Crit Care Nurs J. 2016 August; 9(3):e8389. doi: 10.17795/ccn-8389.

Published online 2016 August 30. **Research Article**

Comparing Blood Values Sampled From Venipuncture and Continuous Infusion Catheter

Mansooreh Aliasgharpour,[1] Rashid Jafari,[2,*] Seyedeh Fatemeh Jalalinia,[1] Seyed Jalal Madani,[3] Fariba Tabari,[1] and Anoushirvan Kazemnegad Lili[4]

[1]Department of Medical-Surgical, School of Nursing and Midwifery, Tehran University of Medical Sciences, Tehran, IR Iran
[2]School of Nursing and Midwifery, Tehran University of Medical Sciences, Tehran, IR Iran
[3]Baqiyatallah University of Medical Sciences, Tehran, IR Iran
[4]Tarbiat Modarres University, Tehran, IR Iran

[*]*Corresponding author*: Rashid Jafari, School of Nursing and Midwifery, Tehran University of Medical Sciences, Tehran, IR Iran. Tel: +98-2166927171, E-mail: rjafari60@gmail.com

Received 2016 August 22; **Accepted** 2016 August 24.

Abstract

Background: Most patients hospitalized at intensive care units have a continuous infusion catheter in place for receiving drugs and solutions; nonetheless, blood sampling in these units is still performed through an invasive and painful venipuncture. However, it is possible to take blood from a peripheral venous catheter to obtain accurate laboratory test results and alleviate the suffering of patients.
Objectives: The aim of this study was to compare hematology, chemistry, and blood gas values sampled from venipuncture and continuous infusion intravenous catheter.
Methods: In this cross-sectional comparative study, a convenient sample of 61 adult patients was drawn according to the inclusion and exclusion criteria, from the intensive care unit. Two blood samples, one from a continuous infusion catheter, which was already in place and one from venipuncture at the other extremity, were obtained from each patient. The two sets of samples were compared in terms of hematology, biochemistry and blood gas values by using the paired-samples t-test.
Results: The two sets of samples differed significantly in terms of blood sugar values. Other differences between the two sets were not statistically significant.
Conclusions: Except for blood sugar, blood sampling from a continuous 24-hour infusion catheter produces reliable hematology, biochemistry and blood gas results as that of venipuncture blood sampling method. Moreover, compared with the routine venipuncture method, sampling from a continuous infusion catheter is simpler, easier and safer.

Keywords: Venipuncture, Intravenous Infusion, Catheter, Intensive Care Unit, Venous Blood Gases and Blood Test

1. Background

Rapid patient assessment significantly contributes to positive patient outcomes. Accordingly, agility and precision are the essential prerequisites for patient assessment and care in hospital wards, particularly in intensive care units. One of the key aspects of patient assessment is laboratory evaluations, such as complete blood count and electrolyte analysis (1-3).

Laboratory analysis of blood necessitates performing venipuncture, which is a painful and invasive procedure with different complications (4, 5).

Venipuncture and blood sampling in patients with fragile veins are particularly difficult and time-consuming and may result in clot formation and unreliable laboratory findings (2). Beside acute pain, venipuncture may also be associated with other complications such as bruising, hematoma, infection; vasovagal reaction and even peripheral nerve damage (6-9). Consequently, studies have been conducted to develop and employ less-invasive sampling procedures for minimizing such complications (10-12). For instance, some studies focused on sampling from peripheral intermittent infusion catheter or saline lock system (2, 11), while others dealt with sampling from continuous intravenous infusion catheter or central venous line (1, 12). Nonetheless, pain is still a common sampling-related problem in clinical settings (1, 4, 10-12). This study was conducted to provide further evidence in this area. Most of the previous studies reported that the saline lock and venipuncture blood sampling techniques did not significantly differ from each other regarding cellular, biochemistry and coagulation parameters (13-15). However, the findings of differences in different sampling methods regarding blood sugar levels and venous blood gases are conflicting (2, 11, 16). For instance, Herr et al. (16) found that serum level of bicarbonate sampled through the venipuncture method differed significantly from that of the intermittent infusion catheter (16). Hambleton et al. (11) also found a significant difference between saline lock and venipuncture sampling techniques in terms of serum levels of creatinine, potassium, calcium, albumin, coagulation tests and blood gas analysis.

