Critical Care Nursing
Journal home page: www.inhc.ir
Iran J Crit Care Nurs. 2014;7(2):84-91

A comparison of two methods of heparinizing hemodialysis set by continuous infusion and intermittent bolus effects on the rate of dialysis adequacy in hemodialysis patients

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ARTICLE INFO

Article type:
Original article

Article history:
Received: 23 Jul 2013
Revised: 28 May 2014
Accepted: 09 Jun 2014

Keywords:
Dialysis adequacy
Hemodialysis patients
Heparin
Continuous infusion

ABSTRACT

Aims: Hemodialysis is one of the main treatments for patients with chronic renal failure. If performed hemodialysis does not have necessary efficacy, the rate of patients' mortality increases. One of the most important measures in this area is to prevent clot formation which can be achieved by using proper administration of anticoagulants (heparin). Therefore, present study aimed to comparison of two methods of heparinizing hemodialysis set effects on the rate of dialysis adequacy in hemodialysis patients.

Methods: In a quasi-experimental study, 176 hemodialysis patients admitted in the dialysis centers of Kermanshah Medical Sciences University who had inclusion criteria were under the two methods of anticoagulation with heparin (continuous infusion or intermittent bolus group) through convenient sampling method. In order to evaluate the adequacy of dialysis of Urea Reduction Ratio (URR) and KT/V were used. The study was conducted in before and after comparative form. Data collection tools include demographic and background features and the checklist of doing hemodialysis. Finally, data were analyzed by SPSS16 statistical software.

Results: Results showed that comparing dialysis adequacy based on URR and KT/V mean in the two methods did not have statistical significant difference.

Conclusions: Both continuous infusion and intermittent bolus have almost the same effect on dialysis adequacy.

Please cite this paper as:
Sabour B, Mohammadi Z, Omrani H, Rezaei M. A comparison of two methods of heparinizing hemodialysis set by continuous infusion and intermittent bolus effects on the rate of dialysis adequacy in hemodialysis patients. Iran J Crit Care Nurs. 2014;7(2):84-91.

1. Introduction

ESRD (End Stage Renal Diseases) is a clinical situation that is made because of losing irreversible performance of the kidneys, in a way that the patient needs permanent renal replacement therapy (dialysis or kidney transplant) to avoid life-threatening uremia [1,2]. Dialysis in ESRD patients is stated as a maintenance treatment and includes hemodialysis and peritoneal dialysis [3].

According to the provided reports, number of the ESRD patients will reach to 2.24 million people in United States of America until 2030 [4]. In our country, the growth of ESRD new cases is very high and it is equal to 22.6% per

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year; about 4000 new patients are added to the previous patients annually [5].

Hemodialysis is one of the important ways of treatment in patients with renal failures and it is the most common method of ESRD replacement treatment [6,7]; in this method, patients are usually under treatment two or three times a week and every time about four hours. For doing hemodialysis we need blood flow out of the body (extracorporeal); so because of regular contact of blood with the surfaces of external materials and different parts of hemodialysis device (such as; lines , catheters, chambers and Dialyzer membranes); activating platelets, leukocytes and coagulation cascade will happen and the probability of clot formation gets high [3,5,8,9,10,11,12,13].

In order to prevent clot formation in hemodialysis, anticoagulation of dialysis system by heparin is required [9, 14]. Heparin by attaching to anti-thrombin factor III has disabled VII, VI, IV, II coagulation factors practically and as the result decreases activity and platelet aggregation [5, 9, 15].

The use of heparin during hemodialysis needs a bolus dose and consequently a maintenance dose, because of its short half -life, often only the initial dose is not enough for being certain about proper anticoagulant during one hemodialysis session [12, 14]. In the most common method for patients without increase of bleeding risk, heparin is administered as a followed basic bolus dose by permanent infusion or repetitive bolus [8,16,17,18,19,20].

Dialysis patients considering physical, mental and economic conditions experience many problems and from the other side, performed dialysis in the best conditions has only one tenth of efficacy of the kidney in filtering body wastes, so if performed hemodialysis does not have the necessary adequacy, these problems will be exacerbated and patients' death level will be increased. Decrease of dialysis adequacy increases numbers of dialysis sessions, cost of treatment and increase of patient's hospitalization days [1].

