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A Study to Compare Arterial, Capillary and Venous Blood Glucose levels in Patients with Hypotension on Vasopressor versus Normotensive Patients

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Abstract
Background: *Monitoring blood glucose and strict glycemic control is important particularly in ICU settings to reduce mortality/morbidity. Various methods can be used to measure the blood glucose, but its reliability in critically ill patient with hypotension and that too on vasopressor support is doubtful. Thus this study was planned to compare accuracy of arterial, capillary and venous glucose measurement in patient with shock and on vasopressor.*
Methods: *It is a prospective study conducted on 50 patients admitted in ICU of KIMS hospital, Bangalore, India. Out of 50 included patients, 25 patients who were taken as a study group had hypotension and were on vasopressor support, while rest 25 who were taken as control were normotensive patients. Three samples (one arterial, one capillary and one venous) were tested simultaneously from each patient from both the group for blood glucose levels.*
Results: *Out of 50 patients, 34 patients were male and 16 were female, with the mean age of 48 +/- 10 years. In study group, the mean arterial glucose was 159.6 ± 72.8 mg/dl, mean venous glucose was 158.9 ± 71.4 mg/dl, and mean capillary glucose was 153.2 ± 68.3 mg/dl, while in control group, the mean arterial glucose was 164.1 ± 63 mg/dl, mean venous glucose was 163.2 ± 62.1 mg/dl, and mean capillary glucose was 162.9 ± 64.2 mg/dl. There was a significant difference between the arterial/venous and capillary measurements of blood glucose levels in study group with significant p value (p = 0.039) as compared to control group.*
Conclusion: *Arterial or venous blood sample may be more relevant as compared to capillary blood for estimating glucose in patients on inotropes.*

Introduction

Monitoring the blood glucose level along with strict glycemic control is important particularly in ICU settings as both the hypoglycaemia and hyperglycaemia are independently associated with increase in morbidity and mortality among the critically ill patients. Various methods can be used to measure the blood glucose, such as handheld glucometer or using Arterial Blood Gas analysis or from central laboratory. Although the capillary blood sampling using handheld glucometer is the simple, convenient and quick method of blood glucose measurement in normotensive patients, its reliability in critically ill patient with hypotension and that too on vasopressor support is doubtful, as reported by several studies.

In the hypotensive patient on vasopressor support, the capillary blood flow is generally low because of the reduced peripheral perfusion which in turn is due to vasoconstrictor effect of the medication. Reduced peripheral perfusion and capillary flow leads to increase in glucose transit time and hence causing increased extraction of the glucose from the blood by the tissues, which in turn can give false reading. Thus in the hypotensive patient on vasopressor support, the blood glucose measurement by capillary method is not reliable. In such scenario, arterial or the venous blood sampling can be used to measure blood glucose levels.

Also to the best of our knowledge no other study have compared simultaneously all the three different methods of blood glucose measurement i.e. arterial, venous and capillary blood sampling in patient on vasopressor support. Hence this study was planned to compare accuracy of arterial, capillary and venous glucose measurement in patient with shock and on vasopressor.

Methods

A prospective study was conducted on patients admitted in a tertiary care hospital in Bangalore, India. A total of 50 patients were included in this study and it was carried out over period of 2 months. Out of 50 included patients, 25 patients who were taken as a study group had hypotension and were on vasopressor support, while rest 25 who taken as control were normotensive patients. Those patients who were on more than one vasopressor were exluded from the study and also patient or patients attendant not consenting for study, or those with very high glucose values in the range which was unable to measure on glucometer, severe limb edema were excluded from study.

Informed consent was taken from patient or patient's attendant. A pre structured and pre tested proforma was used to collect the data. Baseline data including name, age, sex, detailed medical history were recorded and detailed clinical examination was done. Patients in shock were defined as those requiring equal to or more than 0.1 μg/kg/min of noradrenaline to maintain the target mean arterial pressure of more than 70 mm Hg.

Measurements

Three samples (one arterial, one capillary and one venous) were tested simultaneously from each patient. Samples were obtained within 24 h of admission. According to ICU routine, laboratory venous plasma glucose (laboratory glucose) was measured at 6 a.m. in all ICU patients and repeated as clinically indicated. Glucose measurements were performed by skilled nursing staff. Capillary blood samples were obtained by finger prick after proper sterilization and blood glucose was tested by reflectance glucometry at the bedside using the Accu-check instant S Glucose Monitoring System (Roche Diagnostics). To measure arterial blood sample, blood was drawn from the artery after proper sterilization and the glucose levels were measured using Arterial Blood Gas (ABG) analysis while for venous sampling, it was sent to central laboratory for testing of glucose. All the three sample types were collected within 5 min of each other. The central clinical laboratory result for blood glucose was considered the reference standard.

