was no statistically significant difference in blood glucose readings between the first and second drops of blood when compared to the venous blood control (Li et al., 2014). However, researchers used 75% alcohol, which is not common in the United States. The 75% alcohol also “dried” before the lancing, which is not an accurate reflection of nursing practice. Furthermore, venous blood, used as the control, has not been proven to accurately reflect capillary blood glucose.

Stein's 2007 experiments sought to identify if any statistically significant difference existed in capillary blood glucose readings with and without the use of 70% isopropyl alcohol and between the first or second drop of blood. The four capillary blood samples were taken from 37 non-diabetic volunteers. Stein found no significant difference between the first and second drop when alcohol was not used, or when alcohol was used and the second drop was sampled. However, when the alcohol prep pad and the first drop of blood were used, there was an average increase in blood glucose values by 0.49mmol/L ($P=0.006$). Stein concluded that, while the increase was statistically significant, it is not a large enough increase to effect clinical decision making (2007).

Fruhstorfer and Quarder reported on the effects of milking the finger and using the first drop of blood on capillary blood glucose accuracy (2009). Their experiment involved 63 non-diabetics, a relatively small sample. Researchers compared the first and second drops of blood to each other and did not find a significant variation between the values. Therefore, the researchers concluded that it is acceptable to use the first drop of blood for glucose sampling (Fruhstorfer and Quarder, 2009). However, the study and the methods were not thoroughly reported. It is unknown if the fingertip was prepared with 70% isopropyl alcohol.

Overall, there was a poor quality and quantity of evidence. Furthermore, the studies that were identified had different conclusions. Ferretti and Martin (2008) found that isopropyl alcohol lowered blood glucose values significantly. Stein (2007) found a clinically insignificant elevation in blood glucose values when isopropyl alcohol was used in combination with the first drop of blood. However, neither Li & Shan (2014) nor Fruhstorfer & Quarder (2009) found a significant difference between the first and second drops of blood. None of the studies fully reflect the technique employed by nurses on inpatient units in the United States. In conclusion, a review of

the literature fails to produce a consensus on the effect of 70% isopropyl alcohol on capillary blood glucose results. Further research in this domain will lead to the creation of evidence-based, accurate protocols for capillary blood glucose monitoring.

Research Questions

Group 1 Research Question: Do 70% isopropyl alcohol prep pads affect capillary blood glucose values?

Group 2 Research Question: Is there a difference between blood drop 1 and blood drop 2 when no isopropyl alcohol is used?

Group 3 Research Question Is there a difference between blood drop 1 and blood drop 2 when isopropyl alcohol is used.

Methods

Study Design

The study was a quantitative, quasi-experimental design. Subjects were randomly assigned to either Group 1, Group 2, or Group 3. Each group underwent a different pair of capillary blood glucose tests

Sample

Research subjects were volunteers aged 18+. There was no inclusion or exclusion criteria.

Instruments

Capillary blood glucose tests were taken using the Bayer Contour Next Diabetes EZ meter, Contour Next test strips, single-use lancets, and 70% isopropyl prep pads (when indicated). The Contour Next EZ meter is highly accurate; 99.1% of blood sugars obtained were

within $\pm 10\%$ of the laboratory reference value. This exceeds the FDA's requirement that 95% of values are within $\pm 20\%$ (Bayer, 2014). Quality control tests were performed at the beginning of each day with the Contour Next control solution. Per manufacturer instructions, the meter was disinfected with a 0.55% bleach containing wipe between each subject (Bayer, 2014).

Procedure

All tests were performed in the nursing simulation laboratory at Hewitt Hall in Durham, New Hampshire. Two capillary blood glucose tests were performed on each study subject. Group 1 underwent tests A and B. Group 2 underwent tests A and C. Group 3 underwent tests B and D. The subjects washed and thoroughly dried their hands with soap before the tests. Tests were performed on different fingers of the same hand, using the same blood glucose meter, within a 2 minute time period. The capillary blood glucose values were shown on the meter screen and immediately recorded onto a spreadsheet.

Test A (no alcohol, 1st drop). The value was obtained from the 1st drop of blood.