Dialysis adequacy is influenced by three important factors such as; the ability of dialyzer in removing and transporting waste materials, the amount of blood flow and the duration of dialysis [21]. In studying dialysis adequacy, the important issue is the amount of urea removal by dialyzer in a four-hour stage of dialysis. Dialysis has appropriate adequacy when it removes at least seventy percent urea of the body and it happens when the dialyzer is used with its highest ability and the capillary tubes in a dialyzer are not clot [1, 5].

Clot formation in the course of dialysis and specially dialyzer decreases dialyzer efficacy and since one of the factors affecting dialysis adequacy is the ability of dialyzer membrane in removing and transporting blood waste, this clot formation finally leads to dialysis adequacy decrease (one of the main determinants of mortality in dialysis patients) [22,23,24].

Nowadays the most common way of measuring and evaluating dialysis adequacy is URR and KT/V measure [6,25,26,27]. Studies have shown that using KT/V is preferred to URR since it reflects urea removal more accurate [6, 26, 27]. Also several studies have shown that for every 0.1 increase in KT/V to almost 1.2, mortality rate decreases to 0.7% and for every 0.5% increase in URR to 65%, mortality rate decreases to 11% [28].

Considering daily increase of ESRD and hemodialysis patients and consequently complications and problems due to dialysis and insufficient dialysis adequacy in most of the dialysis centers of the country, all the necessary efforts should be done for doing hemodialysis with the highest quality in these patients, one of the important actions in this regard is preventing clot formation, which can be done by using proper administration method of anticoagulant (heparin).

Since nurses of dialysis centers are free in choosing one of these two methods of anticoagulation by considering patient's conditions and from the other side, most of them use intermittent method by mentioning some reasons such as ; shortage of time and

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high number of patients, and so in the first stage they put themselves in the risk of being needle stick and its complications and in the next stage due to risk of dementia in administrating repeated bolus doses expose the patient at the risk of complications of dialysis adequacy decrease, researchers decided to assess the effect of heparinizing hemodialysis set on the amount of dialysis adequacy in hemodialysis patients referring to dialysis centers of Kermanshah Medical Sciences University in 2012 during a study and prepare appropriate strategies in this regard based on the achieved results and provide the most appropriate method of coagulation to the relevant organizations and nurses of dialysis centers.

2. Methods

In a quasi-experimental study, 176 hemodialysis patients referring to dialysis centers of Kermanshah Medical Sciences University that had inclusion criteria were under two methods of anti-coagulation with heparin through convenient sampling.

Data collection tools included; demographic and background information and the checklist of doing dialysis. Demographic and background information part included questions regarding; gender, age, height, weight, marital status, education, occupation, residence, monthly income, history of dialysis and number of dialysis sessions per week.

The checklist part included patient's dialysis information (including: type of hemodialysis machine , type of dialyzer, number of dialyzer, blood flow rate per minute, dialysate solution flow, dialysis solution temperature, dialysate sodium solution, the method of vascular access, patient's blood pressure, weight before and after dialysis, the amount of patient's increased weight, ultra filtration (weight decrease) rate in every session, the amount of achieving heparin, duration of hemodialysis per session, having accompanied during dialysis) and the information related to two methods of heparin administration and dialysis adequacy (including: the amount of urea before and after dialysis and the amount of KT/V and URR).

It was a quasi-experimental study (before and after comparison), it means the patient during two times of his/her referring was under one of the methods of anti-coagulation every time and at the end of four hours of hemodialysis, the amount of dialysis adequacy in every time was recorded and compared. The two methods were done with one week interval; these two methods included:

Infusion method: In this method at the beginning of dialysis and before the arrival of the blood to the arterial chamber, the patient received half of the dose of heparin that received permanently in bolus form through arterial line. After perfusion in the route of hemodialysis and three to five minutes after the beginning of the dialysis, the remaining half-dose infusion of heparin was prepared and set by the infusion pump to the end of the third hour and one hour before the end of dialysis, infusion was cut off and the patient did not receive any kind of heparin.

Intermittent method: also in this method, at the beginning of dialysis and before blood arrival to the arterial chamber, the patient received half the dose of the heparin that received permanently in bolus form through arterial line. Then the other half was injected in the form of doses of divided bolus with an hour and half interval to the end of the third hour and also the patient did not receive any heparin in the last hour.