To the best of our knowledge, a few studies have so far compared blood values sampled from a continuous infusion intravenous catheter (CIC) with those from a simultaneous venipuncture at the other extremity. Berger Achituvet al. (12), Himberger and Himberger (1), found that except for blood sugar level, the differences between these two techniques regarding cellular and biochemistry parameters were not statistically significant. The key step to developing the safest and most reliable blood sampling technique is to resolve the current controversies.

2. Objectives

The aim of this study was to compare blood values sampled from venipuncture and continuous infusion intravenous catheter (CIC).

3. Methods

This cross-sectional study was conducted from September 2013 to January 2014. The study population and sample consisted of respectively patients, who were hospitalized at the intensive care unit. With a confidence interval of 95%, a power of 80% and consideration of blood sodium level, the following sample size calculation formula showed that 61 pairs of samples were needed for the study. It should be noted that the sample size was calculated separately for all the variables and the maximum sample size was calculated based on the amount of sodium, therefore this variable was used as a benchmark to determine the sample size.

$$\begin{aligned} &\frac{\left(\left(Z_{1-\frac{\alpha}{2}}+Z_{1-\beta}\right)^2\times\left(S_1^2+S_2^2\right)\right)}{d^2} \\ &=\frac{\left((1.96+0.84)^2\times\left(2^2+1.9^2\right)\right)}{1^2} \\ &=60.1 \\ &\approx 61 \end{aligned} \quad (1)$$

Consequently, a convenience sample of 61 patients was drawn. The inclusion criteria were being completely conscious, having an age of 18 years or older, having an 18-guage or larger CIC in place in only one extremity, receiving continuous fluid and drug infusion from the catheter, having normal vital sign readings, having no sign or symptom of phlebitis, having no history of diabetes mellitus and hematologic disorder, and receiving neither isotonic or hypertonic dextrose-containing solutions nor total parenteral nutrition. Patients whose CIC could not be aspirated were excluded.

Initially, patients' demographic characteristics and underlying diseases, the size of their CIC, as well as the infused solutions and medications were documented in a data sheet. The validity of the sheet was evaluated and confirmed by a panel of nursing faculty members. Two blood samples were obtained from each patient, one from the CIC and one from performing a venipuncture at the other corresponding extremity. Laboratory blood tests including pH, Hemoglobin (Hb), Hematocrit (Hct), and the levels of lactate, bicarbonate (HCO_3), ionized Calcium (Ca), Sodium (Na), Potassium (K), pressure of venous Oxygen (PvO_2), Carbon Dioxide ($PvCO_2$), were performed on each pair of samples. Then, the laboratory findings of the two sets of samples were compared.

Sampling procedures were performed as follows. For obtaining a sample from the CIC, we initially blocked the flow of the infusing solution for 30 seconds. Then, a tourniquet was applied for 30 seconds at 15 - 20 centimeters proximal to the insertion site to prevent the vein from being collapsed. Thereafter, 2 mL of blood was drawn and discarded. The discarded volume of blood was two times more than the dead space of the catheter (0.2 mL) and the infusion set (0.8 mL) (17-19). Finally, 0.5 mL of blood was drawn using a heparinized syringe. The syringe was placed in a cold box and sent to the laboratory. On the other hand, for obtaining a sample through venipuncture, we identified the site of puncture at the other extremity and applied a tourniquet at 15 - 20 centimeters proximal to the insertion site for 30 seconds (19, 20). Then, a venipuncture was performed and 0.5 mL of blood was sampled by using a heparinized syringe (21). The syringe was immediately placed in a cold box and sent for laboratory analyses. All laboratory analyses were performed in the same laboratory using a similar GEM Premier 300 analyzer. The GEM Premier 300 is an electrode-based intensive care blood analyzer, which is used for rapid laboratory analysis.

The SPSS software (v. 16.0) was used for analyzing the data. Descriptive statistics measures such as mean, standard deviation, as well as absolute and relative frequencies were used for summarizing the data. Moreover, the normality of the study variables was evaluated by conducting the Kolmogorov-Smirnov test. In this regard the sampling was done in a group, and different extremities, paired t-test was used. The paired-samples t and the Wilcoxon signed rank tests were also performed for comparing the groups regarding blood values. The level of significance was set at below 0.05.

This study was conducted after obtaining formal written approval from the ethics committee and the institutional review board. After informing the participants about the aim of the study and the confidentiality of their personal information, we invited them to read and sign the consent form of the study. The study intervention did not inflict physical, emotional, or mental harm to the participants.