Test B (alcohol, 1st drop). The fingertip was cleaned with a 70% isopropyl alcohol prep pad for 5 seconds. The value was obtained from the 1st drop of blood within 10 seconds of alcohol application.

Test C (no alcohol, 2nd drop). The 1st drop of blood was wiped away with gauze. The value was obtained from the 2nd drop of blood.

Test D (alcohol, 2nd drop). The fingertip was cleaned with a 70% isopropyl alcohol prep pad for 5 seconds. The 1st drop of blood was wiped away with gauze. The value was obtained from the 2nd drop of blood within 10 seconds of alcohol application.

Human Subjects Considerations

The use of human subjects was approved by the University of New Hampshire Institutional Review Board; the use of biological materials was approved by the University of New Hampshire Biosafety Committee. A recruitment flyer was emailed to members of the Department of Nursing and posted in Hewitt Hall. The subjects were provided with verbal and written information regarding the study's objectives, methods, risks, and benefits. Subjects signed the informed consent document. Subjects' ages and genders were the only demographic points recorded. A candy bar worth approximately \$1 was provided as incentive/compensation for research subjects.

Data Analysis

All data was entered into Microsoft Excel and analyzed using Jump 13 and SPSS 16. Descriptive statistics and distributions were calculated. Based on distribution statistics, outliers were eliminated. Subjects with abnormal blood sugars (>130) were also eliminated due to decreased meter reliability in hyperglycemic samples.

Paired sample t-tests were performed to detect significant differences within each group. A one-way ANOVA was also performed to detect significant differences between the groups. A statistically significant difference was defined as $p \leq 0.05$.

Results

Sample

A total of 96 individuals participated in the study. The mean age of subjects was 26 years (Std. Deviation = 13.37); 82% of subjects were female. An analysis of age and gender distribution within each group confirmed that group assignments were random. In 2 subjects, a

second drop of blood could not be obtained; these subjects were eliminated from further analysis. 5 participants had abnormally high blood sugars (>130) and were not included in the data analysis because of decreased meter reliability in hyperglycemic values. Based on the distributions of blood sugar differences, 2 outliers from Group 3 were eliminated. In these 2 outliers, the primary investigator determined that alcohol diluted the blood during Test B because a formed blood drop could not be obtained. The data producing sample included 31 subjects from Group 1, 29 subjects from Group 2, and 27 subjects from Group 3.

Capillary Blood Glucose Values

Table 1: Descriptive Statistics

	Test	N	Mean	Std. Deviation
Group 1	Test A (no alcohol, 1 st drop)	31	95.68 mg/dL	13.315
	Test B (alcohol, 1 st drop)	31	94.81 mg/dL	12.679
Group 2	Test A (no alcohol, 1 st drop)	29	96.45 mg/dL	11.670
	Test C (no alcohol, 2 nd drop)	29	97.62 mg/dL	12.240
Group 3	Test B (alcohol, 1 st drop)	27	94.33 mg/dL	11.910
	Test D (alcohol, 2 nd drop)	27	96.41 mg/dL	13.491

Table 2: Paired Samples Test

		Mean	Std. Dev.	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Group 1	TestA – TestB	.871	7.671	1.378	-1.943	3.685	.632	30	.532
Group 2	TestA – TestC	-1.172	4.158	.772	-2.754	.409	-1.518	28	.140
Group 3	TestB – TestD	-2.074	5.030	.968	-4.064	-.084	-2.143	26	.042

In Group 1, there was no significant difference between Test A values and Test B values.

In Group 2, there was no significant difference between Test A values and Test C values. In

Group 3, a statistically significant difference was present between Test B values and Test D values.

ANOVA. A one-way ANOVA was performed to detect significant differences between Groups 1-2, 1-3, and 2-3 regarding blood glucose values. No significant difference was detected (ANOVA: $F = 1.934$, $df = 2$, $p = .151$).