In both of the methods, the amount of the received heparin, type of heparin and expiration date of heparin were the same. In the permanent infusion method, total amount of the patient's received heparin was diluted with 19 ml of normal saline solution. At the beginning of dialysis, 10 ml of this amount was injected in bolus form in the arterial line and after three to five minutes of the initial bolus, the other 10 ml was set through heparin pump for infusion to the end of the third hour.

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Table 1: The mean (standard deviation) of hemodialysis patients' dialysis characteristics referring to dialysis centers.

Results	Variable
Blood flow rate (ml per minute)	279.35±35.66
Dialysis solution temperature (centigrade degree)	36.96±0.23
Hemodialysis solution sodium (mEq per liter)	138±0.5
Dialysis duration (hour)	3.45 ±0.32
Systolic blood pressure (mmHg)	130.5±20.5
Ultrafiltration (l per one session dialysis)	2.0175±1.002

For every patient during the two stages of hemodialysis, the same hemodialysis equipment (machine, set, dialyzer (type and number), fistula and number of chamber), the same dialysis conditions (prime, type of solution, blood flow rate, the solution rate, the solution sodium, solution temperament, duration of dialysis, ultrafiltration rate, vascular access method (graft, fistula, catheter), method of dialysis and lack of using dry dialysis) and same controlling during dialysis (vital signs, washing dialyzer and receiving liquids and foodstuffs) was used.

For evaluating dialysis adequacy, sample of urea was taken before and after dialysis through standard method; in this way that for the urea before dialysis (through the arterial needle and before heparin infusion) and urea after dialysis (after the end of dialysis and before removing the patient from the machine, pump of dialysis machine was set on fifty ml per minute for twenty to thirty seconds and then the pump was stopped) from the arterial route before the dialyzer, the sample of blood was taken and sent to a laboratory unit and the samples were measured by a fixed laboratory expert with the same kit and device. The achieved results were calculated based on URR and KT/V formula and then they were compared. The amount of dialysis adequacy based on URR and KT/V were categorized like the following:

Lack of dialysis adequacy:
KT/V≤0.89 and URR≤60%
Relatively appropriate dialysis adequacy:
KT/V=0.90-1.29 and URR=61%-70
Complete appropriate dialysis adequacy:
KT/V≥1.30 and URR≥71%

Data were analyzed by the help of SPSS16 software and by using descriptive statistic (mean, standard deviation and two-dimensional tables in the form of number and percentage) and analytic statistic (paired t).

3. Results

Among 176 patients of the study 55.1% were male. The mean age and weight of these patients were respectively 55.84±13.44 years old and 64.88±13.47 kilograms. Regarding monthly income; 69.9% of the patients did not have any income. Most of the patients of the study were married (81.2%), illiterate (49.4%) and unemployed (67.1%). 88.6% of them were living in the city and 58.25% of them were not accompanied by anybody during dialysis session.

Regarding patients' dialysis characteristics, duration of hemodialysis in them was at least four and at most 119 months with the mean of 30.67±24.88months. 89.2% of the patients were under dialysis three times a week and 10.8% of them were under dialysis two times a week. Fresenius was the using machine in 93.2% of the cases and PS dialyzer were the using dialyzer in 89.77% of the cases. Patients used fistula in 64.2% of the cases as the vascular access and 39.8% of the patients of the study referred to the centers in the morning shift for doing hemodialysis.

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Table 2: Dialysis adequacy distribution according to KT/V in two different methods of hemodialysis set anti-coagulation with heparin

KT/V	infusion		intermittent	
	number	percent	number	percent
Lack of dialysis adequacy	46	26.14	35	19.89
Relatively appropriate adequacy	78	44.31	86	48.86
Complete appropriate adequacy	52	29.55	55	31.25
Total	176	100	176	100

Table 3: Dialysis adequacy distribution according to URR in two different methods of hemodialysis set anti-coagulation with heparin

URR	Infusion		Intermittent	
	Number	percent	number	percent
Lack of dialysis adequacy	88	50	79	44.89
Relatively appropriate adequacy	58	32.96	68	38.64
Complete appropriate adequacy	30	17.04	29	16.47
Total	176	100	176	100

Table 4: Comparing the mean (standard deviation) of dialysis adequacy indexes in two different methods of hemodialysis set anti-coagulation with heparin

Adequacy index	Infusion	intermittent	*P value*
KT/V	1.11±0.32	1.15±0.29	0.271
URR	59.67±11.2	61±10.2	0.277

Also the mean of blood flow rate (pump speed) was 279.35±35.66ml per minute (it was at least 200 and at most 360 ml) (table 1).