Hypoglycemia was defined as a main clinical laboratory venous plasma glucose below 70 mg/dl and clinically significant hypoglycemia was defined as below 40 mg/dl.

Severity of disease was assessed according to acute physiology and chronic health evaluation (APACHE) II scores. Study was approved by the Institute's Ethical Committee.

Statistical Analysis

All characteristics were summarized descriptively. Statistical Package for Social Sciences [SPSS] for Windows, Version 22.0 Released 2013. Armonk, NY: IBM Corporation was used to perform statistical analyses. All results were expressed as mean ± SD. Chi Square test was used to compare the categorical variables. Continuous data were compared using Student's *t* test. A Bland–Altman analysis and Pearson correlation coefficient (r) was used to evaluate the relationship between the mean arterial, venous and capillary glucose measurement. The level of significance [P-Value] was set at $P<0.05$.

Results

A total 50 patients were analyzed in our study, 25 with hypotension on inotropes and 25 normotensive patients. The patient characteristics are compared in Table 1. Out of 50 patients, 34 patients were male and 16 were female, with the mean age of 48 +/- 10 years. Out of 25 patients in study group, the majority of the patients i.e. 23 patients had hypotension secondary to sepsis, in which sepsis due to pneumonia and Urinary tract infection (UTI) being common and 2 patients had hypotension secondary to hypovolemia. Among the 25 patients in control group, majority patients i.e. 8 patients were admitted for viral fever with thrombocytopenia, 5 patients with Chronic Kidney Disease, 5 patients had Pneumonia, 4 patients with COPD, and 3 patients had UTI. Patients in both groups were comparable with respect to age, sex ratio. Patients in study group were sicker as compared to control group which was assessed by APACHE II score.

In study group, the mean arterial blood glucose was 159.6 ± 72.8 mg/dl, mean venous blood glucose was 158.9 ± 71.4 mg/dl, and mean capillary blood glucose was 153.2 ± 68.3 mg/dl. While in control group, the mean arterial blood glucose was 164.1 ± 63 mg/dl, mean venous blood glucose was 163.2 ± 62.1 mg/dl, and mean capillary blood glucose was 162.9 ± 64.2 mg/dl. The mean APACHE 2 score was 28.3 ± 7.9 for study group and 16.6 ± 5.7 for control group.

For the study group, the Bland–Altman analysis showed a mean absolute difference between arterial and capillary samples of 6.38 mg/dl, between venous and capillary samples of 5.68 while between arterial and venous samples of 0.69 mg/dl. On the other hand, for the control group, the Bland–Altman analysis showed a mean absolute difference of 1.13 mg/dl between arterial and capillary samples, 0.32 mg/dl between venous and capillary samples while 0.89 mg/dl between arterial and venous samples. There was a significant difference between the arterial/venous blood glucose and capillary measurements in study group with significant p value ($p = 0.039$) as compared to control group.

Table 1: Comparison between the study and control groups

Parameter		Study Group (n=25)	Control Group (n=25)
Mean Age (Years)		47 ± 12	48 ± 11
Sex	Male	17	17
	Female	8	8
Mean APACHE II score		28.3 ± 7.9	16.6 ± 5.7
Mean arterial glucose (mg/dl)		159.6 ± 72.8	164.1 ± 63
Mean venous glucose (mg/dl)		158.9 ± 71.4	163.2 ± 62.1
Mean capillary glucose (mg/dl)		153.2 ± 68.3	162.9 ± 64.2

Discussion

Various methods are available to measure blood glucose level such as Glucometer, Arterial Blood Gas (ABG) analysis or using analyzer machine in central laboratory. Though the capillary blood glucose estimation using glucometer is most convenient and quicker method as compared to other technique, its relevancy is doubtful in patients on vasopressor support, which is confirmed by other studies as well. Due to reduced blood flow in capillary in patients on inotropes because of vasopressor effect and increased extraction of glucose from capillary in such situation, the capillary blood glucose levels by glucometer can give false results. Thus we conducted prospective study on 50 patients admitted in ICU at KIMS hospital, Bangalore.

As mentioned above in results, in our study we found that the mean capillary blood glucose level was significantly lower as compared to arterial and venous blood in study population but in control group no such significant difference found. Thus in ICU settings and in critically ill patients on inotropes, instead of capillary blood glucose estimation, artetial or venous blood glucose may predict better results and thus can be helpful for strict glycemic control. But as these methods are time consuming and practically difficult to carry out in such settings, thus limiting its use. This can be overcome by using arterial or venous blood sample and using simple glucometer for glucose estimation instead of ABG or sending to central laboratory.

Conclusion

Thus to conclude, arterial or venous blood sample may be more relevant as compared to capillary blood for estimating glucose in patients on inotropes, though it is convenient method for blood glucose estimation in stable patients.

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