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Comparison of the effect of direct venipuncture and venous catheter blood sampling methods on the biochemical results of patients hospitalized in CCU

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ABSTRACT

Background: Diagnostic and therapeutic evaluation of patients hospitalized in the coronary care unit (CCU) requires frequent blood sampling. Following the routine schedule of the ward means using new intravenous lines for each blood sample, which causes damage and pain in patients. With this background in mind, this study aimed to compare the effect of blood sampling through direct venipuncture and venous catheter on the blood biochemical results of patients hospitalized in the CCU.

Methods: In this quasi-experimental study, 80 hospitalized patients in the CCU were selected through purposive sampling in one of the teaching hospitals of Zahedan, Iran in 2015. At first, 5 cc of blood was obtained via a venous catheter, and the same volume was collected by direct venipuncture from the other hand of the patients to conduct biochemical tests. Samples were assessed in terms of glucose, cholesterol, triglyceride, sodium, potassium, urea, creatinine and C-reactive protein (CRP) levels. Data analysis was performed in SPSS version 16.0 using paired t-test and Pearson's correlation-coefficient.

Results: In this study, no statistically significant difference was observed between the two groups of venous catheter and direct venipuncture in terms of the levels of glucose, cholesterol, triglyceride, sodium, potassium and CRP. However, a significant difference was found in the level of urea (P=0.004) and creatinine between the study groups (P=0.015).

Conclusion: According to the results, venous catheter can be used to obtain reliable blood samples for laboratory assessments. Nevertheless, given the significant difference between the levels of urea and creatinine, it is recommended that further studies be conducted to compare the two blood sampling methods in this regard.

1. Introduction

Results of medical diagnostic tests are an important part of information used to aid physicians in the diagnosis and treatment of patients.[1] In normal conditions, blood samples are directly collected from the vein, which not only causes pain and discomfort for patients during the process, but also increases the possibility of peripheral vein injuries, phlebitis, bleeding and difficulty in using vessels in the future.[2] Prevention of these complications in patients, especially those with cardiac diseases, is of paramount importance. Evidence suggests that since these patients use anticoagulants, their body is more susceptible to extensive bleeding and hematoma formation at the site of injection. While cardiac patients should not be exposed to stress (e.g., pain caused by blood sampling), a number of blood tests should be frequently performed for diagnostic and therapeutic purposes.[3]

In addition to the adverse effects of direct venipuncture on patients, this method could cause damage to the hospital staff, especially nurses. Blood sampling by direct venipuncture in patients without suitable vessels leads to the exposure of healthcare providers to needle stick, as well as wasted time and energy.[4, 5] As a result, nurses often use venous catheters to collect blood samples from patients in order to decrease the associated complications, improve patient comfort and increase nursing productivity.[6] Application of these catheters has eliminated unnecessary use of needles; moreover, venous catheters facilitate vascular access in difficult cases, leading to easier sample collection. Vein damage and patient discomfort could be avoided by cleaning venous catheters with sodium chloride (Na-Cl) 0.9% solution flush before collecting samples. This process decreases the side effects of bleeding and possible infections, as well as the duration of blood sampling.[7] Nevertheless, the majority of institutes have accepted the procedure of placing peripheral venous catheter as an alternative for solution infusion to keep the artery open.[8] In addition, venous catheters are needed in the majority of hospitalized patients for the administration of intravenous fluids and medicines. However, since it is believed that blood sample collection through venous catheter might change the final test results, nurses and laboratory staff are usually unwilling to use such methods.[9]

Simundic et al. (2012) have demonstrated that blood sampling errors before the final lab results might lead to inaccurate diagnosis, which is often caused by errors in the process of blood collection, failure in sample transportation or improper sample preparation.[10]

Extensive research has been conducted on the validity of blood sampling via venous catheters. While some of the previous studies have confirmed the reliability of final results, others considered the laboratory results to be invalid. These studies have emphasized the necessity of repeated evaluation of different patient groups with various ages to confirm the data.[4, 5, 11, 12] Corbo et al. (2007) conducted a study on 81 cardiac patients, and the results revealed no significant difference between the final results obtained by intravenous catheter and direct venipuncture in terms of hematocrit, electrolytes and cardiac enzymes.[5] In a study by Hambleton et al. (2014), the test results of hematology, biochemistry, venous blood gas and coagulation parameters in the obtained samples by venous catheter and direct venipuncture were evaluated. According to the findings of the mentioned study, the validity of blood samples obtained by venous catheter (with or without injection) was confirmed for assessing the results of hematology, biochemistry and coagulation parameters; however, no such results were obtained regarding venous blood gas.[11]

In a study, Berger-Achituv et al. (2010) reported that venous catheter could be used as an invasive method to collect most of the blood samples. Nevertheless, the results obtained by this method were not reliable in terms of glucose values.[4] In line with the results of the previous study, no significant difference was found between the two blood sampling methods regarding the mean values of sodium, potassium, urea, creatinine, glucose, cholesterol and triglycerides in a study by Yazdankhah Fard et al. (2015). However, a statistically significant difference was observed in hemoglobin levels of the study groups.[12] Given the results of the aforementioned studies and importance of reducing pain and stress factors in cardiac patients hospitalized in the CCU, the present study aimed to compare the effects of direct venipuncture and venous catheter blood sampling methods on the biochemical test results of patients hospitalized in the CCU.