4. Results

Sixty-one critical care patients participated in this study. Table 1 shows participants' characteristics. In total, 122 blood samples were obtained and analyzed. All samples were obtained from upper extremities. Moreover, all of our sampling attempts were successful. Table 2 shows the characteristics of peripheral venous catheters and the infused solutions and medications. The results of the paired-samples t and the Wilcoxon signed rank tests showed that besides blood sugar (P = 0.01), the two sets of samples did not differ significantly in terms of hematology, biochemistry and blood gas values (P > 0.05; Table 3).

Table 1. Overall Characteristics of the Sample

Characteristics	No. (%)
Gender, n	
Male	31 (50.8)
Female	30 (49.2)
Age, y	
Mean ± SD	62.2 ± 17.5
Range	18 - 92
Type of Surgery, n	
General Surgery	44 (72.1)
Urologic	10 (16.4)
Orthopedic	4 (6.6)
Gynecologic	2 (3.3)
ENT	1 (1.6)
Admission days	
Mean ± SD	3.2 ± 2.1
Range	1 - 12

Table 2. Catheter Characteristics

Characteristics	No. (%)
Catheter size, gauge	
18	48 (78.7)
16	10 (16.4)
14	3 (4.9)
Time of catheter placements, days	
Mean ± SD	2 ± 0.2
Range	1 - 3
IV infusing solution type	
3.3% dextrose in third-normal saline	40 (65.6)
Normal saline	11 (18)
Half saline	8 (13.2)
Ringer's	1 (1.6)
Lactated Ringer's	1 (1.6)
Type of infusing drugs	
Antibiotics	61 (100)
H2 blockers	41 (67.2)
Proton pump inhibitors	13 (21.3)
NSAIDS	3 (5)
Narcotics	60 (98.3)
Vitamins and supplements	6 (9.8)
Beta blockers	1 (1.6)
Electrolytes	10 (16.4)
Anti-emetics	1 (1.6)
Corticosteroids	6 (9.8)
Diuretics	3 (4.9)
Nitroglycerin	10 (16.4)

5. Discussion

The study findings revealed that the two sets of samples did not differ significantly regarding Hct and Hb. Himberger and Himberger (1), Berger-Achituv et al. (12) and Hambleton (11), also reported the same findings. Corbo et al. (2) also found that samples obtained from venipuncture and saline lock did not differ significantly in terms of Hct and Hb. These findings confirm that sampling from CIC produces reliable Hct and Hb results.

We also found that there were no significant differences between the two sets of samples regarding Na and K. This finding is consistent with the findings of studies conducted by Himberger and Himberger, (1) Rezaei et al. (14), Berger-Achituv et al. (12) and Hambleton et al. (11). Moreover, the two sets of samples did not differ significantly regarding ionized Ca. This finding contradicts the findings of a study conducted by Hambleton et al. (11); this contradiction can be attributed to the fact that our study was conducted on ionized calcium obtained from venipunc-

Table 3. Analysis of Venipuncture and Continuous infusing Catheter Samples (Cellular, Biochemical and Venous Blood Gas Indices)

Lab Test	Inf Cath Mean ± SD	Venipuncture Mean ± SD	P Value
Hemoglobin	12.59 (± 2.42)	12.61(±2.43)	t = 0.474; P = 0.637
Hematocrit	37.97 (± 0.932)	38.13(±0.947)	t = 1.229; P = 0.224
Blood Sugar	154.93 (± 52.1)	144.25 (± 51.5)	t = -3.496; P =0.01
Sodium	141.95 (± 4.3)	141.38 (± 4.3)	t = 1.12; P = 0.26
Potassium	3.73 (± 0.53)	3.69 (± 0.54)	t = -0.8; P = 0.421
Ionized calcium	3.02 (± 0.49)	2.95 (± 0.55)	t = -1.08; P = 0.282
PH	7.34 (± 0.754)	7.34 (± 0.721)	t = -1.24; P = 0.220
Pvco2	43.14 (± 8.03)	43.15 (± 7.89)	t = 1.055; P = 0.295
Pvo2	41.57 (± 14.07)	37.55 (± 12.80)	t = -2.82; P = 0.06
Svo2	64.60 (± 23.67)	62.52 (± 20.32)	t = -0.78; P = 0.01
Bicarbonate	27.69 (± 21.25)	25.99 (± 15.67)	Z = -1.289; P = 0.197
Lactate	1.57 (± 0.99)	1.61 (± 1.01)	t = 0.732; P = 0.467

ture and CIC, while Hambleton et al. (11), compared the levels of total Ca sampled from venipuncture and saline lock catheter.