Discussion

Sample

During data cleaning, values from 2 subjects were eliminated. These subjects were eliminated after the primary investigator determined that blood dilution with 70% isopropyl alcohol had occurred. The dilution likely occurred because a rounded drop of blood was not formed. In these 2 subjects, blood spread out on the finger-tip and was subsequently “scraped” onto the test strips. Both of these subjects were in Group 3, and underwent Test B and Test D. Test B values (alcohol, 1st drop) were 20 and 22 points lower than Test D values (alcohol, 2nd drop). Therefore, it can be hypothesized that significant blood drop dilution may occur when 70% isopropyl alcohol prep pads are used, the first drop is sampled, and a rounded blood drop fails to form. However, this rare combination of events may not be enough to justify a broadly implemented nursing intervention (ex: testing the second drop on all patients). More research into this specific phenomena is indicated.

Capillary Blood Glucose Values

In Group 1, the blood glucose values from the fingertip prepared without isopropyl alcohol (Test A) were not significantly different from the values from the fingertip prepared with 70% isopropyl alcohol. This indicates that the use of 70% isopropyl alcohol does not impact

blood glucose results. This result contradicts Ferretti and Martin (2008), who found that alcohol prep pads lowered blood sugar values by a mean of 10 mg/dL.

In Group 2, the blood glucose values from the first drop of blood were not significantly different than the values from the second drop of blood. Subjects in Group 2 did not have their fingertips prepared with 70% isopropyl alcohol. This result indicates that wiping away the first drop of blood, and sampling the second drop, has no effect on blood glucose values when an alcohol prep pad is not used. Studies from Stein (2007) and Fruhstorfer & Quarder (2009) concur with this conclusion.

In Group 3, 70% isopropyl alcohol prep pads were used on both fingertips. The blood glucose values from the first drop of blood were a mean 2.074 mg/dL (STD. = 5.03) less than blood glucose values from the second drop of blood. While the mean 2.074 mg/dL difference was statistically significant, this difference would not affect patient care decisions and is not clinically significant. Furthermore, a 2.143 mg/dL discrepancy is well within the acceptable $\pm 20\%$ error allowance of blood glucose meters. This result indicates that 70% isopropyl alcohol lowers capillary blood glucose samples by a clinically insignificant amount when the first drop of blood is tested compared to when the second drop of blood is tested. Li et al. (2014) found no difference when the first drop was compared to the second drop. However, Stein (2007) found an increase of 9 mg/dL when alcohol was used and the first drop was sampled.

Limitations

There were several limitations to this study. For example, no formal procedure was in place to identify or record blood samples that were not “round, formed drops”. A formal procedure to identify these abnormal blood samples would be imperative for follow up studies.

All tests were performed with a meter rated for in-home use, not hospital use. The impact of this factor is unknown. Furthermore, the sample population was young, predominantly female, and presumably healthy. Therefore, the sample does not accurately reflect the population that undergoes capillary blood glucose monitoring in the hospital. All blood glucose tests were performed by a single investigator who used a formalized, consistent technique. If protocols are to be developed based on these results, they would need to withstand inter-rater reliability as nurses adapt the protocol to their personal practice.

Implications

Nurses do not need to wipe away the first drop of blood, even when 70% isopropyl alcohol prep pads are used to clean the fingertip. Eliminating this unnecessary step in the procedure will not affect capillary blood glucose values. Furthermore, testing the first drop will ease the testing process for patients who cannot easily produce a second drop of blood. Future studies should evaluate the impact of poorly formed blood drops on capillary blood glucose values.

Conclusions

This results of this study indicate that 70% isopropyl alcohol prep pads do not significantly affect capillary blood glucose values. There was also no difference between blood drop 1 and blood drop 2 when no alcohol was used. When blood drop 1 was compared to blood drop 2 after the use of 70% isopropyl alcohol prep pads, blood drop 1 was a mean of 2.1 mg/dL less than blood drop 2. However, this difference is both clinically insignificant and within the acceptable range of error of blood glucose meters. Based on these results, it is not necessary for nursing personnel to wipe away the first drop of blood and sample the second drop, even when alcohol

prep pads are used. However, significant alcohol dilution did occur in 2 subjects when a round blood drop could not be formed. The impact of poorly formed drops on blood glucose values should be investigated further. Evidence-based protocols regarding the use of alcohol and the first drop of blood should be developed and disseminated in order to maximize accuracy and minimize waste during capillary blood glucose monitoring.

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