2. Methods

2.1. Design

This quasi-experimental study was conducted on cardiac patients, who were hospitalized in the CCU of one of the hospitals in Zahedan, Iran, after the diagnosis of acute coronary syndrome in 2015.

2.2. Participants and setting

According to the results obtained by similar studies,[1, 8, 12] sample size was estimated within the range of 23-81 individuals, and researchers considered the maximum sample size for the present study based on the viewpoint of critic professors. In total, 80 patients were selected via purposive sampling.

Inclusion criteria were age range of 35-70 years, physicians' order based on blood biochemical and coagulation tests, hematocrit levels between 25% and 60%, hemoglobin values greater than 12 g/dl in women and 14 g/dl in men, non-pregnant female patients, and hemodynamic stability. The last variable is important since abnormal blood dilution and concentration could significantly impact the test results.[13] On the other hand, exclusion criteria were discharge and transfer of patients prior to sampling and phlebitis.

2.3. Instruments

Data collection tools included a researcher-made questionnaire, in which age, gender and satisfaction level of patients, families and staff with

each blood sampling method were evaluated. Lab results in terms of the levels of glucose, sodium, potassium, urea, creatinine, C-reactive protein (CRP), cholesterol and triglyceride, were included in this form for the two methods. Information of this form was collected through accurate observation, evaluation and interviews.

Study tests were performed using Alcyon Abbott autoanalyzer, which was calibrated by biomedical equipment specialist of the hospital. In addition, Fors-teb laboratory kit (Iran) was used to determine the levels of sodium and potassium, and concentrations of glucose, cholesterol, triglyceride, urea and creatinine were evaluated using Pars Azmoon test kits (Iran). Assessment of CPR levels was carried out using kit of Pasteur Institute of Iran.

2.4. Data Collection

In this study, followed by the placement of venous catheters (size: 18 or 20) in the upper arm superficial veins with no peripheral vein infusion line to decrease the side effects of medications and infused serums by venous catheters. Following that, the catheter insertion site was covered with sterile transparent gauze to limit the chances of phlebitis. In the next stage, one ml of sodium chloride 0.9% was injected into the catheter to keep the vein open, followed by the flushing of the catheter with sodium chloride solution every eight hours. All the nurses were informed that the catheter was only used to collect laboratory blood samples.

Researcher conducted blood sampling on the patients around 8-10 a.m. every day after the visit of the physician. This process was performed through a five-minute interruption in medication infusion and application of tourniquet to increase the filling of veins with blood and facilitate the entry of blood into the syringe. A tourniquet was attached 8-10 cm above the fixed catheter by applying pressure of 40 mm Hg for one minute. Afterwards, one ml of blood (5.2 times the volume of the dead space of the catheter) was aspirated from the catheter and discarded using a 2mm syringe. Following that, the required volume of blood was collected with a 10cc syringe and added to test tubes to conduct the necessary tests on the patients.

In the next stage, the catheter was washed with two ml of sodium chloride again, followed by immediate attachment of the tourniquet to the same area on the other arm using the mentioned method, and the same amount of blood was taken from the vein using a needle stick (No.20). Samples were sent to the laboratory with two specific codes so that the healthcare personnel would be blinded to the experiment.

2.5. Ethical considerations

Objectives of the research were explained to the participants prior to study, and they were assured of the safety of study procedures. Written informed consent was obtained from the eligible patients.

2.6. Statistical analysis

Data analysis was performed in SPSS version 16 using paired t-test (to assess the differences in the laboratory results of direct venipuncture and venous catheter) and Pearson's correlation-coefficient (to identify the association between the values obtained by the two methods).

3. Results

In this study, the majority of participants were male (56.2%) with mean age of 57.31±9.83 years. Comparison of biochemical test results of blood samples collected via venous catheter and direct venipuncture using paired t-test revealed no statistically significant difference between the laboratory values of glucose, sodium, potassium, cholesterol, triglyceride and CRP. However, blood sampling via venous catheter lowered urea levels (P=0.004) compared to direct venipuncture. On the other hand, creatinine level (P=0.015) was significantly higher in the samples collected by direct venipuncture (Table 1).