The study findings also showed that the level of blood sugar sampled from CIC was significantly higher than that of the venipuncture method. Previous studies reported conflicting findings about the differences between different sampling methods regarding blood sugar. For instance, while Berger-Achituv et al. (12) found a significant difference between these two sampling methods regarding blood sugar, Hambleton et al. (11) and Zand et al. (13) reported that the difference between the two sets of samples regarding blood sugar was not statistically significant.

Finally, we found that the differences between the two sets of samples regarding blood levels of pH, PvO_2, $PvCO_2$, HCO_3 and lactate were not statistically significant. Previous studies reported conflicting findings about the differences between different sampling methods regarding blood gas analysis. For instance, Hambleton et al. (11) reported that samples obtained from venipuncture and standard sampling for blood gas analysis were not significantly correlated regarding pH, $PvCO_2$ and PvO_2. Moreover, Herr et al. (16) and Corbo et al. (2) found that samples obtained from infusion catheter and venipuncture significantly differed regarding $PvCO_2$ and HCO_3. They attributed these conflicting findings to gas exchanges between test tubes and atmospheric air. To prevent gas exchange and other chemical changes, we used heparinized syringes for blood sampling and immediately transferred sample-filled syringes to the laboratory by using a cold box. It is noteworthy that none of the previous studies had dealt with comparing different sampling methods regarding lactate.

The study findings indicate that except for blood sugar, blood sampling from a CIC produces as reliable hematology and biochemistry results as the venipuncture sampling method. Moreover, compared with the venipuncture method, sampling from a CIC is simpler, easier, and safer. Accordingly, CIC route can be used for rapid blood sampling in intensive care units.

The CIC sampling technique is a credible alternative to conventional sampling through venipuncture. Given the numerous complications of the venipuncture technique, the CIC technique can be used for obtaining blood samples without inflicting pain and discomfort to patients. Moreover, the CIC technique is associated with lower risk of needle stick injury for nurses and other healthcare professionals. However, given the scarcity of studies, further studies are still needed for providing adequate evidence regarding the usefulness and harmlessness of the CIC sampling technique.

Acknowledgments

The researchers would like to appreciate the department of research of Tehran University of Medical Sciences for their support and all patients, who honestly and patiently participated in this research. Also, sincere cooperation and contributions of the authorities and nurses of the surgical ICU of Baqiatallah hospital of Tehran are cordially appreciated.

Footnote

Funding/Support: The results of this study were extracted from an MSc thesis (No. 615) submitted to the Tehran University of Medical Sciences.

References

1. Himberger JR, Himberger LC. Accuracy of drawing blood through infusing intravenous lines. *Heart Lung.* 2001;**30**(1):66–73. doi: 10.1067/mhl.2001.110535. [PubMed: 11174369].
2. Corbo J, Fu L, Silver M, Atallah H, Bijur P. Comparison of laboratory values obtained by phlebotomy versus saline lock devices. *Acad Emerg Med.* 2007;**14**(1):23–7. doi: 10.1197/j.aem.2006.06.053. [PubMed: 17099189].