Regarding assessing dialysis adequacy based on URR and KT/V in the two methods, the results were as the following:

In infusion method in 44.31% of the cases and in intermittent method in 48.86% of the cases, relatively appropriate dialysis adequacy for KT/V was observed (table 2). Also dialysis adequacy based on URR in 50% of the cases for infusion method and in 44.89% of the cases for intermittent method showed lack of dialysis adequacy (table 3). Also paired t-test showed that the mean of URR and KT/V in the two methods does not have any significant difference (table 4).

4. Discussion

Results of the study showed that by using infusion method, the mean of dialysis adequacy was relatively appropriate. Similarly Alaa Sabry et al. showed that the mean of KT/V after using heparin through infusion method was 1.23±0.28 [14]; also Sergio Stefoni et al. for URR and KT/V in using heparin through infusion method achieved 67.3±2.1 percent and 1.3±0.12 respectively [13]. Dialysis adequacy in our study was less than the above studies; it can be because of different lifestyles of the samples of our study with the samples of the above studies.

Among the other findings of the study, it can be pointed out to the mean of relatively appropriate dialysis adequacy in intermittent method. Also in this method, low percentage of

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the studied patients had complete appropriate dialysis adequacy that is KT.V>1.3 (31.1%) and URR higher than 70% (15.6%). Similarly, Baradaran et al. in their study stated that in using heparin through intermittent method, only 20% of the people had URR>65% [29].

Findings of the study state that comparing dialysis adequacy based on the mean of URR and KT/V in the two methods were not statistically significant (p>0.05); this finding was in consistent with several studies; Baradaran et al. and Stefoni et al. during comparison of heparin with LMWH showed that dialysis adequacy is same in the both methods [13,29].

Lack of significant statistical difference in dialysis adequacy in the two methods can be due to several reasons. Among them it can be said that: dialysis adequacy in addition to anti-coagulation is under the control of other factors such as hydration, urea and phosphor of the body and other blood wastes, duration of dialysis in every session (normal time is twelve to twenty hours per week), type and measure of the dialyzer and the person's diet. in this study for controlling the above factors, completely same dialysis parameters were used in both of the methods; also the patients were educated about control diet and the weight between the sessions before and during the study, although it was not possible to control these precautions completely (limitation of the study). In addition to that, in our study due to time limitation and lack of complete cooperation of the patients for doing the study in broad period of time, evaluation of dialysis adequacy in every method was done only based on one time of use of that method (four-hour dialysis session).

Results of the study showed that the mean of URR and KT/V in both methods is less than the acceptable minimum recommended by health ministry (KT/V=1.2 and URR>65%) though near the standard level, which indicates insufficient dialysis adequacy in this center; this finding is in consistent with the findings of the studies which are conducted in different areas of the country: in the study of Movahed et al. 55.5% of the people had inadequate administered dialysis and URR mean was 57.46 that in 79% of the patients, the achieved results were less than the standard level [30].

Also in the study of Zeraati et al. in 2008, the mean of KT/V=1.05±0.26 was and 60.4% of the patients had KT/V<1.2 and 39.6% had KT/V>1.2 [28].

Low dialysis adequacy in this center can be due to several reasons such as: lack of administrating appropriate dose of dialysis which depends on type and size of the dialyzer, duration of dialysis, blood flow and urea distribution volume; other reasons include: limitation of number of devices and time, high number of patients, increase of re-circulation because of proximity of arterial and venous catheters to each of other and lack of following appropriate diet.

5. Conclusions

Results showed that both permanent infusion and intermittent bolus have almost the same role in dialysis adequacy. Since infusion method has also the same effect as intermittent method on the amount of dialysis adequacy, this method can be recommended as a safe method to the dialysis centers for preventing the risk of being needle stick (and as the result; preventing the risk of transmission of infection diseases) and increase of patients' dialysis adequacy due to eliminating the risk of dementia in administrating repetitive bolus doses.

6. Acknowledgments

This article is taken from a student thesis in Medical Sciences University of Kermanshah. We thank and appreciate all the colleagues of dialysis units of Imam Reza and Imam Khomeini hospitals in Kermanshah for helping us in doing this study.

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