Pearson's correlation-coefficient was used to determine the correlations between the test values in the two sampling methods. Moreover, Pearson's correlation-coefficient values were estimated for each test of the two methods before the intervention, as follows: CRP (r=0.977), glucose (r=0.817), urea (r=0.893), creatinine (r=0.793), sodium (r=0.629), potassium (r=0.751), triglyceride (r=0.979) and cholesterol (r=0.892) (P<0.001).

Table 1. Comparison of biochemical blood test results obtained by venous catheter and direct venipuncture

peripheral venous catheter Tests	Venous catheter M±SD	Direct venipuncture M±SD	*P
Glucose (mg/dl)	147.92±76	152.71±93.31	0.428
Sodium (mg/dl)	140.19±3.15	140.48±2.48	0.308
Potassium (meq/L)	4.16±0.26	4.15±0.28	0.693
Urea (mg/dl)	15.03±5.20	14.58±4.99	0.004
Creatinine (mg/dl)	0.90±0.18	0.92±0.19	0.015
C-reactive protein (mg/dl)	1.12±1.19	1.17±1.26	0.103
Triglyceride (mg/dl)	111.64±57.91	109.64±55.82	0.129
Cholesterol (mg/dl)	157.55±38.35	158.26±47.23	0.770

*Paired t-test

4. Discussion

According to the results of the present research, no significant difference was observed between the two groups of direct venipuncture and venous catheter in terms of blood biochemical test results (e.g., glucose, sodium, potassium, cholesterol, triglyceride, and CRP levels); however, contradictory results were observed regarding urea and creatinine levels. In a study by Zlotowski et al. (2001), while no significant difference was observed between the values of sodium, urea and creatinine in the two groups (i.e., direct venipuncture and venous catheter), the test results of glucose and potassium levels revealed statistically significant differences between the groups.[9] In terms of sodium values, the results of the mentioned study are in line with our findings; nevertheless, no such similarity was observed regarding potassium, urea, creatinine and glucose levels. This contradiction in results might be due to the differences in study samples (healthy participants in the mentioned study), blood collection methods and total number of discarded blood units. Furthermore, in the mentioned research, three different samples were obtained from the subjects, as follows: one sample was collected through direct venipuncture after bolus infusion of 200 ml normal saline, and two samples were consecutively obtained from aspirated catheter (without any blood waste).[9]

Baker et al. (2013) conducted a study to determine the favorable volume of discarded blood with seven different volumes and evaluate sodium and glucose levels in healthy individuals. A significant difference was found between the test results of two blood collection methods when sampling was performed without any blood waste. However, no such difference was observed after discarding 0.5-3 ml of blood. Therefore, it is suggested that at least one ml of blood be discarded by nurses from aspirated catheters, so that the required amount of blood could be aspirated for lab tests.[14] Although the mentioned study was conducted on healthy samples, the final results were in congruence with our findings regarding the levels of sodium and glucose. This similarity might be due to the lack of serum or medication infusion in venous catheter.

In line with the results of the present study, no significant difference was observed in electrolyte levels obtained via venous catheter and saline lock in a study by Seemann et al. (2000).[15] In another study by Yazdanikhah et al. (2015), levels of sodium, potassium, urea and creatinine in both blood samples, obtained via direct venipuncture and venous infusion line, were compared after liquid injection; accordingly, no statistically significant difference was observed between the study groups. While results of sodium and potassium blood tests were consistent with our findings, no such consistency was found regarding urea and creatinine levels. Differences in methods and number of discarded blood units were the main reasons of incompatibility between these results. In the study by Yazdanikhah et al., five ml of blood was discarded prior to blood collection,[12] while only one ml of blood was wasted in the present research.

Rezayi et al. (2009) conducted a study to compare the final values of glucose, cholesterol, triglyceride, sodium, potassium, urea, creatinine and cardiac enzymes in samples obtained through direct venipuncture and saline lock. Obtained results were indicative of no statistically significant difference between the examined values.[16] Findings of the mentioned study are in line with our results, and lack of consistency in terms of urea and creatinine levels might be due to the differences in testing methods applied by laboratory staff or effects of confounding factors (e.g., hemolysis) on the final results.

One of the major drawbacks of the present study was the selected sample size, which limited the generalizability of study results.

5. Conclusion

According to the results of this study, blood sampling via venous catheter (preferably fixed at upper limb and washed with normal saline) could be used as a trusted and beneficial method to achieve suitable blood samples from a large number of patients in the CCU. Nevertheless, given the

significant difference between the levels of urea and creatinine, it is suggested that further studies be conducted on patients diagnosed with renal problems by discarding a greater number of blood units.

Conflicts of interest

The authors declare no conflicts of interest.

Authors' contributions

Zahra Pishkar Mofrad: Design and implementation of research, drafting of manuscript. Shahla Shafiee: Scientific advisor, drafting and editing of manuscript. Nasrin Mahmoodi: Drafting of manuscript. Mojhde Jahantigh: Assistance in research implantation. Hamide Samadzade: Assistance in research implantation.

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