3. Jun WH, Gwak YS, Han HJ, Lee G. Comparison of laboratory values obtained via central venous catheters and venipuncture for better clinical decisions regarding sampling procedures of intensive care unit patients. *J Clin Nurs.* 2015;**24**(5-6):866–8. doi: 10.1111/jocn.12436. [PubMed: 24329766].
4. Alhani F. The effect of programmed distraction on the pain caused by venipuncture among adolescents on hemodialysis. *Pain Manag Nurs.* 2010;**11**(2):85–91. doi: 10.1016/j.pmn.2009.03.005. [PubMed: 20510838].
5. Ibrahim I, Ooi SB, Yiong Huak C, Sethi S. Point-of-care bedside gas analyzer: limited use of venous pCO2 in emergency patients. *J Emerg Med.* 2011;**41**(2):117–23. doi: 10.1016/j.jemermed.2008.04.014. [PubMed: 18930370].
6. Asheghan M, Khatibi A, Holisaz MT. Paresthesia and forearm pain after phlebotomy due to medial antebrachial cutaneous nerve injury. *J Brachial Plex Peripher Nerve Inj.* 2011;**6**:5. doi: 10.1186/1749-7221-6-5. [PubMed: 21896172].
7. Jacoby TS, Kuchenbecker RS, Dos Santos RP, Magedanz L, Guzatto P, Moreira LB. Impact of hospital-wide infection rate, invasive procedures use and antimicrobial consumption on bacterial resistance inside an intensive care unit. *J Hosp Infect.* 2010;**75**(1):23–7. doi: 10.1016/j.jhin.2009.11.021. [PubMed: 20338669].
8. Coutaux A, Salomon L, Rosenheim M, Baccard AS, Quiertant C, Papy E, et al. Care related pain in hospitalized patients: a cross-sectional study. *Eur J Pain.* 2008;**12**(1):3–8. doi: 10.1016/j.ejpain.2007.05.002. [PubMed: 17604196].
9. Hogan ME, Kikuta A, Taddio A. A systematic review of measures for reducing injection pain during adult immunization. *Vaccine.* 2010;**28**(6):1514–21. doi: 10.1016/j.vaccine.2009.11.065. [PubMed: 20003927].
10. Hajiseyedjavady H, Saeedi M, Eslami V, Shahsavarinia K, Farahmand S. Less painful arterial blood gas sampling using jet injection of 2% lidocaine: a randomized controlled clinical trial. *Am J Emerg Med.* 2012;**30**(7):1100–4. doi: 10.1016/j.ajem.2011.07.011. [PubMed: 22030199].
11. Hambleton VL, Gomez IA, Andreu FA. Venipuncture versus peripheral catheter: do infusions alter laboratory results?. *J Emerg Nurs.* 2014;**40**(1):20–6. doi: 10.1016/j.jen.2012.03.014. [PubMed: 22766144].
12. Berger-Achituv S, Budde-Schwartzman B, Ellis MH, Shenkman Z, Erez I. Blood sampling through peripheral venous catheters is reliable for selected basic analytes in children. *Pediatrics.* 2010;**126**(1):179–86. doi: 10.1542/peds.2009-2920. [PubMed: 20566616].
13. Zand S, Rezaie K, Koohestani H. Effect of blood sampling via saline lock on the validity of coagulation tests results. *J Birjand Univ Med Sci.* 2010;**17**:19–25.
14. Rezaie K, Zand S, Kohestany HR, Baghcheghy N. Comparison of Biochemical Values Obtained by Venipuncture and SalineLock after Intermittent Administration of Fluids and drugs. *J Arak Univ Med Sci.* 2009;**12**:49–56.
15. Zengin N, Enc N. Comparison of two blood sampling methods in anticoagulation therapy: venipuncture and peripheral venous catheter. *J Clin Nurs.* 2008;**17**(3):386–93. doi: 10.1111/j.1365-2702.2006.01858.x. [PubMed: 17394539].
16. Herr RD, Bossart PJ, Blaylock RC, Kroger K, Ash O. Intravenous catheter aspiration for obtaining basic analytes during intravenous infusion. *Ann Emerg Med.* 1990;**19**(7):789–92. [PubMed: 2117865].
17. Ohio State University Medical Center . Laboratory Guide to Services. OHIO: Specimen & Collection Procedures Department of Clinical Laboratories; 2012.
18. Seemann S, Reinhardt A. Blood sample collection from a peripheral catheter system compared with phlebotomy. *J Intraven Nurs.* 2000;**23**(5):290–7. [PubMed: 11847740].
19. World Health Organization . WHO guidelines on drawing blood best practices in phlebotomy. Geneva: World Health Organization; 2010.
20. Granados Gamez F, Granados Gamez G, Gomez Rubio J, Caparros Cortes G, Pícher Vidal D, Gomez Gomez P. Concordancia entre los valores analiticos de las muestras de sangre extraidas a traves de cateter periferico y las de puncion directa [in Spanish]. *Enferm Clin.* 2003;**13**(1):1–6.
21. Zlotowski SJ, Kupas DF, Wood GC. Comparison of laboratory values obtained by means of routine venipuncture versus peripheral intravenous catheter after a normal saline solution bolus. *Ann Emerg Med.* 2001;**38**(5):497–504. doi: 10.1067/mem.2001.118015. [PubMed: 11679860].